

<b>Project Name:</b>	Harry Walker Parkway Warehouse Upgrade	<b>Date Issued:</b>	November 12, 2024
<b>Quasar Project #:</b>	CM-22-149		
<b>Client Project #:</b>			

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**Addendum #:** E02

**Revision #:**

This Addendum forms part of the Contract Specifications and Drawings, and modifies the Bidding Documents, with Amendments and Additions noted below. This Addendum shall be added to the front of the specifications as issued. Bidders shall acknowledge receipt of this Addendum in the space provided in the Bid Form and include in bid amount.

This addendum includes modifications to the drawings as summarized below. Unless otherwise noted, all drawings listed below are attached herewith.

**1.0 Revisions to Specifications [Refer to the attached specifications for details]:**

1. Added specification section 26 27 13.00 – Electricity Metering to specifications package.
2. Revision to specification section 26 0923.00 – Lighting Control Devices. All new lighting controls shown in drawings shall be by the manufacturer Reliable Controls.

**Changes to Drawings:**
**2.0 Revisions to Drawings [Refer to the attached drawings for details]:**

- .1 **Drawing – E-002 – EV CHARGER SITE PLAN**
  - i) Revised circuiting for all EV chargers.
- .2 **Drawing- E-200- PUBLIC WORKS DEMOLITION LIGHTING PLAN – MAIN FLOOR**
  - i) Note 6 revision.
- .3 **Drawing- E-201- PUBLIC WORKS NEW LIGHTING PLAN – MAIN FLOOR**
  - i) Lighting controls have been added to main floor below mezzanine level in public works area.
- .4 **Drawing- E-202- LIGHTING LAYOUT – PUBLIC WORKS LEVEL 2**
  - i) Lighting controls have been added to the mezzanine level in the public works area.
- .5 **Drawing- E-203- NEW LIGHTING LAYOUT – CORPORATE SERVICE**
  - i) General note 1 revision.
- .6 **Drawing- E-204 – LIGHTING LAYOUT – MEZZANINE LEVEL**
  - i) Lighting controls has been added to both level 1 and level 2 of the mezzanine level.
  - ii) General Note 1 revision.
- .7 **Drawing- E-302 – ELECTRICAL DETAILS 2**
  - i) Revision to detail 2. Add another conduit, two conduits total to each EV Charger, one for power one for data.
- .8 **Drawing- E-306 – LIGHTING SCHEDULES**
  - i) Added note 7 to lighting fixture schedule.
- .9 **Drawing- E-307 – ELECTRICAL PANEL SCHEDULES**
  - i) Revision to circuits 80,82,84 in panel RP-WS.

**.10 Drawing- E-308- ELECTRICAL PANEL SCHEDULES 2**

- i) Added EV charger circuits to panel DP-EV1 and DP-EV2.

**.11 Drawing- E-501- NEW SINGLE LINE DIAGRAM**

- i) Information has been revised for transformer feeders TX-WS, TX-M, and TX-WD to 3W.

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Project Manual

Issued for Tender – Addendum #2  
11/11/2024

**DAVID CARTER ARCHITECTS INC.**

## **Harry Walker Warehouse Upgrades**

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QCG Project No. CM-22-149

## **PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP**

### **Division 00 Procurement and Contracting Requirements**

#### **Introductory Information**

00 01 01	Project Title Page
00 01 10	Table of Contents

#### **Procurement Requirements**

Not Used

#### **Contracting Requirements**

Not Used

## **SPECIFICATIONS GROUP**

### **GENERAL REQUIREMENTS SUBGROUP**

Not Used

### **FACILITY CONSTRUCTION SUBGROUP**

#### **Division 02 to Division 07**

Not Used

#### **Division 08 Openings**

08 31 00	Access Doors and Panels
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#### **Division 09**

Not Used

#### **Division 10 Specialties**

10 44 16	Fire Extinguishers
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#### **Division 11 to Division 19**

Not Used

### **FACILITY SERVICES SUBGROUP**

#### **Division 20 Common Mechanical Requirements**

20 05 00	Common Work Results for Mechanical
20 05 05	Selective Demolition for Mechanical
20 05 10	Mechanical Work General Instructions
20 05 13	Common Motor Requirements for Mechanical Equipment
20 05 17	Sleeves and Sleeve Seals for Mechanical Piping
20 05 19	Meters and Gauges for Mechanical Systems
20 05 29	Hangers and Supports for Mechanical Piping and Equipment
20 05 48.13	Vibration Controls for Mechanical Systems
20 05 53	Identification for Mechanical Piping and Equipment
20 05 93	Testing, Adjusting, and Balancing for Mechanical Systems
20 07 00	Mechanical Systems Insulation

#### **Division 21 Fire Suppression**

21 13 00	Fire-Suppression Sprinkler Systems
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**Division 22 Plumbing**

22 11 00	Facility Water Distribution
22 13 00	Facility Sanitary Sewerage
22 15 00	General Service Compressed-Air Systems
22 33 13	Instantaneous Electric Domestic Water Heaters
22 42 00	Commercial Plumbing Fixtures

**Division 23 Heating, Ventilating, and Air Conditioning**

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23 30 00	HVAC Air Distribution
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23 35 13.03	Fume Extractor Extension Arms
23 51 23	Gas Vents
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23 74 23	Packaged, Outdoor, Heating-Only Makeup-Air Units

**Division 24**

Not Used

**Division 25 Integrated Automation**

25 05 01	Automatic Control Systems
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**Division 26 Electrical**

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26 01 50.81	Luminaire Replacement
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26 05 05	Selective Demolition for Electrical
26 05 19	Low-Voltage Electrical Power Conductors and Cables
26 05 26	Grounding and Bonding for Electrical Systems
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26 05 33.13	Conduit for Electrical Systems
26 05 33.16	Boxes for Electrical Systems
26 05 33.23	Surface Raceways for Electrical Systems
26 05 43	Underground Ducts and Raceways for Electrical Systems
26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 44.13	Firestopping for Electrical Systems
26 05 47	Outdoor Pedestals for Electrical Systems
26 05 48.13	Vibration Controls for Electrical Systems
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26 05 73.16	Coordination Studies
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26 05 83	Wiring Connections
26 08 00	Commissioning of Electrical Systems
26 08 50	Commissioning of Lighting
26 09 23	Lighting Control Devices
26 12 19	Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
26 18 00.02	44 kV Terminal Poles
26 22 13	Low-Voltage Distribution Transformers
26 24 13	Switchboards
26 24 16	Panelboards
26 27 13	Electricity Metering
26 27 16	Electrical Cabinets and Enclosures
26 27 23	Indoor Service Poles

26 27 26	Wiring Devices
26 27 26.13	Floor Box Assemblies
26 28 13	Fuses
26 28 16.02	Molded Case Circuit Breakers
26 28 16.16	Enclosed Switches
26 33 53	Static Uninterruptible Power Supply
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26 51 19	LED Interior Lighting
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**Division 27 Communications**

27 05 00	Common Work Results for Communications
27 05 26	Grounding and Bonding for Communications Systems
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27 05 28.61	Pathways for Access Control and Intrusion Detection
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27 05 36	Cable Trays for Communications Systems
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**Division 28 Electronic Safety and Security**

28 01 10.71	Revisions and Upgrades of Access Control
28 01 20.71	Revisions and Upgrades of Video Surveillance
28 01 80.71	Revisions and Upgrades of Fire Detection and Alarm

**Division 29**

Not Used

**SITE AND INFRASTRUCTURE SUBGROUP**

Not Used

**PROCESS EQUIPMENT SUBGROUP**

Not Used

**APPENDICES**

Appendix A1	City of Brampton - Security System Specifications V11 February 2023
Appendix A1	City of Brampton - Security System Specifications V11 February 2023

**1 General**

**1.01 Section Includes**

- .1 Procedures for preparation of integrated systems testing and coordination of all sub-trades in the execution of this testing to ensure life safety systems meet code requirements.

**1.02 Related Requirements**

- .1 Division 08 – Openings.
- .2 Division 21 – Fire Suppression.
- .3 Division 23 – Heating, Ventilating, and Air Conditioning.
- .4 Division 26 – Electrical.
- .5 This section describes requirements applicable to all Sections within Division 02 to Division 49.

**1.03 References**

- .1 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .2 2012 Ontario Building Code.

**1.04 Submittals**

- .1 The Integrated Testing Report shall include all documentation described in Subsection 7.3 of CAN/ULC-S1001. This includes:
  - .1 The Integrated Testing Plan.
  - .2 Integrated Testing Forms.
  - .3 Integrated Testing Forms for Re-tests.
  - .4 Documentation required by Section 5.3 of CAN/ULC-S1001.

**1.05 Closeout Submittals**

- .1 The Integrated Testing Report shall be provided to the following:
  - .1 The Consultant.
  - .2 The Owner.
  - .3 Municipal fire inspector as requested.
- .2 Maintain a copy of the CAN/ULC-S1001 functional test report on site.

**1.06 Qualifications**

- .1 Integrated Testing Coordinator:
-

- .1 Must have all licenses and certifications required by contractual obligations, as well as those required by federal, provincial, and other regulations.
- .2 Must have the competencies listed in CAN/ULC-S1001.
- .3 Must prepare an Integrated Testing Plan.
- .4 Must provide the Integrated Testing Plan to the professional designers for review/acceptance prior to the test.
- .5 Collect the required pre-test documentation (e.g. confirmation from designers/installers/verifiers that systems are ready for testing, confirmation that building occupants have been notified and that safety measures are in place, etc.).
- .6 Determine what previous testing of the systems can be accepted to avoid duplication of testing.
- .7 Determine which parties are required to participate in the Integrated Systems Test.
- .8 Implement the Integrated Testing Plan (perform the tests) and record the results to show proper integration (ensure re-testing is performed as needed).
- .9 Compile all the documentation into an Integrated Testing Report and provide it to the building owner, Authority Having Jurisdiction (as required), and keep a copy on the building site.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Responsibility**

- .1 The General Contractor is responsible for coordinating integrated systems testing to meet the requirements of CAN/ULC-S1001. Time is to be allocated in the construction schedule for these tests, and the General Contractor is to ensure that the key sub-trades are a part of this testing.
  - .2 Pre-requisites for integrated systems testing are individual verification reports such as fire alarm verification report, sprinkler sign off, elevator sign off, fire/smoke/life safety fan balancing reports, and others.
  - .3 The intent is not to replicate the tests of each device, but to test the operation of the life safety system as a whole. Examples include but are not limited to the following:
    - .1 Fan shutdown on duct smoke detector.
    - .2 Activation of fans (stair pressurization, vestibule pressurization, smoke evacuation) on fire alarm.
    - .3 Successful integration of sprinkler devices, pre-action systems, etc.
    - .4 Proper operation of door hold-open devices, mag locks, fire shutters, etc.
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- .5 Elevators recall to home and alternate home floors.
- .6 Operation of life safety systems upon loss of power or on generator power.
- .4 Based on the level of 3<sup>rd</sup> party commissioning hired by the Owner required for the project, the Commissioning Authority may require to witness these tests.

### 3.02 Examples from CAN/ULC-S1001 of Systems that Require Integrated Testing

- .1 Door Hardware:
    - .1 Electromagnetic hold-opens:
      - .1 Each door tested to ensure returns to closed and latched position upon signal from fire alarm or from actuation of local smoke detectors.
    - .2 Electromagnetic locks:
      - .1 Each must de-energize upon activation of the fire alarm system or from actuation of the local manual pull station.
    - .3 Fire shutter doors close upon activation of the fire alarm system.
    - .4 Power door operators on doors located on fire separations deactivate when fire alarm system is activated.
  - .2 Fire Suppression:
    - .1 Freeze Protection Systems: annunciates on fire alarm annunciator panel upon loss of power to heat tracing for sprinkler piping.
    - .2 Sprinkler systems:
      - .1 Flow switches and other water flow indicating devices annunciate as alarm on fire alarm control panel when water flow is detected.
      - .2 Supervised valves annunciate as supervisory on fire alarm control panel when valves are closed.
    - .3 Standpipe systems: Supervised valves annunciate as supervisory on fire alarm control panel when valves are closed.
    - .4 Fire pumps: Operate as required.
    - .5 Water supplies (test responses to pressure sensors, level sensors, etc.):
      - .1 Loss of pressure in sprinkler piping will trigger the fire alarm. This pressure loss indicates that either an active fire has started, or the integrity of the sprinkler piping has been compromised.
    - .6 Water supply control valves.
    - .7 Fixed fire suppression systems (release of suppression agent not required).
  - .3 HVAC:
    - .1 Smoke control systems.
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- .2 Emergency pressurization systems.
  - .3 Smoke exhaust systems.
  - .4 High-Volume Low-Speed (HVLS) fans shut down on sprinkler flow.
  - .5 Parking garage ventilation system and controls.
  - .6 Confirm and document that the air handling unit disengages when fire or smoke is detected. Preventing the conveyance of smoke, ash, particulates, or the fire itself through the air system substantially strengthens a building resilience in an emergency, and protects personnel.
  - .7 Confirm and document that areas requiring pressurization (such as stairwells and other emergency routes) are functioning as designed during emergency conditions.
- .4 Electrical:
- .1 Emergency generators (e.g. startup test, loss of power simulations)
    - .1 Confirm and document that emergency generators engage, and alarm is announced during a fire or low-fuel conditions. It is critical to the functioning of all life safety systems that the backup power generation be capable of indicating when its operability has been compromised, including low-fuel alarms for diesel or propane fuelled generator sets, and supervision of valves for natural gas fuelled generator sets.
    - .2 Confirm and document that when primary power is interrupted the emergency generators engage and powers critical life saving systems such as alarms, sprinkler pumps, elevators, and air handling units. Ensuring backup power generation is timely, of sufficient strength and properly functioning can be the difference between an incident and a disaster.
  - .2 Automatic Transfer Switches: Operate as required.
  - .3 A/V and lighting control systems: Systems deactivate upon fire alarm signal.
- .5 Public Address and Paging Systems: de-activate system upon actuation of the fire alarm system.
- .6 Sound Masking System: de-active system upon actuation of the fire alarm system.
- .7 Fire Alarm System:
- .1 Transmissions with fire signal receiving centre (e.g. receipt of signals).
    - .1 Confirm and document that the fire alarm monitoring centre is receiving these various alarms in a timely fashion. With legacy buildings, a risk exists that physical lines may have been cut and/or subscriptions have elapsed.
    - .2 Confirm and document that manual pull fire stations are functioning as designed. Quick action from the first person to notice a fire will minimize the impact to people and structures.
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- .8 Smoke and carbon monoxide alarms.
- .9 Hazardous protection monitoring.

**3.03 Site Tests and Inspections**

- .1 In accordance with CAN/ULC-S1001.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Fire rated and non-fire rated access doors and frame units.

### **1.02 Related Requirements**

- .1 Section 20 05 00 – Common Work Results for Mechanical.
- .2 Section 26 05 00 – Common Work Results for Electrical.

### **1.03 References**

- .1 UL/ULC Fire Resistance Directory.

### **1.04 Action Submittals**

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for access door components and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings:
  - .1 Submit catalogue details for each type of door illustrating profiles, dimensions, and methods of assembly.
  - .2 If access door is to be installed in a fire rated assembly, shop drawing to indicate the rating.
- .4 Before commencing installation of work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange the work to suit.

### **1.05 Closeout Submittals**

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data:
  - .1 Submit operation and maintenance data for cleaning and maintenance of finishes for incorporation into manual.
  - .2 Submit manufacturer's ordering information for additional keys.
- .3 At time of instruction of Owner's operating staff, hand-over and obtain signed receipt for four sets of each type of key used to lock access doors in secure areas.

### **1.06 Delivery, Storage, and Handling**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00, and with manufacturer's written instructions.
-

- .2 Delivery and acceptance requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Store and protect access doors from nicks, scratches, and blemishes.
- .4 Leave protective coatings in place until final cleaning of building.

## **2 Products**

### **2.01 Manufacturers**

- .1 Acudor Acorn.
- .2 Baird – ABCO.
- .3 Mifab.
- .4 Stelpro - Type 700.
- .5 Watts Water Technologies (Canada) Inc.

### **2.02 Access Doors**

- .1 Construction:
  - .1 Access doors shall be flush to edge of frame, concealed continuous hinge with screwdriver operated cam latch.
  - .2 Steel, prime coated, flush mounted with 180 degree opening door, round safety corners, concealed hinges, plaster lock and anchor straps.
  - .3 Rounded safety corners, concealed hinges, screwdriver latch, anchor straps, able to open 180 degrees.
  - .4 Door construction to be minimum 14 gauge with 16 gauge frame.
  - .5 Fire-rated door construction to be a minimum 20 gauge insulated door with 16 gauge frame. Insulation thickness to provide required rating.
  - .6 Provide for plaster surfaces recessed 16 gauge prime painted steel door and welded metal lath, ready to take plaster.
  - .7 Provide for tiled surfaces, recessed type 16 gauge primed steel doors to suit type of tile used.
  - .8 Provide other access doors of welded 12 gauge steel, factory prime coated, flush type.
- .2 Materials:
  - .1 Tiled or marble surfaces: stainless steel with [brushed satin] [polished] finish.
  - .2 Other areas: prime coated steel.
  - .3 Constructed of stainless steel in areas finished with tile or marble surfaces.

- .4 Constructed of stainless steel with neoprene gasketed door in damp and high humidity areas.
- .5 Latching:
- .6 Fitted with screwdriver operated latches.
- .7 In areas subject to security risks (Public Corridors, Public Washrooms, etc.), fitted with keyed cylinder locks with similar keys.
- .3 Fire Ratings:
  - .1 When access doors are required to be located in fire rated walls, floor and ceilings, provide ULC tested and labelled units rated in accordance with the structures being penetrated i.e. 3/4 hour, 1 hour, 2 hour.
- .4 Minimum dimensions (or as indicated otherwise on drawings):
  - .1 600 mm by 600 mm (24 in by 24 in) for personnel entry.
  - .2 450 mm by 450 mm (18 in by 18 in) for hand entry.
  - .3 300 mm by 300 mm (12 in by 12 in) for viewing only.
  - .4 Size doors to allow adequate operating/maintenance clearance for devices.
  - .5 Access doors shall be, wherever possible, of a standard size for each application.
- .5 Example products based on Acudor Acorn:
  - .1 Concealed plaster: PS-5010.
  - .2 Concealed drywall: DW-5015.
  - .3 Existing drywall: DW-5040.
  - .4 Fire-rated: FW-5050/FB-5060 to match assembly.

## **2.03 Exclusions**

- .1 Lay-in tile ceilings: use unobtrusive identification locators.

## **3 Execution**

### **3.01 Examination**

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for access door installation in accordance with manufacturer's written instructions.
  - .2 Lay-in type ceiling tiles, properly marked, with lamaroid label on adjacent ceiling carrying channel, may serve as access panels. Where ceiling tiles are required to be clipped, provide the appropriate access clips.
  - .3 Before commencing installation of work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors.
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Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange the work to suit.

- .4 Confirm exact access door dimensions and locations with the Consultant prior to ordering and prior to commencing installation. Arrange work to suit.

### 3.02 Installation

- .1 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.
  - .2 Provide access doors for [new and existing] concealed valves, dampers, junction boxes, equipment, etc.
  - .3 Provide access doors wherever equipment, valves, dampers, control devices, junction boxes, pull boxes, etc., are concealed behind walls or inaccessible ceilings.
  - .4 Provide access doors to give access to all valves, cleanouts, strainers, duct access doors, and other mechanical devices which may need maintenance or repair which are concealed in inaccessible construction.
  - .5 Access doors shall match wall and ceiling finishes.
  - .6 Access doors in gypsum ceiling shall be recessed type.
  - .7 Locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.
  - .8 Supply access doors, and make arrangements and pay for installation by trade in whose work they occur.
  - .9 Size and locate access doors in applied tile, block, or in glazed or unglazed structural tile to suit joint patterns.
  - .10 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.
  - .11 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at one corner of each panel below point requiring access. Colour code markers to show service or device above.
  - .12 Provide access doors at locations where equipment requires inspection, service, maintenance, or adjustment, including by not limited to the following:
    - .1 Expansion joints.
    - .2 Plumbing cleanouts.
    - .3 Dampers.
    - .4 Fire dampers.
    - .5 Air valves.
    - .6 Air terminal units.
    - .7 Valves.
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- .8 Heating or cooling coils.
- .9 Junction and pull boxes for power wiring or control wiring.
- .10 Any concealed electrical devices.

**3.03 Protection**

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

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit product data sheets for all products specified in this Section.

### **1.02 References**

- .1 Fire extinguishers are to be in accordance with following Codes and Standards:
  - .1 National Fire Code of Canada;
  - .2 NFPA 10-2010, Standard for Portable Fire Extinguishers;
  - .3 CAN/ULC-S508:2023, Standard for the Rating and Testing of Fire Extinguishers.

## **2 Products**

### **2.01 General**

- .1 Fire extinguishers are to be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and UL and/or ULC listed and labelled for the class of fires and hazard locations for which they are specified.
- .2 Each extinguisher is to be complete with:
  - .1 manufacturer's identification label indicating extinguisher model number, rating, and operating instructions;
  - .2 anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock;
  - .3 discharge hose with nozzle or horn and hose securing clip;
  - .4 for wall mounting extinguishers, a wall mounting bracket.
- .3 Fire extinguishers in fire hose cabinets will be supplied with the cabinet and are specified in Section 21 12 00 – Fire-Suppression Standpipes.

### **2.02 3A10B:C Rated Dry Chemical Extinguishers**

- .1 Multi-purpose 3A10B:C dry chemical extinguishers are to be 100 mm (4") dia., 2.27 kg (5 lb.), each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.

### **2.03 Fire Extinguisher Cabinets**

- .1 Surface Mounted: Rectangular break-glass type enclosures sized to suit the extinguishers to be housed, constructed of 18 gauge corrosion resistant steel with a baked white enamel finish, front glass panel, break-glass mechanism, and keyed alike cylinder lock.
  - .2 Recessed: Rectangular cabinets sized to suit the extinguishers to be housed, with an 18 gauge corrosion resistant white enamelled steel tub, 14 gauge cleaned and prime coat painted steel door and adjustable trim assembly with rounded corners, semi-concealed piano hinge, safety glass panel, and flush stainless steel door latch.
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## **2.04 Fire Blankets**

- .1 Equal to National Fire Equipment Ltd. Model #FB-6078-MC 300 mm x 400 mm (12" x 16") red enamelled 16 gauge surface mounting steel cabinet identified "FIRE BLANKET" and "PULL TAB TO REMOVE", complete with non-combustible glass fibre fire blanket pressure fit into the cabinet and equipped with pull-back release straps.

## **3 Execution**

### **3.01 Installation of Fire Extinguishers**

- .1 Provide fire extinguishers of type(s) in accordance with requirements of NFPA 10.
- .2 Unless otherwise shown or specified, wall mount extinguishers using wall brackets supplied with extinguishers.
- .3 Do not install extinguishers until after wall finishing work is complete.
- .4 Be responsible for maintaining fire extinguishers until Substantial Completion of the Work.
- .5 If extinguishers are indicated adjacent to a door, locate extinguishers at the strike side of the door.

### **3.02 Installation of Fire Extinguisher Cabinets**

- .1 Provide wall cabinets for fire extinguishers where required.
- .2 Unless otherwise shown or specified, locate cabinets so centerline is approximately 1.2 m (4') above finished floor.
- .3 Confirm exact locations prior to installation.

### **3.03 Installation of Fire Blankets**

- .1 Provide fire blankets in wall mounted cabinets in the Kitchen. Confirm exact locations prior to installation.

**End of Section**

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**1 General**

**1.01 Section Includes**

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

**1.02 References**

- .1 Division 00 and Division 01 apply to and are a part of each Mechanical Division:
  - .1 Division 20 – Common Mechanical Requirements;
  - .2 Division 21 – Fire Suppression;
  - .3 Division 22 – Plumbing;
  - .4 Division 23 – Heating, Ventilating, and Air Conditioning;
  - .5 Division 25 – Integrated Automation.
- .2 The provisions of this Section also apply to the following sections:
  - .1 Section 08 31 00 – Access Doors and Panels.
  - .2 Section 10 44 16 – Fire Extinguishers.

**1.03 Submittals**

- .1 Submit shop drawings/product data sheets for:
    - .1 pressure gauges and thermometers;
    - .2 electric motors (submit with equipment they are associated with).
  - .2 Submit weight loads for selected equipment (upon request).
  - .3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.
  - .4 Submit a list of equipment identification nameplates indicating proposed wording and sizes.
  - .5 Submit a list of pipe and duct identification colour coding and wording.
  - .6 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
  - .7 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
  - .8 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.
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#### **1.04 Maintenance Material Submittals**

- .1 As specified in Part 2 of this Section, submit a spare belt set, tagged, and identified, for each belt driven piece of equipment.

### **2 Products**

#### **2.01 Firestopping and Smoke Seal Materials**

- .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section 20 05 17 - Sleeves and Sleeve Seals for Mechanical Piping, and work is to be done as part of mechanical work unless otherwise specified in Division 07.

### **3 Execution**

#### **3.01 General Piping and Ductwork Installation Requirements**

- .1 Unless otherwise specified, locate, and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
  - .2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.
  - .3 Install pipes and ducts parallel to building lines and to each other.
  - .4 Neatly group and arrange exposed work.
  - .5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.
  - .6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
  - .7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.
  - .8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
  - .9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.
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- .10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.
- .11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.
- .12 Provide continuous galvanized sheet metal drip pan under drain, water and water solution piping extending through rooms with electrical equipment such as electrical, elevator equipment and transformer rooms, and other spaces provided primarily for the installation of electrical equipment. Drip pans are to be complete with a drain pipe connection and drain piping is to be extended to closest drain.
- .13 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.
- .14 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.
- .15 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m (40')) piping runs to permit removal of sections of piping.
- .16 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

### **3.02 Pipe Joint Requirements**

- .1 Do not make pipe joints in walls or slabs.
  - .2 Ream piping ends prior to making joints.
  - .3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.
  - .4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.
  - .5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.
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- .6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.
- .7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.
- .9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
- .10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
- .11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
- .12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

### **3.03 Duct Openings**

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.
- .2 Size openings for fire dampers to suit damper arrangement with folding blade out of air stream.
- .3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

### **3.04 Sleeve and Formed Opening Location Drawings**

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
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- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

### **3.05 Installation of Pipe Escutcheon Plates**

- .1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

### **3.06 Supply of Access Doors**

- .1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.
- .2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.
- .3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.
- .4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with the Consultant prior to ordering.
- .5 Group piping and ductwork to ensure minimum number of access doors is required.
- .6 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

### **3.07 Installation of Valves**

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:
  - .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
  - .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;

- .3 unless otherwise specified, provide a check valve in discharge piping of each pump;
- .4 valve sizes are to be same as connecting pipe size;
- .5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;
- .6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

### **3.08 Finish Painting of Mechanical Work**

- .1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.
- .2 Touch-up paint damaged factory applied finishes on mechanical work products.

### **3.09 Pipe Leakage Testing**

- .1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.
  - .2 Tests are to be witnessed by the Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
  - .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
  - .4 Gravity Drainage and Vent Piping
    - .1 Test piping in accordance with local governing building code.
    - .2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.
  - .5 Pumped Drainage Piping
    - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
  - .6 Domestic Water Piping
    - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
  - .7 Sprinkler System Piping
    - .1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.
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- .8 Standpipe System Piping
    - .1 Test system piping in accordance with requirements of NFPA No. 14, "Standpipe and Hose Systems", and in accordance with any additional requirements of governing authorities.
  - .9 CO2 Fire Extinguishing System Piping
    - .1 Test system piping in accordance with requirements of NFPA No. 12, "Standard on Carbon Dioxide Extinguishing Systems", and in accordance with any additional requirements of governing authorities.
  - .10 Clean Agent Fire Extinguishing System Piping
    - .1 Test system piping in accordance with requirements of NFPA No. 2001, "Standard on Clean Agent Extinguishing Systems", and in accordance with any additional requirements of governing authorities.
  - .11 Heat Transfer (HVAC) System Piping
    - .1 Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of 2 hours.
  - .12 Steam and Condensate Piping
    - .1 Test piping with cold water for a minimum of 2 hours at following pressures:
      - .1 0 kPa to 105 kPa (0 psi to 15 psi) low pressure piping – 690 kPa (100 psi);
      - .2 110 kPa to 690 kPa (16 psi to 100 psi) medium pressure piping – 1035 kPa (150 psi);
      - .3 greater than 690 kPa (100 psi) high pressure piping – 1380 kPa (200 psi).
  - .13 Natural Gas Piping
    - .1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.
    - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
    - .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
  - .14 Propane Gas Piping
    - .1 Test piping in accordance with requirements of CAN/CSA B149.2 and any additional requirements of local governing authorities.
    - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
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- .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
  - .15 Compressed Air Piping
    - .1 Test piping with dry compressed air or nitrogen at 690 kPa (100 psi) for a minimum of 2 hours.
    - .2 Test piping joints with a water-soap solution while piping is under pressure to detect leaks.
  - .16 Fuel Oil Piping
    - .1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi).
    - .2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
  - .17 Gasoline Piping
    - .1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi) in accordance with TSSA requirements.
    - .2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
  - .18 Refrigerant Piping
    - .1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of ASHRAE Handbook - Fundamentals.
  - .19 Control Air Piping and Tubing
    - .1 Test control air piping and tubing with dry compressed air or nitrogen before concealing and again before connection of instruments.
    - .2 Rough-in test pressure is to be 345 kPa (50 psi) maintained over 24 hours with a pressure drop not to exceed 35 kPa (5 psi).
    - .3 Test joints for leaks with a soap solution.
    - .4 Finish test is to be 205 kPa (30 psi) with a permissible loss of 7 kPa (1 psi) over a 4 hour period. Prior to connecting instruments, blow systems clean and dry, and test component connections for leaks with a water/soap solution.
  - .20 Pure Water Piping
    - .1 When piping has been properly flushed and cleaned, test at 690 kPa (100 psi) for 2 hours with only distilled water or filtered dry compressed air. If distilled water is used, drain system when testing is complete.
  - .21 Following requirements apply to all testing:
    - .1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
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- .2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
- .3 when testing is carried out below highest level of the particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;
- .4 include for temporary piping connections required to properly complete tests;
- .5 piping under test pressure is to have zero pressure drop for length of test period;
- .6 tighten leaks found during tests while piping is under pressure. If this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
- .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
- .8 tests are to be done in reasonably sized sections so as to minimize number of tests required;
- .9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

### **3.10 Interruption to and Shut-Down of Mechanical Services and Systems**

- .1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning, unless otherwise specified in Division 01. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.
  - .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
  - .3 Prior to each shut-down or interruption, inform Owner and the Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
  - .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
  - .5 Pipe freezing shall be used to connect new piping to existing piping. Alternative methods may be proposed, if site conditions are evaluated and permit, and are approved by the Consultant.
  - .6 Where existing isolation valves do not hold, pipe freezing shall be used to connect new piping to existing piping.
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### 3.11 Mechanical Service Requirements for Floating Floor Slabs

- .1 Where mechanical services are required to be installed in or through a vibration isolated floating slab, install such services so as not to transmit any vibration to base slab on which floating floor slab is placed.
- .2 Wherever possible, arrange mechanical work to avoid penetrating a floating floor slab.

### 3.12 Excavation and Backfill Work

- .1 Unless otherwise specified in Division 31, provide all excavation and backfill associated with the mechanical scope of work.
  - .2 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.
  - .3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.
  - .4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.
  - .5 Unless otherwise specified in Division 31, provide excavation, backfill and related work required for mechanical work. Obtain a copy of soil test report if available from the Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.
  - .6 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.
  - .7 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.
  - .8 Before backfilling, arrange for inspection of work by the Consultant. Do not backfill work unless reviewed with the Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.
  - .9 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6") thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.
  - .10 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.
  - .11 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.
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- .12 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.
- .13 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.
- .14 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.
- .15 Unless otherwise directed in Division 02 and/or Division 31, store and dispose of excavated materials as follows:
  - .1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;
  - .2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.
- .16 Perform pumping as required to keep excavations free of water.
- .17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to the Consultant for review.
- .18 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.
- .19 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

### **3.13 Cutting, Patching and Core Drilling**

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by the Consultant.
  - .2 Criteria for cutting holes for additional services:
    - .1 cut holes through slabs only; no holes to be cut through beams;
    - .2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
    - .3 keep at least 100 mm (4") clear from beam faces;
    - .4 space at least 3 hole diameters on centre;
    - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
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- .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
- .7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.
- .3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.
- .5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.
- .6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.
- .7 Firestop and seal openings in fire rated construction. Do not leave openings open overnight unless approved by Owner and Consultant.

### **3.14 Packing and Sealing Core Drilled Pipe Openings**

- .1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:
  - .1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;
  - .2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
  - .3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

### **3.15 Flashing for Mechanical Work Penetrating Roof**

- .1 Unless otherwise specified in Division 07, perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.
- .2 Perform flashing work in accordance with requirements of drawing details and/or requirements specified in Division 07.

### **3.16 Cleaning Mechanical Work**

- .1 Refer to cleaning requirements specified in Division 01.
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- .2 Clean mechanical work prior to application for Substantial Performance of the Work.
- .3 Include for vacuum cleaning interior of air handling units and ductwork systems.

### **3.17 Connections to Other Equipment**

- .1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

### **3.18 Seismic Restraint Anchor Points for Equipment**

- .1 Where mechanical equipment requires seismic restraint, it is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by equipment manufacturers, so equipment may be bolted down or restrained in the field.
- .2 Equipment to be restrained must be designed such that the strength and anchorage of its internal components exceed force level; used to restrain and anchor the equipment to the supporting structure.

### **3.19 Installation of Flexible Connectors**

- .1 Provide flexible connectors in piping connections to seismically restrained equipment, where applicable, and wherever else shown.
- .2 Provide flexible connectors in piping connections to vibration isolated equipment.

### **3.20 Fan Noise Levels**

- .1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

### **3.21 Equipment and System Manufacturer's Certification**

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to the Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

### **3.22 System Startup**

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:
  - .1 Submit a copy of each equipment/system manufacturer's start-up report sheet to the Consultant for review, and incorporate any comments made by the Consultant.
  - .2 Under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to the Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

- .3 Commission interconnected life safety systems in accordance with CAN/ULC-S1001-11 and provide written report for Consultant's review.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 This Section specifies requirements, criteria, methods, and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

**2 Products – Not Used**

**3 Execution**

**3.01 Disconnection and Removal of Existing Mechanical Work**

- .1 Where indicated on drawings, disconnect, and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.
- .2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.
- .3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.
- .4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.
- .5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.
- .2 Be responsible for advising product vendors of requirements of this Section.

### **1.02 Related Requirements**

- .1 Division 00 and Division 01 apply to and are a part of this Section.

### **1.03 Definitions**

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
  - .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
  - .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
  - .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
  - .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify, and certify.
  - .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery, and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties, and manufacturers' assistance to Contractor.
  - .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with the Consultant.
  - .8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
  - .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
  - .10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
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- .11 "Mechanical Divisions" – refers to Division 20, Division 21, Division 22, Division 23, Division 25, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .12 "Electrical Divisions" – refers to Division 26, Division 27, Division 28, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .13 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

#### **1.04 Documents**

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
  - .2 Specification is arranged in accordance with CSI/CSC 49 Divisions of MasterFormat.
  - .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
  - .4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
  - .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
  - .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
  - .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
  - .8 Locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
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- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any other party.
- .12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

#### **1.05 Metric and Imperial Measurements**

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

#### **1.06 Examination of Documents and Site**

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

#### **1.07 Work Standards**

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
  - .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with the Consultant.
  - .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
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- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
  - .2 Air Movement and Control Association (AMCA);
  - .3 American Iron and Steel Institute (AISI);
  - .4 American National Standards Institute (ANSI);
  - .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
  - .6 American Society of Mechanical Engineers (ASME);
  - .7 American Society of Testing and Materials (ASTM);
  - .8 American Water Works Association (AWWA);
  - .9 Associated Air Balance Council (AABC);
  - .10 Building Industry Consulting Services, International (BICSI);
  - .11 Canadian Gas Association (CGA);
  - .12 Canadian General Standards Board (CGSB);
  - .13 Canadian Standards Association (CSA);
  - .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
  - .15 Electrical Safety Authority (ESA);
  - .16 Electronic Industries Association (EIA);
  - .17 Factory Mutual Systems (FM);
  - .18 Illuminating Engineering Society (IES);
  - .19 Institute of Electrical and Electronic Engineers (IEEE);
  - .20 International Standards Organization (ISO);
  - .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
  - .22 National Building Code of Canada (NBC);
  - .23 National Electrical Manufacturers Association (NEMA);
  - .24 National Environmental Balancing Bureau (NEBB);
  - .25 National Fire Protection Association (NFPA);
  - .26 National Standards of Canada;
  - .27 NSF International;
  - .28 Occupational Health and Safety Act (OHSA);
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- .29 Ontario Building Code (OBC);
  - .30 Ontario Electrical Safety Code (OESC);
  - .31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
  - .32 Technical Standards and Safety Authority (TSSA);
  - .33 Thermal Insulation Association of Canada (TIAC);
  - .34 Underwriters' Laboratories of Canada (ULC);
  - .35 Workplace Hazardous Materials Information System (WHMIS);
  - .36 Material Safety Data Sheets by product manufacturers;
  - .37 Local utility inspection permits;
  - .38 Codes, standards, and regulations of local governing authorities having jurisdiction;
  - .39 Additional codes and standards listed in Trade Sections;
  - .40 Owner's standards.
  - .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
  - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
  - .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
  - .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
  - .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with the Consultant at any time.
  - .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
  - .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to the Consultant and submission of reports and certificates to the Consultant.
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- .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Owner and reviewed with the Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.
- .13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

#### **1.08 Permits, Certificates, Approvals, and Fees**

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

#### **1.09 Requirements for Contractor Retained Engineers**

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
  - .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
  - .3 Unless otherwise specified in Division 00 or Division 01, liability insurance requirements are as follows:
    - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
    - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
    - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
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- .4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
- .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

#### **1.10 Workplace Safety**

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered, or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with the Consultant.

#### **1.11 Planning and Layout of Work**

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
  - .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
    - .1 piping requiring uniform pitch;
    - .2 piping 100 mm (4") dia. and larger;
    - .3 large ducts (main runs);
    - .4 cable tray and bus duct;
    - .5 conduit 100 mm (4") dia. and larger;
    - .6 piping less than 100 mm (4") dia.;
    - .7 smaller branch ductwork;
    - .8 conduit less than 100 mm (4") dia.
  - .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling
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space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.

- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to the Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Shut-off valves, balancing devices, air vents, equipment, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

#### **1.12 Scheduling**

- .1 Include for any and all scheduling, coordination, and construction phasing to suit project, specified in Division 01 and/or as indicated on the drawings. Review exact phasing requirements with Consultant prior to start of Work.
  - .2 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, coordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review phasing requirements with the Consultant prior to start of Work.
  - .3 Protect existing areas above, below, and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with the Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.
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- .4 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with the Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium timework to meet these requirements.
- .5 Project partial occupancy permits may be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

### 1.13 Coordination

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
  - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
  - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
  - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
  - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

### 1.14 Products

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
  - .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied
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from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.

- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
  - .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
  - .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by the Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to the Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
  - .6 Listing of a product as "acceptable" does not imply automatic acceptance by the Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
  - .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare, and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
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- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of the Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to the Consultant for review. Failure of submission of these documents to the Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by the Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
- .12 Any proposed changes initiated by Contractor after award of Contract may be considered by the Consultant at the Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with the Consultant, and costs for review, to be borne by Contractor.
- .13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

#### **1.15 Shop Drawings**

- .1 At start-up meeting, review with the Consultant products to be included in shop drawing submission. Prepare and submit list of products to the Consultant for review.
  - .2 Submit electronic copies of shop drawings unless otherwise directed by the Consultant. Coordinate exact requirements with the Consultant.
  - .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to the
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Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:

- .1 product literature cuts;
  - .2 equipment data sheets;
  - .3 equipment dimension drawings;
  - .4 system block diagrams;
  - .5 sequence of operation;
  - .6 connection wiring schematic diagrams;
  - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
  - .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
  - .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
  - .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
    - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
    - .2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
  - .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:
    - .1 "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."
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- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with the Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .13 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment must indicate compliance with this Standard or they will be returned for correction and re-submittal.

#### **1.16 Equipment Loads**

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to the Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location, and method of support of equipment may differ from those assumed by the Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with the Consultant prior to construction.

#### **1.17 Openings**

- .1 Supply opening sizes and locations to the Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval from Owner and reviewed with the Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to the Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and reviewed with the Consultant, do not leave any openings unprotected and unfinished overnight.

#### **1.18 Scaffolding, Hoisting and Rigging**

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with the Consultant.
  - .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
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- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with the Consultant.

#### 1.19 Changes in the Work

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare and submit to the Consultant for review, a quotation being proposed cost for executing change or revision.
  - .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
  - .3 Unless otherwise specified in Division 00 or Division 01, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
  - .4 Unless otherwise specified in Division 00 or Division 01, following additional requirements apply to all quotations submitted:
    - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
    - .2 material costs are not to exceed those published in the latest edition of Allpriser price guide, less 20%;
    - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
    - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
    - .5 costs for journeyperson and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
    - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
    - .7 costs for rental tools and/or equipment are not to exceed local rental costs;
    - .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
    - .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
  - .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
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- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from the Consultant.

#### **1.20 Progress Payment Breakdown**

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

#### **1.21 Notice for Required Field Reviews**

- .1 Whenever there is a requirement for the Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to the Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until the Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

#### **1.22 Preliminary Testing**

- .1 When directed by the Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
  - .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
  - .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
  - .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.
-

### **1.23 Provisions for Systems/Equipment Used During Construction**

- .1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.

### **1.24 Temporary Services**

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling, and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

### **1.25 Maintaining Equipment Prior to Acceptance**

- .1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

### **1.26 Record Documentation**

- .1 Drawings for this project have been prepared on a CAD system using [AutoCAD] [Revit] software of release version reviewed with the Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from the Consultant.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes, and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
  - .1 dimensioned location of inaccessible concealed work;
  - .2 locations of control devices with identification for each;
  - .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
  - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;

- .5 location of piping system air vents;
- .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to the Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of the Consultant.
- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by the Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with [AutoCAD] [Revit] software release version confirmed with the Consultant.
- .6 Unless otherwise noted in Division 00 or Division 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with the Consultant.
- .7 For projects with phased turnover of project (refer to Division 01), review with the Consultant completeness of as-built drawings prior to turn over of an area. Interim as-built drawings to be made available to Owner's maintenance personnel.
- .8 Where part of the Mechanical Scope of Work, retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, transfer survey work to as-built drawings.

#### 1.27 Operation and Maintenance Data

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data as a PDF file on a USB drive. Consolidated O&M manual PDF to include:
  - .1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
  - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
  - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
  - .4 Table of Contents sheet, and corresponding index tab sheets;
  - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to

be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;

- .6 Operating data is to include:
    - .1 pressure test reports, and certificates issued by governing authorities;
    - .2 description of each system and its controls;
    - .3 control schematics for equipment/systems including building environmental controls;
    - .4 wiring and connection diagrams;
    - .5 if applicable, BAS architecture and all required operating data;
    - .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
    - .7 operation instruction for each system and each component;
    - .8 description of actions to be taken in event of emergencies and/or equipment failure;
    - .9 valve tag schedule, and flow diagrams to indicate valve locations.
  - .7 Maintenance data is to include:
    - .1 operation and trouble-shooting instructions for each item of equipment and each system;
    - .2 schedules of tasks, frequency, tools required, and estimated task time;
    - .3 recommended maintenance practices and precautions;
    - .4 complete parts lists with numbers.
  - .8 Performance data is to include:
    - .1 equipment and system start-up data sheets;
    - .2 equipment performance verification test results, and final commissioning report;
    - .3 final testing, adjusting and balancing reports.
  - .9 copies of warranties;
  - .10 items requested specifically in Section Articles.
  - .2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
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- .3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O&M Manual and submit to the Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

#### **1.28 Commissioning**

- .1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
  - .1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems.
  - .2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
  - .3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.
  - .4 Submit final commissioning data sheets, TAB reports as specified in Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems, project closeout documents, and other required submittals.

#### **1.29 Warranty**

- .1 Unless otherwise specified in Division 00 and Division 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.
  - .2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to the Consultant.
  - .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
  - .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
  - .5 Do not include Owner deductible amounts in warranties.
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- .6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.
- .7 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
  - .1 once during 1st month of building operation;
  - .2 once during 3rd month of building operation;
  - .3 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

### **1.30 Closeout Submittals**

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following as applicable to the project:
  - .1 Operating and Maintenance Manuals;
  - .2 as-built record drawings and associated data;
  - .3 extended warranties for equipment as specified;
  - .4 operating test certificates, i.e. Sprinkler Test Certificate;
  - .5 final commissioning report and TAB report;
  - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
  - .7 other data or products specified.

### **1.31 Instructions to Owner**

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
  - .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
  - .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
  - .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
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- .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
  - .2 Troubleshooting – diagnostic instructions, test and inspection procedures;
  - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
  - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
  - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .5 Before instructing Owner's designated personnel, submit to the Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from the Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
- .1 date instructions were given to Owner's staff;
  - .2 duration of instruction;
  - .3 names of persons instructed;
  - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation, and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to the Consultant copy of electronic version of training materials and include in operating and maintenance manuals submission.

### **1.32 Final Inspection**

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
    - .1 deficiencies noted during job inspections have been completed;
    - .2 field quality control procedures have been completed;
    - .3 systems have been tested and verified, balanced, and adjusted, and are ready for operation;
    - .4 maintenance and operating data have been completed and submitted to, reviewed with the Consultant and accepted by Owner;
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- .5 tags and nameplates are in place and equipment identifications have been completed;
- .6 clean-up is complete;
- .7 spare parts and replacement parts specified have been provided and acknowledged by the Consultant;
- .8 as-built and record drawings have been completed and submitted to and reviewed with the Consultant and accepted by Owner;
- .9 Owner's staff has been instructed in operation and maintenance of systems;
- .10 commissioning procedures have been completed.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Cleaning**

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 Clean equipment and devices installed as part of this project.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Motors and starters for all equipment specified in Mechanical Divisions.

### **1.02 Related Requirements**

- .1 Section 26 05 83 – Wiring Connections.

### **1.03 Submittals**

- .1 Submit shop drawings/product data sheets for:
  - .1 electric motors (submit with equipment they are associated with).
- .2 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

## **2 Products**

### **2.01 Equipment Belt Drives**

- .1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:
  - .1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;
  - .2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch ( $\pm 10\%$  range) for motors under 10 hp, fixed pitch type with split tapered bushing and keyway for motors 10 hp and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;
  - .3 motor slide rail adjustment plates are to allow for centre line adjustment.
- .2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

### **2.02 Equipment Drive Guards and Accessories**

- .1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OSHA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-1/2") diameter tachometer openings at each shaft location.
  - .2 For flexible couplings – removable "U" shaped galvanized steel guards to OSHA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.
  - .3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (3/4") galvanized steel wire mesh with galvanized steel frames, all to OSHA Standards.
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## 2.03 Electric Motors

- .1 Unless otherwise specified, motors are to conform to NEMA Standard MG 1, applicable IEEE Standards, and applicable CSA C22.2 standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
  - .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.
  - .3 Efficiency of 1-phase motors to 1 hp is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 hp and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
  - .4 Unless otherwise specified, 1-phase motors smaller than ½ hp are to be 115 V, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
  - .5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 V continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.
  - .6 Unless otherwise specified, motors ½ hp and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
  - .7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.
  - .8 Motor(s) for 2-speed cooling tower(s) are to be as specified above but 2-speed single winding type.
  - .9 Motor(s) for 2-speed fan(s) are to be as above but 2-speed double winding type.
  - .10 Unless otherwise indicated, motors 30 hp and larger are to be complete with a heat sensing PTC thermistor in the end turn of stator winding for each phase and connected in series inside motor with 2 marked leads brought out to motor conduit box.
  - .11 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG 1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
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- .12 Motors 150 hp and larger with "wye-delta" reduced voltage starters are to be complete with six leads for connection to motor starter.
- .13 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.
- .14 Manufacturers:
  - .1 TECO-Westinghouse Motors (Canada) Inc.;
  - .2 Canadian General Electric;
  - .3 Baldor Electric Co.;
  - .4 U.S. Electrical Motors;
  - .5 Weg Electric Corp.;
  - .6 Marathon Electric;
  - .7 Toshiba Corp.;
  - .8 Leeson Canada.

#### **2.04 Motor Starters and Accessories**

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
  - .2 Unless otherwise specified, starters for 1-phase motors are to be 115 V, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
  - .3 Unless otherwise specified, starters for 3-phase motors less than 50 hp are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
  - .4 Unless otherwise specified, starters for 3-phase motors 50 hp to 150 hp are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
  - .5 Unless otherwise specified, starters for 3-phase motors 150 hp and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
  - .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
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- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
  - .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
  - .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
    - .1 enclosures located in sprinklered areas – Type 2;
    - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
    - .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
    - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
    - .5 enclosures except as noted above – Type 1;
    - .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
  - .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.
  - .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
  - .12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
  - .13 Manufacturers:
    - .1 Rockwell Automation Inc. - Allen-Bradley;
    - .2 Eaton Corp. – Cutler-Hammer;
    - .3 Eaton Corp. – Moeller Electric;
    - .4 Siemens Canada;
    - .5 Schneider Electric.
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## **2.05 Sprinkler Proofing**

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
  - .1 factory constructed by respective equipment manufacturers;
  - .2 constructed from non-combustible materials (sheet steel);
  - .3 enamel painted to match equipment;
  - .4 surfaces and edges filled/sanded smooth prior to painting;
  - .5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
  - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.
- .6 Obtain CSA approval where required by local governing authorities.

## **3 Execution**

### **3.01 Installation of Equipment Drive Guards and Accessories**

- .1 Provide OSHA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.
- .2 Install belt guards to allow movement of motors for adjusting belt tension.
- .3 Provide a means to permit lubrication and use of test instruments with guards in place.
- .4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.
- .5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

### **3.02 Supply of Motor Starters and Accessories**

- .1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment. Refer to Motor Starter Schedule.
  - .2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to a concrete housekeeping pad.
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- .3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor control centre, provide a disconnect switch in motor control centre in lieu of a motor starter.
- .4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.
- .5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor starter panel, a disconnect switch will be provided on motor starter panel as part of electrical work.
- .6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at the proper time.

### **3.03 Electrical Wiring Work for Mechanical Work**

- .1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:
    - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment.
    - .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment.
    - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment.
    - .4 provision of receptacles for plug-in equipment.
    - .5 provision of disconnect switches for motors in excess of 10 m (30 ft) from starter location, or cannot be seen from starter location, and associated power wiring.
    - .6 motor starter interlocking in excess of 24 V.
    - .7 wiring from motor winding thermistors in motors 30 hp and larger to motor starter contacts.
    - .8 120 V power connections to electrical receptacles integral with small ceiling exhaust fans.
    - .9 [120 V power connections to small exhaust fans, and ceiling fans for all line voltage control devices, including but not limited to wiring through toggle switches, line voltage thermostats, countdown timer switches, or line voltage speed controllers. Coordinate requirements with Electrical Division.]
    - .10 120 V wiring connections to lighting fixture/switch combinations integral with air handling units.
    - .11 120 V wiring connections to duplex receptacles integral with air handling unit control panels.
-

- .12 120 V wiring connections to BAS system controllers/panels and other control system or component requiring 120 V power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.
- .2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This Section specifies firestopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 Submittals**

- .1 At least 4 weeks prior to work commencing, submit a sample of each type of firestop and smoke seal system in applied form, for approval. Identify each system with manufacturer's name and type, ULC designation, and proposed use. After samples are reviewed, work is to conform to reviewed samples.
- .2 Submit a product data sheet and a WHIMIS sheet for each firestopping and smoke seal product.
- .3 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .4 Sleeve and Formed Opening Location Drawings
  - .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
  - .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
  - .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

### **1.03 Closeout Submittals**

- .1 Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

### **1.04 Quality Assurance**

- .1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be reviewed by the Consultant.
- .2 Comply with firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

## **2 Products**

### **2.01 Pipe Sleeves**

- .1 Galvanized Sheet Steel – Minimum 16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.
  - .2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
-

- .3 Waterproof Galvanized Steel Pipe – Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.
- .4 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

## **2.02 Firestopping and Smoke Seal Materials**

- .1 Ensure all sealant and fire stopping is low VOC type in accordance with LEED.
- .2 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN/ULC-S115 and CAN/ULC-S101 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than fire resistance rating of surrounding fire rated construction.
- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly.
- .4 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .5 Manufacturers:
  - .1 A/D Fire Protection Systems "FIREBARRIER";
  - .2 Tremco Inc. Fire Protection Systems Group "TREMSTOP";
  - .3 3M Canada;
  - .4 Hilti (Canada) Ltd. Firestop Systems;
  - .5 Specified Technologies Inc.

## **2.03 Waterproofing Seal Materials**

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Manufacturers:
  - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
  - .2 The Metraflex Co. "MetraSeal" type ES.

## **2.04 Pipe Escutcheon Plates**

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.
-

### 3 Execution

#### 3.01 Installation of Pipe Sleeves

- .1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
    - .1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
    - .2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.
  - .2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:
    - .1 in mechanical room floor slabs, except where on grade;
    - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
    - .3 in floors equipped with waterproof membranes;
    - .4 in roof slab;
    - .5 in waterproof walls.
  - .3 Size sleeves, unless otherwise specified, to leave 12 mm ( $\frac{1}{2}$ ") clearance around pipes, or where pipe is insulated, a 12 mm ( $\frac{1}{2}$ ") clearance around pipe insulation.
  - .4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
    - .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;
    - .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
    - .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.
  - .5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.
  - .6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.
  - .7 "Gang" type sleeving will not be permitted.
  - .8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.
-

**3.02 Installation of Waterproof Mechanical Seals**

- .1 Provide watertight link type mechanical seals in exterior wall openings.
- .2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

**End of Section**

## **1 General**

### **1.01 Submittals**

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

## **2 Products**

### **2.01 Pressure Gauges and Thermometers**

.1 Pressure gauges as follows:

.1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;

.2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;

.3 stainless steel rotary movement with stainless steel bushings and socket;

.4 clear acrylic window;

.5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;

.6 black pointer.

.2 Pressure gauge accessories and additional requirements as follows:

.1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;

.2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;

.3 each pressure gauge for steam piping or steam equipment is to be equipped with a steel coil syphon;

.4 pressure gauges in fire protection piping must be ULC listed and labelled;

.3 Thermometers as follows:

.1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;

.2 hermetically sealed stainless steel case with stainless steel ring;

.3 dampened bimetal coil;

.4 calibration adjustment screw;

.5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;

.6 black aluminum pointer;

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- .7 double strength glass window;
- .8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;
- .9 suitable thermowell.
- .4 Manufacturers:
  - .1 H.O. Trerice Co.;
  - .2 Weiss Instruments;
  - .3 Ashcroft.

### **3 Execution**

#### **3.01 Installation**

- .1 Provide pressure gauges in following locations where applicable:
    - .1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
    - .2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
    - .3 in expansion tank(s);
    - .4 in separate domestic hot water storage tank(s);
    - .5 at top most outlet in each standpipe fire protection system riser;
    - .6 in piping at each side of a pressure reducing valve;
    - .7 in potable water service piping downstream of meter;
    - .8 wherever else shown and/or specified.
  - .2 Provide thermometers in following locations where applicable:
    - .1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;
    - .2 wherever else shown and/or specified.
  - .3 Conform to following installation requirements where applicable:
    - .1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
    - .2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
    - .3 locate, mount and adjust instruments so they are easily readable;
-

- .4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

**End of Section**

**1 General**

**2 Products**

**2.01 Piping Hangers and Supports**

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
    - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
    - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
  - .2 Hangers and supports for horizontal suspended piping as follows:
    - .1 adjustable steel clevis hanger – MSS Type 1;
    - .2 adjustable swivel ring band hanger – MSS Type 10;
    - .3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.
  - .3 Supports for horizontal pipe on vertical surfaces as follows:
    - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
    - .2 heavy-duty steel pipe clip – MSS Type 26;
    - .3 single steel pipe hook – Myatt Fig. 156;
    - .4 epoxy coated steel pipe stays are not permitted.
  - .4 Floor supports for vertical risers as follows:
    - .1 copper tubing riser clamp – MSS Type 8;
    - .2 heavy-duty steel riser clamp – MSS Type 8.
  - .5 Supports for vertical piping on vertical surfaces as follows:
    - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
    - .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
    - .3 extension split pipe clamp – MSS Type 12;
    - .4 epoxy coated steel pipe stays are not permitted.
  - .6 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.
-

- .7 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
  - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
  - .2 adjustable roller chair – MSS Type 44 with MSS Type 39 steel protection saddle.
- .8 Special hangers and supports for various applications as follows:
  - .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
  - .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
  - .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;

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[OR]

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- .4 for piping on new roofs – Lexcor "Flash-Tite" or Thaler Roofing Specialties Products Inc. "MERS" Series insulated aluminum support risers with diameter, height, securement method and flashing to suit the application, channel type aluminum cross members, and galvanized steel pipe hangers and supports conforming to MSS SP-58, complete with all required accessories;
  - .5 for glass drain and vent piping – special padded hangers supplied by pipe supplier;
  - .6 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;
  - .7 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;
  - .8 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
  - .9 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
  - .10 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.
- .9 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case, minimum 9.5 mm (3/8") diameter.
  - .10 Manufacturers:
    - .1 E. Myatt & Co. Inc.;
    - .2 Anvil International Inc.;

- .3 Empire Industries Inc.;
- .4 Hunt Manufacturing Ltd.;
- .5 Unistrut Canada Ltd.;
- .6 Nibco Inc. "Tolco";
- .7 Taylor Pipe Supports.

### **3 Execution**

#### **3.01 Installation of Fastening and Securing Hardware**

- .1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls, and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.
- .5 Do not attach fasteners to steel deck without written consent from the Consultant.

#### **3.02 Installation of Pipe Hangers and Supports**

- .1 Provide required pipe hangers and supports.
  - .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
  - .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
  - .4 Support requirements for underground piping are as follows:
    - .1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;
    - .2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs;
    - .3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.
-

- .5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.

- .6 Space hangers and supports in accordance with following:

- .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
- .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
- .3 glass pipe – conform to pipe manufacturer's recommended support spacing and support requirements;
- .4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

Pipe dia.	Max. Spacing Steel	Max. Spacing Copper
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints;
- .7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
- .8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .9 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
  - .1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;
  - .2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;

- .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
  - .4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;
  - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
- .11 Support piping on the roof as follows:

[OR]

- .1 on new roof – supply manufactured roof supports as per Part 2 of this Section to accommodate piping involved and support spacing specified above, and hand supports to roofing trade on roof for installation as part of roofing work, then secure piping in place on supports.
- .12 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .13 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
- .14 Do not support piping from steel deck without written consent from Consultant.

### 3.03 Equipment Bases and Supports

- .1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to following requirements:
  - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;
  - .2 place anchor bolts during concrete pour and be responsible for required levelling, alignment, and grouting of equipment;
  - .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.
- .2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to following requirements:
  - .1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;
  - .2 flange bolt steel stands to concrete housekeeping pads;

- .3 seismically restrained stands and supports in accordance with applicable requirements.
- .3 Where indicated on mechanical drawings, provide welded, cleaned and prime coat painted structural steel platforms, designed by a structural engineer registered in the jurisdiction of the work, for service access to equipment. Submit stamped and signed design drawings with calculations as shop drawings for review. Conform to following requirements:
  - .1 platforms in accordance with OHS requirements and adequately sized, braced, anchored, and, as required, seismically restrained;
  - .2 flooring equal to Fisher & Ludlow "Tru-Weld" Type 19-4, Borden type W/B (19-W-4), welded steel bar type grating;
  - .3 support legs constructed of welded Schedule 40 black steel pipe with welded steel cross-bracing, securely anchored and sway braced;
  - .4 safety guard rails, constructed from minimum 32 mm (1-¼") dia. Schedule 40 black steel pipe, for all platforms and complete with vertical stanchions at maximum 1.2 m (48") centres, top and intermediate horizontal railing, and toe plates at floor;
  - .5 vertical ladders constructed of Schedule 40 black steel pipe, 25 mm (1") dia. for equal height rungs, 40 mm (1-½") for stringers, anchored to floors and walls and sway braced as required;
  - .6 ships ladders, used wherever space conditions permit, of welded steel construction, climbing at an approximate 60° angle, and complete with channel iron stringers, open grate equal height risers approximately 165 mm (6-½") wide and factory made by grating manufacturer, handrails, and suitable anchoring and support.

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**3.04 Concrete Work for Mechanical Equipment Bases and Pads**

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[OR]

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**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 Related Requirements**

- .1 [Section 13 48 13 – Manufactured Sound and Vibration Control Components: floating floor for mechanical and generator rooms to minimize sound and vibration transmission to spaces below.]

### **1.03 Submittals**

- .1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.

### **1.04 Closeout Submittals**

- .1 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

### **1.05 Seismic Restraint Requirements**

- .1 Where applicable to the project, for requirements for the use of a Seismic Consultant and seismic restraint requirements required for vibration isolated materials and equipment, refer to Section 20 05 48.16 – Seismic Controls for Mechanical Systems.

## **2 Products**

### **2.01 General**

- .1 Vibration isolation products are to be in accordance with the most recent edition of the ASHRAE Handbook and/or as indicated on drawings, schedules, details, and as specified below.
  - .2 Springs are to be stable, colour coded, selected to operate at no greater than 2/3 solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.
  - .3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.
  - .4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
  - .5 Seismic rated isolators and snubbers are to be listed, rated, and approved by State of California Office of Statewide Health and Planning Department (O.S.H.P.D.) and carry an
-

O.S.H.P.D. pre-approved number. Seismic restraints supplied with vibration isolation are to meet requirements specified in Section 20 05 48.16 – Seismic Controls for Mechanical Systems.

- .6 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

## **2.02 Isolation Pads**

- .1 Sandwich type pads, 20 mm ( $\frac{3}{4}$ ") nominal thickness, selected for 3.2 mm ( $\frac{1}{8}$ ") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum 10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type NSN;
  - .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";
  - .3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;
  - .4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;
  - .5 J. P. America Inc. Type JSJ.

## **2.03 Rubber Floor Isolators**

- .1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type R;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type RSM;
  - .3 Kinetics Noise Control Vibron Products Group Type RQ;
  - .4 Mason Industries Inc. Type BR;
  - .5 J. P. America Inc. Type TRM.

## **2.04 Spring Floor Isolators**

- .1 Seismically rated captive spring mount isolator complete with levelling bolts, upper and lower neoprene spring cups, neoprene cushion, ductile iron housing, neoprene sound pads, and neoprene isolation grommets for securing bolts.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type SFS;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type AMSR;

- .3 Kinetics Noise Control Vibron Products Group Type FLSS;
- .4 Mason Industries Inc. Type SSLFH;
- .5 J. P. America Inc. Type TSO-C-SC.

## **2.05 Open Spring Mounts**

- .1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type FS;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A;
  - .3 Kinetics Noise Control Vibron Products Group Type FDS;
  - .4 Mason Industries Inc. Type SLFH;
  - .5 J. P. America Inc. Type TSO.

## **2.06 Closed Spring Mounts**

- .1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type CM;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Types B and C;
  - .3 Kinetics Noise Control Vibron Products Group Type FLS;
  - .4 Mason Industries Inc. Type C;
  - .5 J. P. America Inc. Type TSC.

## **2.07 Totally Retained Spring Mounts**

- .1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type CSR;

- .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type MS;
- .3 Kinetics Noise Control Vibron Products Group Type SM;
- .4 Mason Industries Inc. Type SLRSO;
- .5 J. P. America Inc. Type TSR.

## **2.08 Spring Hangers**

- .1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type SHR-SN;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;
  - .3 Kinetics Noise Control Vibron Products Group. Type SRH;
  - .4 Mason Industries Inc. Type 30N;
  - .5 J. P. America Inc. Type TSH.

## **2.09 Neoprene Hanger Isolators**

- .1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type NH;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;
  - .3 Kinetics Noise Control Vibron Products Group Type RH;
  - .4 Mason Industries Inc. Type HD or WHD;
  - .5 J. P. America Inc. Type TRH.

## **2.10 Concrete Inertia Type Equipment Base**

- .1 Welded steel bases, each complete with a structural black steel channel frame, concrete reinforcing rods, and brackets for spring mounts welded to frame.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type CIB;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;
  - .3 Kinetics Noise Control Vibron Products Group. Type CIB;

- .4 Mason Industries Inc. Type KSL;
- .5 J. P. America Inc. Type BCI.

#### **2.11 Steel Equipment Base**

- .1 Fully welded structural steel equipment and motor support bases, each complete with a wide flange steel frame, full depth cross members, brackets for spring mounts, and adjustable motor slide rails.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type SB;
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WFB;
  - .3 Kinetics Noise Control Vibron Products Group Type SFB;
  - .4 Mason Industries Inc. Type WFSL;
  - .5 J. P. America Inc. Type BWS (with motor slide rail).

#### **2.12 Combination Steel/Concrete Inertia Equipment Base**

- .1 Welded steel bases with a structural black steel channel frame, concrete reinforcing rods, bottom sheet steel pan, brackets for spring mounts welded to frame and adjustable motor slide rails.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Type CIB (with motor slide rails);
  - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WPF (with motor slide rails);
  - .3 Kinetics Noise Control Vibron Products Group Type CIB (with motor slide rails);
  - .4 Mason Industries Inc. Type BMK or K;
  - .5 J. P. America Inc. Type BSI (with motor slide rail).

#### **2.13 Slung Steel Base**

- .1 Slung steel bases of structural members with gusset plates welded to ends and complete with adjustable motor slide rails and vertical section size to suit equipment's motor power output.
  - .2 Manufacturers:
    - .1 Vibro-Acoustics Ltd. Type SS;
    - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;
    - .3 Kinetics Noise Control Vibron Products Group Type CIB-H;
    - .4 Mason Industries Inc. Type MSL.
-

## 2.14 Continuous Rail Type Isolation for Roof Mounted Equipment

- .1 Continuous rooftop isolation shipped completely assembled, consisting of:
  - .1 galvanized steel sections formed to fit roof curb and associated equipment with a flexible air and weather seal joining upper and lower rail sections;
  - .2 stable springs, cadmium plated and selected to provide minimum deflection with 50% additional travel to solid;
  - .3 neoprene cushioned and wind restraints allowing 6 mm (¼") movement before engaging and resisting wind loads in any lateral direction.
- .2 Manufacturers:
  - .1 Vibro-Acoustics Ltd. Vibro-Acoustics Type RTR;
  - .2 The VMC Group Vibration Mounting and Controls (Korfund-Dynamics) Type RTIR;
  - .3 Kinetics Noise Control Vibron Products Group Type KSR;
  - .4 Mason Industries Inc. Type RSC;
  - .5 J. P. America Inc. Type BRC.

## 3 Execution

### 3.01 Installation of Vibration Isolation Materials

- .1 Unless otherwise stated in the drawings, schedules and/or typical details, vibration isolation is to be provided for all mechanical equipment as per the recommendations contained within in the most recent edition of the ASHRAE Handbook.
  - .2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.
  - .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.
  - .4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
  - .5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
    - .1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
    - .2 steel bases are to clear the sub-base by 25 mm (1");
    - .3 concrete bases are to clear the sub-base by 50 mm (2").
-

- .6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
  - .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
  - .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
  - .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.
- .9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .10 Isolate designated piping risers at floor support points in accordance with drawing detail and/or where indicated on drawings.
- .11 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance. Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C. After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.
- .12 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to the Consultant.
- .13 For requirements pertaining to seismically restrained vibration isolation, refer to Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
- .14 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 Nameplates.
- .2 Tags.
- .3 Pipe Markers.

### **1.02 References**

- .1 ASME A13.1 – Scheme for the Identification of Piping Systems.

### **1.03 Submittals**

- .1 Section 01 33 00: Submittals.
- .2 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.
- .3 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- .4 Product Data: Provide manufacturers catalogue literature for each product required.
- .5 Samples: Submit two labels, tags samples to Consultant for approval.
- .6 Manufacturer's Installation Instructions: Indicate special procedures, and installation.

### **1.04 Closeout Submittals**

- .1 Section 01 77 00: Project Closeout.
- .2 Record actual locations of tagged valves.

## **2 Products**

### **2.01 Mechanical Work Identification Materials**

- .1 Confirm with the Owner if an existing mechanical work identification system is in place and, if so, match accordingly.
- .2 If an existing mechanical work identification system is not in place, the following is to be used:
  - .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
    - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;

- .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
  - .3 supply stainless steel screws for securing nameplates in place;
  - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
- .2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12 200 mm (8") CHILL. WATER NORMALLY OPEN
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- .3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
- .1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
  - .2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .4 Identification wording and colours for pipe identification materials are to be as follows:

Pipe Service	Identification Colour	Legend
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
chilled drinking water	green	CH. DRINK WTR.
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
acid sanitary drainage	yellow	ACID DRAIN
acid drainage vent	yellow	ACID VENT
fire protection standpipe	red	F.P. STANDPIPE
fire protection sprinklers	red	F.P. SPRINKLER
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
propane gas	to Code	to Code, c/w pressure

Pipe Service	Identification Colour	Legend
propane gas vent	to Code	to Code
fuel oil supply	yellow	FUEL OIL SUPPLY
fuel oil return	yellow	FUEL OIL RETURN
fuel oil vent	yellow	FUEL OIL VENT
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN
glycol heating supply	yellow	GLY. HTG. SUPPLY
glycol heating return	yellow	GLY. HTG. RETURN
glycol heating drain	yellow	GLY. HTG. DRAIN
glycol heat reclaim return	yellow	GLY. HTG. RECLAIM R.
glycol heat reclaim supply	yellow	GLY. HTG. RECLAIM S.
heat pump geothermal loop – source side supply	green	GEO. LOOP SOURCE SUPPLY
heat pump geothermal loop – source side return	green	GEO. LOOP SOURCE RETURN
heat pump geothermal loop – load side supply	green	GEO. LOOP LOAD SUPPLY
Heat pump geothermal loop – load side return	green	GEO. LOOP LOAD RETURN
condenser water supply	green	COND. WTR. SUPPLY
condenser water return	green	COND. WTR. RETURN
chilled water supply	green	CH. WTR. SUPPLY
chilled water return	green	CH. WTR. RETURN
chilled water drain	green	CH. WTR. DRAIN
low pressure steam	yellow	....kPa STEAM
medium pressure steam	yellow	....kPa STEAM
high pressure steam	yellow	....kPa STEAM
low pressure condensate	yellow	L.P. CONDENSATE
medium pressure condensate	yellow	M.P. CONDENSATE
high pressure condensate	yellow	H.P. CONDENSATE
pumped condensate	yellow	PUMPED CONDENSATE
steam vent	yellow	STEAM VENT
boiler feedwater	yellow	BLR. FEEDWATER
boiler blowdown	yellow	BLR. BLOW-OFF
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS
diesel engine exhaust	yellow	ENGINE EXHAUST
gasoline	yellow	GASOLINE
distilled water	green	DISTILL. WATER
demineralized water	green	DEMIN. WATER
compressed air (< 700 kPa)	green	....kPa COMP. AIR
compressed air (>700 kPa)	yellow	....kPa COMP. AIR
control air	green	CONTROL AIR

.5 Colours for pipe identification legends and directional arrows are to be as follows:

Identification Colour	Legend and Arrow Colour
yellow	black
green	white
red	white

- .6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

### 3 Execution

#### 3.01 Preparation

- .1 Degrease and clean surfaces to receive adhesive for identification materials.

#### 3.02 Installation

- .1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
- .1 at every end of every piping or duct run;
  - .2 adjacent to each valve, strainer, damper and similar accessory;
  - .3 at each piece of connecting equipment;
  - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
  - .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
  - .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.
- .2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
- .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
  - .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
  - .3 at each access door location;
  - .4 at each piece of connected equipment, automatic valve, etc.
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
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- .4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements. Identify piping at intervals as specified above.
- .5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.
- .6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".
- .7 Tag valves and prepare a valve tag chart in accordance with following requirements:
  - .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;
  - .2 prepare a digital valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
  - .3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
  - .4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals.
- .8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
  - .1 HVAC piping valves and equipment: yellow
  - .2 fire protection valves and equipment: red
  - .3 plumbing valves and equipment: green
  - .4 HVAC ductwork dampers and equipment: blue
  - .5 control system hardware and equipment: orange

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 Definitions**

- .1 “Agency” – means agency to perform testing, adjusting, and balancing work.
- .2 “TAB” – means testing, adjusting, and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 “hydronic systems” – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 “air systems” – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 “flow rate tolerance” – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 “report forms” – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting, and balancing.
- .7 “terminal” – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 “main” – means duct or pipe containing system’s major or entire fluid flow.
- .9 “submain” – means duct or pipe containing part of the systems’ capacity and serving 2 or more branch mains.
- .10 “branch main” – means duct or pipe servicing 2 or more terminals.
- .11 “branch” – means duct or pipe serving a single terminal.

### **1.03 Submittals**

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
  - .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.
  - .3 Submit a report by Agency to indicate Agency’s evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.
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#### **1.04 Closeout Submittals**

- .1 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .2 Submit a draft report, as specified in Part 3 of this Section.
- .3 Submit a final report, as specified in Part 3 of this Section.
- .4 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .5 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

#### **1.05 Quality Assurance**

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting, and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
  - .1 AABC – Associated Air Balance Council;
  - .2 NEBB – National Environmental Balancing Bureau.
- .2 NBCTA certification in lieu of the above noted organizations is not permitted.
- .3 Testing, adjusting, and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with one of following publications:
  - .1 National Standards for a Total System Balance published by Associated Air Balance Council;
  - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
  - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

### **2 Products – Not Used**

### **3 Execution**

#### **3.01 Scope of Work**

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
  - .2 Mechanical systems to be tested, adjusted, and balanced include:
-

- .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
  - .1 domestic hot water recirculation piping;
  - .2 tempered water piping flows.
- .2 TAB of swimming pool systems is to include all pool piping water flows.
- .3 TAB of laboratory systems is to include flows through piping, fittings including bench work fittings, and associated equipment including special ventilation systems.
- .4 TAB of medical gas systems is not part of TAB work and is specified in Section entitled Medical Gas Piping Systems.
- .5 TAB of fuel oil system is to include supply and return oil flows as applicable, and is to be in accordance with requirements of CAN/CSA B139.
- .6 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .7 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .8 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities, and flows.

### **3.02 Testing, Adjusting, and Balancing**

- .1 Conform to following:
    - .1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
    - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
    - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting, and balancing;
    - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
    - .5 testing, adjusting, and balancing is not to begin until:
-

- .1 building construction work is substantially complete and doors have been installed;
  - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
  - .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting, and balancing;
  - .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
  - .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
  - .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
  - .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
  - .11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
  - .12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
  - .13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of  $\pm 5\%$  of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
  - .14 Agency is to perform testing, adjusting, and balancing to within  $\pm 5\%$  of design values, and make and record measurements which are within  $\pm 2\%$  of actual values;
  - .15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
  - .16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within  $2.8^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ) wet bulb temperature of maximum summer design condition, and within  $5.5^{\circ}\text{C}$  ( $10^{\circ}\text{C}$ ) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 Prepare reports as indicated below.
-

- .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.
  - .2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.
  - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:
    - .1 General Information and Summary;
    - .2 Air Systems;
    - .3 Hydronic Systems;
    - .4 Temperature Control Systems;
    - .5 Special Systems.
  - .4 Agency is to provide following minimum information, forms, and data in report:
    - .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
    - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
    - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
    - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
  - .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
  - .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper
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testing, adjusting, and balancing, they are to be immediately corrected without additional cost to Owner.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

### **1.02 Definitions**

- .1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
- .2 "exposed" – means exposed to normal view during normal conditions and operations.
- .3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.
- .4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

### **1.03 Submittals**

- .1 Submit a product data sheet for each insulation system product.
- .2 Submit a colour chart for coloured lagging adhesive for canvas jacketed insulation.

### **1.04 Closeout Submittals**

- .1 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.

### **1.05 Quality Assurance**

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure surfaces to be insulated are clean and dry.
- .4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

## **2 Products**

### **2.01 Fire Hazard Ratings**

- .1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
-

## 2.02 Thermal Performance

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

## 2.03 Pipe Insulation Materials

- .1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with ULC-S115 and ULC-S101 firestopping.
  - .1 Manufacturers:
    - .1 Roxul "Techton 1200";
    - .2 IIG (Johns Manville Inc.) MinWool-1200;
    - .3 Paroc 1200.
- .3 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket.
  - .1 Manufacturers:
    - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
    - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
    - .3 Manson Insulation Inc. "ALLEY K APT";
    - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .4 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m<sup>3</sup> (1-½ lb/ft<sup>3</sup>) density, with a factory applied vapour barrier facing.
  - .1 Manufacturers:
    - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
    - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
    - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
    - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .5 Pre-moulded weatherproof jacketed mineral fibre is to be Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weather-proof jacket and a 100 mm (4") butt joint sealing strip with each section.

## 2.04 Ductwork System Insulation Materials

- .1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m<sup>3</sup> (3 lb/ft<sup>3</sup>) density, with a factory applied reinforced aluminum foil and kraft paper facing.
  - .1 Manufacturers:
    - .1 Knauf Fiber Glass Insulation Board with FSK facing;
    - .2 Manson Insulation Inc. "AK BOARD FSK";
    - .3 Johns Manville Inc. Type 814 "Spin-Glas";
    - .4 Owens Corning 703.
- .2 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m<sup>3</sup> (1-½ lb/ft<sup>3</sup>) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing.
  - .1 Manufacturers:
    - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
    - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
    - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
    - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .3 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A.
  - .1 Manufacturers:
    - .1 Armacell "AP/Armaflex SA";
    - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.
- .4 Extruded polystyrene tapered insulation – equal to Soprema Sopra-ISO Tapered, closed cell polyisocyanurate foam core with organic facers reinforced with glass fibres, 172 kPa compressive strength as per ASTM D1621, 32 kg/m<sup>3</sup> density, 50 mm minimum thickness, 2% slope. Thickness shall increase if width of duct work is larger than 1200 mm to maintain 2% slope.

## 2.05 Insulation Fastenings

- .1 Wire – minimum 15 gauge galvanized annealed wire.
  - .2 Wire with Mesh – minimum 15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.
  - .3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
  - .4 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.
-

- .5 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.
- .6 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.
- .7 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.
- .8 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.
- .9 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.
- .10 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .11 Screws – No. 10 stainless steel sheet metal screws.

## **2.06 Insulation Jackets and Finishes**

- .1 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories.
  - .1 Manufacturers:
    - .1 Proto Corp. "LoSMOKE";
    - .2 The Sure-Fit System "SMOKE-LESS 25/50";
    - .3 Johns Manville Inc. "Zeston" 300.
  - .2 Foamed glass insulation protective coating is to be Pittsburgh Corning "PITTCOTE 300e" flexible acrylic latex weather barrier coating, white unless otherwise specified.

## **3 Execution**

### **3.01 General Insulation Application Requirements**

- .1 Unless otherwise specified, do not insulate following:
    - .1 factory insulated equipment and piping;
    - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
    - .3 heating piping in soffits and/or overhang spaces and connected to bare element radiation in spaces;
    - .4 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
-

- .5 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
- .2 Install insulation directly over pipes and ducts, not over hangers and supports.
- .3 Install piping insulation and jacket continuous through pipe openings and sleeves.
- .4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.
- .6 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .7 Where piping and/or equipment is traced with electric heating cable, ensure cable has been tested and accepted prior to application of insulation, and ensure cable is not damaged or displaced during the application of insulation.
- .8 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.
- .9 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
- .10 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .11 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

### **3.02 Insulation for Horizontal Pipe at Hangers and Supports**

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

### **3.03 Pipe Insulation Requirements – Mineral Fibre**

- .1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:
  - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
  - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;

- .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;
- .4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1-½") thick;
- .5 tempered domestic water piping, supply and return, less than 40 mm (1-½") dia. – 25 mm (1") thick;
- .6 tempered domestic water piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
- .2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.
- .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
- .4 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
- .5 lavatories.
- .6 .
- .7 Install insulation as required to fit shape and contour of equipment. Secure insulation in place with adhesive, and with aluminum straps on 450 mm (18") centres. Apply a 6 mm (¼") thick skim coat of insulating cement, then, when insulating cement has dried, apply a 6 mm (¼") thick coat of cement trowelled smooth.
- .8 For "cold" equipment, prime insulation with suitable sealer and apply a jacket of glass thread reinforced foil and kraft paper vapour barrier jacket material laminated in place with a full coverage of adhesive.
- .9 Provide removable and replaceable insulated metal covers for equipment with removable heads to permit heads to be removed and replaced without damaging adjacent insulation work.

### **3.04 Equipment Insulation Requirements – Semi-Rigid Mineral Wool**

- .1 Insulate following equipment with calcium silicate equipment insulation of thickness indicated:
  - .1 engine-generator set exhaust system silencer(s) – 75 mm (3") thick;
  - .2 uninsulated boiler breeching where inside the building – 75 mm (3") thick.
- .2 Cut or mitre insulation (or use factory scored type insulation) to fit shape and contour of equipment and secure insulation in place with aluminum straps on 450 mm (18") centres. Point joints, mitres, scores and gaps with insulating cement. Apply a 12 mm (½") thick coat of insulating cement and trowel smooth.

### 3.05 Equipment Insulation Requirements – Closed Cell Foamed Glass

- .1 Insulate following equipment with closed cell foam glass insulation of thickness indicated:
  - .1 [ ];
  - .2 [ ].
- .2 Install insulation in strict accordance with manufacturer's published instructions using adhesive, wrap, sealant, etc., to secure insulation in place, to secure and seal joints, and to produce a 100% water-tight installation.

### 3.06 Equipment Insulation Requirements – Removable/Reusable Type

- .1 Provide custom designed and manufactured removable and reusable insulation covers for following:
  - .1 plate type heat exchanger(s);
  - .2 150 mm (6") dia. and larger piping strainers, backflow preventers, etc.;
  - .3 diesel engine exhaust manifolds;
  - .4 150 mm (6") dia. and larger steam traps and similar equipment.
- .2 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") dia.

### 3.07 Ductwork Insulation Requirements – Mineral Fibre

- .1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:
    - .1 Outdoor air and combustion air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;
    - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
    - .3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
    - .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
    - .5 any other ductwork, casings, plenums, or sections specified or detailed on drawings to be insulated – thickness as specified.
-

- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.
- .3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:
  - .1 at trapeze hanger locations, install insulation between duct and hanger;
  - .2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.
- .4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.
- .5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
- .6 Insulation application requirements common to all types of rigid ductwork are as follows:
  - .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
  - .2 installation of fastener pins and washers is to be concurrent with duct insulation application;
  - .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
  - .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
  - .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

### 3.08 Ductwork Insulation Requirements – Flexible Elastomeric

- .1 Insulate exposed exterior ductwork (except outdoor air intake ductwork) and associated plenums and/or casings outside building with minimum 75 mm (3") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 40 mm (1 ½") thick layers with staggered tightly butted joints.

- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.
- .3 Provide Calcium Silicate insulation between ductwork and duct supports. Tightly butt flexible elastomeric insulation to Calcium Silicate insulation. Cover Calcium Silicate insulation with a continuous sheet of self-adhesive multilayer jacketing which overlaps 75 mm past the Calcium Silicate insulation to the adjacent flexible elastomeric insulation.
- .4 Provide extruded polystyrene tapered insulation between flexible elastomeric insulation and jacketing to allow for water runoff on all exterior duct work.

### 3.09 Ductwork Insulation Requirements – Calcium Silicate

- .1 Insulate following kitchen exhaust ductwork with minimum 40 mm (1-½") thick calcium silicate block insulation:
  - .1 kitchen exhaust ductwork from exhaust hood to masonry shaft – 2 hour rating;
  - .2 stairwell pressurization ductwork from fan to stairwell – 1 hour rating;
  - .3 Trauma Room and Operating Room supply and exhaust ductwork complete – 1 hour rating.
- .2 Secure insulation in place with adhesive and with wire on 450 mm (18") centres. Point gaps and joints with insulating cement. Where ductwork is exposed, cover insulation with wire mesh secured to wire and with edges laced together and apply a coat of finishing cement trowelled smooth. Use drywall type metal corner bead for duct edges where finishing cement is applied.

### 3.10 Application of Insulating Coatings

- .1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:
  - .1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
  - .2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

### 3.11 Insulation Finish Requirements

- .1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
  - .2 Unless otherwise shown or specified, jacket exposed mineral fibre insulation listed below with canvas jacket secured in place with a full covering coat of coloured lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size.
-

Remove lagging adhesive splatter from adjacent surfaces. Insulated services to receive coloured lagging adhesive are as follows:

- .1 Domestic Cold Water Piping;
  - .2 Domestic Hot Water Piping;
  - .3 Domestic Hot Water Recirculation Piping;
  - .4 Indoor Ductwork;
- .3 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit shop drawings/product data sheets to regulatory authority for review and approval prior to submitting to the Consultant. Conform to following requirements:
  - .1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
  - .2 sprinklers shall be referred to on drawings and product submittals, and be specifically identified by the manufacturer's listed model or series designation. Trade names and other abbreviated listings are not allowed;
  - .3 submit complete CAD layout drawings indicating source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer registered in jurisdiction of the work as specified below;
  - .4 submit copies of all calculations, including hydraulic calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;
  - .5 in addition to submitting shop drawings to regulatory authority as specified above, shop drawings must be approved by Owner's insurer prior to being submitted to the Consultant for review.

### **1.02 Closeout Submittals**

- .1 Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.

### **1.03 Spare Parts**

- .1 Fill spare sprinkler head cabinet complete with spare heads.

### **1.04 Quality Assurance**

- .1 Fire protection sprinkler system work is to be in accordance with following Codes and Standards:
  - .1 NFPA 13, Standard for the Installation of Sprinkler Systems;
  - .2 CSA B137.2, Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications;
  - .3 CSA B137.3, Rigid Polyvinylchloride (PVC) Pipe for Pressure Applications;
  - .4 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;
  - .5 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;
  - .6 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;
  - .7 ASTM A536, Standard Specification for Ductile Castings;

- .8 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;
- .9 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);
- .10 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.
- .2 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. Site personnel are to be licensed in jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter licensed in jurisdiction of the work.
- .3 Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site and accept responsibility for and cost of making adjustments to piping and/or spacing to avoid interference with other building components.
- .4 Verify working condition of existing sprinkler system equipment which has direct interface with project work and is to remain. Replace with new equipment where necessary.
- .5 System components must be ULC listed and labelled.
- .6 All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- .7 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

#### **1.05 Design Requirements**

- .1 Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and standards of Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at nearest fire hydrant to obtain criteria to be used in system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 Include for a qualified mechanical professional engineer registered and licensed in the jurisdiction of the work to design the fire protection standpipe work. For requirements regarding Contractor retained engineers, refer to Section 20 05 10 – Mechanical Work General Instructions.
- .3 Sprinkler /System Occupancy – Hazard Design requirements: In accordance with NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

## **2 Products**

### **2.01 Pipe, Fittings, and Joints**

- .1 Pipe, fittings, and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
    - .1 Schedule 40 Steel – Grooved Coupling Joints
-

- .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.
  - .2 Schedule 40 Steel – Screwed and Welded Joints
    - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
  - .3 Schedule 10 Steel – Grooved Coupling Joints
    - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints.
  - .4 Schedule 10 Steel – Screwed Joints
    - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
  - .5 "Lightwall" Steel – Grooved Coupling Joints
    - .1 Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings equal to Victaulic "Fire Lock" grooved fittings and Victaulic Style 009N QuickVic or 005 rigid coupling joints.
  - .6 "Lightwall" Steel – Screwed Joints
    - .1 Commercial quality, "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, ULC listed, mill or site threaded, complete with galvanized exterior, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
  - .7 Flexible Pipe – Equal to Victaulic "VicFlex"
    - .1 The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1" NPT Male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head.
    - .2 Option: Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
    - .3 The drop shall include a cULus/FM approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces.
    - .4 The hose shall be listed for:
-

- .1 (4) bends at 31" length;
- .2 (5) bends at 36" length;
- .3 (8) bends at 48" length;
- .4 (10) bends at 60" length;
- .5 (12) bends at 72" length.
- .5 Union joints shall be provided for; ease of installation, prevention of hose torque stresses and on site changing of factory 5.75" straight reducing nipple in reduced spaces under obstructions (optional reducing nipples; 4.83" or 6.57" reducing 90 and 9" or 13" straight reducer x ½ or ¾" outlet) All VicFlex assemblies and related accessories to be installed as per the guidelines and listings in Victaulic submittal 10.85.
- .6 On T Bar ceiling grid with drop in tile application, the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place.
- .7 On T Bar ceiling grid designed for hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB2 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.
- .8 On Hat Furring Channel grid with hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB4 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.
- .9 The braided drop system shall be cULus listed and FM Approved for sprinkler services to 175 psi (1206 kPa).

## 2.02 Shut-Off Valves

- .1 Minimum 2070 kPa (300 psi) rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.
- .2 Butterfly valves shall include a pressure responsive seat, and the stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- .3 Basis of Design: Victaulic Style 705.
- .4 OS&Y Gate Valves: 1725 kPa (250 psi), grooved ends. Ductile iron body, yoke, and handwheel conforming to ASTM A-536; EPDM coated ASTM A-126-B cast iron disc; ASTM B16 brass rising stem; flanged and epoxy coated ductile iron bonnet; EPDM O-ring stem seals and body gasket. Victaulic Series 771H (Grooved ends) and Series 771F (Grooved x Flanged).
- .5 Supervised closed applications:
  - .1 Basis of Design: Victaulic Series 707C supervised closed butterfly valve.

### 2.03 Sprinkler Heads

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss.
- .3 For locations where corrosive resistant coatings are required, body shall be coated with UL listed and FM approved anti-corrosion VC-250 coating (silver coloring).
- .4 Provide quick response sprinkler heads unless standard response required to suit the hazard class.
- .5 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.
- .6 Where exposed pendent heads occurs in areas with suspended ceilings, they are to be complete with [chrome plated] escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with [chrome plated] escutcheon plates.
- .7 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .8 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
- .9 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.
- .10 Manufacturers:
  - .1 Victaulic Co.;
  - .2 Tyco Fire Suppression & Building Products;
  - .3 The Viking Corporation;
  - .4 The Reliable Automatic Sprinkler Co.

### 2.04 Spare Sprinkler Head Cabinets

- .1 Surface wall mounting, red enamelled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.
  - .2 Cabinet is to be sized to accommodate a minimum of 4 spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.
-

### **3 Execution**

#### **3.01 Demolition**

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

#### **3.02 Piping Installation Requirements**

- .1 Provide required sprinkler system piping.
  - .2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.
  - .3 Piping, unless otherwise specified, is as follows:
    - .1 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;
    - .2 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;
    - .3 for piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;
    - .4 for branch piping to heads in suspended ceilings, etc. – at your option, flexible piping installed in accordance with manufacturer's instructions;
    - .5 for branch piping to heads in MRI suites – copper pipe, fittings, and sprinkler head adapters with stainless steel hangers and support hardware.
  - .4 Exceptions to piping requirements specified above are as follows:
    - .1 dry pipe zone steel piping, fittings, unions, couplings and flanges are to be galvanized;
    - .2 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;
    - .3 PVC piping is not to be used above grade;
    - .4 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.
  - .5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during the tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route the main unless approved by Consultant.
  - .6 Pipe, fittings, couplings, flanges and similar components are to be clean after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibits rust and carefully coat with suitably coloured primer.
-

- .7 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.
- .8 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative of the mechanical joint manufacturer shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products.

### 3.03 Installation of Shut-Off Valves and Check Valves

- .1 Provide shut-off valves and check valves in piping where shown and wherever else required.
- .2 Locate valves for easy operation and maintenance.
- .3 Confirm exact locations prior to roughing-in.

### 3.04 Installation of Sprinkler Heads

- .1 Provide required sprinkler heads in accordance with following schedule:

Application	Sprinkler Head Type
Rooms/areas with a suspended ceiling	Victaulic V38/V39 or Tyco Series RFII "Royal Flush II" concealed pendent Victaulic V27 or Tyco Series TY-FRB recessed pendent Victaulic V27 or Tyco Series TY-FRB pendent with escutcheon plates
Rooms/areas without a suspended ceiling	Victaulic V27 or Tyco Series TY-FRB pendent
Elevator shafts	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
Unheated exterior stairwells	Victaulic V36 or Tyco Series DS-1 dry pipe horizontal sidewall Victaulic V36 or Tyco Series DS-3 wet pipe horizontal sidewall
Air handling system outdoor air and relief air plenums (unheated)	Tyco Series DS-3 ECOH dry horizontal sidewalls in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping

Application	Sprinkler Head Type
Unheated and unfinished areas	Victaulic V36 or Tyco Series DS-3 ECOH dry horizontal sidewall in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping
Heated areas with overhead doors	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
Unheated parking garage	Victaulic V34 or Tyco Series EC-11 or EC-14 ECOH upright or Victaulic V27 or Series TY-FRB upright for dry piping
Heated parking garage	Victaulic V34 or Tyco Series EC-11 or EC-14 ECOH upright or Victaulic V27 or Series TY-FRB upright for wet piping
Parking garage ramp	Victaulic V34 or Tyco Series EC-11 or EC-14 ECOH upright or Series TY-FRB upright or Victaulic V27 or Series ELO SW-20 or SW-24 ECOH sidewall
At non-rated windows in rated walls	Tyco Model WS horizontal and pendent vertical sidewall

- .2 Sprinkler head manufacturers indicated on schedule are for type indication purposes. Manufacturers are listed in Part 2 of this Section.
- .3 Provide quick response type sprinkler heads for warehouse facility.
- .4 Coordinate sprinkler head locations with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .5 Maintain maximum headroom in areas with no ceilings.
- .6 Provide guards for heads where they are subject to damage.
- .7 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

### 3.05 Installation of Spare Sprinkler Head Cabinets

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of types used (minimum 4 of each type) and place in a wall mounting storage cabinet located adjacent to sprinkler system "head end" equipment where later directed.

**End of Section**

## **1 General**

### **1.01 References**

- .1 Domestic water piping and valves are to comply with following codes, regulations, and standards (as applicable):
  - .1 applicable local codes and regulations;
  - .2 CAN/CSA B64, Backflow Preventers and Vacuum Breakers;
  - .3 CAN/CSA B125.1, Plumbing Supply Fittings;
  - .4 CAN/CSA B125.3, Plumbing Fittings;
  - .5 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
  - .6 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
  - .7 NSF/ANSI 61, Drinking Water System Components – Health Effects;
  - .8 NSF/ANSI 372, Drinking Water System Components – Lead Content.

### **1.02 Submittals**

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine solution.

## **2 Products**

### **2.01 Pipe, Fittings, and Joints**

- .1 Copper - Solder Joint
  - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin / 5% Antimony or "SILVABRITE 100" solder for other services.
- .2 Copper - Pressure Coupled Joint
  - .1 Type "L" hard drawn seamless copper to ASTM B88 with Viega "ProPress with Smart Connect feature" copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.

### **2.02 Shut-Off Valves**

- .1 Ball Valves
    - .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, 304 stainless steel ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
    - .2 Manufacturers:
-

- .1 Toyo Valve Co.
  - .2 Milwaukee Valve Co.
  - .3 Kitz Corporation.
  - .4 Apollo Valves.
  - .5 Watts Industries (Canada) Inc.
- .2 Butterfly Valves - Flanged Joint
  - .1 Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with valve in position and either side of connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles. Butterfly valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.
  - .2 Manufacturers:
    - .1 DeZurik #632L Series;
    - .2 Kitz Corporation Code #6122EL/EG;
    - .3 Toyo Valve Co. #918BESL/EG;
    - .4 Bray Valve and Controls Canada Series 31;
    - .5 Apollo Valves #141 Series;
    - .6 Watts Industries (Canada) Inc. #BF-03.
- .3 Butterfly Valves – Grooved End
  - .1 Equal to Victaulic Series 608N, for copper pipe rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Seat material shall be EPDM UL Classified in accordance with ANSI/NSF 61 for ambient +86°F and hot +180°F potable water service and ANSI/NSF 372.
  - .2 Victaulic Series 461, for stainless steel pipe rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Seat material shall be EPDM UL Classified in accordance with ANSI/NSF 61 for ambient +86°F and hot +180°F potable water service and ANSI/NSF 372.

## 2.03 Check Valves

- .1 Horizontal
    - .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
    - .2 Manufacturers:
      - .1 Toyo Valve Co. Fig. 237A-LF;
      - .2 Milwaukee Valve Co. #UP1509;
-

- .3 Kitz Corporation Code 823;
- .4 Apollo Valves #61LF Series.
- .2 Vertical
  - .1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

#### 2.04 Drain Valves

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain. Ball material to be 304 stainless steel.
- .2 Manufacturers:
  - .1 Toyo Valve Co.
  - .2 Dahl Brothers Canada Ltd.
  - .3 Kitz Corporation.
  - .4 Apollo Valves.
  - .5 Watts Industries (Canada) Inc.

#### 2.05 Partition Stops

- .1 Equal to Dahl Brothers Canada Ltd. Fig. E2300 Series or equal lead-free partition stops with EDPM packing, slotted spindles, extension tubes, stainless steel access plates, and 3 identified keys.

#### 2.06 Domestic Hot Water Thermostatic Mixing Valves

- .1 Lawler Manufacturing Co. Inc. 800 Series "High-Low Thermostatic Mixer" factory assembled rough bronze thermostatic mixing valve assembly complete with rotatable union end inlet piping with check stops and stainless steel strainer screens, union outlet piping with thermometer connection, all sized as shown, and following:
  - .1 mixing valve with liquid motor, stainless steel piston and liner, tamper-resistant control adjustment, and 3-way protection against runaway temperatures, thermal shock, and scalding;
  - .2 dial type thermometer conforming to requirement specified in Section 20 05 00 – Common Work Results for Mechanical;
  - .3 ball type outlet shut-off valve conforming to valve requirements specified in this section;
- .2 Manufacturers:
  - .1 Lawler Manufacturing Co. Inc.;
  - .2 Leonard Valve Co.;
  - .3 Symmons Industries Inc.

## 2.07 Interior Hose Bibbs

- .1 Flush-Concealed
    - .1 Recessed, 92 mm (3-5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (3/4") dia. hose connection, and a vacuum breaker.
    - .2 Manufacturers:
      - .1 Watts Industries (Canada) Inc. #HY-330.
      - .2 Jay R. Smith #5509QT-CL-SAP;
      - .3 Zurn #Z1350;
      - .4 Mifab #MHY-55;
  - .2 Semi-Recessed - Finished Areas
    - .1 Anti-siphon type, 100 mm (4") deep hose bibb with stainless steel face with operating key, bronze interior parts, 20 mm (3/4") dia. solder inlet, 20 mm (3/4") dia. hose connection, and integral vacuum breaker.
    - .2 Manufacturers:
      - .1 Watts Industries (Canada) Inc. #HY-430.
      - .2 Jay R. Smith #5619-SAP-98;
      - .3 Zurn #Z1333 "ECOLOTROL";
      - .4 Mifab #MHY-30;
  - .3 Surface – Exposed – Cold Water – Unfinished Areas
    - .1 Brass or bronze hose bibb with hose end vacuum breaker.
    - .2 Manufacturers:
      - .1 Watts Industries (Canada) Inc. #SC8-1;
      - .2 Jay R. Smith #5609QT-SAP.
      - .3 Zurn/Wilkins # Z1341 with hose end vacuum breaker;
      - .4 Chicago Faucets #293-E27CP;
  - .4 Exposed – Unfinished Areas – Hot and Cold Water
    - .1 Mixing faucet for surface mounting.
    - .2 Manufacturers:
      - .1 Watts Industries (Canada) Inc. #HY-300-2-VB.
      - .2 Jay R. Smith #5560QT-LB-SAP;
-

- .3 Zurn #Z841L1-RC;
- .4 Delta Commercial #28T8083;

## 2.08 Floor Drain Trap Seal Primers

- .1 Primer Valve Type
  - .1 Precision Plumbing Products Inc. Model P2-500 trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm ( $\frac{1}{2}$ ") threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.
- .2 Primer Valve Type with Manifold
  - .1 Precision Plumbing Products Inc. Model P1-500 trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.
- .3 Electronic Type
  - .1 Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
    - .1 galvanized steel cabinet with door;
    - .2 20 mm ( $\frac{3}{4}$ ") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
    - .3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm ( $\frac{1}{2}$ ") dia. compression type copper tube connections on 40 mm (1- $\frac{1}{2}$ ") centres with quantity to suit the number of items to be primed;
    - .4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

## 2.09 Shock Absorbers

- .1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting water pipe and equipment it is provided for.
- .2 Manufacturers:
  - .1 Watts Industries (Canada) Inc. "SG" Series.
  - .2 Jay R. Smith 5000 Series "HYDROTROL";
  - .3 Zurn #Z1700 "SHOKTROL";
  - .4 Mifab "HAMMERGUARD" WHB Series;

## 2.10 Water Hammer Arrestors

- .1 Piston type, sealed, all stainless steel construction, pressurized water hammer arrestors suitable for either vertical or horizontal installation, each complete with a pressurized compression chamber, welded nesting-type expansion bellows surrounded by non-toxic mineral oil, and a male treaded nipple connection.
- .2 Manufacturers:
  - .1 Jay R. Smith 5000 Series;
  - .2 Precision Plumbing Products "SS" Series.
- .3 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to diameter of pipe in which arrestor is required.
- .4 Manufacturers:
  - .1 Watts Industries (Canada) Inc. LF05 or LF15M2;
  - .2 Zurn #Z1260;
  - .3 Precision Plumbing Products Inc. SC Series;
  - .4 Mifab MWH Series.
- .5 Pressurized type, selected to withstand system pressure and to suit calculated movement from -5°C (23°F) to maximum operating temperature plus 25% safety factor, complete with stainless steel bellows and shroud, copper tube sweat type female ends, anti-torque device, and proper and suitable alignment guides for both sides of each compensator.
- .6 Manufacturers:
  - .1 Senior Flexonics Series HB;
  - .2 Hyspan Precision Products Series 8500.

## 2.11 Pipe Anchors

- .1 Welded structural black steel anchors of a design, size, and type to securely anchor pipe at point shown. Each anchor is to withstand 150% axial thrust, and is to be designed and detailed by a professional structural engineer registered and licensed in jurisdiction of the work. Submit anchor design and fabrication shop drawings, stamped by design engineer.

## 2.12 Air Vents

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm (¾") straight water main vent valves, each tapped at the top for a 3.2 mm (1/8") safety drain connection.

## 3 Execution

### 3.01 Piping Installation Requirements

- .1 Provide required domestic water piping.
-

- .2 Piping, unless otherwise specified, is as follows:
  - .1 for 12 mm (½") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;
  - .2 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints.
    - .1 Type "L" hard copper with pressure coupled mechanical joints.
- .3 Slope piping so it can be completely drained.
- .4 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

### **3.02 Installation of Shut-Off and Check Valves**

- .1 Refer to Part 3 of Section 20 05 00 – Common Work Results for Mechanical.
- .2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

### **3.03 Installation of Drain Valves**

- .1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.
- .2 Locate drain valves so they are easily accessible.

### **3.04 Installation of Partition Stops**

- .1 Provide partition stops in domestic water piping to each group of suite washroom plumbing fixtures. Locate partition stops in piping near floor level in inconspicuous but accessible locations. Confirm exact locations prior to roughing-in.

### **3.05 Installation of Domestic Hot Water Thermostatic Mixing Valves**

- .1 Provide a domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with an engraved nameplate.

### **3.06 Installation of Hose Bibbs**

- .1 Provide hose bibbs.
  - .2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above floor. Confirm exact locations prior to roughing-in.
  - .3 Provide non-freeze ground hydrants. Confirm exact locations prior to roughing-in.
  - .4 Ensure length of piping to outlet box suits depth of underground piping, and underground piping elbow and valve housing is set in an envelope of clean sharp, 100% Proctor
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density compacted sand. Provide a length of small bore copper tubing from valve drain port into sand envelope.

.5 Provide a shut-off valve inside building to each ground hydrant.

.6 .

### **3.07 Installation of Trap Seal Primers**

- .1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.
- .2 Water closet flush valves may be used for priming washroom floor drain traps if flush tube is properly tapped and primer tubing exposed in washroom is chrome plated.
- .3 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.
- .4 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple (4 to 30) traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.
- .5 Ensure trap primer piping is secured to floor drain primer tapplings and not terminated through the tapping in the throat of the drain.

### **3.08 Installation of Shock Absorbers**

- .1 Provide accessible shock absorbers in make-up water piping to equipment.
- .2 Ensure size of each shock absorber is properly selected to suit size of water pipe and equipment pipe is connected to.
- .3 Install down stream of backflow preventor.

### **3.09 Installation of Water Hammer Arrestors**

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
  - .1 in headers at groups of plumbing fixtures;
  - .2 at top of risers;
  - .3 at ends of long horizontal runs of piping;
  - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
  - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with manufacturer's instructions and details.

### **3.10 Flushing and Disinfecting Piping**

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Isolate new piping from existing piping prior to flushing and disinfecting procedures.
- .3 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .4 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.
- .5 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.

### **1.02 Closeout Submittals**

- .1 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.
- .2 Record Drawings: Indicate inverts of new below grade sanitary and storm piping on as-built drawings.

## **2 Products**

### **2.01 Pipe, Fittings, and Joints**

- .1 PVC Sewer
    - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
    - .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.
  - .2 PVC - DWV
    - .1 For Low Buildings: Equal to IPEX System 15 drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating not more than 25 when tested to CAN/ULC S102.2, with solvent weld joints or MJ Grey mechanical joint couplings, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.
    - .2 For High Buildings and Plenums: Equal to IPEX System XFR drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating not more than 25 and a smoke developed classification not more than 50 when tested to CAN/ULC S102.2, with solvent weld joints or MJ Grey mechanical joint couplings, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.
  - .3 Copper - Solder Joint
    - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
  - .4 Cast Iron
    - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
  - .5 Copper-Victaulic Coupling Joint
-

- .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.
- .6 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.
- .7 Each vent stack cover is to be complete with a vandal-proof cap.

## **2.02 Cleanouts**

- .1 Horizontal Piping
  - .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping
  - .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

## **2.03 Floor Cleanout Terminations**

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 Manufacturers:
  - .1 Watts Industries (Canada) Ltd. # CO-200-R-1.
  - .2 Jay R. Smith #4020-F-C Series;
  - .3 Zurn # ZN-1602-SP Series;
  - .4 Mifab # C1100-XR-1 or #C1000-R-3;
- .3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

## **2.04 Floor Drains, Funnel Floor Drains, and Hub Drains**

- .1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.
- .2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.
- .3 Manufacturers:
  - .1 Watts Industries (Canada) Ltd.;
  - .2 Jay R. Smith Manufacturing Co.;

- .3 Zurn Industries Ltd.;
- .4 Mifab Inc.

### **3 Execution**

#### **3.01 Demolition**

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

#### **3.02 Drain and Vent Piping Installation Requirements**

- .1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:
    - .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;
    - .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;
    - .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
    - .4 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;
    - .5 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.
  - .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
  - .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
  - .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
  - .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
  - .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.
-

### **3.03 Installation of Shut-Off and Check Valves**

- .1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.
- .2 Locate valves so they are easily accessible without the use of ladders or other such devices.

### **3.04 Supply of Vent Stack Covers**

- .1 Supply a properly sized vent stack cover for each vent stack penetrating roof.
- .2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

### **3.05 Installation of Cleanouts**

- .1 Provide cleanouts in drainage piping in locations as follows:
  - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
  - .2 at or as close as practicable to the foot of each drainage stack;
  - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
  - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
  - .5 in the wall at each new urinal or bank of urinals in a washroom;
  - .6 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

### **3.06 Installation of Floor Cleanout Terminations**

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.
- .2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
- .4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

### **3.07 Installation of Floor Drains, Funnel Floor Drains and Hub Drains**

- .1 Provide floor drains, funnel floor drains and hub drains.
-

- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.
- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit shop drawings/product data sheets for all products specified in this section, except piping and valves.

### **1.02 Closeout Submittals**

- .1 Submit a letter from compressor manufacturer/supplier to certify proper compressor set installation as specified in Part 3 of this section.
- .2 Training attendance records.

## **2 Products**

### **2.01 Pipe, Fittings and Joints**

- .1 Galvanized Steel
  - .1 Schedule 40 mild steel, galvanized, ASTM A53, screwed, complete with Class 125 galvanized cast iron screwed fittings and screwed joints.
- .2 Copper
  - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with forged solder type fittings to suit pipe, and soldered joints using 95% tin / 5% Antimony solder.

### **2.02 Piping Unions**

- .1 Screwed Steel Piping
  - .1 Malleable iron, galvanized, ground joint, brass to iron or bronze to bronze seat unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Soldered Copper Piping
  - .1 Solder-on forged copper or bronze screwed unions suitable in all respects for the application.

### **2.03 Low Pressure Shut-Off Valves**

- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body with solder joint or screwed joint ends as required, forged brass cap and blowout-proof stem, forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle.
  - .2 Manufacturers:
    - .1 Toyo Valve Co. Fig. 5049A solder or Fig. 5044A screwed;
    - .2 Watts Industries (Canada) Ltd. #FBV-3 or #FBVS-3;
    - .3 Kitz Corporation Code 59 solder or Code 58 screwed;
    - .4 Apollo Valves #70-100 screwed or #70-200 solder.
-

## 2.04 High Pressure Shut-Off Valves

- .1 Equal to Apollo Valves #70-100-27, 4140 kPa (600 psi) rated Class 600, screwed bronze ball valve with a PTFE seat, automatic relief vent, and removable lever handle.

## 2.05 Drain Valves

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm ( $\frac{3}{4}$ " dia. straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ( $\frac{3}{4}$ " dia. garden hose, and a cap and chain.
- .2 Manufacturers:
  - .1 Toyo Valve Co. Fig. 5046;
  - .2 Kitz Corporation Code 58CC;
  - .3 Apollo Valves #78-100 or #78-200;
  - .4 Watts Industries (Canada) Ltd. #B6000-CC.

## 2.06 Air Compressor Set

- .1 CompAir Kellogg "American", CSA certified, tank mounted, package type, duplex, pre-piped and pre-wired air compressor set designed for loadless starting, and complete with 2-stage, air cooled compressors arranged for automatic operation, and a separate power/control panel.
- .2 Compressor set model number, performance and electrical characteristics as indicate on mechanical drawings.
- .3 Each compressor complete with:
  - .1 cast iron cylinders, heads, crankcase, and cast iron connecting roads with replaceable automotive type insert bearings;
  - .2 cast iron crankshaft supported on both ends by oversized tapered roller bearings;
  - .3 pressure type oil lubrication with oil sight gauge;
  - .4 steel inlet and discharge valves, and a high efficiency intercooler with steel fins on copper tubes;
  - .5 heavy-duty dry type inlet filter-silencer;
  - .6 high volume, statically balanced flywheel/cooing fan;
  - .7 motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, on an adjustable support base, and V-belt drive with OHSA type steel belt guard, also as specified in Basic Mechanical Materials and Methods.
  - .8 Total Air system (TAS) Package with integrated dryer and filter system
- .4 Welded steel receiver including an ASME rated tank in accordance with CSA B51 and TSSA requirements, complete with welded steel support feet, and following:

- .1 ASME rated safety relief valve;
  - .2 positive seating ball type outlet valve, a screwed union, and a length of braided metallic flexible connection;
  - .3 pressure gauge with gauge cock;
  - .4 adjustable pressure switch for automatic start-stop operation of the compressors;
  - .5 valved manual tank drain, and an automatic tank drain;
  - .6 properly sized neoprene-steel-neoprene vibration isolating mounting pads;
  - .7 braided stainless steel flexible pipe connectors supplied loose.
- .5 Surface wall mounting power and control panel in a NEMA 1 (NEMA 2 if room is sprinklered) enamelled steel enclosure with a hinged (piano hinge) lockable front door, door interlock disconnect switch, and following:
- .1 overload protected across-the-line, non-reversing magnetic starter, and a door mounted H-O-A switch for each motor, in accordance with Section 20 05 00 – Common Work Results for Mechanical;
  - .2 fused control transformer;
  - .3 electronic alternator to automatically alternate lead compressor after each start cycle, and to automatically start lag compressor should the lead compressor fail to start;
  - .4 door mounted "power on" LED for panel and door mounted "run" LED for each compressor;
  - .5 terminal block and strips for power and control wiring connections, including control wiring from receiver mounted pressure switch.
- .6 Manufacturers:
- .1 Ingersoll Rand
  - .2 CompAir Kellog;
  - .3 Atlas Copco Compressors Canada;
  - .4 DeVair Systems.

## 2.07 Refrigerated Dryer

- .1 Package type, wall mounting refrigerated air dryer supplied with air compressor set, capable of reducing the dew point of total compressor set air delivery to -23°C (-10°F) with a maximum 20 kPa (3 psi) pressure drop at rated capacity, and complete with:
  - .1 pressure regulator;
  - .2 moisture separator with automatic drain;
  - .3 manual 3-valve bypass to permit isolation and removal of heat exchanger for servicing without interrupting air flow;

- .4 pressure relief valve;
- .5 pre-wired NEMA 1 (NEMA 2 if room is sprinklered) power and control panel with disconnect switch, motor starter, power on LED, air inlet temperature gauge, high temperature LED, refrigerant suction pressure gauge, air outlet temperature gauge, air outlet pressure gauge, and terminal strips for wiring connections;
- .6 non CFC refrigerant;
- .7 hot gas by-pass to maintain continuous operation and stable dew point;
- .8 replaceable element air filter capable of removing 99% of the total oil present, 100% of solid particles 0.6 micron or larger, and 90% of solid particles 0.4 micron or larger.

## **2.08 Piping System Components**

- .1 Outlets equal to DeVair or ARO Fluid Products female bayonet lock type quick-connect outlets with exact type and size as directed, each complete with a non-corrosive hose hanger.
- .2 Pressure regulators equal to Watts (CompAir) R119 Series, adjustable, heavy-duty diaphragm type pressure regulators, each complete with a pressure gauge and a mounting bracket.
- .3 Filters equal to Watts (CompAir) F602 Series heavy-duty 40 micron filters, each complete with a zinc bowl with sight glass, internal automatic drain, and mounting bracket.
- .4 Combination filter-regulator assemblies equal to Watts (CompAir) B11 Series general purpose filter-regulators, each complete with an adjustable diaphragm type pressure regulator with pressure gauge, a 40 micron filter with zinc bowl, sight glass and automatic drain, and a mounting bracket.

## **3 Execution**

### **3.01 Installation of Air Compressor Set**

- .1 Provide an air compressor set.
  - .2 Secure set in place on vibration isolation on a concrete housekeeping pad.
  - .3 Install accessories shipped loose with set, except power and control panel.
  - .4 Extend type DWV soldered hard copper drainage piping from tank drain assemblies to nearest floor drain.
  - .5 Hand power and control panel to electrical trade at site for mounting and power wiring connections as part of electrical work.
  - .6 Connect receiver pressure switch to starter and control panel with wiring in conduit to the standards of the electrical work and in accordance with panel supplier's instructions.
  - .7 Touch-up paint any damage to the factory finish.
-

### **3.02 Installation of Refrigerated Dryer**

- .1 Provide a refrigerated dryer and wall mount adjacent to compressor set. Connect with piping, including type DWV hard copper drainage piping terminated over a floor drain.

### **3.03 Installation of Piping and Piping System Components**

- .1 Provide required compressed air piping. Unless otherwise specified, install horizontal piping to outlets 1.5 m (5 feet) above finished floor level.
- .2 Pipe is to be Schedule 40 mild galvanized steel, screwed, or type "L" hard copper, soldered.
- .3 Support and secure piping generally as specified in Section 20 05 00 – Common Work Results for Mechanical, but with extra support and securing hardware as required to prevent drumming. Provide rigid supports at each side of outlets.
- .4 Arrange piping so condensate will drain from mains and branches into drip legs. Provide drip legs at bottom of risers, every 30 m (100') of pipe run, and at the end of each branch piping run, whether indicated on drawings or not.
- .5 Drip legs are to extend down from bottom of pipe and consist of a piping tee and 250 mm (10") long pipe nipple same size as main or branch pipe, then a reducing fitting (if required) and 12 mm (½") dia. piping extended down to floor level and terminated with a ball valve. Ensure drain points are easily accessible and identified.
- .6 Extend branch piping to outlets and/or equipment off the top of the main(s).
- .7 Provide shut-off valves in piping at all equipment connections, to isolate piping components for removal or maintenance, and wherever else specified or shown. Provide vented type valves between air compressor set and pressure reducing stations.
- .8 Provide unions in piping at connections to equipment.
- .9 When piping is complete and has been pressure tested, but before connection of outlets, blowout piping to remove oil and foreign matter.
- .10 Provide adjustable pressure regulators, filters, compressed air outlets, etc. Unless otherwise indicated locate outlets 1.5 m (5 feet) above floor and properly secured in place. Provide a hose hanger at each outlet location. Confirm exact location of piping components prior to roughing-in.

### **3.04 System Startup**

- .1 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
  - .2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Submit a copy of the letter prior to Substantial Performance of the Work.
-

**3.05 Closeout Activities**

- .1 Include for 4 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Electric water heaters and water heater accessories.

### **1.02 References**

- .1 ANSI Z21.22, Relief Valves for Hot Water Supply Systems.
- .2 ASHRAE/IESNA 90.1, Energy Standard For Buildings Except Low-Rise Residential Buildings.
- .3 CSA C22.2 No. 88, Construction and Test of Industrial Heating Equipment.

### **1.03 Submittals**

- .1 Product Data: For each product:
  - .1 Manufacturer's data sheets indicating unit performance and compliance with requirements.
  - .2 Include details of electrical and mechanical operating parts.
  - .3 Show mounting and securing requirements and utility connection requirements.

### **1.04 Closeout Submittals**

- .1 Submit manufacturer/supplier installation certification letters as specified in Part 3 of this Section.
- .2 Submit with delivery of heater(s) a copy of the factory inspection and test report for each heater and include a copy of each report with O&M manual project closeout data.
- .3 Submit, prior to Substantial Performance of the Work, start-up or test data specified in Part 3 of this Section.

### **1.05 Warranty**

- .1 Standard Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  - .1 Standard Warranty Period: From Date of Substantial Completion:
    - .1 Electrical Components: two years
    - .2 Heating Elements: four years
    - .3 Heat Exchanger free from leaks: eight years.

## **2 Products**

### **2.01 Point-of-Use Electric Domestic Hot Water Storage Tank and Heater**

- .1 ULC listed and CSA certified electric domestic hot water storage tank and heater with model number and performance as specified on drawings, and complete with:
-

- .1 1035 kPa (150 psi) rated (working pressure) steel tank, glass lined, polyurethane foam insulated, covered with an enamelled steel jacket with access panel, and equipped with a bottom hose end drain cock;
  - .2 immersion heating element imbedded in magnesium oxide and sealed in a seamless copper tube;
  - .3 sacrificial anode rod;
  - .4 surface mounted adjustable thermostat and a high temperature safety cut-out;
  - .5 ASME rated temperature and pressure relief valve;
  - .6 round galvanized steel auxiliary catch pan with drain hole and connection spigot.
- .2 Acceptable manufacturers are:
- .1 A.O. Smith Water Products Co.;
  - .2 John Wood (GSW Water Heating Co.);
  - .3 Rheem Canada Ltd.;
  - .4 Bradford White Canada Inc.

### **3 Execution**

#### **3.01 Drainage coordination**

- .1 Coordinate drain requirements of plumbing equipment provided by Mechanical Division and or Owner with location of drains specified in Section 22 13 00.

#### **3.02 Installation of Instantaneous Electric Hot Water Heater**

- .1 Provide a tankless, electric, instantaneous, point-of-use domestic hot water heater.
- .2 Rigidly secure in place in accordance with manufacturer's instructions and ensure unit is easily accessible.
- .3 Coordinate installation with electrical trade who will connect heater with power wiring.
- .4 Set thermostat to ensure heater produces maximum 49°C (120°F) hot water.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Submit a copy of the letter prior to Substantial Performance of the Work.

#### **3.03 Installation of Point-of-Use Electric Domestic Hot Water Storage Tank and Heater**

- .1 Provide a point-of-use domestic hot water storage tank and heater.
  - .2 Provide a wall bracket (supplied by the heater manufacturer) for heater mounting and rigidly secure in place.
-

- .3 Mount heater in a catch pan and:
  - .1 pipe temperature/pressure relief valve outlet to drain;
  - .2 pipe auxiliary catch pan to drain;
  - .3 coordinate installation with electrical trade who will connect heater with power wiring;
  - .4 check and test heater operation and, unless otherwise specified or instructed, set thermostat to produce 48.8°C (120°F) hot water.

#### **3.04 Training**

- .1 Include for 2 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Plumbing fixtures and related components.

**1.02 Submittals**

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings, including accessories.
- .2 Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- .3 Wiring Diagrams: Power, signal, and control wiring.
- .4 Submit fixture manufacturer's standard colour charts for all fixtures where colours are available, but a particular colour is not specified.
- .5 [Submit proof of WaterSense labelling for all applicable plumbing fixtures in accordance with Section 01 35 66.]

**1.03 Closeout Submittals**

- .1 Operation and maintenance data.

**2 Products**

**2.01 Manufacturers**

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
  - .1 Flush Valves:
    - .1 Sloan;
    - .2 Delta Commercial;
    - .3 Zurn Industries;
    - .4 Moen Commercial.
  - .2 Plumbing Brass:
    - .1 Sloan;
    - .2 Acorn Engineering;
    - .3 American Standard;
    - .4 Delta Commercial;
    - .5 Chicago Faucet;
    - .6 Moen Commercial.

- .3 Stainless Steel Sinks:
    - .1 Franke Commercial;
    - .2 Novanni Commercial;
    - .3 Aristaline;
    - .4 Arch Metal Ind.
  - .4 Mop Sinks:
    - .1 Stern Williams;
    - .2 Acorn Engineering;
    - .3 Zurn Industries.
  - .5 Emergency Eye Wash and Emergency Showers:
    - .1 Haws;
    - .2 Speakman;
    - .3 Bradley.
  - .6 Drain Fittings, Angle Supplies, and Traps:
    - .1 McGuire;
    - .2 American Standard;
    - .3 Delta Commercial;
    - .4 Zurn Industries.
  - .7 Fixture Carriers:
    - .1 Watts Industries;
    - .2 Jay R. Smith;
    - .3 Zurn Industries.
  - .8 Hose Bibbs:
    - .1 Jay R. Smith;
    - .2 Zurn Industries.
  - .9 Water Closets, Lavatories, and Urinal:
    - .1 American Standard;
    - .2 Zurn Industries;
    - .3 Kohler.
  - .10 Thermostatic Mixing Valves:
-

- .1 Lawler;
- .2 Delta Commercial;
- .3 Leonard.
- .11 Shower and Associated Trim:
  - .1 American Standard;
  - .2 Delta Commercial;
  - .3 Zurn Industries;
  - .4 Moen Commercial.
- .12 Toilet Seats:
  - .1 Olsonite;
  - .2 Centoco;
  - .3 Bemis Commercial.
- .13 Electronic "No Touch" Flush Valves:
  - .1 Sloan;
  - .2 Delta Commercial;
  - .3 Zurn Industries;
  - .4 Moen Commercial.
- .14 Electronic "No Touch" Faucets:
  - .1 Sloan;
  - .2 Delta Commercial;
  - .3 Zurn Industries;
  - .4 Moen Commercial.

## **2.02 General Re: Plumbing Fixtures and Fittings**

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
  - .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
  - .3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.
-

- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.
- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum 17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

## 2.03 Plumbing Fixtures and Fittings

- .1 Plumbing fixtures and fittings are to be in accordance with the following:
  - .1 JS-1 Floor Mounted Service Sink: Stern Williams MTB-2424-T-10-VB-T-35-T-40-BP-A-20 Sink - Single compartment sink, Service sink, with overall dimension 610 mm (24") long, 610 mm (24") wide, 254 mm (10") high, constructed from Precast terrazzo, Bowl dimensions are 546 mm (21-1/2") wide, 203 mm (8") deep, Pearl grey marble chips and white portland cement, Center waste location, 76 mm (3") pipe size, cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm (3") pipe, stainless steel dome strainer, Mop service sink fitting, Hose and wall hook, Mop hanger, Splash catcher, 610 mm (24") aluminum bumper guard with vinyl insert (1239BB24).  
  
Chicago Faucets 540-LD897SWXFABCP Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Polished chrome finish, 203 mm (8") centerset, Lead free compliant, ECAST® brass construction, 51 mm (2") straight inlet supply arms, Quatern™ compression cartridge (90° turn), Unrestricted flow, Threaded hose end, Low-arc spout, 146 mm (5-3/4") spout reach, 305 mm (12") high, Top brace, Vandal-resistant 60 mm (2-3/8") lever handle with indexed buttons, 13 mm (1/2") NPT female thread inlet.
  - .2 S-1 Wall Hung Service Sink: Franke Commercial WSS6713-2 Sink - Single compartment sink, 203 mm (8") centerset, Service sink, with overall dimension 508 mm (20") long, 483 mm (19") wide, 635 mm (25") high, constructed from 14 gauge Type 304 Stainless steel, Bowl dimensions are 432 mm (17") long, 406

mm (16") wide, 330 mm (13") deep, Polished to #4 satin finish, With 305 mm (12") high backsplash, Radius coved bowl corners, Less overflow, Center waste location, 89 mm (3-1/2") crumb cup strainer, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.

Chicago Faucets 540-LD897SWXFABCP Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Polished chrome finish, 203 mm (8") centerset, Lead free compliant, ECAST® brass construction, 51 mm (2") straight inlet supply arms, Quatern™ compression cartridge (90° turn), Unrestricted flow, Threaded hose end, Low-arc spout, 146 mm (5-3/4") spout reach, 305 mm (12") high, Top brace, Vandal-resistant 60 mm (2-3/8") lever handle with indexed buttons, 13 mm (1/2") NPT female thread inlet.

- .3 ES-EW Combination shower and Eyewash: Emergency Guardian G1902-DC-SSH-HFC Emergency Equipment - Floor mounted, constructed from Stainless Steel Bowl and ABS or Stainless Steel Showerhead, Stainless steel, 283 mm (11-1/8") Ø bowl size, Orange ABS plastic showerhead, Two GS-Plus spray heads with flip top dust cover each, 25 mm (1") Ø I.P.S. chrome-plated brass stay-open ball valve, 13 mm (1/2") Ø I.P.S. chrome-plated brass stay open ball valve, Stainless steel showerhead, 254 mm (10") Ø showerhead size, 75 LPM (20 GPM) flow control, 32 mm (1-1/4") Ø NPT female top or side inlet supply inlet, Schedule 40, Furnished with orange polyethylene pipe, 32 mm (1-1/4") Ø NPT female outlet, GS Dust Cover. Addn. for Each Stn. Steel Dust Cover for GS-Plus™ Spray Head in Place of Plastic, Hand and Foot Control, Hand and Foot Control, Codes and Compliances:, ANSI compliant.

Watts FD-104NH-C-A5-1 Floor Drain - Epoxy coated cast iron, Floor drain, Adjustable Round 6 mm (1/4") thick top, 102 mm (4") pipe size, No-hub outlet, 127 mm (5") diameter nickel bronze strainer, Anchor flange, Trap primer tapping, Reversible membrane clamp, Collar with primary and secondary weepholes, 52 cm² (8 sq. in) free area, Certification and Compliances include: ASME A112.21.1M compliant.

Lawler 911E/F-Unit 84908 Mixing Valve - Emergency mixing valve, Thermostatic High-low master water mixing valve, Chrome plate finish, 229 x 205 x 127 mm (9" x 8" x 5") , Temperature adjustment shall be vandal-resistant, 7.5 LPM (2 GPM) tempered flowrate @ 5 PSI pressure drop, 11 LPM (3 GPM) tempered flowrate @ 10 PSI pressure drop, 18 LPM (5 GPM) tempered flowrate @ 20 PSI pressure drop, 26 LPM (7 GPM) tempered flowrate @ 20 PSI pressure drop, In the event that the liquid motor fails, the control mechanism closes off the hot water port with the reverse seat and fully opens the internal variable bypass to allow cold water flow, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass, Listed to ASSE 1071, 32 mm (1-1/4") NPT inlet, 32 mm (1-1/4") NPT outlet, In the event of interruption of the hot water supply, the control mechanism shall allow cold flow through both the fixed and variable bypass., Outlet Thermometer, In the event of interruption of the cold water supply, the control mechanism closes off the hot water port, stopping all flow. Positive hot water shut-off, 85 F, 125 PSI max inlet pressure, 70-90 F, 120 F Recommended inlet temperature, 65 PSI recommended operating pressure, 38 LPM (10 GPM) tempered flowrate @ 40 PSI pressure drop

## 2.04 Caulking

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by the Consultant from sealant manufacturer's standard colour range.

## 3 Execution

### 3.01 Demolition

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

### 3.02 Installation of Plumbing Fixtures and Fittings

- .1 Provide required plumbing fixtures and fittings.
- .2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions.
- .3 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

Fixture and/or Fitting	Drain Size mm (in)	Vent Size mm (in)	DHW Size mm (in)	DCW Size mm (in)	Temp Water Size mm (in)
Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	-
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-
Emergency Eye Wash	-	-	-	-	12 (½)
Emergency Shower	-	-	-	-	25 (1)

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.
- .5 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).
- .7 For barrier-free water closets utilizing manual flush controls, controls to be installed so that it is operable from the transfer side of the fixture.
- .8 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .9 Locate control panels for electronic faucets under lavatories and recessed into wall. Coordinate panel installations with electrical trade who will provide 115 V power wiring to panels. Install flexible conduit (supplied with box) and extend cord from faucet through the flexible conduit to control box. Connect hot and cold water piping to mixing valve in each box, and tempered water piping from each mixing valve to faucet. Set mixing valve

maximum temperature limit stops to 43°C (110°F) after domestic water systems (hot and cold) are complete. Ensure each programmable controller is properly programmed and water off after deactivation is set for 3 seconds.

- .10 For electronic flush valves, locate transformer in ceiling space above electronic units to be served. Coordinate locations with electrical trade who will provide 120 V line supply to transformers. Provide low voltage wiring from transformers to each electronic flush valve terminal point. Electrical line supply and low voltage wiring is to be concealed and access to transformer must be provided for servicing.
- .11 Protect shower bases from damage during construction and finishing work.
- .12 Confirm exact mixing valve and shower head locations prior to roughing-in.
- .13 Install refrigerated drinking fountains in accordance with manufacturer's instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.
- .14 For emergency showers, install so bottom of shower head is approximately 2 m (82 in) above floor, and approximately 400 mm (16 in) out from the wall. Wall mount mixing valve approximately 1.5 m (5 ft) above floor and adjacent shower head. Set valve temperature limit stop to 35°C (95°F). Ensure valve is open and exposed piping is chrome plated or stainless steel.
- .15 Install eye wash fixtures in accordance with manufacturer's instructions. Ensure exposed piping is painted.
- .16 Wall mount mixing valves for emergency fixtures approximately 1.5 m (5 ft) above floor and secure in place. Check and confirm valve operation and temperature of tempered water supply. Provide cabinets. Identify each cabinet and hand 3 identified cabinet keys to Consultant prior to Substantial Performance of the Work.
- .17 Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

### **3.03 Caulking at Plumbing Fixtures and Fittings**

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.
- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

### **3.04 Clothes Washer Connections**

- .1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:
-

- .1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
- .2 50 mm (2") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Materials and installation for piping, valves, and fittings for gas fired equipment.

### **1.02 References**

- .1 CSA B149.1:20, Natural Gas and Propane Installation Code.
- .2 TSSA FS-255-21, Gaseous Fuels Code Adoption Document Amendment: Ontario requirements effective May 1, 2021.
- .3 CSA C282:19, Emergency electrical power supply for buildings.

### **1.03 Definitions**

- .1 PRV – Pressure Reducing Valve.

### **1.04 Submittals**

- .1 Submit shop drawings/product data for all products specified in Part 2 of this section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.
- .2 For each gas pressure regulating station, submit:
  - .1 a selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;
  - .2 a selection sheet for each relief valve(s) serving a PRV.

### **1.05 Closeout Submittals**

- .1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00.
- .2 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

### **1.06 Quality Assurance**

- .1 All gas system work is to be in accordance with requirements of CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
  - .2 All gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under the TSSA Act.
  - .3 Apply for, on TSSA forms, approval of the gas system design by the TSSA prior to work beginning at the site and prior to ordering any equipment. Submit the completed TSSA form and copies of shop drawings/product data sheets as required to the TSSA and obtain an approval certificate. Pay all costs for the TSSA review and approval process. If the TSSA requires revisions to the system and the revisions result in an extra cost, a Notice of Change will be issued by the Consultant for the revision.
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## 2 Products

### 2.01 Pipe, Fittings, and Joints

- .1 Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site bevelled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces are to be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.
- .2 Polyethylene: Safety yellow coloured polyethylene pipe, fittings, and joints to CSA-B137.4.
- .3 Coated Copper: Type "K" soft temper copper with a factory applied external yellow plastic coating and flare fittings with forged brass nuts to CAN/CSA-B149.1. Nuts are to be stamped with the designation C37700 to indicate that they are forged brass.
- .4 Uncoated Black Steel - Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.
- .5 Uncoated Black Steel - Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .6 Copper-Uncoated: Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45° flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .7 Flexible Stainless Steel: Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. The tubing is to be supplied in coils and is to be complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.
  - .1 Manufacturers:
    - .1 Tru-Flex Metal Hose LLC. "Pro-Flex";
    - .2 Titeflex Corp. "Gastite";
    - .3 Omega Flex Canada "TracPipe".

### 2.02 Piping Unions

- .1 Screwed Piping: Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
  - .2 Flanged Piping: Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.
  - .3 Copper to Steel: Equal to Kamco Products "Copper Stopper".
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## 2.03 Earthquake Activated Automatic Shut-Off Valves

- .1 Equal to KAS International or Nihon Koso Model 315 HPF earthquake activated, flanged, high pressure automatic shut-off valve suitable for both natural gas and propane, ULC listed and in accordance with ANSI Z21.70, Earthquake Actuated Automatic Gas Shutoff Valves.

## 2.04 Shut-Off Valves

- .1 Ball Type:
  - .1 CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.
  - .2 Manufacturers:
    - .1 Neo Valves Inc. #425;
    - .2 Kitz Corp. Code 58;
    - .3 Toyo Valve Co. Fig. 5044A.
  - .2 Plug or Ball Type: CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.
    - .1 Manufacturers:
      - .1 Neo Valves Inc. #1AS40114 plug valve;
      - .2 Newman Hattersley #171M plug valve;
      - .3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.

## 2.05 Position Indicating Switches for Shut-Off Valves

- .1 CSA approved limit switch, rated EX db IICT6/EX tb IIIC T85°C explosion proof, class 1, zone 1, IP67 enclosure.
- .2 Secure water resistant case with multi-angle top and side visual indicator. Red to indicate fully closed position and yellow to indicate fully open position.
- .3 Two single pole double throw mechanical switches.
- .4 Includes position indicating contacts for connection of supervisory cabling and remote monitoring of valve status.
- .5 NAMUR shaft.
- .6 Ensure the shut off valve and the position indicating switch are compatible with one another.
- .7 Manufacturers:
  - .1 CVS Controls Ltd., CVS 870 series limit switch.

.2 Rotork.

.3 Topworx.

## **2.06 Natural Gas Convenience Outlet**

.1 Neo Valves Model 3/375 quick-connect type CSA certified outlet with interlocking safety cam to prevent release of the appliance connector until the valve is off, integral thermal protection to prevent gas flow if the outlet is exposed to temperatures exceeding 90°C (195°F), and a wall enclosure box.

.2 Manufacturers:

.1 Neo Valves Inc.;

.2 Fairview Fittings & Mfg. Ltd.

## **2.07 Pressure Regulators**

.1 CSA certified pressure regulators as follows:

.1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm.

.2 vented type: spring-loaded self-operated design, tight closing, selected for the facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:

.1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel.

.2 Aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring.

.3 Throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of the regulator in coordination with regulator capacity.

.2 Manufacturers:

.1 Maxitrol Co.

.2 Fisher Controls.

.3 Leslie Controls Inc.

.4 Lakeside Process Controls.

## **3 Execution**

### **3.01 Demolition**

.1 Do all required gas system demolition work. Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

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### 3.02 Natural Gas Service

- .1 Make all required arrangement with the natural gas supply utility on behalf of the Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.
- .2 Provide an earthquake activated automatic shut-off valve in gas service piping outside the building in accordance with the valve manufacturer's installation instructions. Provide an angle iron framed wire mesh enclosure around the valve and bolted to the wall.
- .3 Provide 2 m (7') high minimum 200 mm (8") diameter Schedule 80 galvanized steel concrete filled bollards at the meter-regulator location in a pattern to protect the meter-regulator. Install the pipe straight and plumb a 1.2 m (4') below grade in a continuous 600 mm (2') diameter reinforced concrete footing. Smoothly crown the top of the concrete above the top of the pipe.
- .4 Maintain minimum 300 mm (12 in) horizontal separation between buried natural gas piping and other services.

### 3.03 Natural Gas Piping Installation Requirements

- .1 Provide all required natural gas distribution piping and connect gas fired or operated equipment, and provide all required vent piping to atmosphere, including vent piping from pressure regulators. Do all piping work in accordance with requirements of CAN/CSA-B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
  - .2 Piping is to be as follows:
    - .1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;
    - .2 for above ground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.
  - .3 Install flexible stainless steel pipe in strict accordance with the pipe manufacturer's printed instructions.
  - .4 Slope gas piping in the direction of flow to low points.
  - .5 Where natural gas piping is run vertically through internal building risers, provide vent through roof for reach riser.
  - .6 Where natural piping serving an emergency generator is run internally to the building, provide a fire rated enclosure around that piping, isolated from all other natural gas piping or other building services.
  - .7 Ensure that supports for roof mounted piping are sized (height) to accommodate the roof slope and the required piping slope, and to permit the installation of low point dirt pockets.
  - .8 Provide full pipe diameter 150 mm (6") long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.
  - .9 Identify all natural gas piping above ground with two coats of safety yellow enamel applied over primer and coil type vinyl identification makers with arrows. SMS Ltd. or equal can be used for identification markers.
-

- .10 For all underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above the pipe approximately 250 mm (10") below grade.
- .11 Rough-in all required natural gas piping for kitchen and laundry equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for the equipment and confirm exact locations prior to roughing-in. When the equipment has been installed, connect the equipment from the roughed-in Work. Provide shut-off valves in all piping connections to the equipment.
- .12 Include for mounting only of a solenoid valve in the gas piping to kitchen cooking equipment.

#### **3.04 Installation of Shut-Off Valves**

- .1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .2 Ensure that valves are located for easy accessibility and maintenance.
- .3 For all valves installed in an emergency gas supply line including, but not limited to, the regulator station. Provide position indicating contacts to initiate a trouble alarm condition at the generator control panel and/or fire alarm control panel when any valve is closed. Provide in accordance with CSA C282:19 Emergency Electrical Power. Coordinate with electrical trade and generator supplier.

#### **3.05 Installation of Natural Gas Convenience Outlets**

- .1 Provide natural gas convenience outlets and wall mount.
- .2 Provide a shut-off valve in connecting piping, confirm exact location prior to roughing-in, and ensure that the outlet is rigidly secured in place.

#### **3.06 Installation of Pressure Regulators**

- .1 Provide pressure regulators in gas distribution piping where indicated and/or required.
  - .2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with the manufacturer's instructions. Note that these pressure regulators do not require vent piping.
  - .3 Use vented type pressure regulators for all other applications.
  - .4 Install regulating stations in accordance with requirements of CAN/CSA-B149.1.
  - .5 Provide a manual shut-off valve upstream of the pressure regulator and provide overpressure protection devices.
  - .6 Provide 6 mm (1/4") diameter test ports upstream and downstream of each regulator assembly.
  - .7 Locate outdoor regulating stations vent termination a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide all required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.
-

- .8      Locate indoor regulating stations in locations accessible without the use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through the roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 HVAC ducts and casings.
- .2 Acoustic duct lining material.
- .3 Special systems ductwork.
- .4 Dampers.
- .5 Louvres.
- .6 Other duct work accessories.

**1.02 Submittals**

- .1 Submit shop drawings/product data sheets for all products specified in this section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 With shop drawing/product data sheet submission, supply evidence that fire rated duct manufacturer is ULC listed to size requirements shows on drawings.
- .4 Submit duct leakage test data prior to ductwork being covered from view.
- .5 Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.

**1.03 Closeout Submittals**

- .1 Submit proper installation certification from fire rated duct manufacturer as specified in Part 3 of this section.
- .2 Submit a site inspection and start-up report from fan filter diffuser manufacturer's representative as specified in Part 3 of this section.

**1.04 Maintenance Material Submittals**

- .1 Supply and hand to Owner at Substantial Performance of the Work, a minimum of 10 identified (with tags) grille/diffuser volume control damper adjustment keys.

**1.05 Coordination**

- .1 Supply reviewed copies of ventilator/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ventilators, and ensure openings are properly sized and located.

**1.06 Quality Assurance**

- .1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.
-

## **2 Products**

### **2.01 Galvanized Steel Ductwork**

- .1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.
- .2 Rectangular
  - .1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 Round
  - .1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

### **2.02 Flexible Metallic Ductwork**

- .1 Bare
  - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", CAN/ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
- .2 Insulated
  - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", CAN/ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1-½") thick, 12 kg/m<sup>3</sup> (0.75 lb/ft<sup>3</sup>) density fibreglass insulation with a vinyl jacket meeting 25/50 flame spread and smoke developed requirements tested in accordance with CAN/ULC-S102.

### **2.03 Flexible Connection Material**

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber.
- .2 Manufacturers:
  - .1 Duro Dyne Canada Inc. "DUROLON";
  - .2 Dyn Air Inc. "HYPALON".
- .3 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber.
- .4 Manufacturers:
  - .1 Duro-Dyne Canada Inc. "THERMAFAB";
  - .2 Dyn Air Inc. "SILICON HI-T".

#### **2.04 Metal Duct System Joint Sealant**

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Manufacturers:
  - .1 Johns Manville;
  - .2 Manson Insulation;
  - .3 Knauf Insulation.

#### **2.05 Acoustic Lining**

- .1 Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.
- .2 Manufacturers:
  - .1 Johns Manville;
  - .2 Manson Insulation;
  - .3 Knauf Insulation.

#### **2.06 Round to Rectangular Duct Connections**

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

#### **2.07 Splitter Dampers**

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

#### **2.08 Air Turning Vanes**

- .1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
  - .2 For short branch ducts at grille and diffuser connections, air extractor type each equipped with a matching bottom operated 90° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
-

## 2.09 Manual Balancing (Volume) Dampers

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:
  - .1 hexagonal or square shaft extension through frame;
  - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
  - .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
  - .4 linkage for multiple blade dampers;
  - .5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
- .3 Round Dampers: Nailor Industries Inc. model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
- .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
- .5 Manufacturers:
  - .1 Nailor Industries Inc.;
  - .2 T.A. Morrison & Co. Inc. "TAMCO";
  - .3 Greenheck Fan Corp.;
  - .4 Ruskin Co.

## 2.10 Backdraft Dampers

- .1 Nailor Industries Model 1370CB counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:
  - .1 extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;
  - .2 extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;
  - .3 corrosion-resistant synthetic bearings;
  - .4 adjustable plated steel counterweights mounted internally in the airstream;
  - .5 concealed blade linkage located out of the airstream.
- .2 Manufacturers:

- .1 Nailor Industries Inc.;
- .2 T.A. Morrison & Co. Inc. "TAMCO";
- .3 Greenheck Fan Corp.;
- .4 Ruskin Co.

## **2.11 Fusible Link Dampers**

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .4 Manufacturers:
  - .1 Nailor Industries Inc.;
  - .2 Greenheck Fan Corp.;
  - .3 Ruskin Co.;
  - .4 Price Industries (E.H. Price).
- .5 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.
- .6 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .7 Manufacturers:
  - .1 Nailor Industries Inc.;
  - .2 Greenheck Fan Corp.;
  - .3 Ruskin Co.;
  - .4 Price Industries (E.H. Price).

## **2.12 Duct Access Doors**

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.
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### **2.13 Wire Mesh (Birdscreen)**

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm (½" x ½") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

### **2.14 Grilles and Diffusers**

- .1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.
- .2 Manufacturers:
  - .1 Price Industries Inc.;
  - .2 Anemostat;
  - .3 Krueger Division of Air System Components Inc.;
  - .4 Titus;
  - .5 Nailor Industries Inc.;
  - .6 Tuttle & Bailey.

## **3 Execution**

### **3.01 Cleanliness Requirements for Handling and Installation of Ductwork**

- .1 Handle and install ductwork in accordance with CSA Z317.2, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Healthcare Facilities and SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.
- .2 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

### **3.02 Fabrication and Installation of Galvanized Steel Ductwork**

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
  - .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.
  - .3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken or beaded per SMACNA standards. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
  - .4 Variable air volume ductwork from supply fans to boxes is as above but rectangular duct take-offs are double side straight taper type with a take-off length equal to 0.5 times the
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branch duct width but minimum 150 mm (6") length, and double taper side is to have an included angle of minimum 60°.

- .5 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by the Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.
  - .6 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
  - .7 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
  - .8 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
  - .9 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
  - .10 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.
  - .11 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by the Consultant.
  - .12 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.
  - .13 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
  - .14 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:
    - .1 ductwork outside building or otherwise exposed to the elements;
    - .2 dishwasher exhaust;
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- .3 shower exhaust ducts from grilles to duct main or riser;
  - .4 minimum of 3 m (10') upstream and downstream of duct mounted humidifiers or humidifier manifolds;
  - .5 fresh air intakes;
  - .6 wherever else shown.
  - .15 Leakage Testing:
    - .1 Ductwork leakage is not to exceed following:
      - .1 ductwork to 2" W.C. Class, 1% of total air quantity handled by respective fans;
      - .2 ductwork exceeding 2" W.C. Class, 2% of total air quantity handled by respective fans.
    - .2 Leakage testing is to be performed by the Testing, Adjusting and Balancing (TAB) agency in accordance with SMACNA HVAC Air Duct Leakage Test Manual and is to be witnessed by the Consultant.
    - .3 Leakage test following ductwork:
      - .1 [ ];
      - .2 [ ].
    - .4 Be responsible for following:
      - .1 preparing duct systems for leakage testing prior to installation of external insulation including capping duct runouts and provision of final tap-in for test equipment;
      - .2 schedule testing with TAB agency in advance, be present for all testing and ensure notice is given to the Consultant so they may witness testing;
      - .3 resealing and/or replacement of defective ductwork;
      - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
  - .16 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
  - .17 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
  - .18 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.
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- .19 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.
- .20 Round exposed ductwork in Gymnasium is to be 2 metal gauges heavier than standard metal gauge for same size duct, and duct hangers are to be pairs of 9.5 mm ( $\frac{3}{8}$ ") diameter hanger rods secured to 40 mm (1- $\frac{1}{2}$ ") wide #12 gauge galvanized steel split clamps around full circumference of duct at maximum 1.8 m (72") centres. Provide double nuts and lock washers on each hanger rod above and below each clamp.
- .21 Equip ducts with a dimension of 600 mm (24") and larger and located in mechanical equipment rooms of any kind with hanger rods equipped with double deflection neoprene rod isolation hangers properly sized for associated load. Also refer to Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
- .22 In addition to SMACNA duct construction standards specified above, ductwork is to be constructed and installed to meet seismic requirements of British Columbia Building Code and ANSI/SMACNA The Seismic Restraint Manual: Guidelines for Mechanical Systems.

### 3.03 Installation of Flexible Ductwork

- .1 For supply air ductwork, provide maximum 1.8 m fully stretched, long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.
- .2 For return air ductwork, provide maximum 1.0 m fully stretched, long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles. Do not install flexible ductwork through walls, even if shown on drawings.
- .3 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .4 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.
- .5 Do not penetrate fire barriers with flexible duct.

### 3.04 Installation of Acoustic Lining

- .1 Provide acoustic lining in ductwork in locations as follows:
  - .1 wherever shown and/or specified on drawings;
  - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;
  - .3 all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

### **3.05 Installation of Round to Rectangular Duct Connections**

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

### **3.06 Installation of Splitter Dampers**

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

### **3.07 Installation of Turning Vanes**

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

### **3.08 Installation of Manual Balancing (Volume) Dampers**

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.
- .4 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

### **3.09 Installation of Backdraft Dampers**

- .1 Provide backdraft dampers.
- .2 Install and secure dampers so they cannot move or rattle.

### **3.10 Installation of Fusible Link Dampers**

- .1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr) is suitable for fire barrier it is associated with.
-

- .2 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .3 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .4 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple fusible link dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a

### **3.11 Installation of Flexible Connection Material**

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.
- .3 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .4 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.
- .5 When requested, submit a sample of proposed duct access doors for review.
- .6 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

### **3.12 Installation of Wire Mesh (Birdscreen)**

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.
- .3 .

### **3.13 Installation of Grilles and Diffusers**

- .1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.
  - .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
-

- .3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.
- .5 Provide sheet metal plenums, constructed of same material as connecting duct, for linear grilles and/or diffusers where shown. Construct and install plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip duct connection collar(s) with volume control device(s).
- .6 Where linear type diffusers/grilles are installed in suspended T-bar ceilings, clip diffusers/grilles in place using clip supplied by diffuser/grille manufacturer.
- .7 Confirm grille and diffuser finishes prior to ordering.

#### **3.14 Installation of Fan Filter Diffusers**

- .1 Supply door grilles as shown and scheduled.
- .2 Hand grilles to appropriate trade at site for installation.

#### **3.15 Duct System Protection, Cleaning and Start-Up**

- .1 Temporarily cover all open ends of ducts during construction.
- .2 Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.
- .3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted, and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

**End of Section**

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## **1 General**

### **1.01 Submittals**

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

### **1.02 Closeout Submittals**

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

### **1.03 Quality Assurance**

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

## **2 Products**

### **2.01 Centrifugal Fans**

- .1 Centrifugal fans in accordance with drawing schedule, each capable of operating over the complete pressure class limits as specified in AMCA Standard 99-16.
-

- .2 Continuously welded heavy-gauge steel housing, braced and reinforced as required to prevent vibration or pulsation, equipped with a discharge flange, spun, aerodynamically designed inlet cones or venturies with wire grid guards, drain plug, and epoxy enamel coated both inside and outside to a 3 mm dry film thickness.
- .3 Continuously welded, stable, non-overloading wheel with die-formed steel blades and, unless otherwise required, a cast iron hub, statically and dynamically balanced prior to assembly, then balanced as an assembly and braced and secured to base prior to shipment.
- .4 AISI C1040 or C1050 hot rolled steel fan shaft, accurately turned, ground, polished, and ring gauged for accuracy, and sized for a first critical speed of at least 1.25 times the maximum rated speed for fan, and heavy-duty, grease lubricated, ball or roller, self-aligning pillow block type bearings selected for an AFBMA L-10 minimum average bearing life in excess of 200,000 hours, and equipped with extended copper lubrication lines terminated in lubrication fittings immediately inside fan section access door.
- .5 NEMA Premium TEFC motor, adjustable V-belt drive selected for 40% service factor based on motor nameplate data, and OSHA guard, all in accordance with requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .6 Fan and motor support base is to be rigid, welded structural steel, vibration isolated base with steel cross members, factory cleaned, deburred, and finished with epoxy enamel, and complete with a slide type motor base and stable, colour coded spring mounts with sound pads selected to suit static deflection and maximum equipment load and to operate at not greater than 2/3 solid load, and shipping restraints.
- .7 Unless otherwise specified, finish is to consist of rust inhibiting primer applied to cleaned and deburred metal surfaces prior to assembly, then a second coat of primer after assembly and an air dried epoxy enamel finished coat both inside and outside to a 3 mm dry film thickness.
- .8 Manufacturers:
  - .1 Twin City Fan and Blower;
  - .2 Loren Cook Co.;
  - .3 Greenheck Fan Corp.;
  - .4 CML Northern Blower;
  - .5 PennBarry.

## **2.02 Roof Mounted Exhaust Fans**

- .1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.
  - .2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium bird screen, and EMT conduit chase to the motor compartment.
  - .3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.
-

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

### 2.03 Ceiling Mounted Fans

- .1 ULC listed and labelled ceiling mounted centrifugal, AMCA rated and certified (capacity and sound to AMCA Standards 211 and 311), exhaust fans in accordance with drawing schedule, complete with:
  - .1 minimum #20 gauge galvanized steel housing equipped with duct connection collar(s), integral spring loaded aluminum backdraft damper, 12 mm (½") thick acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, multi-position mounting brackets, and

- an integral CSA certified electrical receptacle in an outlet box for plug-in connection of fan motor;
- .2 low RPM, resiliently mounted, direct connected fan wheel and motor assembly with a forward curved, statically and dynamically balanced galvanized steel or calcium carbonate filled polypropylene centrifugal wheel direct connected to a 1-phase motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and equipped with a length of power cord and plug;
- .3 for fans as indicated and/or scheduled, a white calcium carbonate exhaust grille;
- .4 factory supplied accessories in accordance with drawing schedule, as follows:
  - .1 rectangular to round duct transitions;
  - .2 roof cap with backdraft damper and birdscreen;
  - .3 wall cap with backdraft damper and birdscreen.
- .2 Manufacturers:
  - .1 Twin City Fan and Blower;
  - .2 Loren Cook Co.;
  - .3 Greenheck Fan Corp.;
  - .4 CML Northern Blower;
  - .5 PennBarry.

### **3 Execution**

#### **3.01 Installation of Centrifugal Fans**

- .1 Provide centrifugal fans.
  - .2 Secure each base mounted fan in place, level and plumb, on vibration isolation on a concrete housekeeping pad.
  - .3 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers, properly sized galvanized steel hanger rods and galvanized structural steel angle or channel trapeze supports.
  - .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
  - .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
  - .6 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
-

### **3.02 Installation of Roof Mounted Exhaust Fans**

- .1 Provide roof mounted exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.
- .4 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

### **3.03 Installation of Ceiling Fans**

- .1 Provide ceiling exhaust fans.
  - .2 Secure each ceiling mounted fan housing in place in ceiling space, flush with suspended ceiling.
  - .3 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers and galvanized steel hanger rods.
  - .4 Plug fan motors into housing receptacles.
  - .5 Supply exterior wall/roof discharge caps as indicated.
  - .6 Hand roof caps to roof trade for installation and flashing into roof construction as part of roofing work.
  - .7 Install wall caps and secure in place. Caulk perimeter of each wall cap in accordance with caulking requirements specified in Division 07.
  - .8 Connect fan housings and discharges with ductwork.
  - .9 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
  - .10 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
-

**3.04 Closeout Activities**

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

**End of Section**

**1 General**

**1.01 Submittals**

- .1 Product Data: Indicate manufacturer's model number, technical data including description of components, static pressure/air flow chart, performance, accessories and installation instructions.
- .2 Closeout Submittals: Operation and Maintenance Manual including spare parts list.
- .3 Submit a site inspection and start-up report from manufacturer's representative.

**1.02 Quality Assurance**

- .1 Engage an experienced installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance.
- .2 All components shall be fabricated in strict accord with standards set forth in the current edition of ISO 9001 and ISO 14001.
- .3 Engage a firm experienced in manufacturing Extraction Arms similar to that indicated for this Project and with a record of successful in-service performance.
- .4 Conduct conference at Project site. Review methods and procedures related to Extraction Arm system installation.
  - 1. Review access requirements for equipment delivery.
  - 2. Review equipment storage and security requirements.
  - 3. Inspect condition of preparatory work performed by other trades.
  - 4. Review structural loading limitations.
- .5 Review that all components specified in this Section and related components specified in other Sections are accounted for.
- .6 Provide a written warrantee for a period of three years from date of shipment for all components.

**1.03 1.6. PROJECT/SITE CONDITIONS**

- .1 Existing Conditions: Verify dimensions installation areas by field measurements.

**1.04 1.7. COORDINATION**

- .1 Coordinate layout and installation with other work, including light fixtures, fixed equipment and workstations, HVAC equipment, fire-suppression system components and equipment of movement such as overhead cranes.
  - .2 Coordinate location and requirements of service-utility connections.
-

## 2 Product

### 2.01 CS-FMO Workshop Welding

- .1 Structure: The external articulating support structure shall be assembled from extruded aluminum tube stock and hi-grade cast aluminum components. The upper support arm shall consist of two parallel support tubes. The upper tube shall be 3.56 cm x 2.54 cm x 0.229 cm (1.4" x 1" x 0.09") thick extruded aluminum. The lower tube shall be 2.29 cm x 1.52 cm x 0.229 cm (0.9" x 0.6" x 0.09") thick extruded aluminum. The lower support arm shall consist of a single 3.56 cm x 2.54 cm x 0.229 cm (1.4" x 1" x 0.09") thick extruded aluminum tube. The mounting swivel assembly shall be hi-grade cast aluminum incorporating a 90° elbow with 360° rotation. Following and affixed to the mounting swivel, the 13ft. arm shall incorporate a 3' long horizontal arm section that ends in a horizontally articulating double clevis. The arm section shall be powder coated steel and the clevis shall be hi-grade cast aluminum. The heavy duty fume arm shall be articulated by two vertical joints. The vertical joints shall incorporate friction points that are adjustable for tension. In conjunction with the adjustable friction points, the support structure shall be balanced by phosphated steel springs. The upper arm support spring shall be wound from 0.635 cm (0.25") diameter spring steel wire. The lower arm support spring shall be wound from 0.457 cm (0.18") diameter spring steel wire. In order to protect the support structure from dust and dirt it shall be external to the air stream and fully enclosed. The support structure enclosure shall be composed of 0.25 cm (0.10") thick, removable, blue molded polypropylene covers with black PVC bellows covering the articulating joints. The molded covers shall be attached to the support structure using plated steel bolts. The bellows shall be attached to the molded covers using EPDM rubber clips. The arm shall come from the factory fully adjusted for tension. The articulating fume arm shall have an effective reach of 13ft.
- .2 Flexible Hose: The blue external flexible hose shall be composed of two sections. The lower section is to be made of a heavy duty woven glass fabric with an internal and external PVC lamination. The second section is to be made of a polyester fabric material with an internal and external PVC lamination. Both sections of hose shall be supported by a spirally wound steel wire helix. The hose shall be capable of withstanding a maximum operating temperature of 121° C (250° F). The flexible hose shall be 8" diameter. A hose adaptor composed of polypropylene shall connect the two sections of hose. The hose shall be attached externally to the horizontal arm and the support arm covers using hose straps made of PVC and nylon. The hose and hose straps shall be easily removed to allow for cleaning.
- .3 Integral Hood: The articulating arm shall, as a standard component, incorporate a capture hood. The capture hood shall be constructed of 0.13" thick hi-grade cast aluminum with an 20 cm x 22.3 cm (8.25" x 9") mouth opening and a 35.6 cm x 43.2 cm (14" x 17") flanged O.D. The lip of the hood shall be cast so as to be functional as a handle to permit easy mobility. The entire hood is to be protected with a black powder coat finish inside and out. The hood shall incorporate an adjustable damper with positive seal. The damper shall be easily adjustable from outside the hood. The hood shall incorporate, as standard, an inlet grille to keep unwanted debris from entering the system. The inlet grille shall be 0.279 cm (0.11") thick cast aluminum with a 3.18 cm (1.25") blade spacing. The hood shall incorporate a double ball joint mechanism allowing for ease of positioning and a full range of motion. The hood shall incorporate provisions for an optional light kit.
- .4 Mounting Brackets: A fabricated plated steel wall mounting bracket shall be included with each articulating arm. The mounting bracket shall be fabricated from 5.08 cm x 2.54 cm x 0.305 cm (2" x 1" x 0.12") thick steel with 0.305 cm (0.12") thick reinforcing gussets, plated for durability, and shall incorporate predrilled mounting holes.

- .5 Arms shall be shipped fully assembled. No field assembly will be accepted.
- .6 Acceptable Manufacturer
  - .1 Nederman Extraction Arm 10560432
  - .2 Or approved equivalent.

## 2.02 PW-CMS Welding Area

- .1 Structure: The external articulating support structure shall be assembled from extruded aluminum tube stock and hi-grade cast aluminum components. The upper support arm shall consist of two parallel support tubes. The upper tube shall be 3.56 cm x 2.54 cm x 0.229 cm (1.4" x 1" x 0.09") thick extruded aluminum. The lower tube shall be 2.29 cm x 1.52 cm x 0.229 cm (0.9" x 0.6" x 0.09") thick extruded aluminum. The lower support arm shall consist of a single 3.56 cm x 2.54 cm x 0.229 cm (1.4" x 1" x 0.09") thick extruded aluminum tube. The mounting swivel assembly shall be hi-grade cast aluminum incorporating a 90° elbow with 360° rotation. Following and affixed to the mounting swivel, the 5 m (16.5 ft.) arm shall incorporate a 1.83 m (6 ft.) long horizontal arm section that ends in a horizontally articulating double clevis. The arm section shall be powder coated steel and the clevis shall be hi-grade cast aluminum. The heavy duty fume arm shall be articulated by two vertical joints. The vertical joints shall incorporate friction points that are adjustable for tension. In conjunction with the adjustable friction points, the support structure shall be balanced by phosphated steel springs. The upper arm support spring shall be wound from 0.635 cm (0.25") diameter spring steel wire. The lower arm support spring shall be wound from 0.457 cm (0.18") diameter spring steel wire. In order to protect the support structure from dust and dirt it shall be external to the air stream and fully enclosed. The support structure enclosure shall be composed of 0.25 cm (0.10") thick, removable, blue molded polypropylene covers with black PVC bellows covering the articulating joints. The molded covers shall be attached to the support structure using plated steel bolts. The bellows shall be attached to the molded covers using EPDM rubber clips. The arm shall come from the factory fully adjusted for tension. The articulating fume arm shall have an effective reach of 5 m (16.5 ft)
- .2 Flexible Hose: The blue external flexible hose shall be composed of two sections. The lower section is to be made of a heavy duty woven glass fabric with an internal and external PVC lamination. The second section is to be made of a polyester fabric material with an internal and external PVC lamination. Both sections of hose shall be supported by a spirally wound steel wire helix. The hose shall be capable of withstanding a maximum operating temperature of 121° C (250° F). The flexible hose shall be 8" diameter. A hose adaptor composed of polypropylene shall connect the two sections of hose. The hose shall be attached externally to the horizontal arm and the support arm covers using hose straps made of PVC and nylon. The hose and hose straps shall be easily removed to allow for cleaning.
- .3 Integral Hood: The articulating arm shall, as a standard component, incorporate a capture hood. The capture hood shall be constructed of 0.33 cm (0.13") thick hi-grade cast aluminum with a 20 cm x 22.3 cm (8.25" x 9") mouth opening and a 35.6 cm x 43.2 cm (14" x 17") flanged O.D. The lip of the hood shall be cast so as to be functional as a handle to permit easy mobility. The entire hood is to be protected with a black powder coat finish inside and out. The hood shall incorporate an adjustable damper with positive seal. The damper shall be easily adjustable from outside the hood. The hood shall incorporate, as standard, an inlet grille to keep unwanted debris from entering the system. The inlet grille shall be 0.279 cm (0.11") thick cast aluminum with a 3.18 cm (1.25") blade spacing. The hood shall incorporate a double ball joint mechanism allowing for ease of positioning and a full range of motion.

- .4 Mounting Brackets: A fabricated plated steel wall mounting bracket shall be included with each articulating arm. The mounting bracket shall be fabricated from 5.08 cm x 2.54 cm x 0.305 cm (2" x 1" x 0.12") thick steel with 0.305 cm (0.12") thick reinforcing gussets, plated for durability, and shall incorporate predrilled mounting holes.
- .5 Arms shall be shipped fully assembled. No field assembly will be accepted.
- .6 Acceptable Manufacturer
  - .1 Nederman Extraction Arm 10560532
  - .2 Or approved equivalent.

### **3 Execution**

#### **3.01 Examination**

- .1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **3.02 Preparation**

- .1 Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation until site is in proper condition to receive extraction arm installation.

#### **3.03 Installation**

- .1 Install extraction arms and brackets in accord with manufacturer's written instructions, original design and referenced standards.

#### **3.04 Adjusting**

- .1 Adjust extraction arms for proper operation. Replace any parts that prevent the system from operating properly.

#### **3.05 Cleaning**

- .1 Remove all debris caused by installation of the extraction arms. Clean all exposed surfaces to as fabricated condition and appearance.

#### **3.06 Protection**

- .1 Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

#### **3.07 Demonstration /Training**

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

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 Listed gas vents and vent connectors for natural gas fired appliances.

### **1.02 References**

- .1 CSA B149.1:20, Natural gas and propane installation code.
- .2 CAN/ULC-S604:2016, Standard for factory-built type A chimneys.
- .3 CAN/ULC 605:2022, Standard for Gas Vents.
- .4 CAN/ULC 609:2022, Standard for low temperature vents type L and PL.
- .5 ULC-S636-08, Standard for type BH gas venting systems.

### **1.03 Submittals**

- .1 Submit product data sheets for flue gas vents/air intakes and accessories.

### **1.04 Coordination**

- .1 Supply a reviewed shop drawing to appropriate trade to indicate vent size and flashing materials supplied, and accurately locate building openings.

## **2 Products**

### **2.01 Condensing Appliance Type BH Flue Gas Vents (and Combustion Air Intakes)**

- .1 Equal to Ipex "System 636" PVC (for vent gas to 65°C (130°F)) or CPVC (for vent gas to 90°C (195°F)) solvent weld vent pipe and fittings, in accordance with CSA B149.1, certified as type BH vents to ULC-S636, Standard for Type BH Gas Venting Systems, suitable for negative or positive venting and complete with an orange warning label to verify compliance with ULC-S636, and a moulded cap with screen for vertical termination, or low profile wall termination kit, as applicable.

### **2.02 Double Wall Type "A" Vent**

- .1 Sectional, prefabricated, double wall, type 316 stainless steel, insulated Type "A" all fuel vent, ULC listed and labelled to CAN/ULC-S604, maximum 540°C (1000°F) rated, with prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

### **2.03 Double Wall Type "B" Vent**

- .1 Sectional, prefabricated, double wall Type "B" gas vent, ULC listed and labelled to CAN/ULC 605, maximum 243°C (460°F) rated, with an aluminium alloy inner wall, G90 galvanized steel outer wall, annular air space, prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

### **2.04 Double Wall Stainless Steel Vent for Condensing Equipment**

- .1 Positive pressure double wall stainless steel flue gas vent with a type 304 outer casing, an AL29-4C inner flue, and a 25 mm (1") annular air space, ULC-S636 listed and labelled, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.
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## **2.05 Double Wall Type "L" Vent**

- .1 Type "L" Neutral or negative pressure Type "L" double wall stainless steel flue gas vent, listed and labelled to CAN/ULC 609, with a type 304 stainless steel outer casing, type 304 stainless steel inner flue, and a 12 mm (½") annular air space, maximum 300°C (570°F) rated, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

## **2.06 Barometric Dampers**

- .1 Equal to Field Controls UL/ULC listed and CSA certified Type M+MG2, field adjustable, single or double acting barometric damper to suit burner fuel, each complete with a gate which rests on a long, thin, stainless steel knife edge which in turn is supported by self-aligning and self-cleaning bearings, sized to suit the application, approved by equipment manufacturer, and complete with a field thermal switch accessory for dual fuel oil/gas fired burners.

# **3 Execution**

## **3.01 Installation of Type BH Flue Gas Vents (and Combustion Air Intakes)**

- .1 Provide type BH flue gas vents and combustion air intakes for condensing appliances.
- .2 Support spacing is to be in accordance with flue gas vent manufacturer's instructions. Installation is to be in accordance with gas fired appliance manufacturer's instructions and requirements of CSA B149.1.
- .3 Route piping using shortest route possible to termination point while avoiding interference with other work. Slope vent piping for positive drainage.
- .4 Equip termination of vent with a turn-down elbow with open end covered with bronze insect screen. Terminate exhaust vent a minimum of 3 m (10') away from fresh air intakes and operable windows.
- .5 Confirm flue gas vent diameter prior to ordering.

## **3.02 Installation of Flue Gas Vents**

- .1 Provide ULC listed and labelled flue gas vents for equipment. Confirm flue gas vent diameters prior to ordering.
  - .2 Secure horizontal sections in place by means of support hardware supplied with vents and conforming to flue diameter, and hanger rods attached to structure. Support spacing is to be in accordance with vent manufacturer's instructions.
  - .3 Support vertical flue sections inside building at roof level and wherever else required by means of purpose made vertical support accessories supplied by manufacturer.
  - .4 Hand flashing collars to roofing trade at site on roof for installation and flashing into roof construction. Install counter-flashing pieces over collars.
  - .5 Equip termination of each chimney with a rain cap. Confirm height requirement for chimney above roof prior to installation, and ensure proper distance from fresh air intakes is maintained.
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- .6 Provide braided stainless steel aircraft cable guy wires attached to roof anchors and to stainless steel strap anchors on the vents as required and/or shown.
- .7 Anchor and restrain vents in accordance with requirements of Section 20 05 48.16 - Seismic Controls for Mechanical Systems.
- .8 Provide required accessories, including insulated thimbles at building wall penetrations, barometric damper(s), cleanout(s), fire stops, and expansion joints where shown and/or required.
- .9 Locate and install barometric dampers in accordance with manufacturer's instructions and field adjust to suit operating conditions.

**End of Section**

## **1 General**

### **1.01 Related Requirements**

- .1 Section 23 51 23 – Gas Vents.

### **1.02 Submittals**

- .1 Submit shop drawings/product data sheets for radiant heaters, including accessories, control, and power and control wiring schematics.

### **1.03 Closeout Submittals**

- .1 Submit with delivery of heaters, copies of the factory inspection report, and include a copy of each report with O&M Manual project close-out data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Submit signed copies of radiant heater manufacturer's extended warranties as follows:
  - .1 heater controls: 3 years;
  - .2 combustion chamber and radiant tubes: 7 years.
- .4 Submit a signed copy of unit heater manufacturer's 15 year extended warranty for stainless steel heat exchanger of each unit heater.

### **1.04 Quality Assurance**

- .1 Heaters and installation of heaters are to be in accordance with requirements of following:
  - .1 all applicable Provincial Codes and Standards;
  - .2 CAN/CSA-B149.1, Natural Gas and Propane Installation Codes.
- .2 Heater installation tradesmen are to be journeyman tradesmen licensed to install gas fired equipment.

## **2 Products**

### **2.01 Gas Fired Radiant Heaters**

- .1 Brant Radiant Heaters Ltd. "Re-Verber-Ray" modular, gas fired radiant heaters in accordance with drawing schedule, each factory assembled and pre-wired and each in accordance with requirements of ANSI Z83.20/CSA 2.34 and CAN/CSA B149.1. Each heater is to consist of a control box and burner, a combustion chamber tube, a radiant emitter tube, a reflector, controls, hanging and support hardware, and any accessories specified or scheduled.
- .2 2-stage stainless steel burner complete with a centrifugal direct drive fan assembly, factory pre-set fixed metering orifice burner, 15 mm (½") diameter inlet gas connection, gas piping train with valves and pressure regulator, a 600 mm (24") long flexible stainless steel gas inlet piping flexible connector, "globar" ignition system with flame sensing controls and 100% safety shutdown of burner and fan, burner sight glass to permit visual

observation of burner ignition and flame from floor level, and combustion vent connection collar. Enamelled steel control box is to include removable access panels and following:

- .1 terminal strips for power and control connections;
  - .2 24 volt secondary control transformer;
  - .3 heating stage indicator lights;
  - .4 dual safety pressure switches to continuously monitor burner operation;
  - .5 self-diagnostic microprocessor-based control that incorporates pre- and post-purge firing, "hard" safety shutdown which can only be restarted by resetting thermostat, "soft" safety shutdown with 30 minute automatic restart if heater turns off due to environmental conditions such as high winds;
  - .6 fresh air intake connection collar.
- .3 Heat exchanger assembly complete with a stainless steel combustion chamber tube, a Type 1 aluminized steel radiant emitter tube with stainless steel turbulator baffle, a connection system with stainless steel band clamps to maintain a continuous linear appearance, and a high emissive, black, corrosion resistant coating on exterior of exchanger.
  - .4 Fully adjustable polished aluminium parabolic reflector complete with end caps.
  - .5 Hanging hardware factory supplied with each heater and consisting of galvanized steel hangers and reflector tension springs.
  - .6 Surface wall mounting, adjustable, 24 volt thermostat for securing to a recessed outlet box, factory supplied with each heater and complete with thermometer and, where required by mounting location, radiant heat reflector shields.
  - .7 All required hardware to interface with building automation system in accordance with drawing control sequence and points list.
  - .8 Seismic restraint anchors factory secured to heaters.
  - .9 Manufacturers:
    - .1 Brant Radiant Heaters Ltd.;
    - .2 Schwank Group;
    - .3 Superior Radiant Products.

## 2.02 Gas Fired Unit Heaters

- .1 CSA or cETL certified horizontal air flow unit heaters, each factory assembled, pre-wired, and test fired, each in accordance with drawing schedule, and with characteristics as follows:
  - .1 noise: not to exceed 75 dBA at 1 m (3');
  - .2 efficiency: minimum steady state thermal efficiency of 80% in accordance with ASHRAE 90.1;
  - .3 electrical supply: 120 volts, 1-phase, 60 Hz;

- .4 gas supply: between 1.7 kPa and 3.5 kPa (0.25 psi and 0.50 psi);
  - .5 venting: horizontal or vertical.
  - .2 Internally insulated cabinet constructed of heavy-gauge galvanized steel, finished with baked powder epoxy enamel, and complete with hinged access door, adjustable louvers, a wiring junction box mounted inside or on exterior of cabinet, mounting spot nuts for hanger rods secured to top of cabinet, or an accessory mounting bracket kit.
  - .3 Tubular, curved design stainless steel heat exchanger, secured to a vest panel equipped with flue box and a motorized combustion air inducer to purge heat exchanger and positively vent combustion products, and aluminized steel inshot burners, each removable from assembly or all removable as a single component, and complete with a venturi to mix gas and air for proper combustion, and a burner view port.
  - .4 Direct driven propeller type fan(s), depending on unit size, with permanently lubricated open drip-proof motor(s) conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and a wire cage guard.
  - .5 Factory installed and pre-wired controls and safeties complete with:
    - .1 24 volt redundant combination gas valve with 100% safety shut-off, manual main shut-off valve, pressure regulator, and automatic solenoid valve;
    - .2 solid-state, electronic, direct spark ignition and a separate electronic flame sensor to initiate 3 attempts to re-ignite after loss of flame, then locks out unit operation;
    - .3 pressure switch to prove adequate flow through venting;
    - .4 high temperature limit controls with a fixed temperature setting to protect from abnormal operating temperatures;
    - .5 solid-state, integrated, combination ignition and fan control board with fan timer control, diagnostic LED for trouble shooting, and continuous fan operation control;
    - .6 120/24 volt control transformer;
    - .7 terminal strip for 24 volt control connections;
  - .6 Heavy-gauge galvanized steel discharge nozzles selected by heater manufacturer to achieve scheduled air flow, finished to match cabinets.
  - .7 Remote wall mounting, 24 volt, adjustable, tamper-proof thermostats with thermometers complete with guards, supplied loose for field installation.
  - .8 Manufacturers:
    - .1 Lennox Industries (Canada) Ltd.;
    - .2 Thomas & Betts Corp. "Reznor";
    - .3 Sterling HVAC Products.
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### **3 Execution**

#### **3.01 Installation of Gas Fired Unit Heaters**

- .1 Provide gas fired unit heaters.
- .2 Secure unit heaters in place at proper height by means of hanger rods attached to structure. Ensure heaters are level and plumb. Provide any supplemental structural steel necessary for installation where shown. Ensure unit discharge is not obstructed.
- .3 Connect with valved gas piping with drip leg. Use a length of flexible gas piping with 360° loop for final connection.
- .4 Provide a maximum of 1.5 m (5') of single wall stainless steel horizontal vent between unit heater and flue. Provide flues in accordance with requirements of Section 23 51 23 - Gas Vents.
- .5 Provide a thermostat for each heater and mount. Provide required 24 volt control wiring in conduit in accordance with the electrical work wiring requirements. Provide a guard for each thermostat.
- .6 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit shop drawings/product data sheets for all make-up air units. Include following:
  - .1 certified fan performance curves;
  - .2 certified sound power data;
  - .3 hardware for section-to-section site connections;
  - .4 dimensioned layouts, including dimensioned curb layouts as applicable;
  - .5 product data for fan motors.

### **1.02 Closeout Submittals**

- .1 Submit with delivery of each furnace a copy of the factory inspection and fire test report as specified in Part 2 of this section, and include a copy of each report with O&M Manual project close-out data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Training attendance records.

### **1.03 Maintenance Material Submittals**

- .1 Submit spare air filters as specified in Part 2 of this section.

### **1.04 Quality Assurance**

- .1 Make-up air units and installation are to be in accordance with requirements of following:
  - .1 all applicable Provincial Codes and Standards;
  - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
  - .3 CSA or cETL listed and labelled electrical components.
- .2 Make-up air unit installation tradesmen are to be journeyman and licensed gas fitters.

## **2 Products**

### **2.01 Manufacturers**

- .1 En Mar Systems Ltd.;
  - .2 Greenheck Fan Corp.;
  - .3 Trane Canada Corp.;
  - .4 Mestek Inc. Sterling;
  - .5 Engineered Air;
  - .6 Thomas & Betts Reznor.
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## 2.02 Gas Fired Make-Up Air Units

- .1 Down discharge, air-tight, weather-proof make-up air units, approved for operation in ambient temperatures of -50°C (-60°F), in accordance with drawing schedule and details, factory inspected and fire tested with an inspection and fire test report prepared and submitted, and following additional performance features:
    - .1 units are to be suitable for operation at any supply gas pressure between 1.7 kPa and 3.5 kPa (0.25 psi and 0.51 psi);
    - .2 unless otherwise specified, sound emitted through casings or intakes of roof mounted units at maximum air flow rate is not to exceed 78.4 dBA at 1 m (4'), and for interior spaces, sound emitted through supply and return air openings is not to exceed 82 dBA at 1.5 m (5').
  - .2 Sectional, double wall insulated casing and section construction with dimensions and arrangements as shown and detailed on drawings and as follows:
    - .1 rigid, full perimeter structural channel iron base frame with reinforcing channels cleaned and coated with rust resistant primer, lifting lugs and identified lifting points;
    - .2 minimum #16 gauge G90 galvanized sheet steel exterior casing panels, #22 gauge G60 galvanized steel liner panels over all interior insulation including underside of floor, with over-lapped roof panels, all joints neatly caulked with water resistant sealant, and rain shields over all access doors;
    - .3 50 mm (2") thick, minimum 48 kg/m<sup>3</sup> (3 lb/ft<sup>3</sup>) density semi-rigid glass fibre acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested to CAN/ULC-S102, secured in place by means of adhesive and pins;
    - .4 double wall insulated access doors constructed as for casing panels, of sufficient size and number to permit physical entry into sections from both sides of unit for servicing of filters, fans and motors, burners, and other equipment requiring maintenance and service, and each complete with:
      - .1 full perimeter captive gasketing;
      - .2 full length galvanized steel hinges;
      - .3 2 lever lock roller handles operable from both inside and outside casing;
      - .4 for sections such as fan sections requiring full access, double doors of sufficient size with a removable mullion.
    - .5 galvanized steel intake hood complete with storm louvre, aluminium mesh birdscreen, motorized inlet damper, "V" bank filter framing, and 50 mm (2") thick, UL Class 1, 25% to 30% efficient MERV 7 disposable glass fibre filters with an extra set of filters in identified packaging for each unit;
    - .6 clean and prime casing, both inside and outside, and finish with epoxy enamel applied to all panel surfaces, including exterior undersides.
  - .3 Fully modulating direct fired type burners capable of 30:1 turndown ratio and located in a burner section with a heat treated glass observation port for full viewing of flame, and a control panel/gas manifold vestibule with access door and weather-proof electric heater with thermostat, a 120 volt marine light with guard and lighted switch, and a duplex 15
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ampere GFI receptacle factory wired to a separate 120 volt, 1-phase circuit with disconnect switch. Burner efficiency is to limit products of combustion to maximum 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide, and equip burner with:

- .1 adjustable profile plates, stainless steel combustion baffles, non-clogging gas ports, and spark-ignition intermittent pilot with 100% flame safety shut-down;
- .2 pre-piped gas manifold with main gas pressure regulator, manual shut-off and test firing valves, main and auxiliary gas automatic shut-off valve, a modulating control system, pilot pressure regulator and automatic shut-off valve, pilot needle valve, and multiple test ports.
- .4 Burner control, located in burner control/manifold vestibule, factory pre-wired, and consisting of:
  - .1 blower motor starter with ambient compensated overloads, and auxiliary contacts;
  - .2 primary 120 volt control transformer;
  - .3 6000 volt ignition transformer;
  - .4 control circuit breaker and service switch;
  - .5 automatic reset temperature high limit;
  - .6 solid-state flame safeguard relay with LED status and flame rod;
  - .7 discharge temperature control sensor with RTS;
  - .8 all hardware required for site connection of the remote control panel.
- .5 AMCA rated and certified double width and inlet centrifugal fan with forward curved blades, secured to a heavy-duty machined and polished steel shaft with an operating speed not to exceed 75% of its first critical speed, and statically and dynamically balanced. Fan motor, V-belt drive, and OHSA guard in accordance with requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .6 Surface wall mounting (to a recessed or surface mounting outlet box) supervisory control panel with 2 switches, 5 indicating lights including "Clogged Filter", a temperature selector, and a LED discharge temperature readout.
- .7 Roof mounting curb factory supplied loose and ready for site assembly and insulation, 405 mm (16") high, complete with wood nailer and site assembly hardware.

### **3 Execution**

#### **3.01 Installation of Make-Up Air Unit**

- .1 Provide a gas fired make-up air unit on roof.
  - .2 Unless otherwise specified or required, provide required rigging and hoisting/moving equipment required to move units to required location. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
  - .3 Supply a curb for each unit, assemble curb, and hand curb to roofing trade on roof for installation and flashing into roof construction. Provide continuous gasketing around
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perimeter of curb between curb and unit mounting frame. Insulate curb with rigid weather-proof board type insulation in accordance with curb manufacturer's details.

- .4 Install components shipped loose with units. Install a discharge air temperature sensor in supply ductwork approximately 2 m (6-½') downstream of unit and in accordance with manufacturer's recommendations.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

### **3.02 Closeout Activities**

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

**End of Section**

## **1 General**

### **1.01 Submittals**

- .1 Submit shop drawings/product data sheets for following:
  - .1 all control system components;
  - .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
  - .3 certified wiring diagrams for all systems.
- .2 Submit following samples for review:
  - .1 control damper section with linkage, operator, and certified flow and leakage data;
  - .2 wall mounting control system flow diagram as specified in Part 2 of this Section;
  - .3 each type of thermostat to be used, each identified as to intended use.

### **1.02 Closeout Submittals**

- .1 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .2 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

### **1.03 Quality Assurance**

- .1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

## **2 Products**

### **2.01 Control Dampers and Operators**

- .1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4 in) deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4 ft). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:
  - .1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;
  - .2 extruded TPE frame gaskets and extruded EPDM blade gaskets;
  - .3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in

frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.

- .2 For standard damper(s), Series 1000 as above.
- .3 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.
- .4 For stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.
- .5 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 s upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.
- .6 Electric damper operators are to be equal to Belimo EF Series 24 V or 120 VAC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.
- .7 Pneumatic damper operators are to be replaceable elastomer diaphragm piston type, suitable in all respects for damper sequence.

## **2.02 Local Control Panels**

- .1 NEMA 1 (NEMA 2 in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, a perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

## **2.03 Control System Components**

- .1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.
- .2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:
  - .1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:

- .1 chilled water, room temperature, and duct temperature points,  $\pm 1^{\circ}\text{C}$  ( $\pm 0.5^{\circ}\text{F}$ );
  - .2 all other points,  $\pm 0.75^{\circ}\text{C}$  ( $\pm 1.3^{\circ}\text{F}$ ).
  - .2 room temperature sensors constructed to be selected in accordance with the following classifications:
    - .1 Type 1: Space temperature sensor (private/non-public areas);
      - .1 for measurement of space temperature only as shown on the floor plans and/or as described in the Sequence of Operation;
      - .2 set-point adjustment shall be accessible through the cover;
      - .3 sensor operating temperature range from  $4^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  ( $40^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ );
      - .4 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors;
      - .5 mono-chromatic guard secured to mounting plate by screws;
    - .2 Type 2: Space temperature sensor (public areas or secure areas);
      - .1 for measurement of space temperature of space temperature only in areas subject to vandalism as shown on the floor plans and/or as described in the Sequence of Operation;
      - .2 sensor operating temperature range from  $4^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  ( $40^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ );
      - .3 stainless steel flat plate surface type with sensor epoxy-bonded to back of cover plate;
      - .4 tamperproof/secure concealed fasteners;
      - .5 set-point adjustment is to be concealed behind the cover.
    - .3 Type 3: Adjustable space temperature sensor with display (Private Areas, Office areas);
      - .1 for measurement and adjustment of space temperature as shown on the floor plans and/or as described in the Sequence of Operation;
      - .2 digital set point operating temperature adjustment range from  $4^{\circ}\text{C}$  to  $60^{\circ}\text{C}$  ( $40^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ );
      - .3 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors;
      - .4 mono-chromatic guard secured to mounting plate by screws;
      - .5 on/off button to allow occupant override feature;
      - .6 three-digit LED digital temperature display with  $0.2^{\circ}$  display resolution;
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- .7 5% to 95% relative humidity, non-condensing;
  - .8 minimum/maximum limit set point values adjustable from the BAS operator interface and controller.
  - .9 set-point adjustment is to be accessible through the cover.
- .3 outside air sensors designed and constructed for an ambient temperature of -25°C to 60°C (-13°F to 140°F) and 5% to 95% relative humidity, non-condensing, complete with a NEMA 3R enclosure, solar shield, a weatherproof seal at all wall penetrations, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;
- .4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weatherproof with gasket and cover where outside) through a hole in duct;
- .5 for ducts greater than 1.2 m (4 ft) or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;
- .6 Where both temperature and humidity are shown to be measured at same location or in same airstream, use of single measuring unit is permitted provided that features and performance of both temperature sensor and humidity sensor are in accordance with requirements of this specification.
- .3 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 25°C to 60°C (-13°F to 140°F) and 5% to 95% relative humidity, non-condensing and complete with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
- .4 carbon dioxide sensors for air quality control purposes having a maximum 20 s response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
- .1 measurement range: 0 to 2000 ppm;
  - .2 accuracy:  $\pm 100$  ppm;
  - .3 repeatability:  $\pm 20$  ppm;
  - .4 drift:  $\pm 100$  ppm per year;
  - .5 output signal: 0-10 VDC proportional over the 0 to 2000 ppm range.
- .5 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0-10 VDC, or 4-20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the
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high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:

- .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4-20 mA output signal in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
    - .1 maintain accuracy up to 20 to 1 ratio turndown;
    - .2 reference accuracy: +0.2% of full scale.
  - .2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of  $\pm 1\%$  of full span (includes non-linearity, hysteresis, and repeatability);
  - .3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4-20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
    - .1 maintain accuracy up to 20 to 1 ratio turndown;
    - .2 reference accuracy: +0.2% of full span.
  - .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4-20 mA output signal in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
    - .1 maintain accuracy up to 20 to 1 ratio turndown;
    - .2 reference accuracy: +0.2% of full span.
  - .5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:
    - .1 zero and span: (c/o F.S./°F); 0.04% including linearity, hysteresis, and repeatability;
    - .2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F.S.;
    - .3 thermal effects: less than +0.33 F.S./°F over 40°F to 100°F (calibrated at 70°F).
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- .6 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
  - .1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
    - .1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as  $\pm 20^\circ$  in approaching air stream;
    - .2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors placed at equal distances along its length in accordance with ASHRAE Standards for duct traversing.
  - .2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8 in), and transmitter is to produce a 4-20 mA or 0-10 VDC signal linear to air velocity.
  - .3 Duct Flow Measuring Stations: 14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (3/4") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000 ft) per minute. Additional requirements as follows:
    - .1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
    - .2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
    - .3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
    - .4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
    - .5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.

- .4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
  - .5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
  - .6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
  - .7 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 A signal which will be converted to a 4-20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
    - .1 equal to Veris Industries split core current transformer with an operating frequency of from 50 Hz to 400 Hz, 0.6 kV class, 10 kV BIL insulation, and 5 A secondary;
    - .2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of  $\pm 5\%$ , a minimum load resistance of 30 kOhm, an input of 0 to 20 A and an output of 4-20 mA, and a 24 VDC regulated power supply.
  - .8 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.
  - .9 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:
    - .1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
    - .2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 A at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;
    - .3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;
    - .4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 A at 120 VAC and an appropriate scale range and pressure adjustment;
    - .5 water flow switches: equal to Johnson Controls Inc. Model P74;
    - .6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 A at 120 VAC, a minimum 4.5 m (15 ft) sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18 in) section of
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element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.

- .10 Control relays as follows:
    - .1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 A at 120 VAC;
    - .2 lighting control relays: latching type with integral status contacts rated for 20 A at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.
  - .11 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.
  - .12 Each manual override station is to be complete with contacts rated minimum 1 A at 24 VAC and is to provide following:
    - .1 integral H-O-A switch to override controlled device pilot relay;
    - .2 status input to building automation system to indicate whenever switch is not in the Auto position;
    - .3 status LED to illuminate whenever output is On;
    - .4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
  - .13 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 psig to 15 psig, an input of from 4-20 mA or 0-10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
  - .14 Thermostats:
    - .1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.
    - .2 Line voltage thermostats are to be 115 V.
    - .3 Low voltage thermostats are to be 24 V electronic type.
    - .4 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
    - .5 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
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- .6 Guards for thermostats are to be clear, ventilated acrylic covers with Allen key locking hardware.
- .15 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section 25 05 02 – Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

## **2.04 System Wiring Materials**

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

## **3 Execution**

### **3.01 General Re: Installation of Controls**

- .1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.
- .2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.
- .3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

### **3.02 Supply of Control Air Dampers and Operators**

- .1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.
- .2 Unless otherwise specified or scheduled, insulated dampers to be provided for all outdoor air intake and exhaust air applications.
- .3 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.
- .4 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- .5 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

### **3.03 Supply of Automatic Control Valves and Operators**

- .1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.
  - .2 Provide an operator for each valve.
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### **3.04 Installation of Thermostats**

- .1 Unless otherwise noted, provide required thermostats.
- .2 Provide a ventilated clear acrylic cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- .3 Unless otherwise indicated, mount room thermostats 1.5 m (5 ft) above finished floor level. Thermostats intended to be used by building occupants in a barrier-free path of travel to be mounted at 1.2 m (4 ft). Confirm exact location of all thermostats prior to roughing-in.
- .4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.
- .5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

### **3.05 Installation of Control System Components**

- .1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.
- .2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

### **3.06 Control Wiring**

- .1 Perform required control wiring work for control systems except:
  - .1 power wiring connections to equipment and panels, except as noted below;
  - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
  - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2 ft) connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- .4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

### **3.07 Identification and Labelling of Equipment and Circuits**

- .1 Refer to identification requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .2 Identify equipment as follows:
  - .1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;

- .2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

### **3.08 Testing, Adjusting, Certification, Start-Up, and Training**

- .1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting, and balancing work.
- .2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .3 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- .5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

**End OF Section**

## **1 General**

### **1.01 Abbreviations and Definitions**

.1 Abbreviations used in this Specification are as follows:

- .1 BAS building automation system;
- .2 DDC direct digital controls;
- .3 LAN local area network;
- .4 PC personal computer.

### **1.02 Submittals**

.1 Submit shop drawings/product data sheets for BAS components. As a minimum, submit the following:

- .1 BAS network architecture, including modes and interconnections;
- .2 systems schematics, sequences, and flow diagrams;
- .3 points schedule for each point in BAS, including point type, object name, expanded ID, display units, controller type, and address;
- .4 samples of graphic display screen types and associated menus;
- .5 detailed Bill of Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features;
- .6 control damper schedule including a separate line for each damper and a column for each of damper attributes including code number, fail position, damper type, damper operator, duct size, damper size, mounting and actuator type;
- .7 control valve schedules including a separate line for each valve and a column for valves as for control dampers;
- .8 room schedule including a separate line for each HVAC terminal unit indicating type, location and address;
- .9 details of BAS interfaces and connections to other systems;
- .10 product data sheets or marked catalogue pages including part number, photograph and description for BAS hardware and software.

### **1.03 Closeout Submittals**

- .1 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
  - .2 Record "as-built" drawings are to include:
    - .1 schematic outline of BAS for quick reference of overall system scope;
    - .2 adequate record of work as installed, including locations and routing of system wiring.
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- .3 O&M Manual is to include:
  - .1 hardware specification manual which gives a functional description of hardware components;
  - .2 operator's manual which outlines concise instructions for operation of system and an explanation and recovery route for system alarms;
  - .3 engineering manual which outlines and defines system set-up, definition and application;
  - .4 data manual which indicates applications data programmed into system;
  - .5 system software documentation.

#### **1.04 Description of the Building Automation System**

- .1 Building automation system is to consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware and software required for complete, functional DDC control system. BAS is to be accessible through standard personal computers within building through a wireless application protocol device, or remotely through Internet by means of a standard web browser.
  - .2 BAS is to be field expandable, with a distributed architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt execution of control strategies at other operational devices. BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, following integrated features, functions, and services:
    - .1 graphic user interface for accessing and viewing BAS information, commanding points, changing setpoints, responding to alarms, programming time-of-day schedules;
    - .2 operator information, alarm management, and control features;
    - .3 enterprise-level information and control access;
    - .4 information management including monitoring, transmission, archiving, retrieval, and reporting functions;
    - .5 diagnostic monitoring and reporting of BAS functions;
    - .6 off-site monitoring and management access;
    - .7 energy management;
    - .8 standard applications for terminal HVAC systems.
  - .3 BAS is to include, but not be limited to, following:
    - .1 personal computer based server for networking and integrating all hardware components into a single BAS;
    - .2 personal computer based operator work station with colour monitor for colour graphic displays, and a colour printer;
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- .3 portable operator's terminal;
- .4 network of standalone network automation engine(s);
- .5 network of field equipment controllers;
- .6 input/output modules;
- .7 local display devices;
- .8 distributed user interfaces;
- .9 network processing, data storage and communication equipment;
- .10 all other components required for a complete and operating BAS.

#### **1.05 Quality Assurance**

- .1 BAS hardware and software is to be installed by experienced personnel employed and trained by manufacturer/supplier of field equipment controllers. System wiring is to be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.

### **2 Products**

#### **2.01 General Re: Building Automation System**

- .1 Control system components (field devices) other than those specified in this Section are generally specified in Section 25 05 01 – Automatic Control Systems. Components factory installed with equipment or supplied with equipment are specified in mechanical work Sections with equipment.
- .2 BAS specified in this Section is an expandable DDC building automation system in accordance with drawing control diagrams and sequences, and points lists.
- .3 Manufacturers:
  - .1 Reliable Controls.;

#### **2.02 BAS Architecture**

- .1 BAS is to be based industry standard Ethernet TCP/IP communications protocol. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. BAS is to be compatible with other enterprise-wide networks, and where indicated, BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
  - .2 Network automation engines are to provide supervisory control over control network and are to support BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). Control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on control network.
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- .3 BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between BAS and building equipment/system control panels. BAS is to receive, react to, and return information from connected equipment and systems. Data required by application is to be mapped into automation engine's data base and is to be transparent to operator. Point inputs and outputs from building equipment/system control panels is to have real-time interoperability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.

### 2.03 Dedicated Web Based User Interface

- .1 User interface is to be web based and is to operate on a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions including scheduling, history collection, and alarming are to be resident in appropriate components of BAS network to facilitate greater fault tolerance, availability, and reliability.
  - .2 Architecture of personal computer is to be implemented to conform to industry standards such that it can accommodate applications provided with BAS and mechanical systems and equipment, including but not limited to Microsoft Office Applications. Specifically, it must conform to following interface standards:
    - .1 Microsoft Edge (or other standard browser) for user interface functions;
    - .2 Microsoft Office Professional for creations, modification and maintenance of reports, and sequencing other necessary building management functions;
    - .3 Microsoft Outlook or other email 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.
  - .3 Personal computer server or operator workstation is to be configured at minimum as follows:
    - .1 memory: 8 GB;
    - .2 processor: Intel;
    - .3 hard drive: 500 GB free hard drive;
    - .4 graphics card: 1 GB DDR3;
    - .5 ports: 1 HDMI, 2 serial, one parallel, and 2 USB-C ports;
    - .6 keyboard: 101 keyboard and 2-button mouse;
    - .7 monitors: 584 mm (23 in) LCD monitor with 1920 x 1080 resolution;
    - .8 LAN communications: 10/100/1000 network card.
  - .4 Operating System Software: Windows 7 Professional 64-bit Microsoft SQL 2008 Server and SQL 2008 Server Express are automatically installed by EBI. Where user interface is not provided via browser, PC is to be equipped with a complete workstation software package including any software or hardware keys, and package is to include original
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installation discs and licenses for all software, device drivers, peripherals, and software registration cards which are to be handed to Owner.

- .5 Printer is to be at minimum equal to Hewlet Packard "DeskJet" colour printer with a speed of 600 DPI black and 300 DPI colour, and 64 kB input print buffer.

#### **2.04 Distributed Web Based User Interface**

- .1 Features and functions of dedicated web-based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to BAS network, which conforms to the following specifications:
  - .1 software is to run on Microsoft Edge (or other standard browser);
  - .2 minimum hardware requirements are:
    - .1 2 GB RAM;
    - .2 2.0 GHz clock speed Pentium 4 microprocessor;
    - .3 120 GB hard drive;
    - .4 keyboard with 83 keys minimum;
    - .5 SVGA 1024 x 768 resolution display with 64 k colours and 16 bit colour depth;
    - .6 mouse or other pointing feature.

#### **2.05 Remote Access Via Smart Phone and/or Tablet Devices**

- .1 Available with an operator interface designed for use on various modern smart phone devices with network connectivity with the follow features:
  - .1 Mobile user interface operating over standard TCP network connection, performing well down to standard mobile 3G speeds, and optimized to ensure very high performance across different network topologies.
  - .2 Solution written with HTML5 web standards and browser agnostic, not deploying or using ActiveX controls, nor requiring installation of Java Runtime engine.
  - .3 Mobile solution incorporating full scope of responsibilities of BAS operators for remote mobile users, allowing them to view or control points within their assigned facility locations.
  - .4 Without alternation, mobile user interface operable within any standard internet browser from a normal personal computer.
- .2 Along with optimized smart phone user interface, a dedicated tablet access user interface, optionally providing full operator workstation functionality, on a tablet style device. Tablet interface is to support standard operator workstation features including full operator scope of responsibility, and operable using commercial off-the-shelf technology.

#### **2.06 User Interface Application Components**

- .1 Integrated browser based client application is to be used as user operator interface program. System is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to user. Additional features are as follows:
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- .1 inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on drawings, or required as part of system software are to be displayed for operator viewing and modification from operator interface software;
  - .2 user interface software is to provide help menus and instructions for each operation and/or application;
  - .3 system is to support customization of user interface configuration and a home page for each operator;
  - .4 system is to support user preferences in alarm, trend, display, and applications screen presentations;
  - .5 controller software operating parameters are to be displayed for operator to view/modify from user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;
  - .6 operator interface is to incorporate comprehensive support for functions including but not limited to following:
    - .1 user access for selective information retrieval and control command execution;
    - .2 monitoring and reporting;
    - .3 alarm, non-normal, and return to normal condition annunciation;
    - .4 selective operator override and other control actions;
    - .5 information archiving, manipulation, formatting, display and reporting;
    - .6 BAS internal performance supervision and diagnostics;
    - .7 on-line access to help menus;
    - .8 on-line access to current BAS as-built records and documentation;
    - .9 means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.
  - .7 system is to support a list of application programs configured by users that are called up by the Tools Menu, hyperlinks within graphic displays, and key sequences;
  - .8 operation of control system is to be independent of user interface, which is to be used for operator communication only.
- .2 System is to have a minimum of 5 levels of nesting, and the capability of displaying multiple navigation trees to aid operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points, and arranging them on a tree in any order, and nesting groups within other groups. Navigation trees are to be "dockable" to other displays such as graphics, meaning trees will appear as part of display but can be detached and then minimized to Windows task bar or closed
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altogether, however, a simple keystroke will reattach navigation to primary display of user interface.

- .3 Alarms are to be routed directly from network automation engines to PC's and servers, and it is to be possible for specific alarms from specific points to be routed to specific PC's and servers. BAS is to annunciate diagnostic alarms indicating system failures and non-normal operating conditions, annunciate application alarms as required by points lists and sequences, and as a minimum, permit 4 categories of alarm sounds customizable through user defined wav files. Alarm management segment of user interface is to provide, as a minimum, following alarm functions:
    - .1 log, date, and time of alarm occurrence;
    - .2 generate a "pop-up" window or populate a dedicate section of screen with audible alarm to inform a user that an alarm has been received;
    - .3 permit a user with the appropriate security level to acknowledge, temporarily silence, or discard an alarm;
    - .4 provide an audit trail on PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, name of the user, alarm, action taken, and time/date of alarm;
    - .5 facilitate ability to direct alarms to an email address or alphanumeric pager, in addition to pop-up window described above;
    - .6 any attribute of any object in system may be designated to report an alarm.
  - .4 Reports and summaries are to be generated and directed to user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button is to print any displayed report or summary. System is to permit creation of custom reports and queries via a standard web services XML (Extensible Mark-up Language) interface and commercial of-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum, BAS is to provide following reports and summaries:
    - .1 all points in BAS;
    - .2 all points in each BAS application;
    - .3 all points in a specific controller;
    - .4 all points in a user-defined group of points;
    - .5 all points currently in alarm;
    - .6 all points locked out;
    - .7 all BAS schedules;
    - .8 all user defined and adjustable variables, schedules, interlocks, etc.
  - .5 Graphical display for time-of-day scheduling and override scheduling of building operations is to be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it is to be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars
-

provided to permit simplified scheduling of holidays and special days for a minimum of 5 years in advance, user selected with the pointing device or keyboard. Changes to schedules made from user interface are to directly modify network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum, following functions are to be provided:

- .1 weekly schedules;
  - .2 exception schedules;
  - .3 monthly calendars;
  - .4 global schedules.
- .6 BAS Is to be complete with multiple-level password access protection to permit user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:
- .1 each user is to have a user name (24 characters minimum), a password (12 characters minimum), and access levels;
  - .2 each user may change his or her password at any time;
  - .3 when editing or entering passwords, system is not to echo actual characters for display on monitor;
  - .4 minimum of 500 unique password is to be supported;
  - .5 operators are to be able to perform only those commands available for their respective passwords, and display of menu selections is to be limited to only those items defined for access level assigned to password of each user;
  - .6 BAS is to automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in operation or configuration of control system is to be recorded, including acknowledgement and deletion of alarms;
  - .7 minimum of 5 levels of access is to be supported individually or in any combination of following:
    - .1 Level 1 – view data;
    - .2 Level 2 – command;
    - .3 Level 3 – operator overrides;
    - .4 Level 4 – database modification;
    - .5 Level 5 – database configuration;
    - .6 Level 6 – all privileges including password add/modify.
- .7 User interface is to be equipped with screen management capabilities that allows user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network of user defined navigation trees.
-

- .8 Graphics application program is to be an integral part of user interface and is to include a create/edit function and a runtime function, and system architecture is to support a number of graphic documents (graphic definition files) limited only by memory and computing resources to be generated and executed. Graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include following:
    - .1 maximum of 16 graphic applications are to be able to be executed at any one time on a user interface or workstation with 4 visible to user, and each graphic application is to capable of following functions:
      - .1 all graphics are to be fully scalable;
      - .2 graphics are to support a maintained aspect ratio;
      - .3 multiple fonts are to be supported;
      - .4 unique background is to be assigned on a per graphic basis;
      - .5 colour of animations and values on displays is to indicate status of object attribute.
    - .2 it is to be possible to change values (set-points) and states in system controlled equipment by using drop-down windows accessible via pointing device;
    - .3 graphic editing tool is to be provided to permit creation and editing of graphic files, and graphic editor is to be capable of performing/defining animations, defining runtime binding, and:
      - .1 in general, facilitate creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required;
      - .2 be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.
    - .4 many graphic displays representing part of building and various building components are exact duplicates, with exception that various variables are bound to different field values, consequently, it is to be possible to bind value of a graphic display to aliases, as opposed to physical field tags.
  - .9 Trend and change of value data is to be stored within the automation engines or server and uploaded to a dedicated trend database or exported in a selectable data format via a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when trend buffers are full. Exports are to be as requested by user or on a time scheduled basis. System is to be equipped with a configurable data storage sub-system for collection of historical data which can be stored in either Microsoft Access or SQL database format. Each automation engine is to store, trend, and point history data for analog and digital inputs and outputs as follows:
    - .1 any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value;
    - .2 each automation engine or server is to capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.
-

- .10 Trend viewing utility with access to data points and capability of defining trend study displays to include multiple trends is to be provided, and is to include:
    - .1 capability of retrieving any historical database point for use in displays and reports by specifying point name and associated trend name;
    - .2 displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style;
    - .3 display magnitude (zoom capability) and units selectable by operator at any time without reconfiguration of processing or collection of data;
    - .4 display magnitude is to be automatically scaled to show full graphic resolution of data being displayed;
    - .5 trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based;
    - .6 display is to support user's ability to change colours, sample sizes, and types of markers.
  - .11 BAS is to be equipped with a database manager that separates database monitoring and management functions by supporting 2 separate windows. Database secure access is to be accomplished using standard SQL authentication including ability to access data for use outside of BAS application. Additional features are as follows:
    - .1 database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;
    - .2 database manager is to support 4 tabs as follows:
      - .1 statistics, which is to display database server information and trend, alarm (event), and audit information on BAS database;
      - .2 maintenance, which is to be an easy method of purging records from BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting database, and allowing for retention of a selected number of day's data;
      - .3 backup, which is to provide means to create a database backup file and select a storage location;
      - .4 restore, which is to provide a restricted means of restoring a database by requiring user to log into an Expert Mode in order to view Restore screen.
    - .3 status bar is to appear at bottom of BAS database manager tabs and is to indicate information on current display activity with icons as follows:
      - .1 Ready;
      - .2 Purging Record From Database;
      - .3 Action Failed;
      - .4 Refreshing Statistics;
-

- .5 Restoring Database;
  - .6 Shrinking A Database;
  - .7 Backing-Up A Database;
  - .8 Resetting Internet Information Services;
  - .9 Shutting Down BAS Deice Manager;
  - .10 Action Successful.
  - .4 database manager monitoring functions are to be accessed through Monitoring Settings window and are to continuously read database information once user has logged in;
  - .5 system is to advise user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;
  - .6 Monitoring Settings window is to have following sections:
    - .1 General: allow user to set and review scan intervals and start times;
    - .2 Email: allow user to create and review email and telephone text messages to be delivered when a warning or alarm is generated;
    - .3 Warning: allow user to define warning limit parameters, set reminder frequency, and link email message;
    - .4 Alarm: allow user to define alarm limit parameters, set reminder frequency, and link email message;
    - .5 Database Login: protect system from unauthorized database manipulation by creating a read access and write access for each trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.
  - .7 Monitoring Settings taskbars to display following informational icons:
    - .1 Normal: indicates by colour and size that databases are within their limits;
    - .2 Warning: indicates by colour and size that one or more databases have exceeded their warning limit;
    - .3 Alarm: which indicates by colour and size that one or more databases have exceeded their alarm limit.
  - .8 BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;
  - .12 BAS is to be equipped with a demand limiting and load rolling program for purpose of limiting peak energy usage and reducing overall energy consumption. Program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:
    - .1 system is to support 3 levels of sensitivity in Sliding Window demand calculations for fine tuning the system, as follows:
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- .1 Low Setting: sheds loads later and over shortest period of time and maximizes period of time equipment is on;
  - .2 Medium Setting: sheds loads earlier over a period of time greater than Low Setting, and increases time equipment is on and decreases probability of exceeding "Tariff Target";
  - .3 High Setting: sheds loads earlier and over a longer period of time than Medium Setting to minimize probability of exceeding "Tariff Target".
  - .2 system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:
    - .1 when Shed Mode is engaged, system is to actively control demand;
    - .2 when Monitor Mode is engaged, system is to simulate shedding action but will not take any action.
  - .3 Demand Limiting Program is to monitor energy consumption rate and compare it to a user defined "Tariff Target", and maintain consumption below target by selectively shedding loads based on a user defined strategy;
  - .4 Demand Limiting Program is to be capable of supporting a minimum of 10 separate load priorities, with each load user assigned, and a minimum of 12 separate "Tariff Targets" defining maximum allowed average power usage during current interval;
  - .5 system is to support a maximum shed time for each load as determined by user, and system is to restore load before maximum shed time has expired;
  - .6 system is to support a minimum shed time for each load as determined by user, and system is not to restore load before minimum shed time has expired;
  - .7 system is to support a minimum release time for each load as determined by user, and system is not to shed load until it has been off for minimum release time;
  - .8 system is to support three user defined options if meter does not function properly, as follows:
    - .1 shedding – currently shed loads will be released as their maximum shed time expires;
    - .2 maintain current shed rate – system will use demand limiting shed rate that was present when meter began to function improperly;
    - .3 use unreliable meter shed rate – system is to control to a user defined unreliable shed rate target.
  - .9 Load Rolling Program is to sum the loads currently shed and compare sum to a user defined load rolling target, and system is to maintain consumption below target by selectively shedding loads based on a user defined load priority;
  - .10 Load Rolling Program is to be capable of supporting a minimum of 10 separate load priorities with each load user defined to a load priority;
-

- .11 Load Rolling Program is to be capable of supporting a minimum of 12 separate "Tariff Targets" defining amount of energy by which demand must be reduced;
- .12 system is to equip user with a Load Tab that displays all demand limiting and load rolling parameters for any selected load;
- .13 system is to be complete with a Load Summary that displays all loads associated with demand limiting and load rolling program, and status icons for each load are to indicate:
  - .1 Load Is Offline;
  - .2 Load Is Disabled;
  - .3 Load Is Shed;
  - .4 Load Is Locked;
  - .5 Load Is In Comfort Override.
- .14 Load Summary is to include a load summary runtime view listing following load conditions:
  - .1 Load Priority;
  - .2 Shed Strategy;
  - .3 Load Rating;
  - .4 Present Value;
  - .5 Ineligible Status;
  - .6 Active Timer;
  - .7 Time Remaining;
  - .8 Last Shed time.

## **2.07 Network Automation Engines**

- .1 Network automation engines are to be ULC listed and labelled, BACnet Testing Labs (BTL) certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of 100 distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.
  - .2 Each network automation engine is to have ability to deliver a web based user interface as specified above, and computers connected physically or virtually to automation network are to have access to web-based user interface. Additional characteristics/requirements are as follows:
    - .1 web-based user interface software is to be imbedded in each network automation engine;
    - .2 each network automation engine is to support a minimum of 4 concurrent users;
-

- .3 user is to be capable of accessing all system data through one network automation engine;
  - .4 remote users connected to network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine;
  - .5 each network automation engine is to be capable of generating web-based user interface graphics, and this capability is to be imbedded in network automation engine;
  - .6 user interface is to support following functions using a standard version of Microsoft Edge:
    - .1 configuration;
    - .2 commissioning;
    - .3 data archiving;
    - .4 monitoring;
    - .5 commanding;
    - .6 system diagnostics.
  - .7 each network automation engine is to permit temporary use of portable devices without interrupting normal operation of permanently connected modems.
  - .3 Each network automation engine is to be a multi-tasking, multi-user, microprocessor-based real time digital control processor sized to meet requirements of system with a minimum word size of 32 bits, and standard operating systems.
  - .4 Each network automation engine is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for control level devices.
  - .5 Each network automation engine is to include an integrated, hardware based real time clock.
  - .6 Each network automation engine is to be equipped with LED indicators to identify following conditions:
    - .1 Power, On/Off;
    - .2 Ethernet Traffic, Ethernet Traffic/No Ethernet Traffic;
    - .3 Ethernet Connection Speed, 10 Mbps/100 Mbps;
    - .4 FC Bus A, Normal Communications/No Field Communications;
    - .5 FC Bus B, Normal Communications/No Field Communications;
    - .6 Peer Communication, Data Traffic Between Network Automation Engines;
    - .7 Run, NAE Running/NAE in Start-up/NAE Shutting Down/Software Not Running;
    - .8 Battery Fault, Battery Defective/Data Protection Battery Not Installed;
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- .9 24 VAC, 24 VAC Present/Loss of 24 VAC;
  - .10 Fault, General Fault;
  - .11 Modem RX, NAE Modem Receiving Data;
  - .12 Modem TX, NAE Modem Transmitting Data.
- .7 Each network automation engine is to be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator's terminals. Ports are to be as follows:
- .1 2 USB ports;
  - .2 2 RS-232 serial data communication ports;
  - .3 2 RS-485 ports;
  - .4 one Ethernet port.
- .8 Each network automation engine is to continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.
- .9 In event of loss of normal power each network automation engine is to continue to operate for a user adjustable period of up to 10 minutes after which there is to be an orderly shut-down of all programs to prevent loss of database or operating system software, and:
- .1 during a loss of normal power, control sequences are to go to normal system shutdown conditions, and critical configuration data is to be saved into Flash memory;
  - .2 upon restoration of normal power and after a minimum off-time delay, controller is to automatically resume full operation through a normal soft-start sequence without manual intervention.

## **2.08 Field Equipment Controllers**

- .1 Each field equipment controller is to be a fully user programmable BACnet Testing Labs (BTL) certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller is to be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without controller in place.
- .2 Each controller is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and is to be factory programmed with a continuous adaptive tuning algorithm that sense changes in physical environment and continually adjusts loop tuning parameters appropriately.
- .3 Each field equipment controller is to:
  - .1 include troubleshooting LED's to identify following conditions:
    - .1 Power On;

- .2 Power Off;
  - .3 Download or Start-Up In Progress-Not Ready For Normal Operation;
  - .4 No Faults;
  - .5 Device Fault;
  - .6 Field Controller Bus-Normal Data Transmission;
  - .7 Field Controller Bus-No Data Transmission;
  - .8 Field Controller Bus-No Communication;
  - .9 Sensor Actuator Bus-Normal Data Transmission;
  - .10 Sensor Actuator Bus-No Data Transmission;
  - .11 Sensor Actuator Bus-No Communication.
  - .2 support universal inputs, configured to monitor any of following:
    - .1 analog input, voltage mode;
    - .2 analog output, current mode;
    - .3 analog input, resistive mode;
    - .4 binary input, dry contact maintained mode;
    - .5 binary input, pulse counter mode.
  - .3 support binary inputs configured to monitor either of following:
    - .1 dry contact maintained mode;
    - .2 pulse counter mode.
  - .4 support analog outputs configured to output either of following:
    - .1 analog output, voltage mode;
    - .2 analog output, current mode.
  - .5 support binary outputs, 24 VAC Triac;
  - .6 support configurable outputs capable of following:
    - .1 analog output, voltage mode;
    - .2 binary output mode.
  - .7 have ability to reside on a master-slave/token-passing field controller bus supporting BACnet standard protocol as follows:
    - .1 support communications, including input/output communications between field controllers and network automation engines;
-

- .2 support a minimum of one hundred input/output modules and field equipment controllers in any combination;
- .3 operate at a maximum distance of 4560 m (15,000 ft) between field controller and furthest connected device.
- .8 have ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting BACnet standard protocol as follows:
  - .1 bus is to support a minimum of ten devices per trunk;
  - .2 bus is to operate at a maximum distance of 365 m (1200 ft) between field controller and furthest connected device.
- .9 capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over field controller bus or sensor-actuator bus;
- .10 support, but not limited to, following:
  - .1 hot water, chilled water/central plant applications;
  - .2 custom air handling units for special applications;
  - .3 terminal units;
  - .4 special programs as required for systems control.
- .11 support a password protected local controller LCD back-lit display with 6 key keypad as an integral part of field controller or as a remote device communicating over sensor-actuator bus to permit user to view monitored points without logging into system, and to view and change set-points, modes of operation, and parameters.

## **2.09 Input/Output Modules**

- .1 Input/output modules to facilitate additional inputs and outputs for use in field equipment controllers are to be similar to field equipment controllers but less display and with a minimum of 4 and a maximum of 17 points.

## **2.10 System Configuration Tools**

- .1 System configuration tool is a software package supplied with BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. Configuration tool is to provide an archive database for configuration and application data and is to have same look and feel at user interface regardless of whether configuration is being done online or offline. Additional features and characteristics are as follows:
  - .1 tool is to include:
    - .1 basic system navigation tree for connected networks;
    - .2 integration of system enabled devices;
    - .3 customized user navigation tress;

- .4 point naming operator parameter setting;
    - .5 graphic diagram configuration;
    - .6 alarm and event message routing;
    - .7 graphical logic connector tool for custom programming;
    - .8 downloading, uploading, and archiving databases.
  - .2 tool is to have capability to automatically discover field devices on connected buses and networks;
  - .3 tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices;
  - .4 tool is to be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to automation network.
- .2 Bluetooth Wireless Technology converter is to provide temporary wireless connection between sensor-actuator bus or field-controller bus and a wireless enabled portable computer. Converter is to be powered through a connection to either sensor-actuator bus or the field-controller bus and is to support downloading and troubleshooting field equipment controllers and field devices from portable computer over wireless connection. Converter is to be complete with LED indicators for following conditions:
- .1 Power: On/Off;
  - .2 Fault: Fault/No Fault;
  - .3 SA/FC Bus: Bus Activity/No Bus Activity;
  - .4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

## **2.11 Wiring Materials**

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in Division 26 – Electrical.

## **3 Execution**

### **3.01 General Re: Installation of the BAS**

- .1 Provide a complete building automation system in accordance with requirements of this Section of the Specification, Section 25 05 01 – Automatic Control Systems, drawings, and the input/output points list(s).
  - .2 Unless otherwise specified, perform BAS work in accordance with system manufacturer's instructions.
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### 3.02 Installation of Direct Digital Control System Components

- .1 Provide required direct digital control hardware, software, accessories, and wiring for a complete BAS. Refer to drawing control diagrams and sequences, points list(s), and Section 25 05 01 – Automatic Control Systems.
  - .2 Provide operator workstation, including required power and data connections, in a location as directed by the Owner or as indicated on drawings.
  - .3 DDC work is to be performed by skilled technicians, properly trained and are qualified for this work.
  - .4 Materials and equipment used are to be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. Systems and components are to have been thoroughly tested and proven in actual use.
  - .5 System is to be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.
  - .6 Provide new communications bus as required complete with required ancillaries. Connect and extend existing communications bus.
  - .7 Provide 1 supervisory controller (SC) per cabinet fan (air handler). Provide necessary field equipment controllers (FEC).
  - .8 Provide necessary quantity of SC to accomplish requirements of this specification, and to minimize number of mechanical systems that would be inoperative in event of a FEC failure. A maximum of 2 major mechanical systems are to be controlled by 1 FEC.
  - .9 Surface wall mount SC and FEC control units in Mechanical Rooms ensuring they are not mounted on vibrating surfaces, and connect to 15 A/1-pole circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. Power wiring from control units to circuit breakers is to be the responsibility of the controls contractor. Wiring is to be in conduit and conduit and wiring are to be in accordance with standards and requirements of Division 26 – Electrical. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.
  - .10 Indicate via number, and systems controlled by SC and FEC. Indicate via a lamacoid label mounted inside panel the identification number of electrical panel supplying power to SC and FEC.
  - .11 Submit schedule(s) of input/output points to the Consultant for review. Directly connect each SC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by system supplier.
  - .12 Provide required sensors, remote devices, etc., and required interface accessories. Mount duct and/or plenum sensors half-way across duct or plenum.
  - .13 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities must be mounted with snubbers on indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air ports in locations that minimize effects of abnormal surface flow conditions and wind gusts.
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- .14 Supply and turn over to the Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:
  - .1 process control language (PCL) logs;
  - .2 control loop logs;
  - .3 PCL master point.
- .15 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into the system.
- .16 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.

### **3.03 Implementation of Energy Management Programs**

- .1 Implement energy management programs indicated for building equipment and systems.
- .2 Ensure energy management program adjustable parameters are accessible to and adjustable by building operations personnel at operator's workstation.
- .3 Configure energy management programs so they may be enabled/disabled on an individual basis for each system to which they apply.

### **3.04 Control Wiring**

- .1 Perform required control wiring work for control systems except:
  - .1 power wiring connections to equipment and panels, except as noted below;
  - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
  - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2 ft) connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- .4 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in electrical work Division of this Specification.

### **3.05 Identification and Labelling of Equipment and Circuits**

- .1 Refer to Section 20 05 00 – Common Work Results for Mechanical.
  - .2 Identify BAS equipment as follows:
    - .1 enclosures: engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of nameplates;
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- .2 panel points: a weather-proof input/output layout sheet for each controller with the name of each point connected to controller, and associated wire labelling information;
- .3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;
- .4 interface components: a weather-proof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

### **3.06 System Startup**

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

### **3.07 Closeout Activities**

- .1 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:
  - .1 3 full, 8 hour day orientation sessions at system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to BAS operation;
  - .2 2 full, 8 hour day sessions at site using BAS for a "hands-on" demonstration of BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;
  - .3 2 full, 8 hour day seasonal (summer-winter) site sessions to perform additional instruction regarding seasonal changes and how they affect BAS.
- .2 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full day to provide additional system training as required.

**End of Section**

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## **1 General**

### **1.01 Summary**

- .1 Section Includes
  - .1 Staging and coordination requirements for the replacement of main electrical distribution equipment, while eliminating, or minimizing the impact to the Owner's ongoing use of the facility during the changeover. This includes, but is not limited to:
    - .1 Replacement of obsolete main switchboard and utility service.
    - .2 Temporary power provisions, and temporary wiring.
    - .3 Re-connection of existing branch feeders.
- .2 Related Requirements
  - .1 Section 26 21 16 – Low-Voltage Underground Electrical Service Entrance.
  - .2 Section 26 24 13 – Switchboards.
  - .3 Single Line Diagram.

### **1.02 References**

- .1 Ontario Electrical Safety Code: Section 76 – Temporary Wiring.

### **1.03 Submittals**

- .1 Refer to Section 01 33 00.
- .2 Submit staging plan to the Consultant for scheduling replacement of switchboard to maintain operation of existing facility. Include proposed routing of all temporary feeders.
- .3 Submit a detailed Method of Procedures (MOP) document that provides detailed step-by-step instructions for how the work is to be executed.

## **2 Products**

### **2.01 Temporary Power**

- .1 Power source: Trailered diesel-engine-driven generator in sound attenuated compact enclosures with spill containment.
    - .1 Sound level: max 72 db(A) at 7 m perimeter.
    - .2 Prime rating of generator based on existing facility size of service, or based on the peak demand load for the project site over the past 12 months.
    - .3 Automatic voltage regulator.
    - .4 PMG for better motor starting capability.
    - .5 Trailer mounted, for convenient delivery and site set up.
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- .6 Bus bars with lugs or camlock power cable connections.
- .7 Fuel: Onboard fuel tank with 48 hour fuel capacity. Provide sufficient fuel to suit duration of changeover. Include for on-site refuelling as required.
- .2 Temporary Electrical Distribution
  - .1 Weatherproof distribution centres capable of being mounted outdoors to suit space constraints indoors in area of work, installed in a temporary trailer, or included as part of the temporary generator.
  - .2 120/208 volt, 3-phase, 4-wire distribution, match size of existing branch circuit devices.

## **2.02 Temporary Cables, Connectors, and Supports**

- .1 Cables to OESC Section 75 requirements, lengths to suit generator location.
  - .1 SJO cables unless noted otherwise.
  - .2 Non-metallic (NM) building wire with sheathed plastic coating is permitted for feeds up to 100 A.
- .2 Connectors.
- .3 Cable covers: yellow and black, rigid plastic, installed in all pedestrian paths.
- .4 Cable tray: aluminum cable tray sized to support conductors.

## **3 Execution**

### **3.01 Examination**

- .1 Verification of Conditions
  - .1 Refer to single line diagram and existing panelboard schedules for a summary of existing branch circuits.
  - .2 During the bidding period, the Contractor is to conduct a survey of all loads fed from the existing main switchboard, and determine locations, and pathways for all temporary feeders.
  - .3 During the bidding period, Owner to submit existing peak demand load over the past 12 months for sizing of temporary power and location for temporary power source. Temporary power source up to 200 m from main electrical room.
  - .4 Meter each branch circuit during peak periods to determine maximum draw. Review readings with the Consultant to determine whether feeder and fusing reductions will be permitted.

### **3.02 Preparation**

- .1 Submit detailed staging plan to the Consultant, and provide a Method of Procedures (MOP) document detailing timeline for each step in the changeover process. Staging plan to be submitted a minimum of 60 days before changeover work begins.
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- .2 Include delivery date of the new electrical distribution, and applicable work on new utility feeder.

### **3.03 Installation**

- .1 Install all temporary wiring and temporary distribution prior to start of replacement of distribution equipment.
  - .1 Locate temporary wiring so as to minimize interference with equipment replacement operations. This work may occur during normal working hours.
  - .2 Megger test existing feeders, and allow for upsizing temporary cables to maintain 2% voltage drop on distribution feeders.
- .2 Transfer loads to temporary power. Allow for this work to be conducted during premium hours.
  - .1 Maximum 4 hour duration for any power outage during a switchover.
  - .2 Bring new diesel generator online.
  - .3 One by one, remove feeder from existing equipment, and connect equipment to temporary distribution. Cap off and make safe existing feeder to ensure no power at the point of normal supply.
- .3 Once all loads are on temporary power, perform work including removal of existing electrical equipment, and installation of new. Arrange for prompt inspection by Authorities Having Jurisdiction, including Electrical Utility, and Electrical Safety Authority.
- .4 Once new distribution is in place, perform above sequence in reverse to suit operation.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Procedures for luminaire replacement.
- .2 Procedures for in-situ luminaire upgrades.
- .3 Disposal of existing fixtures.

### **1.02 Related Requirements**

- .1 Section 02 84 00 – Polychlorinate Biphenyl Remediation.
- .2 Section 26 05 05 – Selective Demolition for Electrical.
- .3 Section 26 51 19 – LED Interior Lighting.
- .4 Section 26 52 13.13 – Emergency Lighting.
- .5 Section 26 52 13.16 – Exit Signs.
- .6 Section 26 56 19 – LED Exterior Lighting.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 9.0-96 (R2016) – General Requirements for Luminaires.
  - .4 CSA C22.2 No. 250.0:21 – Luminaires (Trinational standard, with UL 1598 and MNX-J307/1-ANCE).
  - .5 CAN/CSA E920-98 (R2017) - Ballasts for Tubular Fluorescent Lamps - General and Safety Requirements (Adopted IEC 920:1990, first edition, including Amendment 1:1993 and Amendment 2:1995, with Canadian deviations).
  - .6 CAN/CSA-E61347-1:03 (R2013) – Lamp controlgear – Part 1: General and safety requirements.
  - .7 CAN/CSA-E61347-2-3:03 (R2013) - Lamp controlgear - Part 2-3: Particular Requirements for A.C. supplied electronic ballasts for fluorescent lamps (Adopted CEI/IEC 61347-2-3:2000, first edition, 2000-10, with Canadian deviations).

### **1.04 Action Submittals**

- .1 Energy Savings Data
  - .1 Submit a table of all luminaire types indicating the total energy consumption of the existing and the proposed luminaires, indicating the nominal energy consumption is equal to or less than the existing luminaire.

- .2 Provide field measurements of three samples of each type and wattage of existing fixtures prior to exchanging for new luminaires. After normal fixture burn-in time, measure the new fixtures to demonstrate actual energy savings.
  - .3 Clearly indicate ballast and/or driver losses.
  - .2 Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:
    - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
    - .2 Provide complete photometric data prepared by independent testing laboratory for each luminaire, for approval by Engineer.
    - .3 Physical description of lighting fixtures including dimensions.
    - .4 Ballast, including BF.
    - .5 Energy-efficiency data, including ballast input wattage.
    - .6 Life, output (lumens, CCT and CRI), and energy efficiency data for lamps.
  - .3 Photometric Data and Calculations
    - .1 Provide Luminaire Data Photometric Testing performed by an independent agency complying with IESNA Lighting Measurement Testing and Calculation Guides.
    - .2 Submit photometric calculations for typical areas based on layouts as indicated on the drawings.
      - .1 Submit a photometric calculation for the typical areas based on the existing conditions.
      - .2 Submit a photometric calculation for the same typical areas based on the proposed new fixtures.
      - .3 Clearly indicate mounting heights, heights of calculation zones, light loss factors and surface reflectance values.
      - .4 Use the follow photometric parameters:
        - .1 Recoverable Light Loss Factors: 0.8
        - .2 Ceiling reflectance values of 80%
        - .3 Wall reflectance value of 50%
        - .4 Floor reflectance value of 20%.
    - .3 Submittals in PDF format, and the native file of the software used to make the photometric analysis.
    - .4 Submit IES photometric data files for the existing and proposed luminaires.
  - .4 Mock-Ups:
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- .1 Provide mock-ups of luminaires to demonstrate compatibility with existing HVAC air handling boots for applicable luminaire types.

#### **1.05 Closeout Submittals**

- .1 Luminaire disposal data.

#### **1.06 Delivery, Storage, and Handling**

- .1 Disposal and recycling of fluorescent lamps as per local regulations.
- .2 PCB ballast handling as described in Section 02 84 00.

### **2 Products**

#### **2.01 Luminaires**

- .1 In accordance with Related Requirements.

#### **2.02 Luminaire Retrofit Kits**

- .1 The contractor is permitted the use of manufacturer's standard retrofit kits to allow the reuse of existing parabolic luminaire housings. Submit for approval prior to placing order.

### **3 Execution**

#### **3.01 Examination**

- .1 Measure samples of each existing luminaire type to be replaced as described in PART 1 of this section for demonstration of energy savings.

#### **3.02 Demolition**

- .1 Remove lamps from existing luminaires for disposal in accordance with AHJ requirements.
- .2 Dispose of PCB ballasts as described in Section 02 84 00.

#### **3.03 Installation**

- .1 Install all new luminaire work in accordance with Related Requirements.
- .2 Luminaire Supports
  - .1 Support luminaires larger than 600 mm by 1200 mm (2 ft x 4 ft) size independent of ceiling framing. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.
  - .2 Provide adequate support (new chain hangers) for new and existing luminaires to suit code requirements where removed luminaires do not have independent support.
- .3 Wiring
  - .1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.

- .2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.16 using flexible conduit.
- .3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .4 Bond products and metal accessories to branch circuit equipment grounding conductor.
- .4 Install specified lamps in luminaire.
- .5 Season all lamps for a minimum of 12 hours and a maximum of 100 hours in full-on mode without dimming. All lamps used for convenience lighting during construction shall be replaced with identical new lamps, which shall then be seasoned as described above, immediately prior to the date of substantial completion as determined by the Consultant.

### **3.04 Cleaning**

- .1 Clean all luminaires and accessories thoroughly after installation. All fingerprints, dirt, tar, smudges, drywall mud and dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens or louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.
- .2 Clean electrical parts to remove conductive and deleterious materials.
- .3 Remove dirt and debris from enclosures.
- .4 Clean photometric control surfaces as recommended by manufacturer.
- .5 Clean finishes and touch up damage.
- .6 Clean and re-lamp existing luminaires to be reused.
- .7 Clean new luminaires.

### **3.05 Site Tests and Inspections**

- .1 Measure samples of each new luminaire type to be replaced as described in PART 1 of this section for demonstration of energy savings.

### **3.06 Protection**

- .1 Re-lamp luminaires that have failed lamps.
- .2 Re-lamp luminaires used for temporary lighting at Substantial Completion.

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 Common requirements for electrical work.
- .2 Mounting heights for electrical equipment and devices.

### **1.02 Related Requirements**

- .1 Provisions of this section apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.
- .2 Document 00 64 01 – Request for Electronic Files Form.
- .3 Section 07 60 00 – Flashing and Sheet Metal.
- .4 Section 07 84 00 – Firestopping.
- .5 Section 08 31 00 – Access Doors and Panels.
- .6 Section 09 91 00 – Painting.
- .7 Building Automation System integration requirements for Electrical Systems as described in Section 25 96 00.
- .8 This section is to be read in conjunction with Division 00 documents, and Division 01 specification sections, which take precedence as described in CCDC 2-2020.
  - .1 General Conditions.
  - .2 Supplementary General Conditions.
  - .3 General Requirements.

### **1.03 Intent**

- .1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter.
  - .2 Leave complete systems ready for continuous and efficient satisfactory operation.
  - .3 Discipline and Trade Jurisdiction:
    - .1 In accordance with CCDC 2-2020 GC 1.1.9: Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.
    - .2 MasterFormat's organizational structure used in a project manual does not imply how the work is assigned to various design disciplines, trades, or subcontractors. MasterFormat is not intended to determine which particular elements of the project manual are prepared by a particular discipline. Similarly, it is not intended to determine what particular work required by the project manual is the responsibility of a particular trade. A particular discipline or trade is likely to be responsible for subjects from multiple Divisions, as well as from multiple Subgroups.
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#### 1.04 Drawings and Specifications

- .1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Consultant in writing before submitting Bid. If this is not done, the maximum, **the most expensive alternate or option will be provided in base tender bid.**
  - .2 All drawings and all Divisions of these specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.
  - .3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of conductors and wiring is not assured. Exact requirements are governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions are to be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.
  - .4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job. Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other, as well as other obstructions.
  - .5 Determine final locations of major work within ceiling spaces based on the largest equipment first.
  - .6 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
  - .7 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made at no additional cost to the Owner.
  - .8 Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc. may not be shown, but where such items are required by other sections of the specifications or where there are required for proper installation of the work, such items are to be furnished and installed.
  - .9 Before ordering any conduit, cable tray, conductors, wireways, raceway bus duct, fittings, etc., verify all pertinent dimensions at the job site and be responsible for their accuracy.
  - .10 If obvious ambiguities or omissions are noticed when tendering refer same to the Consultant for a ruling and obtain the ruling in writing in the form of an Addendum. Claims for extras for ambiguities or omission of items brought to the attention of the Consultant after the award of a contract which, due to the nature of the ambiguity or omission, should have been brought to the attention of the Consultant during the tendering period, will not be allowed.
  - .11 The drawings are performance drawings, diagrammatic, and show locations for apparatus and materials. The drawings are intended to convey the scope of work and do not intend to show Architectural and Structural details. The locations shown are
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approximate, and may be altered, when approved by the Consultant, to meet requirements of the material and/or apparatus, other equipment and systems being installed, and of the building. Do not scale drawings.

- .12 Control devices, equipment requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .13 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were foreseeable by a review of existing conditions or a review of drawings prepared by other disciplines.
- .14 Where drawings indicate that acoustic tile ceiling is being suspended below existing plaster ceilings, coordinate the design of framework used to support this suspended ceiling, lighting, diffusers, and other components that are mounted within or through ceiling. Do not mount devices to suspended ceilings. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.
- .15 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

#### **1.05 Work Restrictions**

- .1 Refer to Section 01 14 00.
  - .2 Existing buildings:
    - .1 Examine the existing building, the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably be ascertained by an inspection prior to Tender closing.
    - .2 All work in the existing building, other than minor works required to permit construction of the new addition, is to be performed in such a manner as to not disrupt the building operations.
    - .3 All systems are to be kept in full operation during normal building hours.
    - .4 Note that any noise generating works that disrupt the building operation shall be coordinated accordingly and carried out after/before normal operating hours.
    - .5 Cut, modify, or extend as necessary or as directed by the Consultant, the existing material or equipment to be reused or relocated to suit work under this contract.
    - .6 Existing materials and equipment which are to be used in new work shall be repaired and refinished as necessary. Provide additional new materials and components as required to facilitate reinstallation of such existing materials and equipment.
    - .7 Co-ordinate with the Owner, and refer to General Conditions.
    - .8 Do work in existing areas to best suit available space and not interfere with or obstruct use of existing facilities.
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- .9 Where disruptions of existing services are required, coordinate shut down with the Owner's operating staff and do the work at a time and in a manner mutually acceptable. Carefully schedule disruptions to keep "down time" to a minimum.
- .3 Do all cutting, patching, and making good to leave in a finished condition and to make the several parts of the Work come together properly. Co-ordinate work to keep cutting and patching to a minimum.
- .4 Quality of workmanship and materials used in patching, making good and refinishing of existing construction and/or compartments shall be of a standard equal to that specified for new construction and if not specified, equal to or exceeding that of original existing work.
- .5 Prior to cutting openings, examine wall, floor, and ceiling construction for buried electrical cables and pipes; and take adequate protection. Conduct cable locating tests to locate buried cables in existing work.

#### **1.06 Allowances**

- .1 Conduit and wireway rough-in for the above systems is part of this contract, and is excluded from the above allowances.

#### **1.07 Substitution Procedures**

- .1 Refer to Section 01 25 00 and General Provisions of the Contract.
  - .2 Additionally, "Approved equal" shall be defined as a substitution approved by the Consultant.
  - .3 If during the tender bid process, the bidding contractor wishes to substitute the specified equipment for an "Approved equal", the bidding contractor must submit shop drawings to the Consultant before the tender close for approval. If no substitution request is made, the as-specified equipment is that to be provided.
  - .4 Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.
  - .5 This contractor, at his option, may use equipment as manufactured by any of the listed manufacturers. This Contractor is responsible to ensure that all items submitted by these other manufacturers meets are requirements of the drawings and specification and fits in the allocated space. The final determination of a product being equivalent is to be determined by the Consultant when a catalog number is not listed, or listed in part.
  - .6 Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Consultant as described in the General Provisions of the Contract for Submittals. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of the design. The Owner or the Consultant may reject manufacturer at time of shop drawing submittal.
  - .7 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space,
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power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of proposed substitution. The Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.

#### **1.08 Contract Modification Procedures**

- .1 Refer to Section 01 26 00.
  - .2 Whenever the Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare, and submit to the Consultant for review, a quotation being proposed cost for executing change or revision.
  - .3 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
  - .4 Unless otherwise specified in Division 00, Division 01, or as identified in the Owner/Contractor agreement, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
  - .5 Unless otherwise specified in Division 00, or Division 01, following additional requirements apply to all quotations submitted:
    - .1 When change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work.
    - .2 Electrical material labour unit costs are to be in accordance with National Electrical Contractors Association (NEMA) Manual of Labor Units (MLU), less 25%.
    - .3 Costs for journey person and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work.
    - .4 Cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary.
    - .5 Overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals.
    - .6 Quotations, including those for deleted work, to include a figure for any required change to Contract time.
  - .6 The Consultant reserves the right to request backup quotations for any materials and/or rentals included within the quotation.
  - .7 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable
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Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

- .8 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .9 Do not execute any change or revision until written authorization for the change or revision has been obtained from the Consultant.

#### **1.09 Coordination**

- .1 Refer to Section 01 31 00.
  - .2 Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connection. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
  - .3 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.
  - .4 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trades.
  - .5 Coordinate utility service outages with the owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.
  - .6 Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switch overs and connections. Notify Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.
  - .7 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
  - .8 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, inserts, and other hardware necessary for the installation and, where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of other trades, carefully co-ordinate the work prior to installation.
  - .9 Working Detail Drawings
    - .1 The contractor is to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where the work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.
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- .2 Carry out all alterations in the arrangement of work which has been installed without proper study and approval, even if in accordance with the contract documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

#### 1.10 Submittal Procedures

- .1 Refer to Section 01 33 00.
  - .2 Before delivery to site of any item of equipment, submit shop drawings complete with all data, pre-checked and stamped accordingly, for review by the Consultant. Indicate project name on each brochure or sheet, make reference to the number and title of the appropriate specification section, type identifier such panelboard ID or luminaire type as indicated on appropriate schedule, and provide adequate space to accommodate the Consultant's review stamp(s).
  - .3 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.
  - .4 Submit shop drawings to the Consultant in electronic (PDF) format, as coordinated after award of contract. Where submittals are derived from digital originals, do not print and rescan documents; submittals made as such will be immediately rejected.
  - .5 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.
  - .6 Shop Drawings
    - .1 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.
    - .2 Obtain and comply with the manufacturer's installation instructions.
    - .3 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with your company name, date each copy with the submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated, and signed will be returned for re-submittal.
    - .4 The Consultant will stamp shop drawings as follows:
      - .1 Reviewed ( )
      - .2 Reviewed as Modified ( )
      - .3 Revise and Re-Submit ( )
      - .4 Not Reviewed ( )
    - .5 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and
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resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.

- .6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the contract documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for co-ordination of the work as well as compliance with codes and inspection authorities such as CSA, etc.
- .7 Confirm layouts of major electrical equipment rooms with the dimensions of as-procured equipment, and submit a layout sketch to the Consultant showing the major equipment and required clear spaces. The contractor may, at their option, revise the layout of the major electrical equipment rooms, but take responsibility for these new layouts and meeting the requirements of the local electrical utilities. Capture final room layouts on as-built drawings.

#### **1.11 Submittals**

- .1 The Contractor is to submit dimensioned drawings or sketches that indicates the dimensions of the procured equipment, demonstrates that the equipment will fit in the allocated spaces, and demonstrates that manufacturer and code required clear spaces are provided.
- .2 Include sketches for the following locations that includes at minimum, major equipment such as, panelboards, wall mounted or floor-mounted telecommunications equipment.
  - .1 Electrical Equipment
  - .2 Telecommunications rooms.
  - .3 Mechanical rooms (layouts to be coordinated with mechanical trade).

#### **1.12 Safety Requirements**

- .1 Refer to Section 01 35 29.
- .2 Be responsible for the safety of workers and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations prevail.

#### **1.13 Regulatory Requirements**

- .1 Refer to Section 01 41 00.
  - .2 Codes and Standards
    - .1 Ontario Electrical Safety Code including all bulletins and amendments.
    - .2 Ontario Building Code and its referenced standards.
    - .3 Applicable CSA and ULC standards.
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- .4 All work shall be in accordance with Owner's Design Guidelines.
- .3 Permits and Fees
  - .1 Obtain and pay for all permits and fees required for the execution and inspection of the electrical work and pay all charges incidental to such permits. Submit to Electrical Inspection Department and Supply authority necessary number of drawings and specifications for examination and approval prior to commencement of work. Arrange and pay for any special inspection of equipment specified if and when required.
  - .2 Apply, pay and obtain all permits as required for the electrical work.
  - .3 Upon substantial completion of your work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.
- .4 Patents
  - .1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner, Architect, Project Manager and Consultants harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

#### 1.14 References

- .1 CSA Group:
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 CSA C235:19, Preferred voltage levels for AC Systems up to 50 000 V.
    - .3 Do underground systems in accordance with CSA C22.3 No. 7-15, Underground systems, except where specified otherwise.
    - .4 Ontario Electrical Safety Code (28th edition/2021), and all bulletins.
  - .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
    - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
  - .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
    - .1 Material Safety Data Sheets (MSDS).
  - .4 Electrical utility requirements and local applicable codes and regulations.
  - .5 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
    - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
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- .6 2012 Ontario Building Code.
- .7 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.

#### **1.15 Definitions**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

#### **1.16 Quality Assurance**

- .1 Refer to Section 01 43 00.
  - .2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.
  - .3 Ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
  - .4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.
  - .5 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Consultant. Any unsatisfactory workmanship will be replaced at no extra cost.
  - .6 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this specification. Electrical Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all electrical equipment and materials in dry locations.
  - .7 Provide foreman in charge of this work at all times.
  - .8 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.
  - .9 Governing Federal, Provincial and Municipal codes and regulations will be considered minimum standards for the work and where these are at variance with the drawings and specification, the more stringent ruling will apply.
  - .10 Where any code, regulation, bylaw, or standard is quoted it shall mean the current edition including all revisions or amendments at the time of the tender.
  - .11 In case of conflict, the codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.
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**1.17 Quality Control**

- .1 Refer to Section 01 45 00.
- .2 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

**1.18 Temporary Utilities**

- .1 Refer to Section 01 51 00.
- .2 Do not use any of the permanent facility systems during construction except as may be specified, or unless written approval is obtained from the Consultant.
- .3 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.
- .4 Temporary heating during the construction period will be provided as described in Division 01.

**1.19 Temporary Facilities and Controls**

- .1 Refer to Section 01 56 00.
- .2 Prior to start of each work period in occupied area, install temporary protection to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.
- .3 Submit temporary protection plan to Owner's Representative for approval prior to use.
- .4 Take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

**1.20 Product Requirements**

- .1 Refer to Section 01 61 00.
  - .2 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.
  - .3 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical Inspection Services, or other government agency.
  - .4 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.
  - .5 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.
  - .6 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.
  - .7 Equipment items shall be standard products of approved manufacturers. Identical units of equipment shall be of same manufacturer. In any unit of equipment, identical component parts shall be of same manufacturer, but the various component parts comprising the unit need not be of one manufacturer.
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- .8 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.
- .9 Materials shall bear approval labels as required by Code and/or Inspection Authorities.
- .10 Install materials in strict accordance with manufacturer's recommendations.
- .11 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.
- .12 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.
- .13 Unless otherwise noted, equipment and material specifications in Sections of the Specification governed by this Section are based on products of a manufacturer selected by the Consultant for the purpose of setting a standard of quality, size, performance, capacity, appearance, and serviceability.
- .14 In most instances the names of acceptable manufacturers are also stated for materials and equipment, and you may base your tender price on equipment and materials produced by either the specified manufacturer or a manufacturer listed as acceptable.
- .15 For any items of equipment, material, or for any system where acceptable manufacturers are not stated, you must provide only the equipment, material or system specified.
- .16 If materials or equipment manufactured and/or supplied by a manufacturer named in the specifications are used in lieu of products of the manufacturer noted as "basis of design", be responsible for ensuring that the substituted material or equipment is equivalent in size, performance and operating characteristics to the specified materials or equipment, and it shall be understood that all costs for larger starters, additional space, larger power feeders, and changes to associated or adjacent work required as a result of providing materials and equipment named as acceptable in lieu of the specified product will be borne by the Contractor.
- .17 In addition to the manufacturers specified or named as acceptable, the Contractor may propose substitute manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each substitute proposed, however, the tender price must be based on apparatus or materials specified or named as acceptable. Certify in writing to the Consultant that the substitute meets all space, power, design, and all other required of the specified or equivalent material or apparatus. In addition, it shall be understood that all costs for larger starters, space, power feeders, and changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed substitutions, will be borne by the party making the proposal. Substitute equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.
- .18 Where a manufacturer is not listed for a particular product, it will be deemed to mean that the Contractor will provide the specified manufacturer's product.

#### **1.21 Examination and Preparation**

- .1 Refer to Section 01 71 00.
  - .2 Examine the existing equipment, the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for
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additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

- .3 Examine work upon which your work depends. Report in writing defects in such work. Application of your work shall be deemed acceptance of work upon which your work depends.
- .4 Drawings are, in part, diagrammatic and are intended to convey scope of work and indicate general and approximate location, arrangement and sizes of equipment, piping, and similar items. Obtain more accurate information about locations, arrangement and sizes from study and coordination of drawings, including shop drawings and manufacturers' literature and become familiar with conditions and spaces affecting these matters before proceeding with work.
- .5 Where job conditions require reasonable changes in indicated locations and arrangements, make such changes with approval of the Consultant at no additional cost to the Owner. Similarly, where existing conditions interfere with new installation and require relocation, such relocation is included in work.

#### **1.22 Cutting and Patching**

- .1 Refer to Section 01 73 29.
- .2 The Electrical Contractor will be responsible for all cutting and patching required for the electrical installation. Structural members are not to be cut without the consent of the Consultant.
- .3 All cutting and patching required under Division 26, Division 27, and Division 28 shall be in accordance with Division 01. Layout such work for approval before undertaking same.
- .4 Cutting shall be kept to an absolute minimum and performed in a neat and workmanlike manner using the proper tools and equipment. Caution shall be exercised in all cutting and procedures to ensure that concealed services are not affected. Do not cut if in doubt. Request the Consultant's presence to determine if concealed services exist.
- .5 Assume responsibility for prompt installation of Work in advance of concrete pouring or similar Work. Should any cutting or repairing of finished/unfinished Work be required because such installation was not done, employ the particular trade, whose Work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such Work for approval before undertaking same.

#### **1.23 Cleaning and Waste Management**

- .1 Refer to Section 01 74 00.
  - .2 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this trade. At the completion of this work, the electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.
  - .3 Clean and repair existing materials and equipment which remain or are to be reused.
  - .4 Luminaires to be reinstalled: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
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- .5 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

#### **1.24 Starting and Adjusting**

- .1 Refer to Section 01 75 00.
- .2 Conduct acceptance tests to demonstrate that the equipment and systems actually meet the specified requirements. Tests may be conducted as soon as conditions permit, and consequently make all changes, adjustments, or replacements required as the preliminary tests may indicate prior to the final tests. Tests shall be as specified in various sections of this Division. Carry out tests in the presence of the Consultant. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. The Electrical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building, equipment, and shall bear all costs for liability, repairs, and restoration in this connection. Submit test results.
- .3 Make tests of equipment and wiring at times requested.
- .4 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.
- .5 Supply meters, materials and personnel as required to carry out these tests.
- .6 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.
- .7 Connect single phase loads so that there is the least possible unbalance of the supply phases.
- .8 Submit all test results in report format.
- .9 Trial Usage
  - .1 The Consultant reserves the right to use any system, piece of equipment, device, or material for such reasonable lengths of time and at such times as may be required to make a complete and thorough test of the same, or for the purpose of learning operational procedures, before the final completion and acceptance of the work. Such tests shall not be construed as evidence of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts of the above due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials or workmanship of any kind. Supply all labour and equipment required for such tests.
  - .2 Perform and pay for all costs associated with any testing required on the system components where, in the opinion of the Consultant the equipment manufacturer's ratings or specified performance is not being achieved.

#### **1.25 Closeout Procedures**

- .1 Refer to Section 01 77 00.
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- .2 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.
  - .3 Building Permit Compliance
    - .1 Provide a minimum of 10 business days notice to the Consultant for scheduling of Consultant's occupancy inspection.
    - .2 Prior to requesting the Consultant's letter "Review of General Conformance" for submission to the municipal building department to allow occupancy, the following items must be complete and submitted to the Consultant, as applicable:
      - .1 General
        - .1 Submit all applicable inspection reports from Authorities Having Jurisdiction.
        - .2 Continuity of fire separations at service penetrations must be complete.
        - .3 All seismic restraint requirements as described in Section 26 05 48.16 must be complete.
      - .2 Electrical
        - .1 Provide Certificate of Acceptance from Electrical Inspection Department.
        - .2 Any devices not installed must have the wiring made safe and terminated in an outlet box complete with cover.
        - .3 All outlets must have cover plates installed. All electrical equipment not located in service rooms must have covers and/or doors installed complete.
        - .4 Emergency lighting system must be operational and tested by the Contractor. Where battery units and remote heads are indicated on the drawing, provide certification letter from equipment manufacturer indicating the system meets code requirements.
        - .5 Simulate normal power failure within the premises in the presence of the consultant and the owner's representative. Test and verify exit lights and emergency lighting operations under emergency conditions. Submit letter of certification copy to the Consultant stating that the systems have been tested, witnessed by the Consultant or the Owner's representative, etc., and the methods of installation and performance are satisfactory to all parties.
        - .6 All exit lights must be installed and operational.
    - .3 Electronic Safety and Security
      - .1 Fire alarm system and devices must be operational. Submit fire alarm verification report per CAN/ULC-S537, and submit audibility test. Indicate tap settings of all signalling devices.
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- .2 Functional testing of the fire alarm system and interconnected systems per CAN/ULC-S1001 must be completed.
- .3 If any of the above items have not been completed at the time of the Consultant's Inspection, and the letter of "assurance of professional field review and compliance" cannot be issued, any costs for subsequent Inspections will be charged to the Contractor.

#### 1.26 Closeout Submittals

- .1 Refer to Section 01 78 00.
- .2 Project Record Documents
  - .1 Provide extra sets of white prints on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete as-built drawings accurately marked up in red ink must be submitted for review by the Consultant before the contract is considered to be completed.
  - .2 Changes and deviations include those made by addenda, change orders, and supplemental instructions, and changes and deviations to be marked on the white print record drawings indicated on supplemental drawings issued with addenda, change orders, and supplemental instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.
  - .3 Upon substantial completion of the work, obtain a set of reproducible white prints of the drawings and neatly amend the print in accordance with the marked-up white prints to produce a true "as-built" set of drawings.
  - .4 As-built drawings are to indicate all circuiting as installed and all distribution junction box locations as well as conduit routes.
    - .1 Request CAD release form from the Consultant, and submit completed form back to the Consultant.
    - .2 Transfer the information from the "as-built" white prints to the files, and submit to the Consultant for review.
    - .3 Employ a competent computer drafts person to indicate changes on the electronic set of as-built drawings. Provide drawings in PDF and AutoCAD formats.
    - .4 Submit three (3) USB flash drives including as-built drawings in AutoCAD format, one with each O&M manual.
    - .5 Provide three (3) sets of full size as-built drawings in hard copy format, one with each O&M manual.
  - .5 As-built Single Line Diagram
    - .1 Provide in Main Electrical Room one wall mounted copy of as-built Single Line Diagram on 6 mm (1/4 in) foam board.
    - .2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.

- .3 Operations and Maintenance (O&M) Data
  - .1 Submit two complete sets of Operation and Maintenance instruction manuals in hard copy, and one in electronic format. Include in each copy of the manual:
    - .1 Verification certificates for installation of life safety systems by the manufacturer's representative.
    - .2 A copy of "reviewed" shop drawings.
    - .3 Complete explanation of operating principles and sequences.
    - .4 Recommended maintenance practices and precautions.
    - .5 Complete wiring and connection diagrams.
    - .6 Certificates of guarantees.
  - .2 Ensure that operating and maintenance instructions are specific and apply to the model and types of equipment provided.
  - .3 Include attendance records for each training session in the O&M manual.
- .4 Warranties
  - .1 Submit a written guarantee to the Owner for one year from the date of acceptance. This guarantee shall bind the contractor to correct, replace or repair promptly any defective equipment workmanship without cost to the Owner.
  - .2 All equipment, materials and workmanship shall be unconditionally guaranteed for a minimum period of one year from the date of acceptance.
  - .3 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.
  - .4 Warranties for temperature controls and building automation systems will start on the date of verification of acceptance by the Consultant.
  - .5 Include these certificates with the maintenance and operating manuals in the appropriate sections.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Demolition**

- .1 Refer to Division 02 and Section 26 05 05.
  - .2 Remove all electrical equipment and devices on redundant structures. Make safe all circuits, and provide continuity of remaining circuits.
  - .3 To make safe: Withdraw redundant wiring and remove unwanted conduit/wiring and accessories. Position breakers to OFF position and update panel schedules.
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- .4 Make safe any redundant mechanical devices as shown on mechanical drawings.
- .5 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained and also implement new Work as detailed.
- .6 Allow for this work in Tender Price.
- .7 Turn over designated equipment to the Owner. Dispose of unwanted materials and equipment.

### **3.02 Concrete Work**

- .1 Refer to Division 03 – Concrete and Section 26 05 29.
- .2 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.
- .3 Provide a 100 mm (4 in) high concrete housekeeping pad for floor mounted electrical distribution equipment, such as the following:
  - .1 Transformers.
  - .2 Switchgear and switchboards.
  - .3 Distribution panelboards.
  - .4 Engine Generators.
  - .5 Uninterruptible Power Supplies and batteries.
  - .6 Transfer Switches.

### **3.03 Lintels**

- .1 Refer to Division 04 – Masonry.
- .2 Lintels for openings in masonry shall conform with requirements of by-laws, and as approved by the Structural Engineer.
- .3 Pay all costs for lintels over openings, required solely by the electrical trades, not shown on architectural or structural drawings.

### **3.04 Metals**

- .1 Refer to Division 05 – Metals.
- .2 Steel construction required solely for the work of this trade, and not shown on architectural or structural drawings shall be provided by this Division to the requirements of Division 05.

### **3.05 Flashing and Sheet Metal**

- .1 Refer to Section 07 60 00.
  - .2 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.
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- .3 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

### **3.06 Firestopping**

- .1 Provide firestopping in accordance with Section 07 84 00 and Section 26 05 44.13.
- .2 Ensure that fire ratings of floors and walls are maintained.
- .3 Provide ULC classified firestopping products by 3M, Hilti, STI, or approved equal which have been tested in accordance with CAN/ULC-S115.
- .4 Pack clearance spaces, fill all spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.
- .5 Install firestopping systems using personnel trained or instructed by the product manufacturer.

### **3.07 Access Doors**

- .1 Provide access doors in accordance with Section 08 31 00.
- .2 Before commencing installation of work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange the work to suit.
- .3 Group conduit work to ensure the minimum number of access doors is required.
- .4 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

### **3.08 Painting and Finishes**

- .1 Refer to Section 09 91 00.
  - .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .3 Repair and finish factory finished equipment, damaged, or scratched during installation, in an approved manner.
  - .4 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d, and leave ready to receive finish paint.
  - .5 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.
  - .6 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps etc., to have galvanized finish or paint finish over corrosion-resistant primer.
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- .7 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.
- .8 Touch up minor damage to finish on factory finished equipment. Items suffering major damage to finish shall be replaced at the direction of the Consultant.
- .9 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.
- .10 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment, etc., before painting.
- .11 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

### **3.09 Location of Outlets**

- .1 Refer to Architectural drawings for dimensions denoting exact locations.
- .2 The Consultant reserves the right to change the location of outlets to within 3 m from the point indicated on the plans without extra charge providing the Contractor is advised before installation is made.
- .3 Location of lighting, convenience, telephone, power, and communication outlets shall be subject to change, without extra cost to Owners, provided information is given prior to installation. No extra amount will be paid for extra labour and materials for relocating outlets up to 3000 mm from their original location nor will credits be anticipated where relocation up to 3000 mm reduces materials and labour. Other cases will be considered on their individual merits.
- .4 Coordinate location of boxes with latest architectural drawings and instructions to suit door swings, millwork etc. prior to rough-in.

### **3.10 Mounting Heights and Device Locations**

- .1 Refer to architectural drawings for exact location of electrical equipment and devices.
  - .2 Architectural elevations take precedence over electrical elevations. If there are conflicts between architectural and electrical, adjust locations of electrical equipment at no additional cost to the owner.
  - .3 Prior to roughing-in, the contractor is to mark locations of electrical equipment and devices for conflicts with architectural, studs, etc. If conflicts are noted, inform the Consultant for a decision prior to commencing the rough-in.
  - .4 Mounting heights of equipment and devices listed below is from finished floor to centreline of equipment, unless specified or indicated otherwise.
  - .5 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
  - .6 Install electrical equipment at following heights above finished floor (AFF). Dimensions are to centre of device unless indicated otherwise.
    - .1 Power door operator push buttons: 1000 mm.
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- .2 HVAC thermostats and manual HVAC controls: 1200 mm.
  - .3 Local switches, and manual lighting control devices:
    - .1 1100 mm.
    - .2 Locate on lock side of door.
  - .4 System furniture service fittings: to suit furniture layout.
  - .5 Wall receptacles:
    - .1 General: min. 400 mm AFF.
    - .2 Above top of counters: 175 mm.
    - .3 Above top of continuous baseboard heater, or mechanical heating/radiation units: 75 mm to bottom of device.
    - .4 In fan rooms, mechanical rooms, and electrical rooms: 1100 mm.
    - .5 For electric ranges: 130 mm.
  - .6 Outlets in raceways or millwork to be located as per Architectural details.
  - .7 Door bell pushbuttons: 1100 mm.
  - .8 Panelboards: as indicated in Section 26 24 16.
  - .9 Emergency lighting remote heads: 300 mm below finished ceiling, or 2400 mm AFF for exposed areas or areas with ceiling height above 2750 mm (9 ft).
  - .10 Communications:
    - .1 Typical communication outlets (voice and data): 400 mm.
    - .2 Communications outlets for wall mounted telephones, intercom, or similar: 1100 mm.
    - .3 Television outlets: 200 mm below finished ceiling.
    - .4 Wall mounted public address speakers: 2100 mm.
    - .5 Clocks: 2100 mm.
  - .11 Access control card readers and keypads: 900 mm.
  - .12 Fire alarm manual pull stations: 1200 mm.
  - .13 Wall mounted fire alarm audible devices, including bells or horns:
    - .1 2300 mm to the top of the device in areas of ceiling height 2450 mm or greater.
    - .2 150 mm below the finished ceiling for ceiling heights less than 2450 mm, measured to the top of the device..
  - .14 Wall mounted fire alarm visible signal devices, including strobes: 2300 mm.
-

### **3.11 Manufacturer's Instructions**

- .1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.
- .2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

### **3.12 Tests and Acceptance**

- .1 The operation of the equipment and electrical system does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.
- .2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.
- .3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition, with raceway and conduit systems properly grounded, wiring free from grounds, shorts, and that the entire installation is free from any physical defects.
- .4 Provide labour and material to conduct the integrated systems testing of interconnected life safety systems in accordance with CAN/ULC-S1001-11.

### **3.13 Closeout Activities**

- .1 Refer to Section 01 79 00.
- .2 In the presence of the Owner, demonstrate the proper operation of all systems.
- .3 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment listed in the trade sections governed by this Section. Obtain in writing from the Consultant a list of the Owner's representatives qualified to receive instructions.
- .4 Arrange for and pay for the services of qualified service technicians and other manufacturer's representatives required for instruction of specialized portions of the installation.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Work in existing facilities.
- .2 Electrical demolition.

### **1.02 Related Requirements**

- .1 Section 02 41 19 – Selective Demolition.

### **1.03 Scheduling**

- .1 Refer to Section 01 14 00, and Section 01 73 00.
- .2 All work in the existing building, other than minor works required to permit construction of the new Work, is to be performed in such a manner as to not disrupt the building operations.
- .3 All systems are to be kept in full operation during normal building hours.
- .4 Coordinate any noise-generating works that disrupt the building operation to be carried out after/before normal operating hours.

## **2 Products**

### **2.01 Materials**

- .1 Materials and equipment for patching and extending work: As specified in individual sections.

## **3 Execution**

### **3.01 Examination**

- .1 Verification of Conditions
    - .1 Verify field measurements and circuiting arrangements are as shown on Drawings.
    - .2 Verify that abandoned wiring and equipment serve only abandoned facilities.
    - .3 Demolition drawings are based on visual field observations and conditions derived from existing drawings, and do not assess the interiors of electrical equipment. Report discrepancies to the Consultant before disturbing existing installation.
    - .4 Beginning of demolition means installer accepts existing conditions.
  - .2 Tracing Existing Electrical Circuits
    - .1 Trace all circuits in the area of work listed as existing, and verify existing conditions prior to any modifications as indicated.
-

- .2 Where drawings indicate "connect to existing circuit", use a spare breaker, where available. Otherwise, verify existing load with a meter and advise the Consultant if the additional load will cause a circuit to trip.
  - .3 Where provided panelboard schedules indicate "Existing Circuit" or similar, provide the correct description for the circuit. Existing Circuit will not be acceptable in the final panelboard schedules submitted as part of closeout submittals.
  - .4 Where existing electrical conductors are to be re-used, verify they are in good condition and test the insulation integrity, if deemed not in good condition advise the consultant.
- .3 Existing Cabling in Return Air Plenums
- .1 In ceilings being used as a return air-plenum, Contractor to review existing low-voltage cabling uncovered as part of the work.
  - .2 Immediately notify the Consultant if any cables identified are not plenum rated (i.e. CMP, or FT6 rated).
- .4 Existing feeders to remain.
- .1 Where the drawings call for the re-use of existing feeders and re-connection to new equipment, (such as when equipment is replaced like-for-like), confirm the size and quantity of conductors of the existing feeder, and provide lug kits on new equipment suitable for the existing feeder.

### 3.02 Preparation

- .1 Coordinate utility service outages with utility company.
- .2 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- .3 Existing electrical service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- .4 Existing Telephone System: Maintain existing system in service. Notify Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- .5 Existing Fire Alarm System: Maintain existing system in service. Minimize outage duration. Provide fire watch as required. Make temporary connections to maintain service in areas adjacent to work area.

### 3.03 Demolition

- .1 Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
  - .2 Demolish and extend existing electrical work to Section 02 41 19, and this Section.
  - .3 Remove, relocate, and extend existing installations to accommodate new construction.
-

- .4 Remove abandoned wiring to source of supply.
- .5 When relocating or removing equipment, should any circuits be abandoned, the conductors to these circuits must be removed or properly terminated as detailed in Ontario Electrical Safety Code (OESC) bulletin 12-25-5, or latest revision.
- .6 Provide knockout fillers when removing circuits from any panelboard or splitter.
- .7 Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- .8 Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- .9 Disconnect and remove abandoned panelboards and distribution equipment.
- .10 Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- .11 Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- .12 Repair adjacent construction and finishes damaged during demolition and extension work.
- .13 Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- .14 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained, and also implement new Work as detailed.

#### **3.04 Restoration**

- .1 Install relocated materials and equipment under the provisions of Division 01.

#### **3.05 Cleaning**

- .1 Clean and repair existing materials and equipment which remain or are to be reused.
- .2 Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.
- .3 Waste Management
  - .1 Turn over designated equipment to the Owner.
  - .2 Dispose of unwanted materials and equipment.

#### **3.06 Protection**

- .1 Maintain access to existing electrical installations which remain active. Modify installation or provide access panels as appropriate.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Building wire and cable.
  - .1 Armoured cable.
  - .2 Metal clad cable.
  - .3 Fire resistive cables.
  - .4 Wiring connectors and connections.
- .2 Permitted voltage drop for feeder and branch circuits.
- .3 Conductor sizes are based on copper unless indicated as aluminum or "AL".

### **1.02 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 0.3-09 (R2019), Test methods for electrical wires and cables.
  - .4 CSA C22.2 No. 48-15, Nonmetallic sheathed cable.
  - .5 CSA C22.2 No. 51-14, Armoured cables.
  - .6 CSA C22.2 No. 52-15, Underground secondary and service-entrance cables.
  - .7 CSA C22.2 No. 65-13, Wire connectors.
  - .8 CSA C22.2 No. 75-17, Thermoplastic insulated wires and cables.
  - .9 CSA C22.2 No. 123-16, Aluminum sheathed cables.
  - .10 CSA C22.2 No. 131-14, Type TECK 90 cable.
- .2 NECA (National Electrical Contractors Association) - Standard of Installation.
- .3 NETA (International Electrical Testing Association) - ATS-2021 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .4 CAN/ULC-S139:2017 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

### **1.03 Alternates**

- .1 Submit bid based on copper conductors only, unless aluminum conductors are explicitly indicated on the drawings. Submit with bid an alternative price indicating the credit to
-

#### **1.04 Coordination**

- .1 Where wire and cable destination is indicated, and routing is not shown, determine exact routing and lengths required.

#### **1.05 Closeout Submittals**

- .1 Record Documents: Indicate as-constructed feeder sizes on a single line diagram.
- .2 Megger test results.
- .3 Thermographic survey report.
- .4 Fire rated cables: manufacturer's certification that the cables have been installed in accordance with the manufacturer's instructions.

#### **1.06 Qualifications**

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

### **2 Products**

#### **2.01 Manufacturers**

- .1 American Wire Group.
- .2 BICC Phillips.
- .3 General Cable.
- .4 Nexans.
- .5 Prysmian.
- .6 Southwire.

#### **2.02 Regulatory Requirements**

- .1 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

#### **2.03 Conductor Material**

- .1 Submit bid based on copper conductors only, unless aluminum is explicitly indicated on the drawings.

#### **2.04 Building Wire**

- .1 RW90:
    - .1 Single copper conductor.
    - .2 Minimum 12 AWG for branch circuit wiring.
    - .3 Minimum 14 AWG for 120 V control wiring.
    - .4 Chemically cross-linked polyethylene insulation.
-

- .5 Rated for 90°C, 208 V.
- .6 Suitable for handling to minus 40°C.
- .7 For interior installations in conduit.
- .2 RWU90:
  - .1 Single copper conductor.
  - .2 Minimum 12 AWG for branch circuit wiring.
  - .3 Minimum 14 AWG for 120 V control wiring.
  - .4 Chemically cross-linked polyethylene insulation.
  - .5 Rated for 90°C, 1000 V.
  - .6 Suitable for handling to -40°C.
  - .7 For exterior installations in conduit.
- .3 T90 Nylon:
  - .1 Single copper conductor.
  - .2 Thin wall PVC insulation with nylon covering.
  - .3 Rated for 90°C, 600 V.
  - .4 May be used up to size 10 AWG for interior installations.
  - .5 Base conduit fill on RW90 cable diameters.

## 2.05 Armoured Cable

- .1 General
    - .1 Connectors: standard as required, complete with anti-short rings.
    - .2 Runs to be limited to fixture drops, and runs to devices in walls and partitions, maximum horizontal runs in exposed areas and ceiling spaces to be 1.8 m (6 ft).
    - .3 Do not daisy chain (leap frog) luminaires with armoured cable.
  - .2 Type AC:
    - .1 Two, three or four copper conductors rated RW90, 1000 V.
    - .2 Bare copper ground wire.
    - .3 Insulation Voltage Rating: 600 V.
    - .4 Insulation Temperature Rating: 90°C (194°F).
    - .5 Insulation Material: Thermoplastic.
    - .6 Overall interlocked aluminum tape armour.
-

- .3 Type SPC90:
  - .1 Use for LED lighting, fluorescent dimming controls, and other SMART building applications.
  - .2 Colour coded cable with power, control, and signal under one cable.
  - .3 12-2C Power with a 16-2C Control.
  - .4 Bare copper ground wire.
  - .5 Insulation Voltage Rating: 600 V.
  - .6 Insulation Temperature Rating: 90°C (194°F).
  - .7 Insulation Material: Thermoplastic.

## 2.06 Fire Resistive Cables

- .1 General:
  - .1 2 hour fire rating to CAN/ULC-S139 and to meet 2012 Ontario Building Code rule 3.2.7.10.
  - .2 Alternative means of compliance:
    - .1 Conduits encased in a minimum of 50 mm (2 in) of concrete.
    - .2 Be protected by a fire rated assembly listed to achieve the minimum fire rating as indicated.
- .2 Manufacturers:
  - .1 nVent Pyrotenax 1850 series Mineral Insulated (MI) cable.
  - .2 VITALink MC Brand Type MC-RC90, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHIT7' or 'FHJR7', dated 19 May 2015). This cable is not to be installed in conduit.
    - .1 Request quotation from manufacturer or manufacturer's representative for field certification of installed Vitalink cables prior to requesting Consultant's construction field review.
    - .2 Power cable must be installed according to UL protocol FHIT7.120 – Electrical circuit integrity systems certified in Canada.
  - .3 Pysmian Lifeline RC90 cable.
    - .1 Installation in accordance with UL protocol FHIT7-51, and FHIT7-51A.
    - .2 System makes use of Remke connectors and Resolve boxes, with no substitutions.
- .3 Substitution Limitations:
  - .1 Substitutions may only be considered by the Consultant if the product is listed by ULC under ULC Category Codes 'FHIT7' or 'FHJR7'.

## **2.07 TECK90 Cable**

- .1 Single, three, or four conductors as indicated on drawings.
- .2 Cable to CSA C22.2 No. 131.
- .3 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .4 Insulation: Cross-linked polyethylene (XLPE), type RW90, rating: 600 V.
- .5 Inner jacket: polyvinyl chloride.
- .6 Armour: interlocking aluminum.
- .7 Overall covering: thermoplastic.
- .8 Fastenings:
  - .1 One-hole steel straps to secure surface cables 50 mm diameter and smaller.  
Two-hole steel straps for cables larger than 50 mm diameter.
  - .2 Channel type supports for two or more cables at 1500 mm centres.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .9 Connectors: Watertight, approved for TECK cable.

## **2.08 Conductor Pulling Lubricant**

- .1 Where pulling lubricant is required, use non-wax based cable lubricants compatible with cable manufacturer recommendations, such as American Polywater.

## **2.09 Connectors**

- .1 Armoured cable connectors must be proper squeeze type connectors and plastic anti-short bushings at terminations.
- .2 Connectors for conductors connecting to devices as per local governing electrical requirements to be equal to IDI Electric (Canada) Ltd., "Ideal" No. 451, No. 452, and No. 453, "Wing-Nut", CSA certified, 600 V, rated pressure type connectors.
- .3 For conductors sized 3/0 AWG and greater, provide long barrel double crimp, two (2) hole compression type lug connectors, unless otherwise noted.

## **2.10 Wiring Termination**

- .1 Lugs, terminals, or screws used for termination of wiring to be suitable for copper conductors. Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and colour coding throughout.
  - .2 Splice wire, up to and including 6 AWG, with nylon insulated expandable spring type connectors.
-

- .1 Thomas & Betts – Marr Max series.
- .3 Splice large conductors using compression type connections insulated with heat shrink sleeves.
- .1 Thomas & Betts – 5400 Series lugs & heat shrink type #s series.

### **3 Execution**

#### **3.01 Examination**

- .1 Verify that field measurements are as indicated.
- .2 Wire and cable routing indicated is approximate unless dimensioned.
- .3 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- .4 Voltage Drop
  - .1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the OESC.
  - .2 Size conductors accordingly when sizes are not identified.
    - .1 Feeder conductors: maximum voltage drop of 2%.
    - .2 Branch circuit conductors: maximum voltage drop of 3%.
- .5 Verify that mechanical work likely to damage wire and cable has been completed.
- .6 Verify that raceway installation is complete and supported.

#### **3.02 Preparation**

- .1 Completely and thoroughly swab raceway before installing wire.

#### **3.03 Installation**

- .1 Route wire and cable as required to meet project conditions.
- .2 Install cable to CSA C22.1 and per manufacturer's installation guidelines.
- .3 Conduit and cable supports:
  - .1 All wiring to be installed in EMT at all exposed areas unless otherwise specified.
  - .2 All mechanical equipment to be connected with liquid tight flexible conduit.
  - .3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.
- .4 Conductors
  - .1 Provide separate neutral for each circuit. Common neutrals not permitted.
  - .2 Use solid conductor for feeders and branch circuits 10 AWG and smaller.

- .3 Use stranded conductors for control circuits.
- .4 Use conductor not smaller than 12 AWG for power and lighting circuits.
- .5 Use conductor not smaller than 16 AWG for control circuits.
- .6 Use 10 AWG conductors for 20 A, 120 V branch circuits longer than 25 m.
- .5 Pulling conductors
  - .1 Pull all conductors into raceway at same time.
  - .2 Use suitable wire pulling lubricant for building wire 4 AWG and larger.
  - .3 Neatly train and lace wiring inside boxes, equipment, and panelboards.
  - .4 Protect exposed cable from damage.
- .6 Connectors
  - .1 Use suitable cable fittings and connectors.
  - .2 Clean conductor surfaces before installing lugs and connectors.
  - .3 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
  - .4 Use split bolt connectors for copper conductor splices and taps 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 per cent of insulation rating of conductor.
  - .5 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
  - .6 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- .7 Identification
  - .1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
  - .2 Where colour-coded tape is utilized, apply a minimum of 50 mm (2 in) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.
  - .3 Utilize colour coding on bussing in panels and, switchgear, disconnects, and metering cabinets to match conductor colour coding.

### **3.04 Conductors, Wires, and Cables**

- .1 Provide fire rated conductors or provide a fire rated assembly around conductors used for life safety applications as described in 2012 OBC 3.2.7.10.
  - .2 Indoor wiring installed in conduit, unless otherwise noted: 600 V "RW90 XLPE".
  - .3 Wiring in channel back of fluorescent and LED lighting fixtures: 600 V type GTF or TEW.
-

- .4 Lighting and power branch circuit wiring:
  - .1 Copper, minimum 12 AWG.
  - .2 Home runs to lighting and receptacle panels, which exceed 22 m (75 ft) in length: minimum 10 AWG.
- .5 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80% loaded circuit.
- .6 Outdoor wiring: "RWU90 XLPE".
- .7 Conductors shall be colour coded. Conductors 10 AWG and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size 8 AWG and larger may be colour coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.
- .8 Colour coding as follows:
  - .1 Phase "A" – Red.
  - .2 Phase "B" – Black.
  - .3 Phase "C" – Blue.
  - .4 Control – Orange.
  - .5 Ground – Green.
  - .6 Neutral – White.
- .9 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

### **3.05 Site Tests and Inspections**

- .1 Perform continuity tests of all feeders, motor circuits, and branch circuits.
- .2 Perform insulation-resistance test (megger test) on each feeder. Submit the report to the Consultant.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Grounding electrodes and conductors.
- .2 Equipment grounding conductors.
- .3 Bonding.
- .4 The terms "connect" and "bond" are used interchangeably in this Specification and have the same meaning.

### **1.02 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 0.4-17, Bonding of electrical equipment.
  - .4 CSA C22.2 No. 41-13, Grounding and bonding equipment.
  - .5 CSA C22.2 No. 75-17, Thermoplastic insulated wires and cables.
- .2 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .3 Institute of Electrical and Electronics Engineers, Inc.
  - .1 IEEE 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

### **1.03 Action Submittals**

- .1 Product Data: Provide for grounding electrodes and connections.

### **1.04 Informational Submittals**

- .1 Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- .2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

### **1.05 Closeout Submittals**

- .1 Project Record Documents: Record actual locations of components and grounding electrodes.
  - .2 Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.
-

## **1.06 Qualifications**

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

## **1.07 Regulatory Requirements**

- .1 Products: Listed and classified testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

## **2 Products**

### **2.01 Manufacturers**

- .1 B-Line by Eaton.
- .2 Hubbell (Burndy).
- .3 Panduit.
- .4 Thomas & Betts.

### **2.02 Performance Criteria**

- .1 Grounding System Resistance: 5 ohms.
- .2 Provide all equipment grounding as required regardless of whether it has been shown on drawings or called for in this specification. Arrange grounds so that under normal operating conditions no injurious amount of current will flow in any grounding conductor.

### **2.03 Grounding and Bonding Conductors**

- .1 Electrical grounding conductors shall be CSA C22.2 No. 75 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors.
- .2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 10 AWG and smaller shall be ASTM B1 solid bare copper wire.

### **2.04 Rod Electrodes**

- .1 Material: Copper-clad steel.
- .2 Diameter: 19 mm.
- .3 Length: 3000 mm.

### **2.05 Ground Rods**

- .1 Copper clad steel, 19 mm (3/4 in) diameter by 3000 mm (10 ft) long, conforming to CSA C22.2 No. 41.
  - .2 Quantity of rods shall be as required to obtain the specified ground resistance.
-

## **2.06 Splices and Termination Components**

- .1 Components shall meet or exceed CSA C22.2 No. 41, and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

## **2.07 Ground Connections**

- .1 Below Grade: Exothermic-welded type connectors.
- .2 Above Grade:
  - .1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
  - .2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

## **2.08 Ground Terminal Blocks**

- .1 At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

## **2.09 Splice Case Ground Accessories**

- .1 Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

## **2.10 Mechanical Connectors**

- .1 Material: Bronze.

## **2.11 Wire**

- .1 Material: Stranded copper.
- .2 Foundation Electrodes: 2/0 AWG.
- .3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

## **2.12 Grounding Well Components**

- .1 Well Pipe: 200 mm by 600 mm long concrete pipe with belled end.
- .2 Well Cover: Cast iron with legend "GROUND" embossed on cover.

# **3 Execution**

## **3.01 Examination**

- .1 Verify that final backfill and compaction has been completed before driving rod electrodes.

## **3.02 Installation**

- .1 General
-

- .1 Ground in accordance with the Ontario Electrical Safety Code, as shown on drawings, and as hereinafter specified.
  - .2 System Grounding:
    - .1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
    - .2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
  - .3 Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.
  - .4 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and Local Inspection Authority's Rules and Regulations.
  - .5 Install grounding conductors, outside Electric Rooms and Electrical Closets in conduit and conceal where possible. Make connections to water mains, all metallic piping systems, neutral and equipment with brass, copper or bronze bolts and connectors or weld using Cadweld or Thermoweld processes.
  - .6 Provide grounding conductors, sized as per Code, and connect to grounding bus or water main wherever non-raceways are installed.
  - .2 Provide bonding to meet Regulatory Requirements.
  - .3 Bond together metal siding not attached to grounded structure; bond to ground.
  - .4 Install ground grid under access floors indicated.
  - .5 Bond together each metallic raceway, pipe, duct, and other metal object entering space under access floors. Bond to underfloor ground grid. Use 6 AWG bare copper conductor.
  - .6 Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing..
  - .7 Secondary Equipment and Circuits
    - .1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
    - .2 Metallic Piping, Building Steel, and Supplemental Electrode(s):
      - .1 Provide a grounding electrode conductor sized per code between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to CSA C22.2 No. 41.
      - .2 Provide a supplemental ground electrode and bond to the grounding electrode system.
    - .3 Conduit Systems:
-

- .1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
- .2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
- .3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- .4 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- .5 Boxes, Cabinets, Enclosures, and Panelboards:
  - .1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
  - .2 Provide lugs in each box and enclosure for equipment grounding conductor termination.
  - .3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- .6 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- .7 Raised Floors: Provide bonding of all raised floor components.
- .8 Corrosion Inhibitors
  - .1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- .9 Conductive Piping
  - .1 Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

### 3.03 Field Quality Control

- .1 Perform inspections and tests listed in NETA ATS, Section 7.13.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Conduit and equipment supports.
- .2 Anchors and fasteners.

### **1.02 References**

- .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (28th edition/2021).
- .3 CECA - Canadian Electrical Contractors Association.

### **1.03 Action Submittals**

- .1 Submit detail, sealed by Contractor retained structural engineer for struct channel support for stacked transformers.

### **1.04 Closeout Submittals**

- .1 Submit the following in the Operation and Maintenance Manual for products used over the course of the project:
  - .1 Product Data: Provide manufacturer's catalogue data for fastening systems.
  - .2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

### **1.05 Regulatory Requirements**

- .1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

## **2 Products**

### **2.01 Manufacturers**

- .1 B-line by Eaton.
  - .2 Burndy Canada Ltd. (Hubbell).
  - .3 Erico Caddy.
  - .4 E. Myatt & Co. Inc.
  - .5 Hilti Canada.
  - .6 Thomas & Betts.
  - .7 Unistrut.
-

## **2.02 General**

- .1 All supporting devices, strut channel, threaded rod, anchors, etc. to be used shall be of the "hot dipped" galvanized type. Electrogalvanized components will not be accepted.
- .2 Materials and Finishes: Provide adequate corrosion resistance.
- .3 Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- .4 Anchors and Fasteners:
  - .1 Concrete Structural Elements: Use expansion anchor and preset inserts.
  - .2 Steel Structural Elements: Use beam clamps and welded fasteners.
  - .3 Concrete Surfaces: Use self-drilling anchors and expansion anchors.
  - .4 Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
  - .5 Solid Masonry Walls: Use expansion anchors and preset inserts.
  - .6 Sheet Metal: Use sheet metal screws.
  - .7 Wood Elements: Use wood screws.

## **2.03 Anchors and Hangers**

- .1 Hangers for electrical conduit shall be galvanized after fabrication.
- .2 Perforated strapping: not permitted.

## **2.04 Inserts**

- .1 Use only factory-made threaded or toggle type.
- .2 Where inserts cannot be placed, use factory-made expansion shields for light weights, where approved by the Consultant.
- .3 Do not use powder-activated tools except with the written permission of the Consultant.

## **2.05 Sleeves**

- .1 Through interior walls, use standard weight steel pipes, conduit, or 18 gauge galvanized steel. Cut flush with finished surfaces. Check room finish schedules.
- .2 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.
- .3 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 in) above finished floors, and cut flush with underside of floor.

## **2.06 Steel Channel**

- .1 Description: Painted steel.
-

## **2.07 Supports**

- .1 Steel supports in wet or dry locations to be galvanized after fabrication.
- .2 Where galvanized members are bolted together use cadmium plated bolts.
- .3 For hanger rods use minimum 10 mm (3/8 in) diameter steel threaded rod. Use clevis type attachment.
- .4 Provide minimum 100 mm (4 in) high concrete bases for all floor mounted equipment.

## **2.08 Supports and Bases**

- .1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with 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 Support hangers, in general, 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 Work without obtaining prior approval.

## **2.09 Threaded Rod Covers**

- .1 Protect cable from abrasion caused by contact with threaded rod.
- .2 To meet UL 94V-0 specifications.
- .3 Colour: Black.
- .4 Manufacturers:
  - .1 Panduit TRC18FR-X20Y.
  - .2 Approved equal.

## **2.10 Concrete Anchors**

- .1 Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
-

- .2 Drilled expansion anchors for anchors set in concrete block or poured concrete after the concrete has set. Size the insert and number of anchors so that the maximum load per anchor does not exceed the manufacturer's recommendation.
- .3 U-channel concrete inserts shall be 12 gauge steel 1-5/8 in square with insert anchors 1 3/8 in long and 100 mm (4 in) on centre.
- .4 Install anchor bolts to elevations required for proper attachment to supported equipment.

#### **2.11 Plywood Equipment Boards**

- .1 Plywood Equipment Boards: preservative treated, and kiln dried; thickness as indicated, or if not indicated, not less than 19 mm (3/4 in) deep. Provide marine grade plywood where subject to moisture conditions.
- .2 Paint plywood board white, or to match adjacent finishes. Leave the fire-retardant label unpainted for verification by the Consultant and by Authority Having Jurisdiction (AHJ).
- .3 Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal 13 mm (1/2 in) rustproof spacers between back of plywood and wall. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads. Maintain at least 100 mm (4 in) from bottom of plywood equipment boards and the finished floor surface.
- .4 Unless directed otherwise in field, plywood equipment boards shall be 2440 mm (8 ft) high by 19 mm (3/4 in) deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings. Unless directed otherwise in field, provide plywood equipment boards for all indoor surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms/areas and only where specifically shown on drawings for all other applications.

#### **2.12 Roof Supports**

- .1 High-density polyethylene platform and base, height adjustable with rounded corners and edges to reduce likelihood of roof penetration.
- .2 Large surface area to spread the weight of supported objects including conduits, and cable trays over a large surface footprint.
- .3 No penetration of the waterproof membrane.
- .4 Self drains water, rot proof, and sunlight resistant.
- .5 Manufacturers:
  - .1 Thomas & Betts Superstrut Adjustable Universal Support.
  - .2 Eaton Dura-Blok series.

### 3 Execution

#### 3.01 Installation

- .1 Obtain permission from the Consultant before drilling or cutting structural members.
- .2 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- .3 Install surface-mounted cabinets and panelboards with minimum of four anchors.
- .4 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 in) off wall.
- .5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- .6 Provide inserts, sleeves, equipment supports and hangers, sealing of sleeves and openings, as required for all electrical work. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on Structural Drawings or as directed by the Consultant.
- .7 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.
- .8 Place insets only in structural members and not in the finishing material.
- .9 Secure all supports and hangers to the structure unless noted otherwise.
- .10 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.
- .11 Secure supports to precast concrete members to inserts originally cast into the members or by rods passing between the members and connected to a steel plate bearing.
- .12 Sealing of Sleeves and Openings to Maintain Fire Rating
  - .1 Use Dow-Corning #3-6548 'Silicone RTV' foam, Thomas & Betts 'Flamesafe' firestop system, Electrovert 'Flameseal' firestop putty, or approved equal materials installed in accordance with the manufacturer's specifications and recommendations.
  - .2 Submit data sheets for review prior to installation.
- .13 Supports
  - .1 All conduits, panels, etc. to be securely and adequately supported.
  - .2 Where more than three conduits run together, conduit racks to be used.
  - .3 Single runs of conduit to be supported by galvanized conduit straps or ring bolt type hangers. Tie wire or perforated metal strap hangers will NOT be accepted.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Rigid metal conduit.
- .2 Flexible metal conduit.
- .3 Liquid tight flexible metal conduit.
- .4 Electrical metallic tubing (EMT).
- .5 Rigid PVC conduit.
- .6 Fittings and conduit bodies.

### **1.02 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 56-17 (R2022), Flexible metal conduit and liquid-tight flexible metal conduit.
  - .4 CSA C22.2 No. 83.1:07 (R2022), Electrical Metallic Tubing – Steel.
  - .5 CSA C22.2 No. 211.1-06 (R2021), Rigid types EB1 and DB2/ES2 PVC conduit.
  - .6 CSA C22.2 No. 211.2-06 (R2021), Rigid PVC (unplasticized) conduit.
  - .7 CSA C22.2 No. 227.1:19 (R2023), Electrical nonmetallic tubing.
  - .8 CSA C22.2 No. 227.2.1:19 (R2023), Liquid-tight flexible nonmetallic conduit.
  - .9 CSA C22.2 No. 2420-09 (R2019), Belowground reinforced thermosetting resin conduit (RTRC) and fittings.

### **1.03 Record Documentation**

- .1 Accurately record actual routing of conduits larger than 51 mm (2 in).
- .2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

### **1.04 Regulatory Requirements**

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

### **1.05 Delivery, Storage, and Handling**

- .1 Accept conduit on site. Inspect for damage.
-

- .2 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

## **1.06 Project Conditions**

- .1 Verify that field measurements are as shown on drawings.
- .2 Verify routing and termination locations of conduit prior to rough-in.
- .3 Conduit routing, if shown on drawings, is approximate unless dimensioned. Route as required to provide a complete wiring system.

## **2 Products**

### **2.01 Manufacturers**

- .1 Where products are listed in this section based on a single manufacturer, the equivalent product from the following manufacturers is acceptable:
  - .1 Appleton.
  - .2 Columbia-MBF.
  - .3 Crouse-Hinds by Eaton.
  - .4 Hubbell.
  - .5 Thomas & Betts Ltd.

### **2.02 Rigid Metal Conduit**

- .1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel, threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Fittings and conduit bodies: Material to match conduit.

### **2.03 Flexible Metal Conduit**

- .1 Flexible metal conduit: to CSA C22.2 No. 56, interlocked steel construction.
- .2 Fittings: CSA C22.2 No. 56.

### **2.04 Liquid Tight Flexible Metal Conduit**

- .1 Description: Interlocked steel construction with PVC jacket.
- .2 Fittings: CSA C22.2 No. 56.

### **2.05 Electrical Metallic Tubing (EMT)**

- .1 Description: CSA C22.2 No. 83.1; galvanized tubing.
  - .2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel type.
-

## **2.06 Electrical Non-metallic Tubing (ENT)**

- .1 To CSA C22.2 No. 227.1.

## **2.07 Non-Metallic Conduit**

- .1 Rigid Type EB1 PVC Conduit: to CSA C22.2 No. 211.1.
- .2 Rigid Type DB2/ES2 PVC Conduit: to CSA C22.2 No. 211.1.

## **2.08 Conduit, Fittings, and Accessories**

- .1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.
- .2 Provide rain tight connectors, couplings, fittings, junction boxes, pull boxes and surface outlet boxes shall be used for surface conduit installations exposed to moisture or in sprinklered buildings.
- .3 Rigid conduit bushings:
  - .1 Thomas & Betts Ltd. - Series 5031.
- .4 EMT Connectors:
  - .1 Thomas & Betts Ltd. - Steel City TC121A series.
- .5 Ground Bushings:
  - .1 Thomas & Betts – Blackjack or 1220 series.
- .6 Flexible conduit connectors:
  - .1 Thomas & Betts Ltd. - Series 3110.
  - .2 EMT couplings: steel concrete tight to match connectors.
- .7 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.
  - .1 Thomas & Betts – 8125 series.
- .8 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.
- .9 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.
  - .1 Thomas & Betts – 5332 series.

## **3 Execution**

### **3.01 Preparation**

- .1 Produce layout sketches of conduit runs through mechanical and electrical service areas, through corridors, and other congested areas in order to resolve any interferences with other work, and to determine the most efficient route to run the conduit.
-

### 3.02 Installation

- .1 Minimum size: 21 mm (3/4 in) unless otherwise specified.
- .2 Conceal all conduit except in mechanical rooms and electrical rooms, or unless otherwise indicated in this specification, or noted on the drawings. Surface conduit work is not permitted unless specifically noted.
- .3 Install wiring in conduit unless otherwise specified. Where conduit sizes are not shown on drawings, provide conduits sized in accordance with Ontario Electrical Safety Code, CSA C22.1. When conduits are indicated, they are the minimum size required, and must be increased to suit the length of run or voltage drop requirements.
- .4 Conduit use:
  - .1 Unless otherwise specified below or shown on the drawings, all systems shall be installed in electrical metallic tubing (EMT).
  - .2 Equipment subject to vibration:
    - .1 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.
  - .3 Outdoor locations, above grade: use rigid steel.
  - .4 Underground: Use rigid PVC conduit for wiring in slabs on grade, and wiring below grade.
  - .5 Wet and damp locations:
    - .1 Use rigid steel.
    - .2 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.
  - .6 Dry locations:
    - .1 Concealed in metal stud partitions:
      - .1 Use electrical metallic tubing.
      - .2 Use of AC90 (Bx) as described in Section 26 05 19.
    - .2 Concealed in concrete: Use electrical non-metallic tubing or rigid PVC.
    - .3 Exposed areas: Use electrical metallic tubing.
    - .4 Use liquid tight flexible metal conduit below raised floors for connections to all devices.
    - .5 Aluminium conduit may be used, in lieu of steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.
    - .6 Raceways installed less than 2 m above grade in an area where they are subject to mechanical damage, shall be of the rigid steel type or protected by a steel guard of not less than no. 10 MSG, adequately secured in place.

- .7 Equipment in sprinklered spaces:
    - .1 Provide CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) where conduits enter the top or the sides of enclosures.
  - .5 Arrangement and supports:
    - .1 Arrange supports to prevent misalignment during wiring installation.
    - .2 Arrange conduit to maintain headroom and present neat appearance.
    - .3 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
    - .4 Group related conduits; support using conduit rack.
    - .5 Construct rack using steel channel; provide space on each for 25 per cent additional conduits.
    - .6 Fasten conduit supports to building structure and surfaces to Section 26 05 29.
    - .7 Do not support conduit with wire or perforated pipe straps.
    - .8 Remove wire used for temporary supports.
    - .9 Do not attach conduit to ceiling support wires.
    - .10 Route exposed conduit parallel and perpendicular to walls.
    - .11 Route conduit installed above accessible ceilings parallel and perpendicular to walls.
    - .12 Route conduit in and under slab from point-to-point.
    - .13 In damp and unheated areas, avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
    - .14 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.
  - .6 Clearances:
    - .1 Maintain adequate clearance between conduit and piping.
    - .2 Maintain 300 mm (12 in) clearance between conduit and surfaces with temperatures exceeding 40°C.
  - .7 Conduit bends:
    - .1 Install no more than equivalent of three 90 degree bends between boxes.
      - .1 Use conduit bodies to make sharp changes in direction, as around beams.
      - .2 Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 50 mm size or provide prefabricated conduit bends.
-

- .8 Install wall entrance seals where conduits pass through exterior walls below grade.
- .9 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.
- .10 Cut conduit square using saw or pipe cutter; de-burr cut ends.
- .11 Bring conduit to shoulder of fittings; fasten securely.
- .12 Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- .13 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.
- .14 Provide suitable pull string in each empty conduit except sleeves and nipples.
- .15 Ground and bond conduit to Section 26 05 26.
- .16 Identify conduit to Section 26 05 53.
- .17 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

### **3.03 Cleaning**

- .1 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Wall and ceiling outlet boxes.
- .2 Pull and junction boxes.

### **1.02 Related Requirements**

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 27 16 – Electrical Cabinets and Enclosures.
- .3 Section 26 27 26 – Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.
- .4 Section 26 27 26.13 – Floor Box Assemblies.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .1 CSA C22.2 No. 18.1:13 (R2022), Metallic outlet boxes.
  - .2 CSA C22.2 No. 18.1-13 (R2022) – Metallic Outlet Boxes (Tri-national standard, with UL 514A and ANCE NMJ-J-023/1).
  - .3 CSA C22.2 No. 40-17 - Junction and Pull Boxes.
  - .4 CSA C22.2 No. 85-14 (R2018) – Rigid PVC Boxes and Fittings.

### **1.04 Closeout Submittals**

- .1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

### **1.05 Regulatory Requirements**

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

## **2 Products**

### **2.01 Outlet Boxes**

- .1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18.1, galvanized steel.
  - .1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm male fixture studs where required.
  - .2 Concrete Ceiling Boxes: Concrete type.

- .2 Non-metallic Outlet Boxes: CSA C22.2 No. 18.1.
- .3 Cast Boxes: CSA C22.2 No. 18.1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- .4 Wall Plates for Finished Areas: As specified in Section 26 27 26.

## **2.02 Pull Boxes and Junction Boxes**

- .1 Sheet Metal Boxes: CSA C22.2 No. 18.1, galvanized steel.
- .2 Hinged Enclosures: As specified in Section 26 27 16.
- .3 Surface Mounted Cast Metal Box: CSA C22.2 No. 18.1, Type 4; flat-flanged, surface mounted junction box:
  - .1 Material: Cast aluminum.
  - .2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.

## **2.03 Outlet Boxes**

- .1 Conform to CSA C22.2 No. 18.1.
  - .2 Where 103 mm (4 in) square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut as described in Division 04 as instructed under this Section. Cut openings to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Use of mortar to patch up openings that are cut too large or to patch ragged edges is not permitted.
  - .3 Ceiling boxes: 103 mm (4 in) octagon or square, complete with fittings, where required to support fixtures.
  - .4 Switch and receptacle boxes:
    - .1 103 mm (4 in) square with plaster ring, where flush mounted in plaster walls.
    - .2 Iberville 1104 series box, or equal, where flush mounted in wood or drywall, with stud fasteners as required.
    - .3 Masonry boxes in masonry walls.
  - .5 Where boxes are surface mounted in unfinished areas they shall be FS conduits.
  - .6 Standard outlet boxes manufactured from code gauge galvanized steel.
  - .7 Provide a suitable outlet box for each light, switch, receptacle, or other outlet, approved for the area it is to be installed.
  - .8 Support outlet boxes independently of conduit and cable.
  - .9 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.
  - .10 Offset outlet boxes, shown back to back in partitions, horizontally a minimum 150 mm (6 in) to minimize noise transmission between adjacent rooms.
-

- .11 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Utilize separate boxes for each system.
- .12 Use tile wall covers where 103 mm (4 in) square outlet boxes are installed in exposed concrete or cinder block in finished areas.
- .13 Provide flush mount boxes, panels, cabinets, and electrical devices, which are installed in finished areas, with suitable flush trims and doors or covers, unless specifically noted otherwise.
- .14 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

### **3 Execution**

#### **3.01 Examination**

- .1 Verify locations of floor boxes prior to rough-in.

#### **3.02 Installation**

- .1 Install boxes to CSA C22.1.
  - .2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
  - .3 Set wall mounted boxes at elevations to accommodate mounting heights indicated.
  - .4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m (10 ft) if required to accommodate intended purpose.
  - .5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
  - .6 Maintain headroom and present neat mechanical appearance.
  - .7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
  - .8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm (6 in) from ceiling access panel or from removable recessed luminaire.
  - .9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods.
  - .10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
  - .11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
  - .12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
  - .13 Use flush mounting outlet box in finished areas.
  - .14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
-

- .15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm (6 in) separation. Provide minimum 600 mm (24 in) separation in acoustic rated walls.
- .16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- .17 Use stamped steel bridges to fasten flush mounting outlet box between studs.
- .18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- .19 Use adjustable steel channel fasteners for hung ceiling outlet box.
- .20 Do not fasten boxes to ceiling support wires.
- .21 Support boxes independently of conduit.
- .22 Use gang box where more than one device is mounted together. Do not use sectional box.
- .23 Use gang box with plaster ring for single device outlets.
- .24 Use cast outlet box in exterior locations exposed to the weather.
- .25 Use cast outlet box in wet locations.
- .26 Set floor boxes level.
- .27 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

### **3.03 Adjusting**

- .1 Adjust floor box flush with finish flooring material.
- .2 Adjust flush-mounting outlets to make front flush with finished wall material.
- .3 Install knockout closures in unused box openings.

### **3.04 Cleaning**

- .1 Clean interior of boxes to remove dust, debris, and other material.
- .2 Clean exposed surfaces and restore finish.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Metal Raceway is an enclosed pathway used for surface distribution of branch circuit electrical wiring, and cabling for voice, data, multi-media, low voltage, and optical fiber. Raceway is typically installed in existing building structures, or after construction is complete. A complete raceway system includes raceway, covers, mounting hardware, various fittings, and outlet boxes installed at specific locations. Specific codes and standards apply to electrical wires and telecommunications cables that are deployed within metal raceway. Compliance to codes and standards is required for installation, grounding and bonding, and cable deployment.

### **1.02 Related Requirements**

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

### **1.03 Quality Assurance**

- .1 Product free from defects in material or workmanship.
- .2 Materials and work specified in this document shall comply with, and are not limited to the codes, standards, and regulations listed below.
  - .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
  - .2 National Electrical Manufacturer's Association (NEMA)
    - .1 ANSI/NEMA WD-6-2002: Wiring Devices – Dimensional Requirements
    - .2 NEMA 250-2003: Enclosures for Electrical Equipment.
- .3 Performance Requirements:
  - .1 Metal raceway and fittings UL Listed and CSA certified.

### **1.04 Submittals**

- .1 Product Data Sheet.
- .2 Manufacturer's Instructions.
- .3 Product Catalog Literature.
- .4 Product Drawings.

### **1.05 Warranty**

- .1 Product is warranted free of defects in material or workmanship.
  - .2 Product is warranted to perform the intended function within design limits.
-

## **2 Products**

### **2.01 Manufacturers**

- .1 Wiremold Legrand.
- .2 Hubbell.
- .3 Thomas & Betts Canada.

### **2.02 Surface Mounted Raceway, General**

- .1 The raceway and all system components must be UL Listed and exhibit non-flammable self-extinguishing characteristics tested to comparable specifications of UL94V-0. The raceway base and cover shall be manufactured by rigid compound, available in ivory or white colours, and allow for field painting.

### **2.03 Single Channel Metal Raceway**

- .1 Raceway:
    - .1 Metal raceway shall be a one-piece design with base and cover, factory assembled, with mounting hardware and instructions included.
    - .2 Metal raceway, cover, surface boxes, shall be a formed steel construction with a thickness of 0.040", and zinc plated. Related fittings shall be galvanized on all surfaces.
    - .3 Metal raceway, cover, and related fittings shall have an Ivory colour powder coat paint finish on all external surfaces.
    - .4 Have tools available for field cutting and bending.
    - .5 Assembly and disassembly of raceway base, cover, and fittings requiring no special tools.
    - .6 Available fittings including couplings, internal and external elbows, tees, entrance fittings, conduit adapters and bushings.
    - .7 Available fittings including internal, external and flat elbows, and tee fitting, with a 1-½" radius to accommodate communications UTP and fiber cabling minimum bend radius requirements.
    - .8 Installed fittings designed to overlap the raceway to cover exposed or uneven edges from field cutting.
  - .2 Device Boxes
    - .1 Compatible device boxes shall have a removable knockout portion to permit metal raceway entry and exit.
    - .2 Device boxes available in standard NEMA single- and double-gang, and multiple gang up to six-gang. Device box depth shall range from 1.125" to 2.75".
    - .3 Device boxes shall have a single seam construction with rounded corners to eliminate sharp edges.
-

- .4 Assembled device box front face design to permit flush mounting of standard wall plates to minimize perimeter profile exposure.
- .5 Device boxes shall have threaded standoff posts attached to the base, to facilitate mounting of covers with short screws for ease of alignment during installation.
- .3 Basis of Design: Wiremold 500 and 700 series.

#### **2.04 Two-Channel Metal Raceway**

- .1 Surface metal raceway, single or complete with snap-in divider to form 2 compartments for power and data, with removable cover. Width to suit application while keeping code and telecommunication standard filling ratios.
- .2 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120 V power receptacles and mounting for voice/data.
- .3 Finish: Designer Grey.
- .4 Basis of Design: Wiremold DS4000 series.

### **3 Execution**

#### **3.01 Preparation**

- .1 Submit layout drawings of the raceway system for reviewed prior to installation.
- .2 Installation of metal raceway in wet areas is not permitted.
- .3 Manufacturer's instructions for installing raceway and fittings shall be followed by the installer.
- .4 All wall surfaces, or other permanent structures to which raceway is mounted shall be finished complete.

#### **3.02 Installation**

- .1 Mount base and cover together to wall or structure using the appropriate fasteners and clips, per manufacturer's instructions.
  - .2 Securely support raceway in intervals not exceeding 3 m (10 ft) or per manufacturer's instructions.
  - .3 Install fittings and device boxes in the specified locations, per manufacturer's instructions and per contract drawing specifications.
  - .4 Completed raceway installation shall be mechanically continuous and connected to all electrical outlets, device boxes, and enclosures with no gaps or exposed cuts.
  - .5 Provide insulated ground wire for power raceways per OESC requirements. Raceway shall not be used as the primary ground path.
  - .6 Prior to wire and cable installation, the raceway system shall be installed complete, including insulating bushings, adapters, fittings, outlets, boxes, and enclosures. Unused raceway openings shall be closed.
-

- .7 Make wiring connections with the proper approved insulated wire connectors or lugs. Exposed conductors at harness wiring junctions are not permitted regardless of connection method.
- .8 Provide a physical barrier in raceway and boxes to separate power and communication wiring.
- .9 Install covers on raceway, boxes and fittings after wiring is complete, or if wire and cable installation is to be done at a later date.

### **3.03 Field Quality Control**

- .1 Verify layout of system to contract drawings.
- .2 Raceway system shall be free of dents, scratches, bare metal edges, and exposed uneven cuts.
- .3 Securely fasten all outlets, boxes, and enclosures walls or permanent structures.
- .4 Verify that all wiring junctions or connections have no exposed conductors prior to energizing the circuits.
- .5 Verify that all bonding locations are code and standards compliant.
- .6 Verify that power and communications wiring are separated by a physical barrier in raceway and boxes.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Cables installed in ducts.
- .2 Direct buried cables.
- .3 Handholes.

### **1.02 Related Requirements**

- .1 Section 31 23 00 – Excavation and Fill.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.3 No. 7-15, Underground systems.
- .2 Institute of Electrical and Electronics Engineers:
  - .1 IEEE 835-1994, Standard Power Cable Ampacity Tables.
- .3 Insulated Cable Engineers Association, Inc. (ICEA).

### **1.04 Submittals**

- .1 Submit records of existing underground utility locates, indicating location plan of existing utilities as found in field and clearance record from utility authority and location plan of relocated and abandoned services, as required.
- .2 Verify existing underground primary duct bank conduit quantity and sizes and determine if it can be re-used for the new electrical service.
- .3 Feeder ampacity calculations from cable manufacturer for any duct banks or direct buried feeders not constructed in accordance with OESC to demonstrate compliance with IEEE 835.

### **1.05 Closeout Submittals**

- .1 Record documentation:
  - .1 Records of underground utility locates.
  - .2 Record as-constructed location of all underground conduits and feeders on as-built drawings regardless of conduit size.

## **2 Products**

### **2.01 Fill Materials**

- .1 Sand fill: clean, natural sand and gravel material, free from silt, clay, loam, friable or soluble materials and vegetable matter.
-

- .2 Backfill material: Selected material from excavation or other sources, reviewed by the Consultant, unfrozen and free from rocks larger than 75 mm (3 inch), rock with sharp angular surfaces, cinders, ashes, sods, refuse, or other deleterious materials.

## **2.02 Direct Buried and Concrete Encased Conduits**

- .1 Rigid Type DB2/ES2 PVC conduit to Section 26 05 33.13.

## **2.03 Conductors**

- .1 RWU90, in accordance with Section 26 05 19 for use in direct buried applications, and in below grade conduits and duct banks.

## **2.04 Tracer Wire**

- .1 Direct burial rated tracer wire: single, solid copper, 12 AWG minimum size with 30 mm PVC jacket.
  - .1 Provide red jacket for circuits 120 V and higher.
  - .2 Provide orange jacket for communications conduits and services lower than 120 V.

## **2.05 Handholes**

- .1 460 mm (18") round handhole.
- .2 Precast concrete, to OPSD 2112.02 standard, suitable for use in vehicular traffic areas.
- .3 Manufacturers:
  - .1 Armtec-Brooklin Concrete.
  - .2 Hy-Grade Precast Concrete.
  - .3 Utilicon.

# **3 Execution**

## **3.01 Examination**

- .1 Perform locates prior to start of work.

## **3.02 Excavation and Fill**

- .1 In accordance with Section 31 23 00.
- .2 Trenching:
  - .1 Excavate to dimensions indicated. Ensure trench width is sufficient to accommodate mechanical vibratory compactor.
  - .2 Do not leave open trench at end of day's operation.
- .3 Backfilling:

- .1 Do not proceed with backfilling operations until Electrical Inspection Authority has inspected and approved installation.
- .4 Restoration:
  - .1 Restore surface of work area to conditions existing prior to execution of work.
  - .2 After backfilling trench, provide new topsoil as required to follow minimum depths after settlement of 100 mm (4 in) for grass seeded areas.
  - .3 Restore surface of paved areas to match existing.

### **3.03 Cable Installation in Ducts**

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

### **3.04 Direct Burial of Cable**

- .1 Provide sand bed as indicated.
  - .2 Lay cables maintaining 75 mm (3 in) clearance from each side of trench to nearest cable. Do not pull cable into trench.
  - .3 Provide offsets for thermal action and minor earth movements. Offset cable 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
  - .4 Install treated planks on cables for mechanical protection. Install above cables and below markers.
  - .5 Cable separation:
    - .1 Maintain 75 mm (3 in) minimum separation between cables of different circuits.
    - .2 Maintain 300 mm (12 in) horizontal separation between low and high voltage cables.
    - .3 When low voltage cables cross high voltage cables maintain 300 mm (12 in) vertical separation with low voltage cables in upper position.
    - .4 At crossover, maintain 75 mm (3 in) minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
-

- .5 Maintain minimum 300 mm (12 in) horizontal separation between cables or conduits and gas service where installed in the same trench.

### 3.05 Markers

- .1 Mark cable every 150 m along duct runs and changes in direction.
- .2 Mark underground splices.
- .3 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .4 Install cedar post type markers.
- .5 Lay concrete markers flat and centred over cable with top flush with finish grade.
- .6 Where warning tape is used to comply with 2021 OESC Rule 12-012(11) or latest edition, bury the tape approximately halfway between the installation and grade level, covering the width of the raceways or cables installed, in accordance with OESC Bulletin 12-2- (latest version).
- .7 Tracer wires:
  - .1 Provide direct burial rated tracer wire above all underground raceways and duct banks for power, control/monitoring, lighting and branch circuits, and communications raceways.
  - .2 Install tracer wire above the warning tape.

### 3.06 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests:
  - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour, and conductors not under test.
  - .3 High Potential (Hipot) Testing.
    - .1 Conduct hipot testing in accordance with manufacturer's recommendations.

- .7 Provide Owner with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Non-Conforming Work: Remove and replace entire length of cable if cable fails to meet any of test criteria.

### **3.07 Waste Management**

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Do not dispose of unused sealant material into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Do not dispose of preservative treated wood through incineration.
- .6 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .7 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.
- .8 Fold up metal banding, flatten and place in designated area for recycling.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Sleeves, sealing of sleeves and openings, as required for all electrical work.

### **1.02 Submittals**

- .1 Submit data sheets for firestopping in accordance with Section 01 33 00.
- .2 Submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .4 Submit dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical work.

## **2 Products**

### **2.01 Sleeves**

- .1 Galvanized steel sleeves:
  - .1 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction.
  - .2 Schedule 40 pipe.
- .2 Schedule 40 PVC sleeves.

### **2.02 Sleeve Seals**

- .1 Manufacturers
    - .1 Hilti Canada.
    - .2 Specified Technologies Inc.
    - .3 3M Canada Inc.
    - .4 Tremco.
    - .5 A/D Fire Protection Systems.
    - .6 Nelson.
  - .2 Asbestos-free, elastomeric materials and intumescent materials, tested, listed, and labelled by ULC in accordance with CAN/ULC-S115, and CAN/ULC-S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
  - .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices
-

in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.

- .4 Maintain fire rating of separation in accordance with architectural drawings.

### **3 Execution**

#### **3.01 Installation**

- .1 Where conduits and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
  - .2 Sleeves in concrete slabs, except as noted below, are to be No. 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.
  - .3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4") above floor.
  - .4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
  - .5 Through interior walls, use standard weight steel pipes, conduit, or galvanized steel. Cut flush with finished surfaces. Check room finish schedules.
  - .6 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.
  - .7 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4") above finished floors, and cut flush with underside of floor.
  - .8 Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled "Sleeve Seals" specified in this Section. Pack and seal sleeves set in exterior walls with governing authority approved materials suitable for application and pack both ends of sleeves watertight with approved permanently flexible and water tight materials. Coordinate exact responsibility of work with General Trades Contractor.
  - .9 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
  - .10 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
    - .1 in Mechanical and Fan Room floor slabs, except where on grade;
    - .2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;
    - .3 in floors equipped with waterproof membranes.
  - .11 "Gang" type sleeving to be permitted only with approval of Owner and reviewed with the Consultant.
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- .12 Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.
- .13 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.
- .14 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.
  - .2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.
  - .3 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.
  - .4 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.
- .15 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.
- .16 Firestop sleeves in accordance with the manufacturer's specifications and recommendations.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Tested firestop systems used in penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

### **1.02 Related Requirements**

- .1 Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
  - .1 Section 07 84 00 – Firestopping.
  - .2 Section 27 05 44 – Sleeves and Sleeve Seals for Communications Pathways and Cabling.

### **1.03 References**

- .1 Underwriter's Laboratories (UL) and Underwriters Laboratories of Canada (ULC):
    - .1 Test Requirements: CAN/ULC-S115:2018, Standard Method of Fire Tests of Firestop Systems.
    - .2 Underwriters Laboratories of Canada (ULC) runs CAN/ULC-S115:2018 under their designation of ULC-S115:2018 and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.
    - .3 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their "Products Certified for Canada (cUL) Directory".
    - .4 CAN/ULC-S102:2018, Standard Test Method for Surface Burning Characteristics of Building Materials and CAN/ULC-S101 Fire Endurance Tests of Building Construction and Materials.
  - .2 ASTM:
    - .1 Omega Point Laboratories runs ASTM E-814 and publishes the results annually in their "Omega Point Laboratories Directory".
    - .2 Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops.", and ASTM E2393 Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
    - .3 Test Requirements: ASTM E 2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus".
    - .4 ASTM D6904, "Standard Practice for Resistance to Wind Driven Rain for Exterior Coatings Applied on Masonry".
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- .5 ASTM C 679, "Standard Test Method for Tack-Free Time of Elastomeric Sealants".
- .3 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.
- .4 Ontario Building Code.
- .5 Ontario Electrical Safety Code.

#### **1.04 Definitions**

- .1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

#### **1.05 Submittals**

- .1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 01 33 00.
- .2 Manufacturer's engineering judgment identification number and drawing details when no ULC or cUL system is available for an application. Engineered judgment must include both project name and contractor's name who will install firestop system as described in drawing.
- .3 Submit material safety data sheets provided with product delivered to project site.
- .4 Submit shop drawings in accordance with Section 01 33 00:
  - .1 Submit complete cUL, ULC, or equivalent approved systems for all applications. Ensure the listing is clearly noted on the submittal.

#### **1.06 Closeout Submittals**

- .1 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to the Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to electrical service penetrations and that installation has been done in strict accordance with requirements of the Ontario Building Code, any applicable municipal bylaws, ULC requirements, and manufacturer's instructions.

#### **1.07 Quality Assurance**

- .1 Fire-Test-Response Characteristics: Provide through-penetration fire stop systems and fire-resistive joint systems that comply with specified requirements of tested systems.
  - .2 Firestop System installation must meet requirements of CAN/ULC-S115 tested assemblies that provide a fire rating as shown in Section 2.1 Clauses 4, 5, 6, and 7 below.
  - .3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
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- .4 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- .5 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

#### **1.08 Installer Qualifications**

- .1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- .2 Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.
- .3 The work is to be installed by a contractor with at least one of the following qualifications:
  - .1 FM 4991 approved contractor.
  - .2 UL approved contractor.
  - .3 Manufacturer's accredited fire stop specialty contractor.
- .4 Installer: Minimum 3 years experience with fire stop installation.

#### **1.09 Delivery, Storage, and Handling**

- .1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.
- .2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at project site.
- .3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- .4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- .5 Do not use damaged or expired materials.

#### **1.10 Project Conditions**

- .1 Do not use materials that contain flammable solvents.
  - .2 Scheduling
    - .1 Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
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- .2 Schedule installation of Drop-In firestop devices after placement of concrete but before installation of the pipe penetration. Diameter of sleeved or cored hole to match the listed system for the device.
- .3 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- .3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- .4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- .5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

## **2 Products**

### **2.01 Performance Requirements**

- .1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
  - .2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
  - .3 Provide a round fire-rated cable management device whenever cables penetrate fire rated walls, where frequent cable changes and additions may occur. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 315 mm (12.4 inches). The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type. Install device per the manufacturer's published installation instructions.
  - .4 Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with CAN/ULC-S115. For penetrations through a Fire Wall or horizontal Fire Separation provide a firestop system with a "FT" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.
  - .5 W-ratings: in accordance with Section 07 84 00.
  - .6 Provide a firestop system with an Assembly Rating as determined by CAN/ULC-S115 which is equal to the time rating of construction joint assembly.
  - .7 Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with CAN/ULC-S115.
    - .1 L-Rating: Not exceeding 5.0 CFM/sqft of penetration opening at both ambient and elevated temperatures.
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- .8 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- .9 Rain and water resistance: provide perimeter joint sealant tested in accordance with ASTM D 6904 with less than 1 hour tack free time as tested in accordance with ASTM C 679.

## 2.02 Manufacturers

- .1 Manufacturer List:
  - .1 AD Fire Protection Systems.
  - .2 Hilti (Canada) Corporation
  - .3 3M.
  - .4 Specified Technologies, Inc. (STI).
  - .5 Tremco, Inc.
- .2 Substitutions: Where a specific manufacturer is noted in this Section, equivalent products from the manufacturers listed above may be used, subject to compliance with through penetration firestop systems and joint systems listed in the ULC Fire Resistance Directory – Volume III, or UL Products Certified for Canada (cUL) Directory.

## 2.03 Materials

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
  - .2 Accessories: provide components for each firestopping and smoke seal systems that are needed to install fill materials. Use only components specified by firestopping material manufacturer, and approved by the qualified testing agency. Accessories include, but are not limited to, the following items:
    - .1 Permanent forming, damming, and backing material.
    - .2 Temporary forming material.
  - .3 Pre-formed firestop devices for use with non-combustible and combustible pipes (closed and open systems), conduit and/or cable bundles penetrating concrete floors and/or gypsum walls:
    - .1 Hilti Tub Box Kit (CP 681) for use with tub installations.
    - .2 Hilti Cast-In Place Firestop Device (CP 680-PX) for use with XFR pipe.
    - .3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.
    - .4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
    - .5 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.
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- .6 Hilti Cast-in Firestop sleeve (CFS-CID MD P) and (CFS-CID MD M) for use with combustible and non-combustible pipes through metal deck.
  - .7 Hilti Firestop Block (CFS-BL).
  - .8 STI SpecSeal series SSC Firestop Collars.
  - .9 STI SpecSeal series LCC Firestop Collars.
  - .4 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).
    - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
    - .2 Hilti Fire Foam (CP 620)/CP 660.
    - .3 Hilti Flexible Firestop Sealant (CP 606).
    - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
    - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
  - .5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe.
    - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
  - .6 Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles.
    - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
    - .2 Hilti Fire Foam (CP 620)/660.
    - .3 Hilti Flexible Firestop Sealant (CP 606).
    - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
    - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
  - .7 Firestop Putty Pads: Intumescent, non-hardening putty pads to be installed on metallic and non-metallic electrical switch and receptacle boxes to reduce horizontal separation between boxes to less than 610 mm (24 in):
    - .1 STI SpecSeal Series SSP Firestop Putty Pads.
    - .2 Hilti Firestop Putty Pad (CP 617).
  - .8 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
    - .1 Hilti Firestop Block (CFS-BL).
    - .2 Hilti Composite Sheet (CFS-COS).
    - .3 Hilti Firestop Mortar (CP 637).
-

- .4 Hilti Fire Foam (CP 620)/660.
- .5 Hilti Firestop Board (CP 675T).
- .9 Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
  - .1 Hilti Firestop Block (CFS-BL).
  - .2 Hilti Firestop Board (CP 675T).
- .10 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls.
  - .1 Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
  - .2 Hilti Firestop Cable Collar (CFS-CC).
  - .3 Hilti Firestop Sleeve (CFS-SL SK).
  - .4 Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
  - .5 Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.
  - .6 Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.
- .11 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected.
  - .1 Hilti CFS-BL Firestop Block (for walls and floors).
  - .2 Hilti CFS-PL Firestop Plug (for walls and floors).
- .12 Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket. Device shall allow for a concrete floor thickness of minimum 63 mm (2-1/2 in) up to 914 mm (36 in) without the use of field applied extension tubing:
  - .1 STI SpecSeal CID Cast-In Firestop Device.
  - .2 Hilti CP 680 Cast-In Place Firestop Device (for floors only).
- .13 For single or cable bundles up to 25 mm (1 in) diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies.
  - .1 Hilti CFS-D Firestop Cable Disc.

### **3 Execution**

#### **3.01 Installers**

- .1 Labour Use to Install Firestop Systems

- .1 To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

### **3.02 Preparation**

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
  - .1 Verify penetrations are properly sized and in suitable condition for application of materials.
  - .2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
  - .3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
  - .4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
  - .5 Do not proceed until unsatisfactory conditions have been corrected.

### **3.03 Coordination**

- .1 Coordinate construction of openings, penetrations to ensure that the fire stop systems are installed according to specified requirements.
- .2 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
- .3 Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.
- .4 Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.

### **3.04 Installation**

- .1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory or Omega Point Laboratories Directory.
  - .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
    - .1 Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
    - .2 Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
    - .3 Protect materials from damage on surfaces subjected to traffic.
-

### 3.05 Field Quality Control

- .1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- .2 Keep areas of work accessible until inspection by applicable code authorities.
- .3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops", or other recognized standard.
- .4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- .5 Manufacturer's Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

### 3.06 Identification and Documentation

- .1 The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration location on the entire project.
  - .2 The Documentation Form for through penetrations is to include:
    - .1 A Sequential Location Number.
    - .2 The Project Name.
    - .3 Date of Installation.
    - .4 Detailed description of the penetration location.
    - .5 Tested System or Engineered Judgment Number.
    - .6 Type of assembly penetrated.
    - .7 A detailed description of the size and type of penetrating item.
    - .8 Size of opening.
    - .9 Number of sides of assemblies addressed.
    - .10 Hourly rating to be achieved.
    - .11 Installer's Name.
  - .3 Copies of these documents are to be provided to the general contractor at the completion of the project.
  - .4 Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
-

- .1 The words: "Warning-Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
- .2 Contractor's Name, address, and phone number.
- .3 Through-Penetration firestop system designation of applicable testing and inspecting agency.
- .4 Date of Installation.
- .5 Through-Penetration firestop system manufacturer's name.
- .6 Installer's Name.

**3.07 Adjusting and Cleaning**

- .1 Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- .2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

### **1.02 Related Requirements**

- .1 Section 03 30 00 – Cast-in-Place Concrete.
- .2 Section 26 27 26 – Wiring Devices.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.2 No. 42-10 (R2020), General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA C22.2 No. 42.1-13 (R2017), Cover plates for flush-mounted wiring devices (Bi-national standard, with UL 514D).
  - .3 CSA C22.2 No. 55-15 (R2020), Special Use Switches.
  - .4 CSA-C22.2 No. 111-18, General-Use Snap Switches (Bi-national standard, with UL 20).

### **1.04 Submittals**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.

## **2 Products**

### **2.01 Outdoor Receptacle Pedestals**

- .1 Aluminum pedestal complete with pedestal cap, gaskets, grounding lug, and all require accessories.
  - .2 Minimum 75 mm by 75 mm (3 inch by 3 inch) cross section.
  - .3 Drain hole.
  - .4 Final mounting height of wiring device shall be no greater than 1200 mm above finished grade, including concrete base.
  - .5 Pedestal will be approved using field evaluation or special inspection and marked by a certification organization accredited by (SCC) standards council of Canada such as "CSA" or "QPS" or "ESA" or "ENTELA" or "UL".
  - .6 Complete with base flange for concealing anchor bolts.
  - .7 Receptacles to be oriented minimum 45 degrees down from horizontal to minimize cable strain.
  - .8 Provide bracket for management of cables, or coiling of excess cable length.
-

## **2.02 Foundations for Pedestals**

- .1 Provide foundations for lighting standards in accordance with manufacturer's recommendations. Submit Equipment Foundation Data in accordance with referenced standards in this section.
- .2 Concrete Foundations:
  - .1 Provide concrete bases as specified in Section 03 30 00.
- .3 Anchor Bolts
  - .1 Provide concealed galvanized high strength steel rod anchor bolts, in accordance with manufacturer's instructions.

## **2.03 Special Receptacles**

- .1 Voltage and configurations as indicated on drawings.
- .2 Receptacles of one manufacturer throughout project.

## **2.04 Receptacle Cover Plates**

- .1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 While-in-use weatherproof cover spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches for outdoor applications. Cover shall be suitable for wet locations whether or not a plug is inserted in the receptacle.
- .4 All outdoor wiring device cover plates to be labeled with riveted 3-ply engraved laminated nameplate identifying panel and circuit number for each device, and receptacle configuration.

# **3 Execution**

## **3.01 Installation**

- .1 Receptacle Pedestal
    - .1 Cut opening required on gasket for wiring access and concrete screw holes.
    - .2 Install galvanized steel concrete screws to secure pedestal to concrete base.
    - .3 Apply a bead of sealant at top of pedestal for weatherproofing.
    - .4 Ground pedestal in accordance with Section 26 05 29.
    - .5 Install receptacles as indicated.
  - .2 Receptacles:
    - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
    - .2 Mount receptacles at height in accordance with Section 26 05 00 as indicated.
-

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

### **3.02 Waste Management**

- .1 Separate and recycle waste materials in accordance with Section 01 74 00.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Owner's Representative.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This section provides minimum acceptance requirements for vibration isolation for all electrical equipment, conduit, and piping.

### **1.02 Related Requirements**

- .1 Concrete work is described in Division 03 and Section 26 05 29.

### **1.03 Submittals**

- .1 All outdoor mounted equipment shall be restrained for the highest wind speed as specified by the project's structural engineer, the governing building code(s) or the authority having jurisdiction.
- .2 Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment, and anchorage requirements.

### **1.04 Closeout Submittals**

- .1 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

### **1.05 Quality Assurance**

- .1 All vibration isolation systems shall be by one manufacturer.
- .2 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:
  - .1 International Building Code 2009.
  - .2 American Society of Civil Engineers 7-05.
  - .3 Ontario Building Code, Latest Edition.
- .3 Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.

## **2 Products**

### **2.01 Manufacturers**

- .1 Vibro-Acoustics.
  - .2 Kinetics Noise Control.
  - .3 BVA Systems.
  - .4 Vibron Limited.
-

- .5 Mason Industries.

## **2.02 Vibration Isolation**

- .1 Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have  $k_x/k_y$  ratios of at least 0.9. All springs shall be fully colour-coded to indicate capacity – colour striping is not considered adequate.
- .2 Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be hot dipped galvanized, powder-coated enamel, or painted with rust-resistant paint.
- .3 Isolators:
- .1 Vibration Isolation Pads: Type N – Neoprene pad type isolators, 10 mm (3/8") minimum thick, ribbed on both sides.
- .1 Type NSN – Sandwich neoprene pad type isolators, with 10 mm (3/8") minimum thick ribbed neoprene pads bonded to each side of a 3.5 mm (10 ga) minimum galvanized metal plate. Isolator pads shall be selected to ensure that deflection does not exceed 20% of isolator free height.
- .2 Rubber-in-Shear Floor Mounts: Type RD – "Double-deflection" neoprene isolators, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.

## **3 Execution**

### **3.01 General**

- .1 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.
- .2 Coordinate locations and sizes of structural supports with locations of vibration isolators (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).
- .3 Isolated equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved by the restraint manufacturer.

### **3.02 Vibration Isolation**

- .1 Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator anchors.
- .2 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.
- .3 Engine-generator set silencers and associated exhaust piping shall be supported with Type SHR isolators with a minimum 40 mm (1-1/2 in) static deflection.
- .4 Equipment Isolation:

			Floor Span											
			Slab on Grade			Up to 6 m (20 ft)			6 m to 9 m (20 ft to 30 ft)			9 m to 12 m (30 ft to 40 ft)		
Eqpm Type	HP and Other	RPM	Base Type	Isolator Type	Min. Defl.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.
Transformers and UPS's														
All	All	All	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	NM	RD/NSN	6 mm (0.25")
Engine-Driven Generators														
All	All	All	N/A	CSR	19 mm (0.75")	N/A	CSR	38 mm (1.50")	N/A	CSR	64 mm (2.50")	N/A	CSR	89 mm (3.50")
Notes: (1) Units that are suspended overhead shall use isolation hangers in place of floor mounted isolators with equal or greater deflection. (2) Floor spans are defined as the distance between structural support columns or walls.														

- .5 There shall be no rigid contact of isolated equipment with shaft walls, floor slabs, partitions, or non-flexible conduits connections.
- .6 Where recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.

### 3.03 Site Tests and Inspections

- .1 After installation, arrange and pay for the vibration isolation product manufacturer, or representative, to visit the site to verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

**End of Section**

## 1 General

### 1.01 Section Includes

- .1 Provide positive seismic restraints on electrical systems and components required by the building code and by the local authority having jurisdiction. **Confirm the seismic restraint requirements with the owner and architect.**
- .2 This section covers design, supply, installation, and inspection of complete SFRS (Seismic Force Resisting System) for electrical systems.

### 1.02 References

- .1 Seismic restraints are to be provided for all electrical and non-structural components of building services in accordance with the current: NBCC; OBC, and good engineering practice (references listed below):
  - .1 CSA S832-14 (R2019), Seismic risk reduction of operation and functional components (OFCs) of buildings.
  - .2 SMACNA (Sheet Metal and Air-conditioning Contractors' National Association's) Seismic Restraint Manual Guidelines for Mechanical Systems (3rd ed.).
  - .3 ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint; ASHRAE Applications Handbook, Seismic and Wind Restraint Design Chapter; ASHRAE Standard 171-2008: Methods of Test for Seismic restraints.
  - .4 VISCMA (The Vibration Isolation and Seismic Control Manufacturers Association) has developed Testing and Rating Standards for Seismic Restraint Components that comply with Code and ASHRAE based requirements.
- .2 The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.
  - .1 Federal Emergency Management Agency (FEMA) manual 413, Installing Seismic Restraints for Electrical Equipment, January 2014.

### 1.03 Coordination

- .1 Trades shall supply necessary information to the Vibration Isolation Manufacturer regarding equipment to be isolated.
- .2 Provide shop drawings to other trades for setting anchor bolts and other appurtenances necessary for the proper installation of this equipment.

### 1.04 Submittals

- .1 Shop Drawings:
  - .1 Include placement drawings for electrical equipment and equipment assemblies including runs of cable trays and conduit/cable racks showing methods of attachment to particular structure for each piece of equipment and assembly and provide anchorage/attachment details. Submit samples of materials required to complete seismic restraint work for review if and when required.

- .2 Product Data:
  - .1 Include Seismic Rating Data for each seismically rated isolator or restraint component.
  - .2 Submit copies of documents requested herein, testing reports, certificate of approvals, and commissioning sheets.
- .3 Delegated Design Submittals:
  - .1 Submit for Consultant's review, seismic design drawings and product shop drawings with calculations approved and sealed by a Professional Engineer licensed and registered in Place of Work and experienced in such Work. Be responsible for costs for services of this Professional Engineer. Shop drawings to identify equipment type, manufacturer's name, model number and weight of equipment to be restrained.
  - .2 Include for manufacturer of vibration control products, to develop/design a seismic restraint system and perform seismic calculations in accordance with latest requirements of local governing building code, requirements of local governing authority having jurisdiction, and additional requirements specified in this article. Design of seismic restraints to include requirements to withstand forces of area rating as per local governing building code requirements.
  - .3 Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces.

#### **1.05 Closeout Submittals**

- .1 Include for Professional Engineer to inspect same on site (note that multiple inspections to be required as work progresses) and to provide typewritten Inspection Reports to the Consultant throughout construction and to provide "Letters of Assurance and Conformance" with specified Codes, Standards and Bylaws. Additionally, include copies of documents in Operating and Maintenance Manuals.
- .2 At the completion of the project, upon request by the Consultant, attend a review of the installation on site.
- .3 Provide a sealed written report, certifying that the installations have been completed in accordance with the specified design(s) and shop drawing(s) can be furnished, by others, upon this request.
- .4 The installing contractor shall submit a report to the Consultant, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the Contractor to properly complete the seismic restraint work as per the specifications.
- .5 Record documents: documented torques.

#### **1.06 Quality Assurance**

- .1 The contractor shall utilize a supplier familiar/experienced with the design of seismic systems to provide a comprehensive package of isolation and seismic restraint for the project. Provide detailed shop drawings showing the proposed restraint system for all required equipment, piping, and ductwork on the project. The shop drawings shall include calculations certified by a Profession Engineer (Structural), licensed in the jurisdiction where the project occurs.
-

- .2 Certification documents to be signed and sealed by a Professional Engineer (Structural) with at least 5 years experience in the design of seismic restraints.

## **2 Products**

### **2.01 Manufacturers**

- .1 Manufacturer List:
  - .1 Eaton TOLCO.
  - .2 Mason Industries.
  - .3 Kinetics Noise Control.
  - .4 nVent (Caddy).
  - .5 Vibro-Acoustics.
- .2 Substitutions: Other manufacturers acceptable to the Authority Having Jurisdiction.

### **2.02 Design Criteria**

- .1 Review architectural and structural drawings to confirm the seismic criteria for the project.

### **2.03 General**

- .1 Electrical equipment installation is to meet local governing authority having jurisdiction and code seismic requirements and additional requirements for vibration isolation.
- .2 Provide labour, materials, and equipment required and necessary to seismically restrain electrical equipment and equipment bases including concrete pads, and guarantee function of materials and equipment supplied.
- .3 Provide additional seismic requirements for suspended electrical raceways, luminaires, and other equipment as per governing local authority requirements and requirements of current codes and by-laws.
- .4 Provide seismic restraining devices to restrain mechanical, electrical, and related equipment, and equipment bases including concrete pads, as per governing local authority requirements and requirements of current codes and by-laws.
- .5 In event that inadequate isolation is provided by isolation product manufacturer's isolation package, be responsible for improving isolation to an acceptable standard at no additional cost to contract. Isolation product manufacturer's seismic restraint engineer to verify that seismic restraints and combination isolator/restraints intended for use on project are fit for intended purpose. Be responsible for ensuring that manufacturer's seismic restraints are in compliance with applicable local building code requirements for Place of Work.

### **2.04 Vibration Controls and Seismic Restraints**

- .1 Electrical equipment installation is to meet local governing authority having jurisdiction and code seismic requirements and additional requirements outlined herein.
-

- .2 Provide labour, materials, and equipment required and necessary to seismically restrain electrical equipment and equipment bases including concrete pads, and guarantee function of materials and equipment supplied.
- .3 Make electrical connections to vibration-isolated equipment with flexible conduit or other flexible means acceptable to the Consultant and local governing authority having jurisdiction so as not to restrict maximum anticipated movement of equipment under seismic excitation movement.
- .4 In event that inadequate isolation is provided by isolation product manufacturer's isolation package, be responsible for improving isolation to an acceptable standard at no additional cost to contract. Isolation product manufacturer's seismic restraint engineer to verify that seismic restraints and combination isolator/restraints intended for use on project are fit for intended purpose. Be responsible for ensuring that manufacturer's seismic restraints are in compliance with applicable local building code requirements for Place of Work.
- .5 Provide additional seismic requirements for suspended electrical raceways, luminaires, and other equipment as per governing local authority requirements and requirements of current codes and by-laws.
- .6 Include for manufacturer of vibration control products to develop/design a seismic restraint system and perform seismic calculations in accordance with latest requirements of local governing building code, requirements of local governing authority having jurisdiction, and additional requirements specified in this article. Design of seismic restraints to include provisions to withstand forces of area rating as per governing building code requirements.
- .7 Provide vibration isolation for equipment or parts connected rigidly to isolated equipment.
- .8 Provide vibration isolation for transformers by means of bridge bearing neoprene isolators or open steel spring isolators. Static deflection of vibration isolators for electrical transformers is indicated below. Isolators requiring a static deflection greater than 13 mm (1/2") to be open spring isolators unless otherwise specified.

<u>Transformer Rating</u>	<u>On Grade (Isolated Slab)</u>	<u>Location on Grade (Continuous Slab)</u>	<u>Upper Floor (Suspended Slab)</u>
Less than 10 kVA	6 mm	6 mm	18 mm
10 – 100 kVA	6 mm	12 mm	25 mm
Greater than 100 kVA	6 mm	25 mm	38 mm

- .9 Standard vibration isolation requirements of equipment such as gensets, power transformers and distribution equipment, to comply with following:
    - .1 Choose equipment isolation mounts on basis of achieving 98% vibration isolation efficiency at lowest operating speed. Natural frequency of each vibration isolation system to be at least 1/10 of lowest excitation frequency of rotating machinery, whenever practicable, but in no case less than 1/7. Where structural floor deflection exceeds 1/10 of determined static deflection of isolator, increase isolator static deflection to maintain this minimum ratio of floor to isolator deflection. Where static deflections are shown on drawings, Specifications, or schedules, they are to be used as a guide only. Actual isolators are to achieve required static deflection under load, with at least 50% reserve deflection;
    - .2 Submit shop drawings identifying equipment, lowest operating speed, weight, brand, type and location of isolators prior to ordering or fabrication.
-

- .10 Neoprene Isolators:
  - .1 Neoprene isolators to be bridge bearing rated type manufactured from bridge bearing quality neoprene, CAN/CSA-S6-88 Section 11.5.8.
  - .2 Where a ribbed pad is used, height of ribs is not to exceed 0.7 times width of rib. A steel layer to be used to distribute load in a multi-layered unit.
  - .3 Select neoprene pads or elements at supplier's optimum recommended loading and do not load beyond limit specified in neoprene manufacturer's literature.
  - .4 Test neoprene isolators to ASTM specifications. Submit to Consultant, following test data to verify performance of neoprene isolators:
    - .1 A data sheet listing all of ASTM test results.
    - .2 Load deflection curves for isolator indicating deflection to full compression for both laterally restrained and unrestrained isolators.
- .11 Open Steel Spring Isolators:
  - .1 Springs to be "Iso-Stiff" (spring coefficient 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.
  - .2 Spring mounts to be complete with levelling devices, minimum 6 mm (1/4") thick neoprene sound pads, and zinc chromate plated hardware.
  - .3 Sound pads to be sized for a minimum deflection of 1.2 mm (0.0472") and meet requirements for neoprene isolators.
- .12 Seismic restraints to restrain equipment in all directions and to be sized to meet appropriate Sp factor defined in Table 4.1.9.D of current National Building Code and Commentary J of Supplement to current Code. Calculations bearing seal of a qualified Professional Engineer to be submitted with shop drawings to justify stated seismic restraint requirements.
- .13 Attachment points and fasteners to be capable of withstanding a load of 3 times sized capacity of restraint. Equipment suppliers to provide proof of conformance with this clause by means of shop drawings certified by a qualified Professional Engineer.
- .14 Submit test data to the Consultant, showing load deflection curves up to 1.5 times rated capacity of restraint, and certifying that neither neoprene elements nor restraint body sustained any deformation after release of load.
- .15 Adjust restraints to have clearances between 3 mm (1/8") and 6 mm (1/4") under normal operating conditions of equipment.

### **3 Execution**

#### **3.01 General**

- .1 The following typical electrical equipment requires seismic protection (as applicable to Project, confirm requirements with Architect and the Owner):
    - .1 Transformers;
    - .2 Switchboards/switchgear;
-

- .3 Panelboards;
- .4 Fire alarm system, cabinets and devices;
- .5 Luminaires;
- .6 Conduit and duct banks;
- .7 Other electrical equipment, as required.

### **3.02 Preparation**

- .1 The Contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The Contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- .3 Coordinate size, shape, reinforcement, and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 20 kPa (3,000 psi) or as specified by the Consultant. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.
- .4 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer seismic restraint manufacturer's written instructions.
- .5 Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g., roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

### **3.03 Installation**

- .1 Isolated and restrained equipment, conduit located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure are not acceptable.
  - .2 Attach conduit to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures.
  - .3 Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse restraint to a wall, and then a longitudinal restraint to either a floor/ceiling/roof at the same braced location.
-

- .4 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.
  - .5 General Seismic Controls for Electrical Systems:
    - .1 Seismically restrain per specific code requirements all Electrical components listed below (unless otherwise indicated on the drawings), using seismic cable restraints:
      - .1 Seismically restrain all conduit 78 mm (3") in nominal diameter and larger. Single supported conduit is restrained in the same fashion as single clevis supported pipe.
      - .2 Seismically restrain all conduit, bus ducts, or cable trays that are supported on trapeze bars, that have been assigned a Component Importance Factor equal to 1.5, and that have a total weight greater than 146 N/m (10 lb/ft). This total weight includes not only the conduit, bus duct, or cable trays, but also includes the trapeze bars as well.
    - .2 The Contractor is to provide the weight per unit length for cable trays and bus duct.
    - .3 Single supported conduit and trapeze supported conduit, bus duct, and cable trays to be seismically restrained in a manner similar to mechanical pipes and HVAC ducts.
    - .4 Provide seismic restraint components intended to be used with suspended single supported conduit and trapeze supported conduit, cable trays, and bus ducts. Components intended to both support and restrain distribution systems such as wall mounted conduit, cable trays, and bus ducts will need to be designed and evaluated for both the dead weight load and the design horizontal seismic load.
    - .5 To ensure that the seismic forces are transferred properly to the restraint points, cables should be strapped either individually or in bundles to the cable tray at regular intervals. It is necessary for the conduit, bus ducts, and cable trays to be attached to the trapeze bars sufficiently to resist the design horizontal seismic forces, both transverse (T) and longitudinal (L).
    - .6 Brace a change of direction longer than 3.7 m (12 ft).
    - .7 This specification does not allow the use of the "12 inch rule" where the piping and electrical may be exempted from seismic restraint based on the length of the support rods provided that the rods are not subjected to bending moments.
    - .8 Install restraint cables so they do not bend across edges of adjacent equipment or building structure. Tie back to structure at 45 degrees to the structure.
    - .9 Longitudinal restraints for single pipe supports shall be attached rigidly to the pipe, not to the pipe hanger.
    - .10 For supports with multiple pipes (trapezes), secure pipes to trapeze member with clamps approved for application.
    - .11 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.
-

- .12 Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
  - .13 Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.
  - .14 Longitudinal restraints for single conduit supports shall be attached rigidly to the pipe, not to the pipe/conduit hanger.
  - .15 For supports with multiple conduits (trapezes), secure conduit to trapeze member with clamps approved for application.
  - .16 Rod Stiffener Clamps are required where the hanger rod exceeds the maximum length shown in the seismic calculation sheets. They are only required at restraint locations.
  - .17 Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.
  - .18 Adjust restraint cables so that they are not visibly slack. Cable not to support weight during normal operation.
  - .19 Seismic systems are to be compatible with requirements for anchoring and guiding of systems.
  - .20 Drilled or power-driven anchors or fasteners shall not be permitted for use with seismic control measures.
  - .21 Friction due to gravity does not constitute a seismic attachment.
  - .22 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.
  - .23 Standard beam clamps can be used to support restrained components; they cannot be used to connect the seismic restraint to the structure – only for the hanger rods.
  - .24 Make electrical connections to vibration-isolated equipment with flexible conduit or other flexible means acceptable to the Consultant and local governing authority having jurisdiction so as not to restrict maximum anticipated movement of equipment under seismic excitation movement.
  - .6 Panelboards, Lighting, Emergency Lighting Battery Units, and Emergency Remote Heads
    - .1 Wall mounted panelboards, lighting, emergency lighting battery units, and emergency remote heads can be directly mounted to the building structure with approved fasteners to suit. Minimum two or more anchors shall be provided on each side of all wall mounted equipment.
    - .2 For emergency battery units, pre-installed brackets must be used.
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### **3.04 Field Tests and Inspections**

- .1 Test, adjust, and certify installation. Submit copies of test report to the Consultant.
- .2 Inspect for removal of break away hardware to ensure proper torques of installed systems.
- .3 For non-visually verifiable product, manufacturers to verify proper torque for a minimum 10% of application. Document torques for applications per manufacturer's instructions.
- .4 The contractor shall notify the local representative of the seismic restraint materials manufacturer mid-way through the listed project if they require an inspection of any and all vibration and seismic restraint devices already installed. A typewritten report of any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system shall be documented and the contractor shall perform all steps that are required from this written report to properly complete the vibration and seismic restraint work as per the specifications. Report to include clear sketches as required.
- .5 The installing contractor shall submit a report to the Consultant, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Nameplates and labels.
- .2 Wire and cable markers.
- .3 Conduit markers.
- .4 Receptacle labels.
- .5 Signage.

### **1.02 Related Requirements**

- .1 Section 09 91 00 – Painting.
- .2 Section 27 05 53 – Identification for Communications Systems.

### **1.03 Submittals**

- .1 Product Data: Provide catalogue data for nameplates, labels, and markers.
- .2 Provide shop drawings of nameplates for Consultant's review prior to fabrication (scale 1:1).
- .3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

### **1.04 Regulatory Requirements**

- .1 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

## **2 Products**

### **2.01 Nameplates and Labels**

- .1 Nameplates:
  - .1 Engraved three-layer laminated plastic, letters on contrasting background.
  - .2 Colours to match existing building system, where applicable. If no building system exists, use the following:
    - .1 347/600 volt system: White text on Blue background.
    - .2 120/208 volt system: Black text on White background.
    - .3 Fire Detection system: White text on Red background.
    - .4 Emergency Lighting system: Red text on White background.
    - .5 LV systems: White text on Green background.

- .3 Confirm colours with the Consultant prior to ordering nameplates.
  - .2 Equipment Nameplates to indicate:
    - .1 Equipment/Panelboard ID.
    - .2 Ampacity.
    - .3 Voltage.
    - .4 Number of Phases.
    - .5 Number of wires in system.
    - .6 Interrupting Capacity.
    - .7 Size, number of poles, Panelboard ID, and circuit number of upstream overcurrent protection device.
      - .1 Location of upstream device if not in the same room.
  - .3 Coordination Study Labels to Section 26 05 73.16.
  - .4 Arc Flash Study Labels to Section 26 05 73.19.
  - .5 Locations:
    - .1 Distribution panelboards, and individual distribution panelboard branch breakers.
    - .2 Receptacle panelboards.
    - .3 Each electrical distribution and control equipment enclosure.
    - .4 Uninterruptible Power Supply.
    - .5 Mechanical Equipment.
    - .6 UPS receptacles.
    - .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
    - .8 Terminal cabinets, junction boxes, and pull boxes: indicate system and voltage.
    - .9 Transformers: indicate capacity, primary and secondary voltages.
  - .6 Letter Size:
    - .1 Use 3 mm letters for identifying individual equipment and loads.
    - .2 Use 6 mm letters for identifying grouped equipment and loads.
  - .7 Labels:
    - .1 Mechanically fastened with sheet metal screws, with 5 mm white letters on black background.
    - .2 White letters on red background for UPS and equipment, and devices downstream of UPS.
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- .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .4 Wording on nameplates and labels to be reviewed by the Consultant prior to manufacturing.
- .5 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.

## **2.02 Wiring Identification**

- .1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

## **2.03 Wire Markers**

- .1 Description: tape, split sleeve, or tubing type wire markers.
- .2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
- .3 Legend:
  - .1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
  - .2 Control Circuits: Control wire number indicated on shop drawings.

## **2.04 Conduit and Box Markers**

- .1 Colour code conduits, boxes, and metallic sheathed cables.
- .2 Colours to match equipment nameplate background colour:
  - .1 347/600 volt system: Blue.
  - .2 120/208 volt system: Black.
  - .3 Fire Alarm system: Red.
  - .4 Emergency Lighting system: Red/White.
- .3 Confirm colours with the Consultant prior to commencing rough-in.

## **2.05 Junction and Pull Boxes**

- .1 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers.
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- .2 Spray painting: not permitted.
- .3 Paint colours to be in accordance with following schedule:
  - .1 Lighting: yellow.
  - .2 Normal power: blue.
  - .3 Emergency power: orange.
  - .4 Fire alarm: red.
  - .5 Communications systems including telephone and data: green.
  - .6 Miscellaneous signals: brown.
- .4 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed. Identify source panelboard for power circuits.

## **2.06 Branch Breaker Labels**

- .1 General:
  - .1 Legibly identify every circuit and circuit modification as to its clear, evident, and specific purpose or use. Include sufficient detail to allow each circuit to be distinguished from all others.
  - .2 Label spare positions that contain unused overcurrent devices or switches.
  - .3 Do not describe any circuit in a manner that depends on transient conditions of occupancy.
- .2 Switchboards, distribution panelboards, enclosed breakers, and disconnect switches:
  - .1 Locate identification at each switch.
  - .2 Branch breaker nameplates on switchboards, distribution panelboards and switchboards, and generator load breakers to indicate:
    - .1 Locate identification at each switch on a switchboard.
    - .2 Identification of downstream equipment fed from the breaker.
      - .1 Location of downstream device if not in the same room.
    - .3 Breaker size and number of poles.
    - .4 Interrupting Capacity.
    - .5 Circuit number (where applicable).
    - .6 Do not describe any circuit in a manner that depends on transient conditions of occupancy.
- .3 Lighting and Receptacle Panelboards:
  - .1 Provide a circuit directory that is located on the face or inside of the panel door.

- .2 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

## **2.07 Receptacle Labels**

- .1 Label all receptacles with the panelboard ID and circuit number.
- .2 Use receptacle labels by electronic labeller Brother P-Touch, model PT-20/25, Dymo-Tape or approved equal.
- .3 Location: On receptacle wall plate.

## **3 Execution**

### **3.01 Equipment Nameplates from Manufacturers**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.
- .2 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.
- .3 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

### **3.02 Conduit and Box Identification**

- .1 Locate labels as follows:
  - .1 At every end of every conduit, duct, or cable run, adjacent to item of equipment serviced.
  - .2 On each exposed conduit, duct or cable passing through a wall, partition, or floor (one on each side of such wall partition or floor).
  - .3 At intervals of 15 m (50 ft) along every exposed conduit, duct or cable run exceeding 15 m (50 ft) in length.
  - .4 At every access point on concealed conduit duct or cable.
  - .5 At each junction box.
- .2 Place labels so as to be visible from 1500 mm (5 ft) above adjacent floor platform.

### **3.03 Preparation**

- .1 Degrease and clean surfaces to receive nameplates and labels.

### **3.04 Application**

- .1 Confirm colours prior to start of work.
  - .2 Install nameplate and label parallel to equipment lines.
  - .3 Secure nameplate to equipment front using adhesive.
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- .4 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- .5 Identify conduit using field painting.
- .6 Paint coloured band on each conduit longer than 2 m.
- .7 Paint bands 6 m on centre.

### **3.05 Labelling**

- .1 Colour code wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components.
- .2 Label wiring with point name using Thomas & Betts 12 character polestar metalized labels with 3 rows of characters per label, or equal by Brady. Label to occur as a minimum at both ends and at pull boxes of the wiring run.
- .3 Identify all pull boxes, junction boxes, etc. (installed as part of this project or used by this project) with the exact use of the box. Indelible felt pen marker is acceptable.
- .4 Label light control items with point name using Thomas & Betts 12 character label, or equal by Brady. Label to be black lettering on clear backing.
- .5 Label relays and controllers inside panels using Thomas & Betts 12 character label, or equal by Brady.
- .6 Provide red, 13 mm (1/2 in) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

### **3.06 Labels and Signs**

- .1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.
- .2 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Provide a short circuit and coordination study for the existing and new portions of electrical distribution system. The basic analysis shall include a protective device evaluation, and a protective device coordination study.
- .2 The project shall begin at the point of utility service for the facility and continue down through the system to all downstream distribution and branch panelboards, motor control centres and significant motor locations.
- .3 The project shall include any new and existing generators and any associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.

### **1.02 Related Requirements**

- .1 Section 26 05 73.19 – Arc-Flash Hazard Analysis.
- .2 Single Line Diagram.

### **1.03 Reference Standards**

- .1 Perform all studies in accordance with the latest applicable IEEE and ANSI standards.
  - .1 ANSI C38.010-1999.
  - .2 ANSI C37.5-1979.
  - .3 ANSI C37.13-1990.

### **1.04 Submittals**

- .1 In accordance with Section 01 33 00:
- .2 Submit the following:
  - .1 Submit for review three copies of the protection coordination study.
  - .2 Shop drawings for equipment affected by the coordination study will not be reviewed until the coordination study has been submitted and reviewed.
  - .3 Include a one-line diagram of the system.
  - .4 Bind the final report in a three-ring binder, as well as a soft copy.
- .3 Projection System Coordination:
  - .1 Prepare a graph or coordination curves, prior to manufacture of service entrance and distribution equipment on K & E No. 336E Time-Current characteristic graph paper. Time-current characteristics shall be plotted of the following:
    - .1 Supply Authorities relays or fuses protecting incoming service (Contractor under this section shall obtain this information).
    - .2 Main and feeder protective devices at every voltage level used in distribution system.

- .3 Protective devices associated with largest motor and/or refrigeration compressor.
- .2 Preliminary submission of graph for comment will be accepted. Submit graph to Supply Authority for approval by them as providing satisfactory co-ordination. When curves have been approved by Supply Authority, they shall be submitted for approval. After approval has been obtained, order protective devices, and calibrate to conform with these curves.
- .3 Each time-current characteristic curve sheet shall include:
  - .1 A single line diagram for the portion of the system involved.
  - .2 Transformer damage curves (where applicable).
  - .3 Cable damage curves (where applicable).
  - .4 Available fault levels for the portion of the system involved.
- .4 Consult manufacturer of the refrigeration compressors and obtain recommendations for settings on starters. Incorporate information in co-ordination curves and submit the associated curves to Compressor Manufacturer and obtain approval from the manufacturer.
- .5 Compressor manufacturer and mechanical trade contractor will determine and calibrate proper protection on motor starters and will ensure that it coordinates with protective devices on switchboard.
- .6 Co-ordination curves, mentioned above, shall be prepared by distribution equipment manufacturers as soon as possible after award of contract.
- .7 At the option of this contractor under this section, these co-ordination curves may also be prepared by an independent testing organization. In this case, the independent testing organization shall determine the proper settings of all protective relays and devices and pass them on to the switchboard manufacturer for incorporation into the switchboards. Include all associated costs in the tender.
- .8 Distribution Equipment manufacturers shall examine drawings and specifications prior to award of contract to ensure that relays and devices being supplied by them will co-ordinate satisfactorily to Supply Authority requirements. Payment will not be allowed, after award of contract, for extra charges due to device changes to comply with recommended practices, due to oversight or negligence by distribution equipment manufacturers.
- .4 Upon review by the Consultant, submit the coordination study to the local electrical utility for their review and approval.

#### **1.05 Closeout Submittals**

- .1 The Engineer who prepared the report shall visit the site and confirm that the feeder sizes as installed are consistent with the report as submitted.
  - .2 Submit final version of the report with as-constructed feeder lengths and feeder sizes.
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## **1.06 Quality Assurance**

- .1 Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project.
- .2 The study shall be prepared in accordance with the latest edition of NETA ATS, the Canadian Electrical Code, as well as manufacturer's recommendations.
- .3 Short-Circuit Analysis and Coordination Study shall be performed by a registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.
- .4 The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.

## **2 Products**

### **2.01 Manufacturers**

- .1 Independent Testing Organizations
  - .1 AC Tesla.
  - .2 Brosz and Associates.
  - .3 C-INTECH.
  - .4 Eastenghouse.
  - .5 Enkompass.
  - .6 G.T. Wood.
- .2 Electrical distribution manufacturers:
  - .1 Eaton.
  - .2 Schneider Electric.

### **2.02 Protective Device Coordination Study**

- .1 Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.
  - .2 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-colour for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System
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coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.

.3 The following information shall be provided on all curve sheets:

- .1 Device identification and associated settings/size.
- .2 Voltage at which curves are plotted.
- .3 Current multiplier.
- .4 ANSI frequent fault damage curve.
- .5 Cable insulation damage curves.
- .6 Transformer inrush point.
- .7 Single-line for the portion of the system.
- .8 Motor starting profiles (where applicable).

### **2.03 Single Line Diagram**

- .1 The final report shall include a multi-colour single line diagram of the electrical distribution system within the scope of the project. The single line diagram shall include:
  - .1 Transformer rating, voltage ratio, impedance, and winding connection.
  - .2 Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
  - .3 Switchgear, switchboards, panelboards, MCC's, fuses, circuit breakers, ATS's and switches continuous current ratings.
  - .4 Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
  - .5 Detailed legend indicating device type identification and other significant details.

## **3 Execution**

### **3.01 Examination**

- .1 Obtain fault level and X/R ratio information from the utility.

### **3.02 Summary**

- .1 The results of the system studies shall be summarized in a final report.
- .2 Where required, copies of the final report shall be submitted to the Supply Authority for their review and approval. Submit approved copies of the report to the Consultant.

### **3.03 Adjusting**

- .1 The contractor shall engage the manufacturer's service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as

required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.

- .2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved protective device coordination study, shall be carried out by manufacturer's service group.
- .3 Submit a final service report confirming that settings have been completed.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Provide an Arc Flash Hazard Analysis Study per the requirements described in CSA Z462 Standard for Electrical Safety in the Workplace.
- .2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA Z462-08, Annex D, or more recent version of the standard as cited by this Section.
- .3 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment manufacturer under this contract.

### **1.02 Related Requirements**

- .1 Section 26 05 73.16 – Coordination Studies.
- .2 Single Line Diagram.

### **1.03 References**

- .1 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - .1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
    - .2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
    - .3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
    - .4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
    - .5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
    - .6 IEEE 1584-2018 - Guide for Performing Arc-Flash Hazard Calculations.
  - .2 American National Standards Institute (ANSI):
    - .1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
    - .2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
    - .3 ANSI C37.010-2016 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
    - .4 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
  - .3 CSA Group:
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- .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (28th edition/2021).
- .3 CSA Z462:21, Workplace electrical safety.

#### **1.04 Submittals**

- .1 Submit the protective device coordination study to the Consultant prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- .2 Upon review by the Consultant, submit the arc-flash study to the local electrical utility for their review and approval.

#### **1.05 Closeout Submittals**

- .1 The results of the protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete final report shall be submitted. Additional copies of the complete report with input and output data shall be provided on CD in PDF format.
- .2 The report shall include the following sections:
  - .1 Executive Summary.
  - .2 Descriptions, purpose, basis, and scope of the study.
  - .3 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.
  - .4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
  - .5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
  - .6 Details of the incident energy and flash protection boundary calculations.
  - .7 Recommendations for system improvements, where needed.
  - .8 Single Line Diagram.
- .3 Arc flash labels (refer to CSA Z462 Annex Q) shall be provided in hard copy only.

#### **1.06 Qualifications**

- .1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a licensed Professional Electrical Engineer skilled in performing and interpreting the power system studies.
  - .2 The licensed Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
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- .3 The licensed Professional Electrical Engineer shall have a minimum of eight (8) years of experience in performing power system studies.
- .4 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

#### **1.07 Computer Analysis Software**

- .1 The studies shall be performed using the latest revision of the SKM or equivalent.

### **2 Products**

#### **2.01 Manufacturers**

- .1 Independent Testing Organizations:
  - .1 AC Tesla.
  - .2 Brosz and Associates.
  - .3 C-INTECH.
  - .4 Eastenghouse.
  - .5 Enkompass.
  - .6 G.T. Wood.
- .2 Electrical distribution manufacturers:
  - .1 Eaton.
  - .2 Schneider Electric.

#### **2.02 Studies**

- .1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA Z462, reference Section 4.1.8.2.2, 4.3.3.

#### **2.03 Data Collection**

- .1 Contractor shall furnish all data as required by the power system studies. The Engineer performing arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
  - .2 Source combination may include present and future motors and generators.
  - .3 If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
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## 2.04 Arc Flash Hazard Analysis

- .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462 Annex D.
  - .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, and splitters) where work could be performed on energized parts.
  - .3 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 112.5 kVA where work could be performed on energized parts.
  - .4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 calories per square centimetre.
  - .5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
  - .6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
  - .7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
    - .1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.
  - .8 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
  - .9 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
  - .10 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
  - .11 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation
-

should utilize the fastest device to compute the incident energy for the corresponding location.

- .12 Arc Flash calculations shall be based on actual overcurrent protective device clearing time.
- .13 Maximum clearing time will be capped at 2 seconds based on IEEE 1584.
- .14 Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

## **2.05 Report Sections**

- .1 Incident energy and flash protection boundary calculations:
  - .1 Arcing fault magnitude.
  - .2 Protective device clearing time.
  - .3 Duration of arc.
  - .4 Arc flash boundary.
  - .5 Working distance.
  - .6 Incident energy.
  - .7 Hazard Risk Category.
  - .8 Recommendations for arc flash energy reduction.

## **3 Execution**

### **3.01 Field Adjustment**

- .1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- .2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- .3 Notify Owner in writing of any required major equipment modifications.

### **3.02 Arc Flash Warning Labels**

- .1 The contractor of the Arc Flash Hazard Analysis shall provide a 90 mm (3.5 in) by 125 mm (5 in) thermal transfer type label of high adhesion polyester for each work location analyzed.
  - .2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
  - .3 The label shall include the following information, at a minimum:
-

- .1 Location designation.
  - .2 Nominal voltage.
  - .3 Flash protection boundary.
  - .4 Hazard risk category.
  - .5 Incident energy.
  - .6 Working distance.
  - .7 Engineering firm and issue date.
  - .8 Labels shall be machine printed, with no field markings.
- .4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
- .1 For each 600 volt, and applicable 208 volt panelboard, one arc flash label shall be provided.
  - .2 For each motor control centre, one arc flash label shall be provided.
  - .3 For each low voltage switchboard, one arc flash label shall be provided.
  - .4 For each switchgear, one flash label shall be provided.
  - .5 For medium voltage switches one arc flash label shall be provided.
- .5 Arc Flash Warning Label General Instructions:
- .1 Only qualified electricians who recognize and avoid the electrical and Arc Flash hazards are allowed to place the arc flash warning labels.
  - .2 Electricians should wear suitable PPE, such as electrical safety boots, Safety Glasses, etc. while performing labeling.
  - .3 Generally, arc flash label shall be put on a prominent pre-cleaned place on the front of the electrical equipment (such as switchgear, panel, disconnect switch, generator output breaker). Label should be visible and readable, displayed horizontally, attached flatly and securely, and not allowed to cover other signs or labels on the equipment.
  - .4 Under the special request of the client, labels could be put on the back of the panel door when the panel is located in clean and finished spaces such as an office area.
  - .5 When putting a label on small equipment with no space labeling on the wall just beside the equipment is allowed.
  - .6 Special request may be attached to this General Instruction. For examples, more than one identical label is applied for large equipment; different labels could be applied for different sections of one equipment; for a splitter with several disconnect switches only one label is placed on the splitter for this group.
-

- .7 Take the pictures for each label to indicate both names of the label and equipment and labeling area of the equipment. Email these pictures to the Consultant for quality control and record.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Electrical connections to equipment specified in other sections.
- .2 Conduit rough-ins for future equipment.

**1.02 Related Requirements**

- .1 Division 08 – Openings.
- .2 Division 11 – Equipment.
- .3 Division 14 – Conveying Equipment.
- .4 Division 20 – Common Mechanical Requirements.
- .5 Section 20 05 13 – Common Motor Requirements for Mechanical Equipment.
- .6 Division 21 – Fire Suppression.
- .7 Division 22 – Plumbing.
- .8 Division 23 – Heating, Ventilating, and Air Conditioning.
- .9 Division 25 – Integrated Automation.

**1.03 References**

- .1 NEMA WD 1 - General Colour Requirements for Wiring Devices.
- .2 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

**1.04 Coordination**

- .1 Coordinate work to Section 01 31 00.
- .2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.
- .3 Determine connection locations and requirements.
- .4 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- .5 Sequence electrical connections to coordinate with start-up schedule for equipment.
- .6 Coordinate location and power requirements with mechanical drawings and mechanical contractor for mechanical equipment and controls during the tender stage. It is the contractors responsibility to ensure all power connections to controls are accounted during the tender stage.

**1.05 Submittals**

- .1 Submit to Section 01 33 00.
-

- .2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.
- .3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

#### **1.06 Regulatory Requirements**

- .1 Provide products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

### **2 Products**

#### **2.01 Common Motor Requirements**

- .1 Motors up to and including 1/3 hp, shall be 1 phase, 60 Hz, 120 V.
- .2 Motors 1/2 hp and above shall be 3 phase, 60 Hz, 575 volts or 208 V.
- .3 Electrical trade shall review the mechanical drawings and equipment drawings in detail and coordinate the required power connections to mechanical equipment.

#### **2.02 Cords and Caps**

- .1 Attachment Plug Construction: Conform to NEMA WD 1.
- .2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
- .3 Cord Construction: NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- .4 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

### **3 Execution**

#### **3.01 Conduit Pathways and Rough-Ins**

- .1 Where drawings indicate to rough-in conduits for future equipment, or equipment to be provided by the Owner, or other systems as noted on the plans, provide pull string in the conduit, and tag the conduit for the reserved future use/purpose.
- .2 Where circuits breakers, disconnect switches, or other electrical distribution is provided for future equipment, tag the devices with the reserved future use/purpose.

#### **3.02 Wiring of Equipment Provided Under Other Divisions**

- .1 Use the following procedures for wiring of motors and equipment provided under other Divisions.
  - .2 The following equipment shall be responsibility of the trade supplying the equipment unless otherwise noted, in accordance with the requirements laid out in the individual section, or this division:
-

- .1 Motors.
  - .2 Starters.
  - .3 Variable Frequency Drives.
  - .4 Motor Control Centres.
  - .5 Control wiring, AC, DC, low and high voltage.
  - .3 In every instance, install starter, motor control centre, variable frequency drivers (VFD), etc. and wire to line side of the starter, the Motor Control Centre (MCC), or VFD. Extend wiring from starter, MCC, or VFD to motor as indicated.
  - .4 Provide all wiring for starters and VFD's from supply to starter to VFD and to motor. Coordinate requirements with the appropriate trade. Coordinate with mechanical trade and provide VFD rated cabling where required.
  - .5 Provide 500 mm of liquid tight flexible metal conduit for final connection to motor. Provide disconnect switches where required by code, and as indicated on the drawings.
  - .6 Where individual starters and controls are grouped together provide a panel for mounting this equipment. Provide a feeder, main fused disconnect and a splitter of adequate size and capacity and wire to line side of the starters on this panel and from starters to motors.
  - .7 Equipment, General
    - .1 Ascertain exact locations of starters, motor control centres, motors, etc. from drawings and coordinate exact locations with the supplying trade.
    - .2 Control wiring shall be the responsibility of the supplying trade.
      - .1 Control wiring shall be in accordance with Section 26 05 19, and Section 26 05 23.
      - .2 Control wiring shall be installed in conduit in accordance with Section 26 05 33.13.
  - .8 Doors
    - .1 Ascertain exact locations of door operators, push buttons, automatic sensors, and other door hardware.
    - .2 Provide branch circuit wiring for door operators.
    - .3 Provide control and control wiring for all low voltage door interconnections.
  - .9 Overhead Doors and Folding Vehicle Doors
    - .1 Ascertain exact locations of control panels, remote controls, safety equipment such as safety eyes, overhead door contacts, etc. from shop drawings and architectural drawings, and coordinate exact locations with overhead door trade.
    - .2 Provide branch circuit wiring for door controls.
    - .3 Provide control and control wiring for all low voltage door interconnections.
-

.10 Plumbing Equipment

- .1 Ascertain exact locations of starters, motor control centres, motors, infra-red plumbing fixture controls from Mechanical Drawings and coordinate exact locations with plumbing trade.
- .2 Provide branch circuit wiring and an outlet for each infra-red plumbing fixture control.
- .3 Control wiring shall be the responsibility of the plumbing trade, as described above. Review mechanical drawings and provide 120V power to controls where required.

.11 HVAC Equipment

- .1 Ascertain exact locations of starters, motor control centres, motors, motorized dampers, VAV boxes, and heating control valves from HVAC drawings and coordinate exact locations with HVAC Division.
- .2 In the case of unit heaters, reheat coils and cabinet unit heaters, terminate wiring on terminals provided. Control wiring, thermostats, or other control devices shall be the responsibility of the HVAC trade, as described above.
- .3 Provide branch circuit wiring and an outlet for each motorized damper, variable air volume (VAV) box, or heating control valve. Control wiring shall be the responsibility of the HVAC trade, as described above.
- .4 Provide 120 V power connections to small exhaust fans, and ceiling fans for all line voltage control devices, including but not limited to wiring through toggle switches, line voltage thermostats, countdown timer switches, or line voltage speed controllers. Refer to mechanical drawings and schedules for control devices and coordinate requirements with HVAC Division.
- .5 Provide 120 V wiring connections to duplex receptacles integral with air handling unit control panels.
- .6 Provide 120 V wiring connections to HVAC maintenance receptacles integral with roof mounted HVAC equipment.
- .7 Provide 120 V wiring connections to lighting fixture/switch combinations integral with air handling units.

.12 Integrated Automation (Building Automation System)

- .1 Refer to Mechanical drawing notes for requirements.
  - .2 Provide 120 V wiring connections to BAS system controllers/panels and other control system or component requiring 120 V power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.
  - .3 From equipment as noted on drawings, extend suitable wiring in conduit from equipment contacts to designated BMS panel serving area, terminating wiring and conduit in a junction box. Leave wiring un-terminated with slack coiled length of minimum 2 m (6 ft) long. Clearly label junction box and wiring end for termination onto BMS panel by respective Mechanical Trade.
-

### **3.03 Examination**

- .1 Verify that equipment is ready for electrical connection, wiring, and energization.

### **3.04 Electrical Connections**

- .1 Provide a local disconnect switch for all equipment, regardless of if a disconnect switch is shown or not shown on the plans.
- .2 Make electrical connections to equipment manufacturer's instructions.
- .3 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.
- .4 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- .5 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- .6 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- .7 Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.
- .8 Install disconnect switches, controllers, control stations, and control devices as indicated.
- .9 Modify equipment control wiring with terminal block jumpers as indicated.
- .10 Provide interconnecting conduit and wiring between devices and equipment where indicated.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Commissioning of all building electrical systems and component including:
  - .1 Testing and adjustment.
  - .2 Demonstration and training.
  - .3 Instructions of all procedures for Owner's personnel.
  - .4 Updating as-built data.
  - .5 Co-ordination of Operation and Maintenance material.
- .2 Provide labour and material to conduct the commissioning process as outlined in this specification section, including the hiring of an Independent Testing Contractor (ITC) as detailed below.
- .3 Provisions of this section shall apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.

### **1.02 Related Requirements**

- .1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.
- .2 Section 26 08 50 – Commissioning of Lighting: additional commissioning requirements for commissioning of lighting and lighting controls.

### **1.03 Commissioning Process Allocation**

- .1 The commissioning process shall be allocated a value equal to 5 per cent of the contract. The Electrical Contractor may draw from this allocation as the commissioning process is completed.
- .2 The Electrical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The Electrical Contractor may claim up to 3 per cent of the contract from this allocation leading up to performance testing. The remaining 2 per cent shall not be paid out until the performance testing, O&M manuals, and training have been completed satisfactorily.

### **1.04 Definitions**

- .1 Cx – Commissioning.
- .2 Commissioning Authority
  - .1 The Commissioning Authority (CxA), also referred to as the Commissioning Consultant, shall be hired by The Owner.
  - .2 The CxA responsibilities shall include:
    - .1 preparing the commissioning plan.

- .2 co-ordinating with the contractor to schedule tests.
- .3 preparing a test form manual.
- .4 witnessing selected tests.
- .5 receiving all test forms.
- .6 co-ordinating the contractors training.
- .7 chair the commissioning meetings.
- .3 The Electrical Contractor shall co-operate with the CxA.
- .4 The Electrical Contractor shall provide assistance to the CxA and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

#### **1.05 Submittals**

- .1 Conform to Section 01 33 00 for requirements for shop drawings and record drawings.
- .2 A commissioning document shall be prepared by the CxA prior to conducting these activities for use by the Commissioning Team.
- .3 The electrical sub-contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.
- .4 As-built drawings and data books must be available two weeks prior to commissioning for review and use by the consultant and Commissioning Team prior to the start of the commissioning activities.

#### **1.06 Closeout Submittals**

- .1 Attendance records for all training sessions.
- .2 Testing reports for system load balance measurements, infra-red test and harmonics tests.

#### **1.07 Quality Assurance**

- .1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Commissioning Team Leader.
- .2 Submit the names of all personnel to be used during the Commissioning activities.

#### **1.08 Warranty**

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.
  - .2 The Electrical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
  - .3 Refer to Division 01 and Section 26 05 00 for the requirements during the warranty period.
-

## **2 Products**

### **2.01 Equipment**

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultant of instrumentation to be used and the dates the instruments were calibrated.

## **3 Execution**

### **3.01 The Commissioning Process**

- .1 The purpose of the commissioning process is to fully test all building systems including architectural, mechanical, and electrical components and operating procedures by challenging these systems to realistic operation conditions.
- .2 The commissioning process consists of:
  - .1 Shop Drawings and Record Drawings.
  - .2 Installation inspection and equipment verification.
  - .3 Independent testing contractor.
  - .4 Testing of equipment and systems.
  - .5 Commissioning meetings.
  - .6 Operating and maintenance manuals.
  - .7 Operating training.
  - .8 Commissioning Agent testing.
  - .9 Systems Demonstration and turnover.
  - .10 Testing forms.
  - .11 Warranties.

### **3.02 Preparation**

- .1 Provide test instruments required for all activities as defined in the commissioning documents.
- .2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.
- .3 Confirm all scheduled activities have identified personnel available.
- .4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

### **3.03 System Description**

- .1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.
-

- .2 Owner will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.
- .3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when need for additional data becomes apparent during the commissioning exercise.
- .4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .5 Conduct presentation on Owner's premises. Owner will provide space.

### **3.04 Commissioning**

- .1 Commission the components of the electrical system using the NETA Acceptance Testing Specifications.
- .2 Refer to the project commissioning plan prepared by the CxA.
- .3 Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.
- .4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning exercise.
- .5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.

### **3.05 Final Report**

- .1 This trade shall assemble all testing data and commissioning reports and submit them to the General Contractor for submission to the Owner.
- .2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

### **3.06 Schedule of Activities**

- .1 Commissioning activities shall be conducted based on pre-established schedule with all members of the commissioning team.
  - .2 In addition, there will be two meetings held through the contract duration to introduce the parties of the commissioning team, establish the schedules and deadlines for the various activities and review the Commissioning Manual.
  - .3 Adhering to the established schedule is very important as the co-ordination and scheduling of the participants will be difficult to alter once this is established. Close co-ordination of this schedule is important.
  - .4 In the event project cannot be commissioned in the allotted time slot, the contractor shall pay for all costs associated with assembling the Commissioning Team at a later date. If the contractor has not performed his duties to reach commissioning stage as outlined earlier, he will incur all expenses of other trades and the Commissioning Team due to his non-compliance.
-

### **3.07 Installation Inspection and Equipment Verification**

- .1 The Electrical Contractor shall co-ordinate with the Electrical Consultant who will inspect the electrical installation.
- .2 The Electrical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
  - .1 Manufacturers name, address, and telephone number.
  - .2 Distributors name, address, and telephone number.
  - .3 Make, model number and serial number.
  - .4 Voltage and current ratings.

### **3.08 Independent Testing Contractor**

- .1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the Electrical Consultant.
- .2 The ITC shall conduct load balancing measurements to verify load balancing performed in accordance with Section 26 05 00.

### **3.09 Testing of Equipment and Systems**

- .1 The Electrical Contractor shall be responsible for all tests detailed in this Section, and those tests required by a manufacturer as part of their installation requirements.
  - .2 The Electrical Contractor shall schedule all tests which shall be witnessed by the Electrical Consultant or the Commissioning Consultant. The contractor shall complete and sign the testing forms.
  - .3 The Electrical Contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
    - .1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
    - .2 Section 26 05 73.16 – Coordination Studies.
    - .3 Section 26 24 13 – Switchboards.
    - .4 Section 26 24 16 – Panelboards.
    - .5 Section 26 24 19 – Motor Control Centres.
    - .6 Section 27 51 16 – Public Address Systems.
    - .7 Section 28 10 00 – Access Control.
    - .8 Section 28 46 13 – Fire-Alarm Systems.
  - .4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra-red test and harmonics tests.
-

### **3.10 Commissioning Meetings and Reporting**

- .1 The Electrical Contractor shall include the schedule for all tests in the construction schedule.
- .2 The Commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the electrical systems shall be directed to the Electrical Consultant, with copies to the Consultant, Commissioning Consultant, and the Owner.
- .4 The forms and reports to be issued shall include:
  - .1 Shop drawings, issued and accepted.
  - .2 Equipment verification forms.
  - .3 Testing forms.
  - .4 Reports resulting from tests.
  - .5 Testing schedule.
  - .6 Minutes of commissioning meetings.
  - .7 Manufacturers' Certificates.

### **3.11 Operating and Maintenance Manual**

- .1 Conform to the specification section for the requirements of the O&M manuals.

### **3.12 Closeout Activities**

- .1 Conform to section for requirements for instructions to the Building Owner for each system and equipment.
  - .2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.
  - .3 The training sessions shall be scheduled, co-ordinated and video recorded by the Commissioning Consultant.
  - .4 Each training session shall be structured to cover:
    - .1 The operating and maintenance manual.
    - .2 Operating procedures.
    - .3 Maintenance procedures.
    - .4 Troubleshooting procedures.
    - .5 Spare parts.
  - .5 Submit a course outline to the Electrical Consultant before training commences. Provide course documentation for up to eight people.
-

- .6 The training session shall be scheduled and co-ordinated by the Commissioning Consultant. The Commissioning Consultant shall video tape the sessions.
- .7 Training shall be provided for the following systems:
  - .1 Electrical Systems including distribution and lighting: 8 hour minimum
  - .2 Section 27 51 16 – Public Address Systems: 1 hour minimum
  - .3 Section 28 10 00 – Access Control: 1 hour minimum
  - .4 Section 28 46 13 – Fire-Alarm Systems: 2 hours minimum
- .8 The Electrical Contractor shall conduct a walkthrough of the installation. During the walkthrough the Electrical Contractor shall:
  - .1 Identify equipment.
  - .2 Identify electrical panels.
  - .3 Identify starters and disconnects.
  - .4 Review the electrical power distribution.
  - .5 Review the light power distribution.
  - .6 Review the switchgear.
  - .7 Review the general maintenance procedures.

### **3.13 The Electrical System Demonstration and Turnover**

- .1 The system demonstration and turnover to The Owner shall occur when:
    - .1 The installation is complete.
    - .2 The acceptance test conducted by the Electrical Consultant has been completed successfully.
    - .3 Training has been completed.
    - .4 Equipment Operating and Maintenance Manuals have been accepted.
    - .5 System operating manuals have been accepted.
    - .6 Shop-drawings have been updated.
    - .7 As-built drawings have been completed.
    - .8 The commissioning process has been completed successfully and system operation accepted by the Electrical Consultant and Commissioning Consultant.
  - .2 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.
-

### **3.14 Testing Forms**

- .1 The Electrical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Electrical Consultant and the Owner before they are used.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Common requirements for commissioning of all electric lighting, including interior, exterior, and emergency lighting.
- .2 The party responsible for the functional testing shall not be directly involved in either the design or construction of the project.

### **1.02 Related Requirements**

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 51 19 – LED Interior Lighting.
- .3 Section 26 52 13.13 – Emergency Lighting.
- .4 Section 26 56 19 – LED Exterior Lighting.

### **1.03 References**

- .1 ASHRAE
  - .1 ASHRAE Guideline 0-2005 – The Commissioning Process.
  - .2 ANSI/ASHRAE/IES 90.1-2013 – Energy Standard for Building Except Low-Rise Residential Buildings.
- .2 Illumination Engineering Society (IES)
  - .1 IES DG-29-11 – Design Guide for the Commissioning Process Applied to Lighting and Control Systems.
- .3 Ontario Building Code
  - .1 Supplementary Standard SB-10: Energy Efficiency Requirements, December 22, 2016 update.

### **1.04 Action Submittals**

- .1 Refer to Section 01 33 00.
- .2 Submit sample commissioning forms.

### **1.05 Closeout Submittals**

- .1 Section 01 78 00: Submittals for project closeout.
  - .2 Submit commissioning reports.
    - .1 Submit a floor plan or spreadsheet table checklist that indicates each local lighting control device, occupancy sensors, daylighting controls, system component.
    - .2 Submit the system sequence of operation fully describing the equipment components and functionality, including set points and alarm functions.
-

- .3 The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings.
- .3 The functional testing party shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Site Tests and Inspections**

- .1 Sensor placement and orientation for all sensor types.
- .2 Occupancy sensor function, sensitivity, and time delays.
- .3 Daylight harvesting sensor calibration.
- .4 Automated shade operation.
- .5 Manual control placement and operation.
- .6 Automated control operation, including scheduled on/off functions and dimming trims and presets.
- .7 Override operation, access, and functionality.
- .8 Centralized control interfaces and operation.
- .9 Client education of operations.
- .10 Documentation archived to client.

### **3.02 Functional Testing**

- .1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
- .2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:
  - .1 Confirm that the placement, sensitivity, and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.
  - .2 Confirm that time switches and programmable schedule controls are programmed to turn the lights off.
  - .3 Confirm that photosensor controls reduce electric lights levels based on the amount of usable daylight in the space as specified.

**End of Section**

---

**1 General**

**1.01 Section Includes**

- .1 Occupancy and Vacancy sensors.
- .2 Power packs, and auxiliary relays, momentary switches.
- .3 Timers.
- .4 Daylight harvesting photo sensors.
- .5 Emergency lighting control units.

**1.02 Products Installed But Not Supplied Under This Section**

- .1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.

**1.03 Related Requirements**

- .1 Section 26 08 50 – Commissioning of Lighting.
- .2 Section 26 27 26 – Wiring Devices.
- .3 Section 26 50 00 – Lighting.
- .4 Section 26 51 19 – LED Interior Lighting.
- .5 Section 26 56 19 – LED Exterior Lighting.

**1.04 References**

- .1 CSA Group:
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
    - .3 CSA C22.2 No. 42 - General Use Receptacles.
    - .4 CSA C22.2 No. 42.1 - Cover Plates for Flush Mounted Wiring Devices.
    - .5 CSA C22.2 No. 141 – Emergency lighting equipment.
    - .6 CSA C22.2 No. 184 - Solid-State Lighting Controls.
    - .7 CSA C22.2 No. 184.1 - Solid State Dimming Controls.
  - .2 Ontario Building Code.
  - .3 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.
  - .4 UL 2043 – Standard for fire test for heat and visible smoke release for discrete products and their accessories installed in air-handling spaces.
  - .5 NEMA WD 7 – Occupancy motion sensors standard.
-

## **1.05 Submittals**

- .1 In accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's descriptive literature and product specifications for each product.
  - .2 Manufacturer's product drawings.
  - .3 Manufacturer's installation instructions.
- .3 Where the lighting controls include the option for custom engraving, or custom touchscreen user interfaces on control devices, switches, or scene controllers, the Contractor is to submit proposed engraving/labelling/graphics as part of the shop drawing submittal, for review by the Owner.

## **1.06 Closeout Submittals**

- .1 Documentation of all lighting control system setpoints, sensor sensitivities, occupancy sensor timeouts, and as-programmed sequences of operation to aid in future troubleshooting.
- .2 Lighting controls functional test report.

## **1.07 Quality Assurance**

- .1 Manufacturer Qualifications: Products free of defects in material and workmanship.

## **1.08 Warranty**

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.

## **2 Products**

### **2.01 Manufacturers**

- .1 Reliable Controls (Existing Lighting Control System). Electrical Contractor to match existing system and add to it as required in drawings.

### **2.02 General Requirements of all Devices**

- .1 Manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 per cent.
  - .2 Five year warranty and CUL listed.
  - .3 All devices specified shall have the ability to be connected on a digital loop and programmed separately.
  - .4 All user input devices with two or more buttons have the ability to be programmed as multiple load switching or single load dimming.
-

- .5 The devices have the ability to be connected as a single room, and also scalable to an enterprise solution.

## **2.03 Occupancy and Vacancy Sensors**

- .1 General:
    - .1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.
    - .2 Configurable sensor timeouts.
    - .3 Rating: 24 VDC input voltage.
    - .4 Environmental:
      - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
      - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing.
    - .5 Sensors shall connect with load controller via cat5e cabling with RJ45 terminations.
  - .2 Dual Technology Wall Switch Sensor, 24V
    - .1 Available in one or two button configuration.
    - .2 Reliable Controls (Basis of Design – Existing System).
    - .3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.
    - .4 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
    - .5 Coverage up to 25 ft diameter for minor motion, and 35 ft diameter with a field view of 180 degrees.
    - .6 Adjustable automatic-ON or manual-ON operation.
    - .7 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
    - .8 Sensor shall have an adjustable time delay.
    - .9 Sensor shall fit in a single gang box with a typical decora faceplate.
  - .3 Dual Technology Ceiling Mounted Sensor, 24V
    - .1 Reliable Controls (Basis of Design – Existing System).
    - .2 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
    - .3 Coverage up to 20 ft diameter for minor motion, and 30 ft diameter with a field view of 360 degrees.
    - .4 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
    - .5 Sensor shall have an adjustable time delay.
-

- .6 Sensor shall fit in a 1.5 in deep octagon box.
- .4 Dual Technology Corner Mount Sensor, 24V
  - .1 Ceiling or wall mounted as directed.
  - .2 Reliable Controls (Basis of Design – Existing System).
  - .3 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
  - .4 Coverage up to 25 ft diameter for minor motion, and 40 ft diameter with a field view of 90 degrees.
  - .5 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
  - .6 Sensor shall have an adjustable time delay.
  - .7 Sensor shall fit in a 4 in square box with mounting plate and base.

#### **2.04 Decorator Low Voltage Momentary Switches**

- .1 Reliable Controls (Basis of Design – Existing System).
- .2 Suitable for switching, dimming and scene selection.
- .3 Available in 1, 2, 3, 4, 5, and 8 button configurations.
- .4 Two RJ45 ports for daisy chaining multiple devices.
- .5 Switch shall fit in a single gang box with a typical decora faceplate.
- .6 Environmental:
  - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
  - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing.

#### **2.05 Power Packs**

- .1 General:
    - .1 Power packs shall have the ability to be daisy chained on one digital loop.
    - .2 Internal relay controlling up to 20A for 120/277VAC or 15A for 347VAC ballast loads total per power pack.
    - .3 Power pack shall be available in 0-10V or forward phase dimming (120/277VAC only) technology.
    - .4 Models of 0-10V dimming technology shall have the option for one, two or three control channels.
    - .5 Power packs are digital and can be configured for pre-set scenes.
    - .6 Power pack shall utilize Zero Crossing Circuitry to protect from the effects of inrush current and increase product longevity.
    - .7 Reliable Controls (Basis of Design – Existing System).
-

- .8 Power pack shall be mounted on a 4 in square junction box and is plenum rated for ceiling installation.
- .9 Power packs shall at minimum meet the following environmental specifications:
  - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
  - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing

## **2.06 Sequences of Operation**

- .1 Refer to Drawing Lighting Control Matrix.
- .2 Vacancy Sensor Operation: Manual On, Manual/Auto Off.
- .3 In accordance with ASHRAE 90.1-2013.

## **3 Execution**

### **3.01 Installation**

- .1 In accordance with manufacturer's instructions.
- .2 Review Reliable Controls existing system configuration and add to it as required to complete a system with all devices as shown in drawings.
- .3 Provide all required connection to BAS system.
- .4 Low voltage lighting control cabling as required by Reliable Controls Manufacturer.
- .5 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- .6 It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.
- .7 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- .8 Install manual control devices and sensors in accordance with manufacturer's instructions for Vacancy Operation.

### **3.02 System Startup**

- .1 The lighting controls manufacturer's representative shall conduct system startup and submit startup report.
-

### 3.03 Site Tests and Inspections

- .1 The lighting controls manufacturer's representative and Contractor shall conduct functional testing and provide report as described in ASHRAE 90.1-2013:
  - .1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
  - .2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:
    - .1 Occupant Sensors
      - .1 Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
      - .2 For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.
      - .3 For projects with more than seven (7) occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry.
      - .4 For each sensor to be tested, verify the following:
        - .1 Status indicator (as applicable) operates correctly.
        - .2 Controlled lights turn off or dim down to the specified level within the required time (20 minutes, or as noted), as applicable to the space type.
        - .3 For auto-on occupant sensors (occupancy mode), the lights turn on to the permitted level when someone enters the space.
        - .4 For manual-on sensors (vacancy mode), the lights turn on only when manually activated.
        - .5 The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation.
    - .2 Automatic Time Switches
      - .1 Confirm that the automatic time switch control is programmed with appropriate weekday, weekend, and holiday (as applicable) schedules.
      - .2 Document for the owner automatic time switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
      - .3 Verify that correct time and date are properly set in the time switch.

- .4 Simulate occupied condition. Verify and document the following:
  - .1 All lights can be turned on and off by their respective area control switch.
  - .2 The switch only operates lighting in the enclosed space in which the switch is located.
- .5 Simulate unoccupied condition. Verify and document the following:
  - .1 All non-exempt lighting turns off.
  - .2 Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shut off occurs.
- .3 Daylight Controls
  - .1 All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate set points and threshold light levels.
  - .2 Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
  - .3 The location where calibration adjustments are made is readily accessible only to authorized personnel.
- .3 The individual(s) responsible for the functional testing shall not be directly involved in either the design or construction of the project and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.
- .2 Commissioning:
  - .1 Upon completion of the installation, the system shall be completely commissioned to verify all adjustments and sensor placement to ensure a trouble-free lighting control system.
  - .2 Submit commissioning report to the Consultant and the commissioning authority for review.
  - .3 Provide the Consultant and Commissioning Authority with ten working days written notice of the scheduled commissioning date.
  - .4 System to be connected to the BAS.

### 3.04 Training

- .1 Provide training session of minimum 4 hours duration in accordance with Section 01 79 00.

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 This section describes the electrical and mechanical characteristics of outdoor, three-phase dead front step-down pad-mounted distribution transformers with secondary voltages not exceeding 700 volts.

### **1.02 References**

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - .1 ANSI/IEEE 386, Separable Insulated Connector Systems for Power Distribution Systems above 600 V.
- .2 CSA Group:
  - .1 CSA C2.1-06 (R2022), Single-phase and three-phase liquid-filled distribution transformers.
  - .2 CSA C227.1, Single-Phase Pad Mounted Distribution Transformers.
  - .3 CAN/CSA-C227.2, Three-Phase, Live Front, Pad Mounted Distribution Transformers.
  - .4 CSA C227.3:06 (R2022), Low-profile, single-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors.
  - .5 CSA C227.4:21, Three-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors.
  - .6 CSA C227.5-08 (R2018), Three-Phase Live-Front Pad-Mounted Distribution Transformers.
  - .7 CSA C802.3-15 (R2020), Minimum efficiency values for power transformers.

### **1.03 Action Submittals**

- .1 Product Data:
    - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, and limitations.
  - .2 Indicate:
    - .1 Anchoring method and dimensioned foundation template.
    - .2 Dimensioned cable entry locations.
    - .3 Dimensioned cable termination and pothead height.
  - .3 Identified internal and external component layout on assembly drawing.
  - .4 Insulating liquid capacity.
  - .5 Submit primary fuse and secondary breaker time-current characteristics.
-

- .6 Front view elevation or outline drawing and weight.
- .7 Dimensioned site plan drawing showing the actual transformer dimensions, any components overhanging the transformer foundation, and the clearances denoted with clear reference to the relevant code clauses.
- .8 Nameplate diagram.
- .9 Conduit entry/exit locations.
- .10 Ratings (on nameplate) including:
  - .1 kVA.
  - .2 Primary and secondary voltage.
  - .3 Taps.
  - .4 Basic Impulse level.
  - .5 Impedance.
- .11 Product data sheets.
- .12 Where applicable, the following additional information shall be submitted to the Consultant:
  - .1 Busway connection.
  - .2 Specified accessories.
- .13 Upon review by the Consultant, submit transformer shop drawings to the local electrical utility for their review and approval.

#### **1.04 Informational Submittals**

- .1 The following information shall be submitted for record purposes:
    - .1 Final as-built drawings and information for items listed in article "Action Submittals" and shall incorporate all changes made during the manufacturing process.
    - .2 Wiring diagrams.
    - .3 Production test reports.
    - .4 Installation information.
    - .5 Seismic certification as specified.
  - .2 Source Quality Control Submittals
    - .1 Submit to Consultant standard factory test certificates of each transformer and type test of each transformer with high voltage accessories in accordance with CSA C2.1.
-

### **1.05 Qualifications**

- .1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- .2 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- .3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

### **1.06 Delivery, Storage, and Handling**

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

### **1.07 Maintenance Material Submittals**

- .1 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.
- .2 Provide operation and maintenance data for pad mounted distribution transformers for incorporation into manual specified in Section 01 78 23.
- .3 Include insulating liquid maintenance data.

### **1.08 Warranty**

- .1 Provide manufacturer product warranty against defects in operation and material for a period of one (1) year from date of Substantial Completion.

## **2 Products**

### **2.01 Manufacturers**

- .1 Carte.
  - .2 CES Transformers.
  - .3 Cooper Power Systems by Eaton.
  - .4 Moloney Electric Inc.
  - .5 Pioneer Transformers.
  - .6 Substitution Limitations: 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 pre-approved by the Consultant ten (10) days prior to bid date.
-

## 2.02 Ratings

- .1 The ratings of the transformer shall be as follows or as shown on the drawings:
  - .1 kVA Rating 1000 kVA ONAN
  - .2 Impedance 5.75% nominal, or to suit the requirements of the coordination study.
  - .3 HV 44 kV Delta to suit Utility.
  - .4 HV BIL 200 kV
  - .5 HV de-energized Taps +/- 2 - 2-1/2% full capacity
  - .6 LV 347/600 Volts Wye
  - .7 LV BIL 30 kV

## 2.03 Transformer Characteristics

- .1 Primary voltage: as required, 60 Hz, delta connected, 3-phase.
- .2 Secondary voltage: as required, wye connected, 3 phase, 4 wire, neutral grounded.
- .3 Capacity: as required to suit project.
- .4 Basic impulse level: as required to suit project.
- .5 Maximum rms short-circuit: as required.
- .6 Impedance: standard.
- .7 No load losses not to exceed 2% of kVA rating.
- .8 Full load losses not to exceed 3% of kVA rating.

## 2.04 Construction

- .1 The unit shall be mineral oil-filled in accordance with CSA requirements.
    - .1 Built to CSA C88.
    - .2 Tamperproof to CSAC227.5.
    - .3 Energy efficiency per CSA C802.3.
  - .2 The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65 degrees C rise, based on an average ambient of 30 degrees C over 24 hours with a maximum of 40 degrees C.
  - .3 The transformer shall be designed to meet the sound level standards for liquid transformers as defined in NEMA and ANSI.
  - .4 High-voltage and low-voltage windings shall be copper. Insulation between layers of the windings shall be by thermally set insulating paper or equal.
-

- .5 The main transformer tank and attached components shall be designed to withstand pressures greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel reinforced with external, internal or sidewall braces. All seams and joints shall be continuously welded.
  - .6 The assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six-hour leak test shall be performed.
  - .7 The transformer(s) shall be compartmental-type, self-cooled and tamper-resistant for mounting on a pad. The unit shall restrict the entry of water (other than flood water) into the compartments so as not to impair its operation. There shall be no exposed screws, bolts or other fastening devices which are externally removable.
  - .8 The transformer(s) shall consist of a transformer tank and full-height, bolt-on high- and low-voltage cable terminating compartments located side-by-side separated by a rigid metal barrier. Each compartment shall have separate doors, designed to provide access to the high-voltage compartment only after the low-voltage has been opened. There shall be at least one additional fastening device accessible only after the low-voltage door has been opened, which must be removed to open the high-voltage door. Doors shall be mounted flush with the cabinet frame. The low-voltage door shall have a handle-operated, three-point latching mechanism designed to be secured with a single padlock. A hex-head or penta-head bolt shall be incorporated into the low-voltage door latching mechanism. Both high and low-voltage doors shall be incorporated into the low-voltage door latching mechanism. Both high and low-voltage doors shall be equipped with stainless steel hinges and door stops to secure them in the open position.
  - .9 Compartment sills, doors and covers shall be removable to facilitate cable pulling and installation. The high-voltage door shall be on the left with the low-voltage door on the right. Compartments shall be designed for cable entry from below.
  - .10 Transformer(s) shall be supplied with a welded or bolted main tank cover and be of a sealed-tank construction designed to withstand a pressure of 7 psig without permanent distortion. The tank cover shall be designed to shed water and be supplied with a tamper-resistant access handhole sized to allow access to internal bushing and switch connections. Transformers supplied with "less flammable" fluids, (high-molecular-weight hydrocarbon or silicone), shall be manufactured to withstand 12 psig without rupture. The transformer shall remain effectively sealed for a top-oil temperature of -5 degrees C to 105 degrees C. When necessary to meet the temperature rise rating specified, cooling panels shall be provided.
  - .11 The transformer manufacturer shall certify that the transformer is non-PCB containing less than 1 part per million detectable PCBs. Nonflammable transformer liquids including askarel and insulating liquids containing tetrachloroethylene, perchloroethylene, chlorine compounds, or halogenated compounds are not acceptable and shall not be provided.
  - .12 When high-voltage taps are specified above, full-capacity taps shall be provided with a tap changing mechanism designed for de-energized operation. The tap changer operator shall be located within one of the compartments.
  - .13 The coil windings shall be designed to reduce losses and manufactured with the conductor material as specified above. All insulating materials shall be rated for 120 degrees C class.
-

- .14 For grounded wye to grounded wye application, the core assembly shall be a 5-legged, distributed-gap, wound core, designed to meet NEMA TR-1 sound levels measured per ANSI standards. For ratings above 2500 kVA, a stacked core design may be utilized.
- .15 The core material shall be high-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10 percent overvoltage excitation. The cores shall be properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.
- .16 The core frame shall be designed to provide maximum support of the core and coil assembly. The core frame shall be welded or bolted to ensure maximum short-circuit strength.
- .17 The core and coil assembly shall be designed and manufactured to meet the short-circuit requirements of ANSI C57.12.90. The core and coil assembly shall be baked in an oven prior to tanking to "set" the epoxy coating on the insulating paper and remove moisture from the insulation prior to vacuum filling.
- .18 Transformer shall be vacuum filled with the appropriate fluid as indicated above. The process shall be of sufficient vacuum and duration to ensure that the core and coil assembly is free of moisture prior to filling the tank.

## **2.05 Equipment**

- .1 Three phase dead front pad mounted distribution transformers: to CSA C227.4.
  - .2 Separable insulated connectors for power distribution systems above 600 V: to ANSI/IEEE 386.
  - .3 Oil filled pad mounted distribution transformers complete with primary and secondary cable compartments, primary fused disconnecting switch options and accessories to form complete factory assembled, self-contained, steel fabricated unit for mounting on concrete foundation.
  - .4 High voltage bushings or high voltage bushing wells for connection to distribution system through separable insulated connectors for dead front operation.
  - .5 Separable insulated connectors.
  - .6 Primary cable terminals with hole for 9.5 mm diameter 16 thread bolt for attachment of solder lug or clamp connector in vertical plane.
  - .7 Spade type low voltage terminals.
  - .8 Connectors for primary and secondary cables.
  - .9 Three fused, three blade primary disconnect switches for single source primary feed.
  - .10 Primary protection oil immersed fuse.
  - .11 Separate padlocking for primary compartment door.
  - .12 Load break inserts for elbow connectors.
  - .13 Stays to hold compartment doors in 110 degree open position.
-

## **2.06 Voltage Taps**

- .1 Four-2.5% taps, 2-FCAN, 2-FCBN.

## **2.07 Tap Changer**

- .1 Internally operated tap changer, with provision for padlocking on 3 phase units.

## **2.08 Accessories**

- .1 Liquid temperature thermometer with one sets of contacts.
- .2 Dial-type thermometer.
- .3 Liquid level gauge with one set of contacts.
- .4 Pressure-vacuum gauge.
- .5 Pressure relief device.
- .6 20 mm drain valve.
- .7 25 mm filler plug.
- .8 Tap switch.
- .9 Drain valve with sample valve.
- .10 Non-PCB label.
- .11 Upper fill/filter press connection or valve.
- .12 Additional accessories:
  - .1 Alarm contacts.
  - .2 Rapid pressure rise relay.
  - .3 Winding temperature relay.
  - .4 Gas sampling valve.

## **2.09 Grounding**

- .1 Copper grounding bus, minimum size 4 mm by 6 mm.
- .2 Connectors for grounding conductor size as indicated.

## **2.10 Finish**

- .1 Transformer units shall include suitable outdoor or indoor paint finish. The paint shall be applied using an electrostatically deposited dry powder system to a minimum of three (3) mils average thickness. Units shall be painted padmount green, Munsell No.7GY3.29/1.5.

## **2.11 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 53.
  - .2 Nameplate showing information in accordance with CSA C2.1.
-

- .3 Provide warning signs in accordance with Section 26 05 53.

## **2.12 Outdoor Concrete Foundation**

- .1 Contractor to allow for the verification of existing outdoor concrete pad foundation and determined if it is suitable to be re-used for the new proposed transformer. If not suitable Provide new.
- .2 To be designed by structural Engineer retained by this contractor to suit the requirements of the equipment provided, consisting of at minimum the following features.
- .3 Concrete Pad to be 3000 psi at 28 days 4-6% air.
- .4 15MM steel rebar to be CSA grade 400.
- .5 Submit sealed structural engineers drawing for review.
- .6 Nominal dimensions 2897 mm W by 3202 mm long.
- .7 Coordinate all conduits

## **3 Execution**

### **3.01 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 applicable ANSI and NEMA standards.
    - .1 Resistance measurements of all windings on the rated voltage connection.
    - .2 Ratio tests on the rated voltage connection and on all tap connections.
    - .3 Polarity and phase-relation tests on the rated voltage connections.
    - .4 No-load loss at rated voltage on the rated voltage connection.
    - .5 Exciting current at rated voltage on the rated voltage connection.
    - .6 Impedance and load loss at rated current on the rated voltage connection.
    - .7 Applied potential test.
    - .8 Induced potential tests.
  - .2 The manufacturer shall provide three (3) certified copies of factory test reports to the Engineer upon request.
  - .3 The following special factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest applicable ANSI and NEMA standards.
    - .1 Temperature test(s) shall be made on all units. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.
    - .2 ANSI impulse test on all primary windings.
-

- .4 Factory tests as outlined above shall be witnessed by the Owner's Representative.
  - .1 The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
  - .2 The manufacturer shall include the cost of transportation and lodging for up to three (3) Owner's Representatives. The cost of meals and incidental expenses shall be the owner's responsibility.

### **3.02 Field Quality Control**

- .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section. 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 herein.
- .2 The Contractor shall provide three (3) copies of the manufacturer's field startup report.
- .3 Perform tests in accordance with Section 26 05 00 and Section 26 08 00.
- .4 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20 degrees C.
  - .1 High voltage to ground with secondary grounded for duration of test.
  - .2 Low voltage to ground with primary grounded for duration of test.
  - .3 High to low voltage.
- .5 Inspect primary and secondary connections for tightness and for signs of overheating.
- .6 Inspect and clean bushings and insulators.
- .7 Check oil level and temperature indicators.
- .8 Set transformer taps to rated voltage as specified.
- .9 Inspect for oil leaks and excessive rusting.
- .10 Inspect oil level.
- .11 Check fuses for correctness of type and size.
- .12 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

### **3.03 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 (3) copies of the manufacturer's representative's certification.
-

### **3.04 Inspection**

- .1 Check factory made connections of transformer unit for mechanical security and electrical continuity.
- .2 Check transformer insulating liquid for correct quantity and specification according to manufacturer's instructions.

### **3.05 Installation**

- .1 The Contractor shall install all equipment per 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 Ensure concrete pad is fully cured before transformer is installed.
- .4 Set and secure transformer unit in place, rigid, plumb, and square.
- .5 Make connections.
- .6 Connect transformer unit ground bus to system ground.
- .7 Wire one set of contacts on liquid temperature thermometer, liquid level gauge, to sound alarm when unsafe condition reached.
- .8 Ensure care is taken to prevent contamination of liquid and components when field filling transformers.
- .9 Use only metal hose when field-filling transformer with oil: never, under any circumstances, use rubber hose.
- .10 Set taps to produce rated secondary voltage at no-load.

### **3.06 Field Tests and Inspections**

- .1 Measure primary and secondary voltages for proper tap settings.
- .2 Megger primary and secondary windings
- .3 Liquid transformers – Test oil for dielectric strength.

### **3.07 Adjusting**

- .1 Adjust primary taps so that secondary voltage is above and within 2 per cent of rated voltage.

### **3.08 Cleaning**

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

### **3.09 Training**

- .1 The Contractor shall provide a training session for up to five (5) Owner's representatives for two normal workdays at a job site 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, circuit breakers and major components within the assembly.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 This section describes the electrical and mechanical characteristics of a new outdoor, 44 kV terminal pole.

### **1.02 Submittals**

- .1 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
- .2 Indicate:
  - .1 Anchoring method and dimensioned foundation template.
  - .2 Dimensioned cable entry locations.
  - .3 Dimensioned cable termination locations.
- .3 Identified internal and external component layout on assembly drawing.
- .4 Submit primary fuse time-current characteristics.
- .5 Front view elevation or outline drawing and weight.
- .6 Dimensioned site plan drawing showing the dimensions, any components overhanging the transformer foundation, and the clearances denoted with clear reference to the relevant code clauses, including but not limited to:
  - .1 Front view and plan view of assembly.
  - .2 Location and identification of all accessories.
  - .3 Anchoring details.
  - .4 Weight, and total shipping weight.
  - .5 equipment reviewed shop drawings;
  - .6 single line diagram.
  - .7 schematic diagram.
  - .8 nameplate data.
  - .9 component list.
  - .10 additional information requested by local governing authority or Consultant.

### **1.03 Delivery, Storage, and Handling**

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
-

#### **1.04 Maintenance Material Submittals**

- .1 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.
- .2 Provide operation and maintenance data for pad mounted distribution transformers for incorporation into manual specified in Section 01 78 23.
- .3 Include insulating liquid maintenance data.

#### **1.05 Warranty**

- .1 Provide manufacturer product warranty against defects in operation and material for a period of one (1) year from date of Substantial Completion.

#### **1.06 Scope**

- .1 The following work shall be the responsibility of the High Voltage electrical subcontractor.
  - .1 Receiving and unloading of equipment.
  - .2 Installation of equipment.
  - .3 Supply and installation of primary feeders.
  - .4 Supplying and installing connections on the H.V. bushings.
  - .5 Supply and install of aluminum lattice.
  - .6 Supply and install all equipment as detailed herein and as shown on the drawings to the complete satisfaction of the Consultant, LDC, and ESA.

### **2 Products**

#### **2.01 Manufacturers**

- .1 S&C Electric Ltd.

#### **2.02 Terminal Poles**

- .1 The terminal poles shall be 50 foot class "L" spun concrete. The free standing pole complete with crossarms, etc. shall be shipped pre-assembled for easy erection on site. The structure shall consist of columns and interconnecting and supporting girders, all as shown on the electrical drawings. All structures to be supplied complete with anchoring bases, strain "U" bolts, tower eyes, insulators and clamps suitable for incoming conductors.
- .2 The structure shall be designed and manufactured in accordance to NEMA SG6-latest revision and ESA Regulations for Electrical Structures. Design loads shall be in accordance with said specifications but shall not be less than the following:
  - .1 Incoming Lines: 1000 lbs. per conductor with lines approaching at an angle of up to 30 degrees from the perpendicular.
  - .2 Dead Load: Self weight of structure plus 1/2" thickness of ice over all surfaces.

- .3 Equipment Load: Actual weight of equipment plus 50% increase for ice coating.
- .4 Wind Load: 25 psf on 1-1/2 x net exposed area of the structure.
- .5 Stresses: The allowable stresses for structural members under static loads plus dead load shall be calculated and have a factor of safety in accordance with the minimum requirements of CSA and the Aluminum Association.
- .6 Horizontal deflection of vertical members - Maximum 1/100 of the vertical height of the structure.
- .7 Vertical deflection of horizontal members - Maximum 1/200 of the span.
- .8 Horizontal deflection of horizontal - Maximum 1/200 of the span.
- .3 All structure and lightning arresters grounding to be supplied installed on the structure complete with clamps and sufficient tail length for connection to the lightning arresters and to the station grounding system. The terminal pole shall include the following:
  - .1 One 46 kV, 600A vertically mounted, 3 pole, load break switch, S&C with ED-381R14-T206.
  - .2 Six SMD2C fuse refills, rating to be in accordance with the co-ordination study.
  - .3 Three 48 kV (39 kV MCOV) intermediate class metal oxide lightning arresters.

### 2.03 Ratings

- .1 All 46 kV equipment including fuses, fuse holders, switch and 44 kV bus with respect to bus size and bus supports must be capable of withstanding a 1500 MVA fault for the duration of the total clearing time of the protective devices. The primary equipment must be capable of interrupting safely a 1500 MVA symmetrical short circuit. All equipment shall be suitable for 46 kV insulation class and operation at 44 kV with a minimum BIL of 250 kV. Insulators, conductors, spacings, phased ground clearances etc. shall also be suitable for 250 kV BIL rating.
- .2 Supply a ground gradient mat and interconnect with pad lockable switch handle. The manufacturer shall supply five copies of the arrangement drawings, anchor bolts layout and foundation stamped by a professional engineer. The pole shall be a minimum 6 metres from the property line. The substation including all electrical equipment, grounding grid, mats and fence shall be grounded in accordance with ESA and LDC requirements.

### 2.04 Cable

- .1 Cable shall be 100% insulation 4/0 aluminum, 46 kV shielded XLPE with grounded concentric neutral and PVC jacket. Supply 46 kV terminators and lugs for all cable ends.

### 2.05 Grounding

- .1 Substation grounding, including ground grid, ground rods, gradient control mats, fence equipment and connections shall be supplied and installed in accordance with the following standards and codes:
  - .1 Ontario Hydro Inspection Bulletin: 36-10-latest.
  - .2 Ontario Electrical Safety Code: Rules 36-300 to 36-310, Table 51, and Table 52.

- .3 IEEE Standard 80-2000.
- .4 Ontario Hydro Grounding Guide 1999.
- .2 Design calculations shall be submitted to the Consultant and Ontario Electrical Safety Authority for approval as outlined in Bulletin 36-10-3 and including:
  - .1 Calculation of maximum ground grid potential rise.
  - .2 Calculation of maximum step and touch voltages.
  - .3 Calculation of resistance of grounding system.

Maximum values shall be as outlined in Table 52 and Rule 36-304.

## **2.06 Equipment Identification**

- .1 Provide equipment identification identifying:
  - .1 Voltage.
  - .2 Amperage.
  - .3 Basic Impulse level.

## **2.07 Source Quality Control**

- .1 Provide list of standard factory tests to be performed on the equipment provided under this section.
- .2 The manufacturer shall provide three (3) certified copies of factory test reports to the Consultant.
- .3 Factory tests as outlined above shall be witnessed by the owner's representative.
  - .1 The manufacturer shall notify the owner six (6) weeks prior to the date the tests are to be performed.
  - .2 The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. Include all applicable "out of town" expenses such as transportation, lodging, meals, etc., for the representatives to witness factory testing.

## **3 Execution**

### **3.01 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for isolating switches installation in accordance with manufacturer's written instructions.

### **3.02 Installation**

- .1 Install as indicated.
  - .2 Check switch contact resistance with low resistance meter.
-

- .3 Megger switch across each pole, from pole to pole, and from pole to ground.

### **3.03 Field Quality Control**

- .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and startup of the equipment specified under this section. 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 herein.
- .2 The Contractor shall provide three (3) copies of the manufacturer's field startup report.

### **3.04 Manufacturer Services**

- .1 Include costs for a manufacturer's representative on site for manufacturers certification to assist the awarded Contractor of the installation. The scheduling of the manufacturer's representative will be by the awarded Contractor.
- .2 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.
- .3 The Contractor shall provide three (3) copies of the manufacturer's representative's certification.
- .4 Manufacturers representative shall allow for four (4) separate site visits to ensure proper installation throughout and allow for a final visit after installation is complete to certify installation is ready for energization. Manufacturer's representative shall be on site when the switch is operated for the first time to energize the load. This shall be coordinated with the designated Electrical contractor.

### **3.05 Training**

- .1 The contractor shall provide a training session for up to five (5) Owner's representatives for one normal workday at a job site 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, circuit breakers and major components within the assembly.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

### **1.02 References**

- .1 ANSI/ASHRAE/IES Standard 90.1-2013 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 47-13 (R2018), Air-cooled transformers (dry type).
  - .4 CSA C9-17, Dry-type transformers.
  - .5 CSA C802.2-18, Minimum Efficiency Values for Dry-Type Transformers.
- .3 IEEE C57.110-2018, IEEE Recommended Practice for Establishing Liquid-Immersed and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents: this standard defines how K-factor is calculated.
- .4 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA ST-20-2014, Dry-Type Transformers for General Applications: sound levels.
- .5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- .6 Ontario Building Code and its referenced standards.
- .7 UL 1561, Standard for Dry-Type General Purpose and Power Transformers.

### **1.03 Action Submittals**

- .1 Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, power, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

### **1.04 Informational Submittals**

- .1 Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 per cent rated load, and sound level.
  - .2 Submit manufacturer's installation instructions.
    - .1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
-

- .2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

#### **1.05 Closeout Submittals**

- .1 Record actual locations of transformers in project record documents.
- .2 Document test results from NETA ATS.
- .3 Copies of completed factory reports and testing reports.

#### **1.06 Delivery, Storage, and Handling**

- .1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations.
- .2 Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- .3 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.
- .4 Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye, and/or brackets provided for that purpose.

#### **1.07 Warranty**

- .1 The transformer shall carry a 1 year warranty from the time of substantial performance.

### **2 Products**

#### **2.01 General**

- .1 Transformers shall be standard general purpose dry type unless otherwise indicated on drawings as K-Rated or Harmonic Mitigation type.
- .2 Use transformers of one manufacturer throughout project and in accordance with CSA C22.2 No. 47 and CSA C9.

#### **2.02 Manufacturers**

- .1 Manufacturer List:
  - .1 Bemag.
  - .2 Delta Transformer.
  - .3 Eaton.
  - .4 Hammond.
  - .5 Powersmiths.

.6 Rex Power Magnetics.

.7 Siemens.

.8 Schneider Electric.

.9 STI.

.2 Substitutions: permitted if approved by the Consultant prior to Tender closing date.

### **2.03 Regulatory Requirements**

.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Efficiency ratings:

.1 Meet or exceed the efficiency levels indicated in CSA C802.2-12, and ASHRAE 90.1-2013, Table 8.4.4.

### **2.04 General Purpose Transformers**

.1 NEMA ST-20, factory-assembled, air cooled low-inrush dry type transformer, ratings and voltages as indicated on drawings.

.2 Single or three phase as indicated on drawings.

.3 Type: AN/AA ventilated self-cooled.

.4 Copper windings.

.5 Finish: Final coating to be ANSI 61 Grey Epoxy Powder.

.6 T-connected transformers are not acceptable.

.7 Isolate core and coil from enclosure using vibration-absorbing mounts.

.8 Impedance: standard (3% to 5% nominal for up to 75 kVA, 4% to 6% for transformers 112.5 kVA and greater).

### **2.05 Insulation System and Average Winding Temperature Rise**

.1 1-15 kVA: Class 185 with 150°C rise.

### **2.06 Case Temperature**

.1 Limits in accordance with CSA C22.2 No. 47.

### **2.07 Winding Taps**

.1 To NEMA ST-20.

.2 Four full capacity 5 per cent adjustment taps, 2 at 2.5 per cent FCBN (full capacity below nominal) and 2 at 2.5 per cent FCAN (full capacity above nominal).

### **2.08 Basic Impulse Level**

.1 10 kV BIL.

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## **2.09 Grounding**

- .1 Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

## **2.10 Mounting**

- .1 1-15 kVA: suitable for wall mounting.

## **2.11 Coil Conductors**

- .1 Continuous windings with terminations brazed or welded.

## **2.12 Enclosure**

- .1 NEMA ST-20, CSA type 2 ventilated, sprinkler-proof. Provide lifting eyes or brackets.
- .2 CSA type 3R for outdoor locations.

## **2.13 Catcher/Drip Base Plate**

- .1 Constructed from galvanized steel sheet metal having the minimum thickness as that of the transformer's enclosure.
- .2 To be provided for all transformers that are wall mounted, or suspended off the floor.

## **2.14 Sound Levels**

- .1 To NEMA ST-20 for transformers up to 300 kVA:
  - .1 Up to 9 kVA: 40 dB.
  - .2 10 – 50 kVA: 45 dB.

## **2.15 Nameplate**

- .1 Transformer shall have embossed aluminum or stainless steel nameplate indicating, but not restricted to the following:
  - .1 kVA rating.
  - .2 Voltage rating.
  - .3 Impedance.
  - .4 Type.
  - .5 Insulation class.
  - .6 Temperature rise.
  - .7 Connection diagram.
  - .8 Serial number.

## **2.16 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 53.
-

## **2.17 Source Quality Control**

- .1 Production test each unit according to NEMA ST-20.

## **3 Execution**

### **3.01 Installation**

- .1 Mounting:
    - .1 Mount dry type transformers up to 75 kVA, on floor, wall, or suspended from ceiling, as indicated on plans.
    - .2 Maintain clear space as described in 2021 OESC Rule 2-312.
    - .3 Mount dry type transformers rated above 75 kVA on floor.
    - .4 For wall mounted transformers, provide rubber-in-shear isolation mounts above bracket-supported rails secured from the wall.
    - .5 For ceiling mounted transformers, provide trapeze hangers and provide rubber-in-shear isolation mounts.
    - .6 Where a transformer is wall mounted or suspended off the floor, provide a metal catcher/drip base plate, and bolt to the bottom of the transformer below the base channel to conform to CSA C22.2 No. 47. Install in accordance with transformer manufacturer's instructions and recommendations.
    - .7 Mount floor mounted transformers on concrete housekeeping pads, minimum 100 mm (4") thick, and extending a minimum of 150 mm (6") beyond the footprint of the transformer.
    - .8 Mount vibration isolating pads suitable for isolating the transformer noise from the building structure in accordance with Section 26 05 48.13.
  - .2 Set transformer plumb and level.
  - .3 Use flexible conduit, under the provisions of Section 26 05 33.13, 600 mm minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
  - .4 Provide grounding and bonding to Section 26 05 26.
  - .5 Ensure adequate clearance around transformer for ventilation.
  - .6 Install transformers in level upright position.
  - .7 Remove shipping supports only after transformer is installed and just before putting into service.
  - .8 Loosen isolation pad bolts until no compression is visible.
  - .9 Make primary and secondary connections in accordance with wiring diagram.
  - .10 Energize transformers after installation is complete.
-

**3.02 Field Quality Control**

- .1 Section 01 43 00: Field Inspection, Testing, Adjusting.
- .2 Perform inspections and tests listed in NETA ATS, Section 7.2.

**3.03 Adjusting**

- .1 Measure primary and secondary voltages and make appropriate tap adjustments.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Distribution Switchboards rated 600 V and less.
- .2 Switchboard accessories.
- .3 Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for distribution switchboards as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

### **1.02 Related Requirements**

- .1 Section 03 30 00 – Cast-in-Place Concrete: Concrete for supporting foundations and pads.
- .2 Section 25 96 00 – Integrated Automation Control Sequences for Electrical Systems.
- .3 Section 26 21 16 – Low-Voltage Underground Electrical Service Entrance.
- .4 Section 26 22 13 – Low-Voltage Distribution Transformers.
- .5 Section 26 27 13 – Electricity Metering.
- .6 Section 26 28 16.02 – Molded Case Circuit Breakers.
- .7 Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.
- .8 Section 26 24 16 – Panelboards.

### **1.03 References**

- .1 ANSI C39.1 – Requirements for Electrical Analog Indicating Instruments.
  - .2 ASTM (ASTM):
    - .1 ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction."
  - .3 CSA Group:
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
    - .3 CSA C22.2 No. 4-16, Enclosed and dead-front switches.
    - .4 CSA C22.2 No. 5-16, Molded case circuit breakers, molded case switches, and circuit-breaker enclosures.
    - .5 CSA C22.2 No. 144.1-16, Ground-fault circuit interrupters.
    - .6 CSA C22.2 No. 244:19, Switchboards.
    - .7 CSA Z462:21, Workplace electrical safety.
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- .8 CSA Z463-18, Maintenance of electrical systems.
- .4 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - .1 ANSI/IEEE C57.13, "Standard Requirements for Instrument Transformers" (copyrighted by IEEE, ANSI approved).
- .5 InterNational Electrical Testing Association (NETA):
  - .1 NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .6 International Organization for Standardization (ISO):
  - .1 ISO 9001, Quality Management Systems - Requirements.
- .7 National Electrical Contractors Association (NECA):
  - .1 NECA 400, "Standard for Installing and Maintaining Switchboards" (copyrighted by NECA, ANSI approved).
- .8 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA AB 1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.
  - .2 NEMA C12.1 - Electric Meters; Code for Electricity Metering.
  - .3 NEMA EI 21.1, "Instrument Transformers for Revenue Metering (110 kV BIL and Less)."
  - .4 NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 volts Maximum).
  - .5 NEMA PB 2 - Deadfront Distribution Switchboards.
  - .6 NEMA PB 2.1 - Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 volts or Less.
  - .7 NEMA 260 - Safety Labels for Pad Mounted Switchgear and Transformers Sited in Public Areas.
- .9 Ontario Building Code and its referenced standards.
- .10 Underwriters Laboratories, Inc. (UL):
  - .1 UL 1283, "Standard for Safety for Electro-Magnetic Interference Filters" (copyrighted by UL, ANSI approved).

#### **1.04 Pre-installation Meetings**

- .1 Conduct pre-installation meeting in accordance with Section 01 31 19.
  - .2 Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Consultant.
-

## 1.05 Action Submittals

- .1 Section 01 33 00: Procedures for submittals.
  - .2 Work of this Section is to be submitted for review after Consultant's review of Coordination Study per Section 26 05 73.16 is completed.
  - .3 Product Data:
    - .1 Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
    - .2 Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Submit product data for each type of switchboard, overcurrent protective device, surge protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
  - .4 Shop Drawings:
    - .1 Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, and ground; and switchboard instrument details.
    - .2 Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data. Submit shop drawings for each switchboard and related equipment.
    - .3 Indicate front and side enclosure elevations with overall dimensions, conduit entrance locations and requirements, nameplate legends, one-line diagrams, equipment schedule and switchboard instrument details.
  - .5 Submit mimic-bus diagram.
  - .6 The following information shall be submitted to the Consultant:
    - .1 Master drawing index.
    - .2 Front view elevation.
    - .3 Floor plan.
    - .4 Top view.
    - .5 Single line.
    - .6 Schematic diagram.
    - .7 Nameplate schedule.
    - .8 Component list.
    - .9 Conduit entry/exit locations.
    - .10 Assembly ratings including:
-

- .1 Short-circuit rating.
- .2 Voltage.
- .3 Continuous current.
- .11 Major component ratings including:
  - .1 Voltage.
  - .2 Continuous current.
  - .3 Interrupting ratings.
  - .4 Cable terminal sizes.
  - .5 Product data sheets.
- .12 Where applicable, the following additional information shall be submitted to the Consultant:
  - .1 Busway connection.
  - .2 Connection details between close-coupled assemblies.
  - .3 Composite floor plan of close-coupled assemblies.
  - .4 Key interlock scheme drawing and sequence of operations.
- .7 Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.
- .8 Quality Control Submittals:
  - .1 Test Reports: Submit field quality control test reports.
- .9 Upon review by the Consultant, submit switchboard shop drawings to the local electrical utility for their review and approval.

#### **1.06 Informational Submittals**

- .1 Section 01 33 00: Submittals for Information.
- .2 The following submittals are informational; responsive action by the Consultant is not required.
- .3 Test Reports: Indicate results of factory production tests.
- .4 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

#### **1.07 Closeout Submittals**

- .1 Section 01 78 00: Submittals for Project Closeout.
-

- .2 Operation and Maintenance Data:
  - .1 Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
  - .2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.
- .3 Thermographic survey report.
- .4 Warranty Documentation: Submit manufacturer's standard warranty documents.
- .5 Record Documentation: Record actual locations of switchboard in project record documents.
- .6 Training session attendance records.
- .7 The following information shall be submitted for record purposes:
  - .1 Final as-built drawings and information shall incorporate all changes made during the manufacturing process.
  - .2 Wiring diagrams.
  - .3 Certified production test reports.
  - .4 Installation information.
  - .5 Seismic certification and equipment anchorage details as specified.

#### **1.08 Maintenance Material Submittals**

- .1 To Section 01 78 00.
- .2 Spare Parts: Provide four of each key.

#### **1.09 Quality Assurance**

- .1 Manufacturer Qualifications:
    - .1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
    - .2 For the equipment specified herein, the manufacturer shall be ISO 9001 or ISO 9002 certified.
    - .3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
  - .2 Installer Qualifications:
    - .1 Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing switchboards similar in type and scope to that required for this Project.
-

- .3 Inspecting and Testing Agency Qualifications:
  - .1 To qualify for acceptance, an independent inspecting and testing agency hired by the Contractor or manufacturer to test products shall demonstrate to the Consultant's satisfaction that they are qualified according to ASTM E 329 to conduct testing indicated.
- .4 Certifications:
  - .1 Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
  - .2 Comply with applicable requirements of the referenced standards.

#### **1.10 Delivery, Storage, and Handling**

- .1 Section 01 61 00: Transport, Handle, Store, and Protect Products.
- .2 Specify shipping split requirements where unusual obstructions, corridor configurations, or door widths will interfere with switchboard handling at site.
- .3 Deliver in 1219 mm (48 in) maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
- .4 Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- .5 Handle to NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- .6 Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
- .7 Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- .8 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

#### **1.11 Warranty**

- .1 Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, or up to eighteen months from date of shipment.

### **2 Products**

#### **2.01 Manufacturers**

- .1 Manufacturer List:
  - .1 Square D by Schneider Electric – Basis of Design

- .2 Eaton (Cutler-Hammer).
- .3 Siemens.
- .2 Substitutions: Not permitted.
- .3 Product Options: 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 pre-approved by the Consultant ten (10) days prior to bid date.

## **2.02 General Switchboard Requirements**

- .1 Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
  - .2 Regulatory Requirements
    - .1 Products certified by CSA Group, or testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.
  - .3 Ratings:
    - .1 Voltage: 600 V.
    - .2 Configuration: Three phase, three wire, grounded.
    - .3 Main Bus: As per Single Line Diagrams.
  - .4 Ground Bus: Extend length of switchboard.
  - .5 Molded Case Circuit Breakers: To Section 26 28 16.02 – Molded Case Circuit Breakers.
  - .6 Ground fault trip, zero sequence type ground fault sensor.
    - .1 Instantaneous trip.
    - .2 Adjustable short time trip.
    - .3 Stationary mounting or drawout construction, as applicable.
    - .4 Include shunt trip where indicated.
  - .7 Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.
  - .8 Ground Fault Sensor: Zero sequence type.
  - .9 Ground Fault Relay: Adjustable ground fault sensitivity from 200 A to 1200 A, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
  - .10 Ground Fault Sensor: Zero sequence type.
-

- .11 Ground Fault Relay: Adjustable ground fault sensitivity from 200 A to 1200 A, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- .12 Incoming entry: As noted on plans.
- .13 Incoming location: As noted on plans.
- .14 Branch Circuit Entry: Top.
- .15 Silver Flashed Copper.
- .16 Minimum Interrupt Rating: 65 kA.
- .17 Bus Bracing Rating: 65 kA.
- .18 Solid Bottom Plates.
- .19 Box Finish - ASA 61 (Std).
- .20 Trim Finish - ASA 61 (Std).
- .21 Silver Flashed Copper Ground Bus.
- .22 Vermin proof.
- .23 Channel Sills.
- .24 Refer to Single Line Diagram for additional information.

### **2.03 Short Circuit Ratings**

- .1 The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 65 000 amperes symmetrical at rated voltage or as indicated on the drawings.
- .2 Use fully rated overcurrent devices. Series ratings will not be accepted.

### **2.04 Construction**

- .1 The entire assembly shall be front accessible and shall consist of main lugs or main device as shown on the plans.
- .2 Feeder devices 150 A frame through 1200 A frame shall be panel-mounted-type construction. Devices over 1200 A frame or main devices shall be individually mounted when required.

### **2.05 Bus**

- .1 All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside the enclosure).
  - .2 A copper ground bus (minimum 1/4 in by 2 in), shall be furnished firmly secured to each vertical section structure, and shall extend the entire length of the switchboard.
  - .3 Copper neutral bus.
-

- .4 All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

## **2.06 Wiring/Termination**

- .1 Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- .2 Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 90°C of the size as indicated on the drawings.
- .3 Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- .4 All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle-type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

## **2.07 Enclosure**

- .1 Provide CSA type 2 steel enclosure complete with sprinklerproof drip shield.
- .2 Align sections at front and rear.
- .3 Switchboard Height: 2286 mm (90 in), excluding floor sills, lifting members and pull boxes.
- .4 Section depths: as per drawings.
- .5 Section widths: as per drawings.

## **2.08 Enclosure Finish**

- .1 All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a factory applied rust-inhibiting phosphatized coating. Colour and finish of the switchboard shall be ANSI 61 light gray.
- .2 Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

## **2.09 Barriers**

- .1 Provide barriers between adjacent switchboard sections.

## **2.10 Insulation and Isolation**

- .1 Provide taped bus for through bus.
-

## **2.11 Front Covers**

- .1 Front covers shall be screw removable with a single tool and doors shall be hinged with removable hinge pins.

## **2.12 Bus Transition and Incoming Pull Sections**

- .1 Match and align with basic switchboard.

## **2.13 Pull Box on Top of Switchboard**

- .1 Provide adequate ventilation to maintain temperature in pull box within same limits as switchboard.
- .2 Set back from front to clear circuit breaker removal mechanism.
- .3 Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
- .4 Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
- .5 Lace cables using industry-approved methods.

## **2.14 Feeder Entry**

- .1 Coordinate busway or cable feeder entry requirements with Single Line Diagram.
- .2 Provide busway flange to suit busway feeders.

## **2.15 Future Devices**

- .1 Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit breaker compartment.
- .2 Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

## **2.16 Metering and Instrumentation**

- .1 Utility Metering Compartment: Provide fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- .2 Instrumentation for Owner's metering:
  - .1 Instrument Transformers: NEMA EI 21.1, ANSI/IEEE C57.13, and the following:
    - .1 Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
    - .2 Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
    - .3 Control Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

- .2 Multifunction Digital Metering Monitor: Microprocessor-based unit suitable for three-wire or four-wire systems and with the following features:
  - .1 Digital Display: Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - .2 Phase Currents, Each Phase:  $\pm 1$  percent.
    - .3 Phase-to-Phase Voltages, 3-Phase:  $\pm 1$  percent.
    - .4 Phase-to-Neutral Voltages, 3-Phase:  $\pm 1$  percent.
    - .5 Megawatts:  $\pm 2$  percent.
    - .6 Megavars:  $\pm 2$  percent.
    - .7 Power Factor:  $\pm 2$  percent.
    - .8 Frequency:  $\pm 0.5$  percent.
    - .9 Megawatt Demand:  $\pm 2$  percent; demand interval programmable from 5 to 60 minutes.
    - .10 Accumulated Energy, Megawatt Hours:  $\pm 2$  percent. Accumulated values unaffected by power outages up to 72 hours.
    - .11 Watt-Hour Meters: Flush or semi-flush type, rated 5 A, 120 V, three-phase, three-wire, with three elements, 15 minute-indicating-demand register, and provision for testing and adding pulse initiation.
    - .12 Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum demand meter with 15 minute interval. Meter shall count and control a succession of pulses entering two channels.
    - .13 Mounting: Display and control unit flush or semi-flush mounted in instrument compartment or main device door.
- .3 Interface with other systems: Provide BACnet gateway for connection to Building Automation per Section 25 96 00.

## 2.17 Mimic Bus

- .1 Provide an anodized aluminum or plastic engraved plaque. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic bus diagram. Produce a concise visual presentation of principal switchboard components and connections.
- .2 Show bussing, connections, and devices in single line form on the front panels of the switchboard using blue colour light metal strips, fastened flat against the panel face with screws or rivets.

## 2.18 Nameplates

- .1 Lamacoid nameplates to Section 26 05 53:
  - .1 Switchboard nameplate.

- .2 Branch circuit nameplates.
- .2 Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16 in high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

## **2.19 Ground Fault Protection**

- .1 Furnish and install in the service equipment and/or switchboard ground fault protection and indication equipment as shown on drawings in accordance with 2021 OESC 14-102. All parts of the systems specified shall be CSA certified. All new ground fault protection and indication equipment shall be factory installed, wired, and tested by the switchboard manufacturer.

## **2.20 Source Quality Control**

- .1 Section 01 43 00: Manufacturer quality control.
- .2 Shop inspect, and test switchboard according to NEMA PB 2.
- .3 Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Consultant at least 7 days before inspections and tests are scheduled.
- .4 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 ANSI and NEMA standards.
  - .1 The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 V for one (1) minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 V for one (1) minute between live parts and ground.
  - .2 Perform factory and installation tests in accordance with applicable OESC, NEMA and CSA requirements.
- .5 The manufacturer shall provide three (3) certified copies of factory test reports.
- .6 A certified test report of all standard production tests shall be available to the Consultant upon request.

## **3 Execution**

### **3.01 Examination**

- .1 Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Consultant, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
-

- .2 Verify that field measurements are as indicated on shop drawings.
- .3 Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

### 3.02 Preparation

- .1 Provide concrete housekeeping pad to Section 03 30 00 and Section 26 05 29.

### 3.03 Installation

- .1 General
    - .1 Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.
    - .2 Install switchboards and accessories according to NEMA PB 2.1 and NECA 400.
    - .3 Install and anchor switchboards level on concrete bases, 100 mm (4 in) nominal thickness. Concrete base is specified in Section 26 05 29, and concrete materials and installation requirements are specified in Division 03.
    - .4 Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
    - .5 Frame and mount the printed basic operating instructions for switchboards, including, but not limited to, control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
    - .6 Install overcurrent protective devices, surge protective devices, and instrumentation.
      - .1 Set field-adjustable switches and circuit breaker trip ranges.
    - .7 Install spare fuse cabinet.
  - .2 Install switchboard in locations shown on drawings, according to CSA C22.1.
  - .3 Tighten accessible bus connections and mechanical fasteners after placing switchboard.
  - .4 Install fuses in each switch.
  - .5 Install all equipment per the manufacturer's recommendations and the contract drawings.
  - .6 The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Contractor supplied floor sills to be set level in concrete per manufacturer's recommendations the floor without the use of floor sills providing the floor is level to 1/8 in per 3 ft distance in any direction. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
  - .7 Examine substrates and conditions in which units will be installed. Check for clearance that will be required before, during and after equipment installation. Do not proceed with installation until unsatisfactory conditions are corrected.
-

- .8 Strictly comply with manufacturer's instructions and recommendations and NEMA PB 2.1. Coordinate installation with adjacent work to ensure proper sequence of construction, clearances, and support.
- .9 Install units plumb, level, and rigid without distortion to the switchboard cubicle(s).
- .10 Identification
  - .1 Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53.
  - .2 Label each switchboard compartment with engraved metal or laminated plastic nameplate mounted with corrosion-resistant screws.
  - .3 Arc Flash Warning Labels
    - .1 Refer to Section 26 05 73.19.
    - .2 Apply in the field, the arc flash warning label to all switchboards to suit future examination, adjustment, servicing, or maintenance while energized to warn qualified persons of potential electrical arc flash hazards.

### **3.04 Field Quality Control**

- .1 Section 01 43 00: Quality Assurance.
- .2 Perform inspections and tests listed in NETA ATS, Section 7.1.
- .3 Prepare for acceptance tests as follows:
  - .1 Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - .2 Test continuity of each circuit.
- .4 Perform the following field tests and inspections and prepare test reports:
  - .1 Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
  - .2 Perform infrared thermographic survey in accordance with NETA ATS, Section 9 "Thermographic Survey". Submit report to the Consultant.
  - .3 Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

### **3.05 Protection**

- .1 Provide final protection and maintain conditions in a manner that shall ensure that the switchboards shall be without damage at time of Substantial Performance.

### **3.06 Adjusting**

- .1 Section 01 78 00: adjusting installed work.
  - .2 Adjust all operating mechanisms for free mechanical movement.
-

- .3 Tighten bolted bus connections to manufacturer's instructions.
- .4 Adjust circuit breaker trip and time delay settings to values indicated as instructed by the Consultant.
- .5 Coordination Study Labels and Field Adjustment
  - .1 Refer to Section 26 05 73.16.
  - .2 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.
  - .3 Necessary field settings of devices, adjustments, and minor modifications to equipment to accomplish conformance with an approved short-circuit and protective device coordination study, shall be carried out by the Contractor at no additional cost to the Owner.

### **3.07 Cleaning**

- .1 Section 01 74 00: cleaning installed work.
- .2 Clean exposed surfaces using manufacturer recommended materials and methods.
- .3 Touch-up damaged coatings and finishes using non-abrasive materials and methods recommended by manufacturer. Eliminate all visible evidence of repair.
- .4 Touch up scratched or marred surfaces to match original finish.

### **3.08 Training**

- .1 The Contractor shall provide a training session for up to five (5) Owner's representatives for normal workdays at a jobsite location determined by the Owner.
- .2 A manufacturer's qualified representative shall conduct the training session. The training program shall consist of instruction on the operation of the assembly, circuit breakers, fused switches, meters, and major components within the assembly.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Power distribution panelboards – Circuit breaker type.
- .2 Lighting and appliance branch circuit panelboards.

### **1.02 Related Requirements**

- .1 Section 26 28 16.02 – Molded Case Circuit Breakers.
- .2 Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits: externally mounted surge protective devices.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 5-16 – Molded Case Circuit Breakers, molded-case switches, and circuit-breaker enclosures.
  - .4 CSA C22.2 No. 29-15 – Panelboards and Enclosed Panelboards.
- .2 NEMA:
  - .1 NEMA ICS 2-2000 (R2020) – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 volts.
  - .2 NEMA KS 1-2013 – Heavy Duty Enclosed and Dead-Front Switches (600 volts Maximum).
  - .3 NEMA PB 1-2011 – Panelboards.
  - .4 NEMA PB 1.1-2013 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 volts or Less.
- .3 NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

### **1.04 Submittals**

- .1 Submit in accordance with Section 01 33 00.
  - .2 Work of this Section is to be submitted for review after Consultant's review of Coordination Study per Section 26 05 73.16 is completed.
  - .3 Shop drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.
  - .4 Shop drawings:
-

- .1 Indicate the following:
  - .1 Outline and support point dimensions.
  - .2 Voltage.
  - .3 Main bus ampacity.
  - .4 Integrated short circuit ampere rating.
  - .5 Circuit breaker arrangement, types, and sizes.
- .2 The following information shall be submitted to the Consultant:
  - .1 Breaker layout drawing with dimensions indicated and nameplate designation.
  - .2 Component list.
  - .3 Conduit entry/exit locations.
  - .4 Assembly ratings including:
    - .1 Short-circuit rating.
    - .2 Voltage.
    - .3 Continuous current.
  - .5 Cable terminal sizes.
  - .6 Product data sheets.
- .3 Where applicable, the following additional information shall be submitted to the Consultant:
  - .1 Key interlock scheme drawing and sequence of operations.
- .5 Submittals for Construction
  - .1 The following information shall be submitted for record purposes:
    - .1 Installation information.

#### **1.05 Closeout Submittals**

- .1 Refer to Section 01 78 00.
  - .2 Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
  - .3 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
  - .4 Final as-built drawings and information shall incorporate all changes made during the manufacturing and installation process.
  - .5 Include a copy of each panelboard schedule in the Operation and Maintenance manual.
-

#### **1.06 Maintenance Material Submittals**

- .1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 volts or Less.
- .2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.
- .3 Provide two of each panelboard key.
- .4 Provide final panelboard schedules indicating panelboard data, phasing, breaker sizes, and loads served.

#### **1.07 Quality Assurance**

- .1 Regulatory Requirements
  - .1 Products: Listed and classified by CSA (Canadian Standards Association).
- .2 Qualifications
  - .1 Company specializing in manufacturing of panelboard products with a minimum of 20 years' experience.
  - .2 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
  - .3 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
  - .4 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

#### **1.08 Delivery, Storage, and Handling**

- .1 Inspect and report concealed damage to carrier within their required time period.
- .2 Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.
- .3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.
- .4 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

#### **1.09 Warranty**

- .1 Warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.
-

## **2 Products**

### **2.01 General**

- .1 Description: CSA C22.2 No. 29, circuit breaker type.

### **2.02 Branch Circuit Panelboards**

- .1 Manufacturers:
    - .1 Square D by Schneider Electric, NQ or NQOD Series.
    - .2 Eaton Cutler-Hammer, POW-R-LINE 1, POW-R-LINE 2, POW-R-LINE 3 Series.
    - .3 Equal by Siemens.
  - .2 Description: CSA C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.
  - .3 Panelboard Bus:
    - .1 Copper, ratings as indicated.
    - .2 Provide copper neutral bus in each panelboard.
    - .3 Provide copper ground bus in each panelboard.
    - .4 Provide insulated ground bus where scheduled.
  - .4 Minimum Integrated Short Circuit Rating: 10 000 amperes RMS symmetrical for 240 V panelboards, or as indicated.
  - .5 Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
  - .6 Current Limiting Molded Case Circuit Breakers where indicated: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
  - .7 Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
  - .8 Enclosure shall be CSA type 2 sprinklerproof complete with drip hood, or as noted.
  - .9 Trims shall be equipped with a flush lock.
  - .10 Breaker positions labeled as "Spare" or "Space" shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.
  - .11 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
    - .1 Install circuit breakers in panelboards before shipment.
-

- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
  - .12 Panelboards rated 240 VAC or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.
  - .13 Bus and breakers rated for symmetrical interrupting capacity, as indicated.
  - .14 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
  - .15 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
  - .16 Two keys for each panelboard and key panelboards alike.
  - .17 Copper bus with neutral of same ampere rating as mains.
  - .18 Mains: suitable for bolt-on breakers.
  - .19 Trim with concealed front bolts and hinges.
  - .20 Trim and door finish: baked grey enamel.
  - .21 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated.
  - .22 Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
  - .23 Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 A frame and through 100 A trip sizes shall take up the same pole spacing. Circuit breakers shall be ULC listed as type SWD for lighting circuits.
  - .1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
  - .24 Circuit breakers shall have a minimum interrupting rating of 10 000 A symmetrical at 240 V, and 14 000 amperes symmetrical at 480 V, unless otherwise noted on the drawings.
  - .25 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.
  - .26 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.
  - .27 Panels shall have mains of voltage and capacity, and main and branch breakers, as shown on the drawings. Spaces shall include necessary bus work such that Owners, at a later date, need buy only the breakers.
-

- .28 Where panels exceed 72 circuits, use multi-section panel with main cross-over solid bus bars unless noted otherwise on drawings. Main bus capacity of each section shall be full size to match cross-over bus.
- .29 Breakers shall have bolted type connections. Multi-pole breakers shall be common trip type with a single handle, suitable for voltage applied and of same manufacture as single pole breakers.
- .30 Panels for 120/208 V, 3-phase, 4-wire systems shall be complete with full size breakers.
- .31 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.
- .32 Provide lighting and receptacle panels suitable for surface, or flush-mounting type, as shown.
- .33 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.
- .34 Panels for non-linear loads shall be complete with lugs for double neutrals.
- .35 Panels shall be given a rust-resistant treatment to both tub and trim.
- .36 Flush panels shall have concealed hinges and flush type combination lock latch. Locks shall be chrome plated. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.
- .37 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.
- .38 Recessed panels shall have standard flush trims.
- .39 Co-ordinate panel finish with Room Finish Schedule.

#### **2.03 Molded Case Circuit Breakers**

- .1 Breakers: to Section 26 28 16.02.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10 per cent of 15 A to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.
- .5 Lock-on devices for fire alarm, security, and sprinkler circuits.
- .6 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.
- .7 Provide breakers for externally mounted Surge Protective Devices in accordance with Section 26 43 13.

#### **2.04 Construction**

- .1 General:
-

- .1 Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- .2 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
- .3 A temporary directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- .4 All locks shall be keyed alike. Key same as existing.
- .2 Branch Circuit Panelboards:
  - .1 Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.
- .3 Distribution Panelboards:
  - .1 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

## **2.05 Bus**

- .1 Lugs: Copper and listed by CSA, or cUL, for use with copper conductors and sized to accept copper conductors of the ampacity specified.
- .2 Main bus bars shall be copper sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65°C above an ambient of 40°C maximum.
- .3 A copper system ground bus shall be included in all panelboards.
- .4 Full-size (100 per cent rated) insulated copper neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200 per cent rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

## **2.06 Equipment Identification**

- .1 Provide equipment identification in accordance with Section 26 05 53.
  - .2 Nameplate for each panelboard size 4 engraved.
  - .3 Nameplate for each branch circuit in distribution panelboards size 2 engraved.
  - .4 Complete circuit directory with typewritten legend showing location and load of each circuit.
-

- .5 Provide an engraved nameplate for each panelboard section.
- .6 Provide copies of all circuit directories in manuals.

## **2.07 Source Quality Control**

- .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 NEMA and CSA standards.

## **3 Execution**

### **3.01 Installation**

- .1 Install panelboards to CSA C22.1.
  - .2 Install panelboards plumb.
  - .3 Height: 1800 mm to top of panelboard; install panelboards taller than 1800 mm with bottom no more than 100 mm above floor.
  - .4 Provide filler plates for unused spaces in panelboards.
  - .5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
  - .6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.
  - .7 Ground and bond panelboard enclosure according to Section 26 05 26.
  - .8 Locate panelboards as indicated and mount securely, plumb, true, and square, to adjoining surfaces.
  - .9 Install surface mounted panelboards on fire rated plywood backboards in accordance with Section 26 05 29. Where practical, group panelboards on common backboard.
  - .10 Connect loads to circuits.
  - .11 Connect neutral conductors to common neutral bus with respective neutral identified.
  - .12 Deliver five (5) duplicate keys for each panel lock to the Owner.
  - .13 Mount electrical panels, where possible, with top of trim at uniform height of 2000 mm.
  - .14 Cap ends of conduits in accessible locations in ceiling spaces above panels, to allow for future wiring.
  - .15 The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.
  - .16 Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and Electrical Code requirements.
  - .17 After completion of wiring, type directory showing a clear description of each circuit being controlled from panel and place in metal frame inside door.
  - .18 Provide revised directories for existing panels if revised.
-

- .19 Provide circuit breaker handle locks for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- .20 Provide three 27 mm empty conduits from top of lighting, receptacle, telephone, signal and communication panels recessed in walls, to ceiling space.
- .21 Coordinate and get owners approval for the final panel board location.

### **3.02 Field Quality Control**

- .1 Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.
- .2 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .3 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20 per cent of each other. Maintain proper phasing for multi-wire branch circuits.
- .4 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

### **3.03 Adjusting**

- .1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other.
- .2 Maintain proper phasing for multi-wire branch circuits.

**End of Section**

## **1 General**

### **1.01 Summary**

- .1 Section Includes
  - .1 The furnishing, installation and connection of electronic meters designed for permanent connection to an electrical service and capable of measuring the following: kilowatt-hours (kWh) with revenue-grade accuracy; instantaneous demand; peak demand; voltage; amperage; phase; VARS; power factor per phase; and total power factor across all phases.
- .2 Related Requirements
  - .1 Section 26 24 16 – Panelboards.
  - .2 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

### **1.02 References**

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) ([www.ansi.org](http://www.ansi.org) and [www.ieee.org](http://www.ieee.org))
    - .1 C12.1 – Electricity Metering
    - .2 C57.13 – Instrument Transformers
  - .2 Canadian Standards Association
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 International Organization for Standardization (ISO).
    - .1 9001:2000 – Quality Management Systems.
  - .4 National Electrical Manufacturers Association (NEMA).
    - .1 WD1 (R2005) – General Color Requirements for Wiring Devices.
    - .2 WD 6 – Dimensional Requirements for Wiring Devices.
    - .3 4X – Enclosures constructed for indoor or outdoor use.
  - .5 Underwriters Laboratories, Inc. (UL) ([www.ul.com](http://www.ul.com)):
    - .1 508 (1999) – Industrial Control Equipment.
    - .2 916 – Energy Management Equipment
  - .6 International Electrotechnical Commission ([www.iec.ch](http://www.iec.ch)).
    - .1 IEC 687 – Electricity Metering Accuracy
-

### 1.03 Definitions

- .1 Accuracy
  - .1 The extent to which a given measurement agrees with the defined value.
- .2 Registration
  - .1 The amount of electric energy, or other quantity, recorded by the meter.
- .3 Percentage Registration
  - .1 The ratio of the measured registration to the true value, expressed as a percent.
- .4 Percentage Error
  - .1 The difference between percentage registration and 100%.
- .5 Demand
  - .1 The average power or related quantity over a specified period of time.
- .6 Demand-Maximum
  - .1 The highest demand measured over a selected period of time.
- .7 Power-Active: The time average of the instantaneous power over one period of a wave, measured in Watts (W).
- .8 Power-Apparent
  - .1 The product of RMS current and voltage, measured in Volt-Amperes (VA).

### 1.04 System Description

- .1 Revenue-grade electronic multi-function meters designed for permanent connection to an electrical service, including instrument transformers as specified herein and shown on the Drawings.

### 1.05 Submittals

- .1 Submit under provisions of Section 01 33 00 and in accordance with Conditions of the Contract.
  - .2 Bill of Materials: Complete list of all parts needed to fully install selected system components.
  - .3 Specification Conformance Document: Indicate whether the submitted equipment:
    - .1 Meets specification exactly as stated.
    - .2 Meets specification via an alternate means and indicate the specific methodology used.
  - .4 Shop Drawings; detail all mechanical and electrical equipment, including:
    - .1 Schematic of system
-

- .2 Physical dimensions of each item
  - .1 Include devices, locations, connections, conduit runs, wiring type, details, and attachments to other work.
- .3 One line diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.
- .5 Product Data: Product data sheets with performance specifications demonstrating compliance with specified requirements.
- .6 Manuals
  - .1 Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.

#### **1.06 Closeout Submittals**

- .1 Warranty documents specified herein.
- .2 2 weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals:
  - .1 Show all terminal identification.
  - .2 Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
  - .3 Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.

#### **1.07 Quality Assurance**

- .1 Manufacturer:
    - .1 Provide phone support by qualified applications engineers.
    - .2 Quality System
      - .1 Registered to ISO-9001:2000 standard.
  - .2 Electricity Metering
    - .1 Listed by UL for United States and Canada.
    - .2 Meets ANSI C12.1 standards for revenue-grade accuracy.
  - .3 Installer Qualifications
    - .1 Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
  - .4 Source Limitations
-

- .1 To assure compatibility, obtain all system components from a single source with complete responsibility over all metering, including accessory products. The use of subcontracted component assemblers is not acceptable.

#### **1.08 Delivery, Storage, and Handling**

- .1 General: Comply with Division 01 Product Requirements Sections.
- .2 Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- .3 Delivery: Deliver materials in manufacturer's original, unopened, undamaged packages with intact identification labels.
- .4 Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

#### **1.09 Project Conditions**

- .1 Do not install equipment until the following conditions can be maintained in spaces to receive equipment:
  - .1 Ambient temperature: -20°C to +50°C (-4°F to 122°F).
  - .2 Relative humidity: Maximum 80%, Pollution Degree 2.
    - .1 Normally only non-conductive pollution occurs. Occasionally, conductivity caused by condensation can be expected for short periods.
  - .3 Electrical meters must be protected from dust during installation.

#### **1.10 Warranty and Service**

- .1 The manufacturer warrants the products it supplies for a period of 2 year from the acceptance date.
- .2 Warranty Service may be performed by the manufacturer or authorized representative.

#### **1.11 Commissioning**

- .1 Instruction
  - .1 Train Owner's Representative in meter configuration, operation, and maintenance. Include:
    - .1 Physical layout of each piece of hardware.
    - .2 Meter configuration, troubleshooting and diagnostics procedures.
    - .3 Repair instructions.
    - .4 Preventive maintenance procedures and schedules.
    - .5 Testing and configuration procedures.

## 1.12 Maintenance

- .1 Enable the end user to order new equipment for system expansion, replacements, and spare parts.
- .2 Make new replacement parts available for a minimum of ten years from the date of manufacture.
- .3 Provide factory direct technical support hotline 24 hours per day, 7 days per week.
- .4 Offer renewable annual service contracts, to include parts, factory labour, and annual training visits.

## 2 Products

### 2.01 Power Monitoring - Digital Power Meter – Advanced Monitoring

- .1 The digital power meter instrument base unit must be flush mountable available as a combined front panel and base unit that can be mounted in switchgear cabinet doors.
  - .2 Features:
    - .1 Form: The digital power meter instrument shall include a large, backlit integrated LCD display with a resolution of 320x240 pixels for ease of viewing from any angle.
    - .2 Voltage inputs: The digital power meter instrument shall have five voltage inputs (V1, V2, V3, V4, Vref). The voltage inputs shall be capable of measuring from 0 to 600 Vrms (line-to-line) and shall have provisions for direct connection delta or wye.
    - .3 Current inputs: The digital power meter instrument shall have five current inputs (I1, I2, I3, I4, I5).
    - .4 Communications: The digital power meter instrument shall support multi-port, multi-protocol communications RS-232/RS-485 and 10BaseT Ethernet with Ethergate. Make available optional 33.6 kbps internal telephone modem or 10Base-FL fiber optic connectivity. Protocol support must be Modbus RTU, Modbus TCP, ION, DNP3.0, and Telnet. IEC61850 must be a standard option on the meter.
    - .5 For ease of set-up the meter must support an internal web page that can be accessed via a standard Internet browser. No other software is required.
    - .6 Harmonics up to the 63rd Harmonic
    - .7 The digital power meter instrument shall be capable of calculating the following information for any reading at 1 second intervals: Sliding Window, Predictive, and Thermal demand calculations for any parameter,
    - .8 Maximum and Minimum value for any measured parameter.
    - .9 Derived values for any combination of measured or calculated parameter, using arithmetic, trigonometric, and logic functions (equivalent PLC capabilities)
-

- .10 Nine (9) programmable oscilloscopic waveform recorders with a resolution of 256 samples per cycle
- .11 The digital power meter instrument shall provide setpoint control of internal recording mechanisms and all digital output relays.
- .12 Minimum event recording response time shall be ½ cycle (8.3 ms) for high speed events and 1 second for other events.
- .13 The digital power meter instrument shall provide extensive Time of Use (TOU) functionality to store and monitor up to 20 years of seasonal rate schedules. The TOU feature shall allow four seasons, 4 day capability.
- .14 The digital power meter instrument shall provide setpoint control of internal recording mechanisms and all digital output relays. Consecutive high speed alarm conditions and triggers shall be supported on a cycle-by-cycle basis with no “dead” time between events (i.e. there shall be no need for a rearming delay time between events).
- .3 Revenue metering capabilities: The digital power meter instrument shall be Measurement Canada Revenue approved and have the provision for sealing.
- .4 I/O: The digital power meter instrument shall include three (3) Form C dry contact relays and four (4) Form A solid state outputs and eight (8) Digital inputs (S1 to S8, SCOM), self-excited dry contact sensing, no external voltage required.
- .5 The digital power meter instrument shall have Power Quality functionality including high-speed voltage transient detection, capture, and recording: ITIC (CBEMA), IEEE. Meter shall support COMTRADE file format export for interconnectivity with other manufacturers of disturbance analysis software.
- .6 A time-stamped event log with the following features: The device shall support at least 500 events; The number of records in the log shall be programmable; Each event record shall record the date and time of the event, the cause and effect of the event, and the priority of the event; Time stamps shall have a resolution of 1 ms; Time stamps shall be able to be synchronized to within 100 ms between devices on the same serial communications medium.
- .7 Approved Manufacturers
  - .1 The Digital Power Instrumentation Package shall be equivalent to the following models:
    - .1 Power Measurement ION7550 Model P7550A0C0B6E0A0A

## 2.02 Instrument Transformers

- .1 Current Transformers (CTs)
    - .1 All Current Transformers shall be donut type with a 5 A secondary unless noted otherwise.
    - .2 CTs shall be Measurement Canada type approved or have a minimum accuracy of 0.3%.
    - .3 All CT secondaries shall terminate in CT shorting blocks before being wired to the meter.
-

- .4 One CT is required for each phase being metered.
- .2 Potential Transformers (PTs).
  - .1 PTs shall be supplied as required.
  - .2 PTs shall be wired line-neutral for Wye systems and line-line for delta systems.
  - .3 CTs shall be Measurement Canada type approved or have a minimum accuracy of 0.3%.
  - .4 Meters shall not be powered from the PT secondaries.
  - .5 Voltage inputs shall be fed from a dedicated 15 A breaker in distribution panel where practical.
  - .6 Supply and install appropriate 1 A fuses.

### **2.03 Meter Enclosures**

- .1 The digital meters shall be installed in new switchgear, panelboards, or switchboards.
- .2 Where meters are not installed in distribution equipment, the meters shall be installed in pre-wired, NEMA 12, CSA approved enclosures.
  - .1 Multiple meters may be installed in the same enclosure.
  - .2 Meters supplied from two different switchboards or different sources cannot be installed in the same enclosure.
  - .3 Meters shall be wired according to manufacturer's recommended method.
  - .4 Meter control power shall be from a separate source or control power transformer and not from the phase inputs to the meter.

### **2.04 Communications / Networking Components**

- .1 To enable the meters to communicate to the central monitoring software, CAT5 – 10BaseT Ethernet shall be run to each meter enclosure. One meter shall have Ethernet connectivity and provide Ethergate network gateway communications to other meters in the same enclosure.
- .2 Routers or other required networking components shall be provided according to Owner's standard.

### **2.05 Monitoring and Reporting Software - Existing**

- .1 The Owner employs the ION Enterprise real-time power and energy monitoring software.
    - .1 The contractor must ensure connectivity from the meters to the software through the Owner's communications network. Coordinate with the Owner.
    - .2 Include an appropriate number of additional device licenses for the ION Enterprise software.
    - .3 The contractor shall ensure the ION Enterprise software is properly commissioned to include new meters; displays and reports according to the existing standard.
-

- .4 Provision for a minimum of three (3) days of on-site software configuration for a trained factory representative to complete the software and meter integration and configuration.
- .5 Include customer training.

### **3 Execution**

#### **3.01 Installation**

- .1 All power supply and communications wiring connections shall be performed in accordance with the guidelines set out in the product documentation.
- .2 All voltage sensing connections to instrumentation shall be made with 2 A fuses.
- .3 Where practical, the meters voltage inputs shall be from a dedicated breaker.
- .4 Appropriately sized current transformers must be installed on each phase and must be installed with CT shorting blocks. All CTs with 5 A secondary shall have CT shorting blocks.
- .5 Meters must be powered from an auxiliary power supply, and not powered from the PTs.
- .6 The installation must be in accordance with the Electrical Code.
- .7 All communications networking including hubs, routers, etc. shall be provided by the contractor in accordance with the standards approved by the Owner.

#### **3.02 Configuration**

- .1 The meters shall be properly configured for the system.
- .2 Any power quality settings on the meters shall be configured so the meter's disturbance capture and transient detection is enabled.
- .3 Communications networking shall be tested and proved to be working before acceptance by the Owner.

#### **3.03 Locations**

- .1 The instrument shall be installed as on the drawings.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Electrical cabinets.
- .2 Electrical enclosures.
- .3 Splitters.

### **1.02 Related Requirements**

- .1 Section 26 27 26 – Wiring Devices.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 94.2:20 – Enclosures for Electrical Equipment, Environmental Considerations.
- .2 Underwriters Laboratories Inc. (UL):
  - .1 UL 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations.
  - .2 UL 50E – Enclosures for Electrical Equipment, Environmental Considerations

### **1.04 Submittals**

- .1 Comply with Section 01 33 00.
- .2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

### **1.05 Quality Assurance**

- .1 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .2 Furnished products shall be listed or classified by third party agencies as suitable for the intended purpose.

### **1.06 Warranty**

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.

## **2 Products**

### **2.01 General**

- .1 NEMA 12/4X screw cover enclosures.
-

- .2 NEMA 12/4X hidden hinge cover enclosures.
- .3 NEMA 12/4X external hinge cover enclosures.

## **2.02 Manufacturers**

- .1 Bel Products.
- .2 EXM Manufacturing.
- .3 Hammond Manufacturing.
- .4 Hoffman.
- .5 Thomas & Betts.
- .6 Ralston Metal.

## **2.03 Regulatory Requirements**

- .1 Provide products listed and classified by CSA (Canadian Standards Association).

## **2.04 Design and Performance Requirements**

- .1 NEMA 12/4X screw cover enclosures:
    - .1 Enclosure shall be UL listed in accordance with UL-50 and CSA or cUL certified to CSA C22.2 No. 94.2.
    - .2 Enclosure shall have CSA enclosure ratings type 1, 2, 3, 3S, 3X, 3SX, 4, 4X and 12.
    - .3 Body shall be manufactured from a high-impact, corrosion resistant solid engineering thermoplastic material; UV stabilized for outdoor use and complies with UL-94 minimum V-2 requirements.
    - .4 Cover shall be manufactured from either a high-impact, corrosion resistant solid engineering material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements, or a clear polycarbonate material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements.
    - .5 Body and cover shall maintain physical properties through overall temperature range of -35°C to 110°C (-31°F to 230°F).
    - .6 Body shall be an industrial grey colour, and lid shall be either industrial grey or clear.
    - .7 Cover and body shall be free of rough corners, sharp edges, or burrs.
    - .8 Cover screws (10-32) shall be captive with a slotted stainless steel (type 304) fillister head.
    - .9 Factory installed brass inserts shall be provided for cover (10-32), mounting flanges (1/4-20), and panel mounting (10-32) screws.
    - .10 Mounting flanges shall be removable and shall permit vertical or horizontal placement on the body.
-

- .11 Back panel mounting means shall accept standard size back panels.
  - .12 Interior body corners shall have dovetail to permit panel to be mounted at any depth.
  - .13 Swing out panel mounts shall be utilized when a second panel is desired, or when access to the rear of the primary panel is desired.
  - .14 Hardware kit for adjustable panel mounting shall be available.
  - .15 Hardware kit for swing out panel mounting shall be available.
  - .16 Enclosure gasket shall be oil resistant continuous closed cell neoprene.
  - .17 Enclosure body shall have tapered edges to keep liquids away from cover opening.
  - .18 Back panel shall be available in either 14 gauge steel, painted white, or in 7 mm (1/4 in) PVC.
  - .19 Enclosure shall be available as factory assembly or as individual components.
  - .2 NEMA 12/4X hidden hinge cover enclosures:
    - .1 Enclosure shall be UL listed in accordance with UL-50 and CSA or cUL certified to CSA C22.2 No. 94.2.
    - .2 Enclosure shall have CSA enclosure ratings type 1, 2, 3, 3S, 3X, 3SX, 4, 4X, and 12.
    - .3 Body shall be manufactured from a high-impact, corrosion resistant solid engineering thermoplastic material; UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements.
    - .4 Cover shall be manufactured from either a high-impact, corrosion resistant solid engineering material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements, or a clear polycarbonate material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements.
    - .5 Body and cover shall maintain physical properties through overall temperature range of -35°C to 110°C (-31°F to 230°F).
    - .6 Body shall be an industrial grey colour, and lid shall be either industrial grey or clear.
    - .7 Cover and body shall be free of rough corners, sharp edges, or burrs.
    - .8 Cover shall be mounted to body with integral hidden non-metallic hinges that shall provide 145° opening.
    - .9 Cover shall be removable and interchangeable.
    - .10 Body shall have integral boss for mounting quick release latches.
    - .11 Quick release (lockable) latches shall be available in either non-metallic, or in type 304 stainless steel.
-

- .12 Cover screws (10-32) shall be captive with a slotted stainless steel (type 304) fillister head.
  - .13 Factory installed brass inserts shall be provided for cover (10-32), mounting flanges (1/4-20), and panel mounting (10-32) screws.
  - .14 Mounting flanges shall be removable and shall permit vertical or horizontal placement on the body.
  - .15 Back panel mounting means shall accept standard size back panels.
  - .16 Interior body corners shall have dovetail to permit panel to be mounted at any depth.
  - .17 Swing out panel mounts shall be utilized when a second panel is desired, or when access to the rear of the primary panel is desired.
  - .18 Hardware kit for adjustable panel mounting shall be available.
  - .19 Hardware kit for swing out panel mounting shall be available.
  - .20 Enclosure gasket shall be oil resistant continuous closed cell neoprene.
  - .21 Enclosure body shall have tapered edges to keep liquids away from cover opening.
  - .22 Back panel shall be available in either 14 gauge steel, painted white, or in 7 mm (1/4 in) PVC.
  - .23 Enclosure shall be available as factory assembly or as individual components.
  - .3 NEMA 12/4X external hinge cover enclosures:
    - .1 Enclosure shall be UL listed in accordance with UL 50 and CSA or cUL certified to CSA C22.2 No. 94.2.
    - .2 Enclosure shall have CSA enclosure ratings type 1, 2, 3, 3S, 3X, 3SX, 4, 4X, and 12.
    - .3 Body shall be manufactured from a high-impact, corrosion resistant solid engineering thermoplastic material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements.
    - .4 Cover shall be manufactured from either a high-impact, corrosion resistant solid engineering material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements, or a clear polycarbonate material, UV stabilized for outdoor use and comply with UL-94 minimum V-2 requirements.
    - .5 Body and cover shall maintain physical properties through overall temperature range of -35°C to 110°C (-31°F to 230°F).
    - .6 Body shall be an industrial grey colour, and lid shall be either industrial grey or clear.
    - .7 Cover and body shall be free of rough corners, sharp edges, or burrs.
    - .8 Cover shall be mounted to body with integral external non-metallic hinges that shall provide 240° opening.
-

- .9 Cover shall be removable and interchangeable.
- .10 Body shall have integral boss for mounting quick release latches.
- .11 Quick release (lockable) latches shall be available in either non-metallic, or in type 304 stainless steel.
- .12 Cover screws (10-32) shall be captive with a slotted stainless steel (type 304) fillister head.
- .13 Factory installed brass inserts shall be provided for cover (10-32), mounting flanges (1/4-20), and panel mounting (10-32) screws.
- .14 Mounting flanges shall be removable and shall permit vertical or horizontal placement on the body.
- .15 Back panel mounting means shall accept standard size back panels.
- .16 Interior body corners shall have dovetail to permit panel to be mounted at any depth.
- .17 Swing out panel mounts shall be utilized when a second panel is desired, or when access to the rear of the primary panel is desired.
- .18 Hardware kit for adjustable panel mounting shall be available.
- .19 Hardware kit for swing out panel mounting shall be available.
- .20 Enclosure gasket shall be oil resistant continuous closed cell neoprene.
- .21 Enclosure body shall have tapered edges to keep liquids away from cover opening.
- .22 Back panel shall be available in either 14 gauge steel, painted white, or in 7 mm (1/4 in) PVC.
- .23 Enclosure shall be available as factory assembly or as individual components.

## **2.05 Splitter Troughs**

- .1 CSA approved.
  - .2 NEMA 1, formed, factory primed and painted steel box enclosure with knockouts.
  - .3 Hinged front cover plate.
  - .4 Suitable mounting provisions.
  - .5 Nameplate giving its rating.
  - .6 Terminal blocks consist of pressure type main lugs and branch lugs approved for copper wiring and mounted on porcelain bases.
  - .7 Splitter trough ratings are scheduled on the drawings.
-

**3 Execution**

**3.01 Installation**

- .1 Install to CSA C22.1.
- .2 Install devices plumb and level.

**3.02 Cleaning**

- .1 Clean exposed surfaces to remove splatters and restore finish.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Indoor aluminum service poles and installation.

### **1.02 Related Requirements**

- .1 Section 12 59 00 – Systems Furniture.
- .2 Section 27 10 00 – Structured Cabling.

### **1.03 References**

- .1 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM B31, Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, and Structural Profiles for Electrical Purposes (Bus Conductor).

## **2 Products**

### **2.01 Manufacturers**

- .1 Wiremold.
- .2 Hubbell.
- .3 Canadian Electrical Raceways (CER).

### **2.02 Indoor Service Poles**

- .1 Indoor service pole assembly to meet telephone company requirements.
- .2 Indoor service poles: extruded aluminum sections to ASTM, anodized finish of 10 micrometres thickness.
- .3 Nominal length of poles: as required in drawings from floor to ceiling, with plus or minus 50 mm adjustment. Total adjustment: 100 mm.
- .4 Service poles approximately 50 mm square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate power from communication systems.
- .5 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
- .6 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles.
- .7 Service poles with two prewired duplex receptacles, two knockout holes for communication. Cord with moulded set extending 3 m from top of pole.

## **3 Execution**

### **3.01 Installation**

- .1 Install service poles as indicated. Coordinate with drawings.
-

- .2 Install service poles in accordance with manufacturer's recommendations. Secure to ceiling and to finished floor. Adjust length as required. Connect cord to receptacle installed in ceiling space.
- .3 Re-adjust service poles as required after telephone cables are installed.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Switches, receptacles, wiring devices, cover plates, and their installation.

### **1.02 Related Requirements**

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 27 26.13 – Floor Box Assemblies.

### **1.03 Unit Prices**

- .1 Refer to Document 00 43 00.26.
- .2 Submit with Tender unit prices to provide the following. Include installation in the unit price:
  - .1 5-15R duplex receptacle, complete with wiring and conduit, based on 10 metre distance from the local panelboard.
  - .2 5-20R duplex receptacle, complete with wiring and conduit, based on 10 metre distance from the local panelboard.
- .3 Unit cost of additional conduit and wire for the above items.

### **1.04 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 14-13, Industrial control equipment.
  - .4 CSA C22.2 No. 42-10 (R2015), General use receptacles, attachment plugs, and similar devices.
  - .5 CSA C22.2 No. 42.1-13, Cover plates for flush-mounted wiring devices.
  - .6 CSA C22.2 No. 55-15 (R2020), Special use switches.
  - .7 CSA C22.2 No.111-10 (R2015), General-use snap switches.
  - .8 CSA C22.2 No. 182.1-17, Plugs, receptacles, and cable connectors of the pin and sleeve type.

### **1.05 Informational Submittals**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
  - .2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.
  - .3 Submit manufacturer's installation instructions.
-

## 2 Products

### 2.01 Manufacturers

- .1 Eaton.
- .2 Hubbell Bryant.
- .3 Leviton.
- .4 Molex.
- .5 Legrand.

### 2.02 Wall Switches

- .1 Single pole, double pole, three-way, four-way switches to: CSA C22.2 No. 55 and CSA C22.2 No.111.
  - .2 Description: CSA 22.2 No. 111, Commercial Spec Grade, AC only general-use snap switch.
  - .3 Local switches shall be 20 A, silent, brown coloured, AC type and CSA certified, specification grade. Provide switches rated to suit system voltage 120 V or 347 V.
  - .4 Manually-operated general purpose AC switches with following features:
    - .1 Terminal holes approved for 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 Voltage: 120 V or 347 V, AC as indicated.
  - .6 Current: 20 A.
  - .7 Body and Handle: white plastic with toggle handle. Confirm finish colour prior to ordering.
  - .8 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - .9 Example Products (Decorator style):
    - .1 120 V:
      - .1 Hubbell HBL2121 series.
    - .2 347 V:
      - .1 Pass & Seymour 2601-347 series.
  - .10 Example Products (Toggle style):
    - .1 120 V:
      - .1 Hubbell HBL1221 (single pole).
-

- .2 Hubbell HBL1222 (double pole).
- .3 Hubbell HBL1223 (three-way).
- .4 Hubbell HBL1224 (four-way).
- .2 347 V:
  - .1 Hubbell HBL18221 (single pole).
  - .2 Hubbell HBL18223 (three-way).
  - .3 Pass & Seymour PS372030I.
- .11 Local switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

## 2.03 Receptacles

- .1 General
    - .1 Description: CSA C22.2 No. 42, Commercial Spec Grade general use receptacles.
    - .2 Device Body: white plastic.
    - .3 Configuration: Type as specified and indicated.
    - .4 Convenience Receptacle: Type 5-15, 5-20 where indicated.
    - .5 GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
    - .6 Data Room Receptacle Types: As indicated on drawings.
    - .7 Receptacles of one manufacturer throughout project.
  - .2 Receptacles shall be white coloured, specification grade, unless noted otherwise.
  - .3 Receptacles shall be as listed below:
    - .1 15 A, 120 V, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.
    - .2 20 A, 120 V, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA
    - .3 15 A, 120 V, weatherproof receptacles shall be equal to those above but complete with gasketed cast plate and hinged covers.
  - .4 **Other types of receptacles shall be provided as shown on Drawings. Confirm CSA Configuration with Owner prior to installation.**
  - .5 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No. 42 with following features:
    - .1 White urea moulded housing.
-

- .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Break-off links for use as split receptacles.
- .4 Eight back wired entrances, four side wiring screws.
- .5 Triple wipe contacts and riveted grounding contacts.
- .6 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
  - .1 White urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Four back wired entrances, 2 side wiring screws.
- .7 Other receptacles with ampacity and voltage as indicated.
- .8 Example Products (Decorator style duplex 5-15R):
  - .1 Pass & Seymour 26252 Series.
  - .2 Hubbell HBL2152 Series.
- .9 Ground Fault Circuit Interrupter (GFCI or GFI) Receptacles
  - .1 Protected by a ground fault circuit interrupter of the Class A type.
  - .2 Any receptacle within 1.5 m (5 ft) of a sink must be GFCI protected.
  - .3 Any receptacle located outdoor must be GFCI protected.

#### **2.04 Cover Plates**

- .1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.
  - .2 Cover plates from one manufacturer throughout project.
  - .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
  - .4 Stainless steel, vertically brushed, cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
  - .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
  - .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
  - .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
  - .8 Decorative Cover Plate: Polycarbonate.
    - .1 Pass & Seymour TP26W series.
-

- .9 Switch, receptacle, telephone, and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.
- .10 Wet Location and weatherproof devices: receptacles and cover plates shall be suitable for wet locations and provide shielding with and without a plug inserted into the receptacle in accordance with 2021 OESC rule 26-708.
  - .1 Weatherproof Cover Plate: Ultra-rugged polycarbonate and synthetic neoprene rubber:
    - .1 Hubbell ML500GCN series (single-gang):
      - .1 low profile design which expands from 25 mm (1 in) to 75 mm (3 in) for weatherproof protection while an outlet is in use while maintaining the "Extra Duty" ratings.
      - .2 Clear window allows for quick/easy visual inspection.
      - .3 All required gasket and mounting hardware.
      - .4 Pre-configured for GFCI type receptacles.
      - .5 Complete with gaskets to accommodate duplex receptacles or Data outlets.
      - .6 NEMA 3R compliant.
      - .7 Colour: Confirm with the Architect prior to tender.
    - .2 Hubbell ML2450GCN series (2-gang):
      - .1 low profile design which expands from 25 mm (1 in) to 75 mm (3 in) for weatherproof protection while an outlet is in use while maintaining the "Extra Duty" ratings.
      - .2 Clear window allows for quick/easy visual inspection.
      - .3 All required gasket and mounting hardware.
      - .4 Pre-configured for GFCI type receptacles.
      - .5 Complete with gaskets to accommodate quadplex receptacles or Data outlets.
      - .6 NEMA 3R compliant.
      - .7 Colour: Confirm with the Architect prior to tender.
      - .8

## 2.05 Pendant Receptacles

- .1 Pendant cord mounted single receptacles complete with strain relief device.
  - .2 Strain relief system: Hubbell Kellems Grips, Molex, or equal.
-

## **2.06 Receptacle Cord Reels**

- .1 Retractable cable reel, mounted to structure above. 125 V, 5-20R C/W 40 feet of cabtire (or equal).
- .2 Provide framing bracket to support reel at underside of structure above.
- .3 Connect to GFCI breakers.
- .4 Manufacturers:
  - .1 Hubbell HBL-C40-123TT.
  - .2 Woodhead (Molex) 997 series.
  - .3 Approved equal.

## **2.07 Special Wiring Devices**

- .1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel flush type.

## **2.08 Pin and Sleeve Devices**

- .1 Manufacturers:
  - .1 Crouse-Hinds by Eaton.
  - .2 Hubbell.
  - .3 Meltric.
  - .4 Mennekes.
  - .5 Russellstoll (Thomas & Betts).
  - .6 Walther Electric.
- .2 Refer to equipment schedule and plans for locations and specific requirements.

## **2.09 Hazardous (Classified) Location Receptacles**

- .1 In accordance with CSA C22.2 No. 159-18, Plugs, connectors, receptacles, and similar wiring devices for use in hazardous locations.
- .2 Manufacturers:
  - .1 Crouse-Hinds.
  - .2 Appleton Electric.
  - .3 Killark; Division of Hubbell Inc.

## **2.10 Regulatory Requirements**

- .1 Provide products listed and classified by CSA (Canadian Standards Association).
-

### **3 Execution**

#### **3.01 Examination**

- .1 Verify that outlet boxes are installed at proper height.
- .2 Verify that wall openings are neatly cut and will be completely covered by wall plates.
- .3 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

#### **3.02 Preparation**

- .1 Provide extension rings to bring outlet boxes flush with finished surface.
- .2 Clean debris from outlet boxes.

#### **3.03 Installation**

- .1 Install to CSA C22.1.
  - .2 Mounting heights in accordance with Section 26 05 00.
  - .3 Install devices plumb and level.
  - .4 Install switches with OFF position down.
  - .5 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
  - .6 Do not share neutral conductor on load side of dimmers.
  - .7 Install receptacles with grounding pole on bottom.
  - .8 Connect wiring device grounding terminal to outlet box with bonding jumper.
  - .9 Install decorative plates on switch, receptacle, and blank outlets in finished areas.
  - .10 Connect wiring devices by wrapping conductor around screw terminal.
  - .11 Use jumbo size plates for outlets installed in masonry walls.
  - .12 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
  - .13 Switches:
    - .1 Install single throw switches with handle in "UP" position when switch closed.
    - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .14 Receptacles:
    - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
-

- .2 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.
- .4 Receptacles for maintenance of HVAC and similar equipment located on rooftops.
  - .1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 in) above finished roof level, complete with wet location "while in use" "extra duty" cover plate.
  - .2 Locate within 7500 mm (25 ft) of new HVAC equipment, and at least 2000 mm (6.5 ft) away from roof line.
  - .3 Refer to 2021 OESC rules 2-316, 26-708, and 26-710, and OESC bulletin 26-27-0, or latest edition.
- .15 Cover plates:
  - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
  - .4 Do not install plates until final painting of room or area is completed. Remove protective covering.
- .16 Circuit identification: in accordance with Section 26 05 53.

### **3.04 Field Quality Control**

- .1 Inspect each wiring device for defects.
- .2 Operate each wall switch with circuit energized and verify proper operation.
- .3 Verify that each receptacle device is energized.
- .4 Test each receptacle device for proper polarity.
- .5 Test each GFCI receptacle device for proper operation.

### **3.05 Adjusting**

- .1 Adjust devices and wall plates to be flush and level.

### **3.06 Cleaning**

- .1 Clean exposed surfaces to remove splatters and restore finish.

**End of Section**

---

## **1 General**

### **1.01 Summary**

- .1 Section Includes
  - .1 In-slab and poke-through style floor monuments for electrical, communications, and audio/video purposes.
- .2 Related Requirements
  - .1 Section 03 80 00 – Concrete Cutting and Boring.
  - .2 Section 26 27 26 – Wiring Devices.
  - .3 Section 27 15 13 – Communications Copper Horizontal Cabling.

### **1.02 Reference Standards**

- .1 Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
  - .1 CSA C22.2 No. 18.1-13 (R2018) - Metallic outlet boxes (Tri-national standard, with UL 514A and ANCE NMX-J-023/1).

### **1.03 Submittals**

- .1 Submit manufacturer's catalog cuts and specifications for all floor boxes and accessories.

## **2 Products**

### **2.01 Manufacturers**

- .1 Canadian Electric Raceways.
- .2 Hubbell.
- .3 Wiremold (Legrand).
- .4 Wellmark.
- .5 Steel City.

### **2.02 Floor Monuments, General**

- .1 Power: two duplex 5-20R receptacles.
  - .2 Data: up to four voice/data drops.
  - .3 Audio/Video:
    - .1 VGA
    - .2 PC Audio.
    - .3 HDMI
  - .4 Power and Low Voltage Divider.
-

- .5 The monument lid should be flush with the finished floor, and be able to accept a cut-to-fit carpet or vinyl tile.

### **2.03 Floor Boxes**

- .1 Floor Boxes: CSA C22.2 No. 18.1, fully adjustable, 38 mm deep.
- .2 Material: Cast metal.
- .3 Shape: Rectangular.
- .4 Service Fittings: As specified in Section 26 27 26.
- .5 Heavy duty lid.

## **3 Execution**

### **3.01 Coordination**

- .1 Coordinate exact pathways of conduits to suit structural conditions.
- .2 Confirm exact conduit sizes with communications trade.
- .3 Install dedicated conduits for power and data and A/V for each floor box. Do not daisy chain conduits between floor boxes.

### **3.02 Installation**

- .1 Contractor to verify the thickness of the floor and select the through floor component that fits floor thickness.
- .2 Install floor box so that cover plates are flush with top of finished floor.
- .3 The electrical documents shall not be used for the purpose of establishing locations of floor outlets. The location of such outlets shall be established by the Architect.

**End of Section**

---

## **1 General**

### **1.01 References**

- .1 CSA C22.2 No. 248 series.

### **1.02 Submittals**

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Provide fuse performance data characteristics for each fuse type and size above 200 amps. Performance data to include average melting time-current characteristics.
- .3 Shop Drawings:
  - .1 Provide shop drawings in accordance with Section 01 33 00.

### **1.03 Delivery, Storage, and Handling**

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.
- .4 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00.

### **1.04 Maintenance Material Submittals**

- .1 Provide maintenance materials in accordance with Section 01 78 00.
- .2 3 spare fuses of each type and size installed above 600 A.
- .3 6 spare fuses of each type and size installed up to and including 600 A.

## **2 Products**

### **2.01 Manufacturers**

- .1 Bussman by Eaton.
- .2 GEC.
- .3 Littelfuse.
- .4 Mersen.
- .5 Substitutions: not permitted.

### **2.02 Fuses - General**

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
-

- .2 Fuses: product of one manufacturer.
- .3 Fuses shall be sized as shown, time delay type, and of the same type throughout.
- .4 Fuses shall be CSA certified Class-J for 1-600 A or Class-L for 650 A and above.
- .5 Provide the following accessories where indicated or where required to complete installation:
  - .1 Fuseholders: Compatible with indicated fuses.
  - .2 Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for uses with larger ampere ratings.

## **2.03 Fuse Types**

- .1 Class J fuses.
  - .1 Type J1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
  - .2 Type J2, fast acting.
- .2 Class L fuses.
  - .1 Type L1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
  - .2 Type L2, fast acting.
- .3 Class R fuses.
  - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum, to meet UL Class RK1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
  - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

## **2.04 Fuse Requirements**

- .1 Dimensions and Performance: CSA C22.2 No. 248 Series, Class as specified or indicated.
- .2 Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- .3 Power Load Feeder Switches: HRC-1 Class J time delay type.
- .4 Other Feeder Switches: HRC-1 Class J time delay type.

## **2.05 Spare Fuse Cabinet**

- .1 Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.
-

- .2 Doors: Hinged, with hasp for Owner's padlock.
- .3 Finish: Prime finish for field painting.
- .4 Dimensions: Minimum 914 mm by 914 mm by 305 mm (3 ft by 3 ft by 1 ft).

### **3 Execution**

#### **3.01 Installation**

- .1 Install fuses to manufacturer's instructions.
- .2 Install fuse with label oriented such that manufacturer, type, and size are easily read.
- .3 Install spare fuse cabinet in electrical room.
- .4 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used in spare fuse cabinet.
- .5 Confirm fuse selection with Coordination Study.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Molded-case circuit breakers.
- .2 Molded-case switches.
- .3 Accessories.

### **1.02 Related Requirements**

- .1 Section 26 24 13 – Switchboards.
- .2 Section 26 24 16 – Panelboards.

### **1.03 References**

- .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (28th edition/2021).
- .3 CSA C22.2 No. 5-16, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
- .4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.
- .5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

### **1.04 Submittals**

- .1 Submit product data in accordance with Section 01 33 00.
  - .2 Include time-current characteristic curves for breakers with ampacity of 400 A and above, or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.
  - .3 Include termination temperature rating in degrees C.
  - .4 Certificate of Origin
    - .1 Prior to any installation of circuit breakers in either a new or existing installation, Contractor must submit three (3) copies of a certificate of origin from the manufacturer, duly signed by the factory and the local manufacturer's representative, certifying that all circuit breakers come from this manufacturer, they are new and they meet standards and regulations. These certificates must be submitted to the Consultant for review.
    - .2 A delay in the production of the certificate of origin won't justify any extension of the contract and additional compensation.
    - .3 Any work of manufacturing, assembly or installation should begin only after acceptance of the certificate of origin by the Consultant. Unless complying with this requirement, Consultant reserves the right to mandate the manufacturer listed on circuit breakers to authenticate all new circuit breakers under the contract, and that, to Contractor's expense.
-

- .4 In general, the certificate of origin must contain:
  - .1 The name and address of the manufacturer, and the person responsible for authentication. The responsible person must sign and date the certificate;
  - .2 The name and address of the licensed dealer, and the person of the distributor responsible for the Contractor's account.
  - .3 The name and address of the Contractor, and the person responsible for the project.
  - .4 The name and address of the local manufacturer's representative. The local representative must sign and date the certificate.
  - .5 The name and address of the building where circuit breakers will be installed:
    - .1 Project title.
    - .2 End user's reference number.
    - .3 The list of circuit breakers.

## **2 Products**

### **2.01 General**

- .1 Molded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5.
- .2 Bolt-on Molded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Plug-in Molded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .4 Common-trip breakers: with single handle for multi-pole applications.
- .5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .6 Circuit breakers with interchangeable trips.

### **2.02 Interrupting Capacity**

- .1 Protective devices shall be fully rated, for required available fault current. Series rated shall not be used on this installation.
  - .2 Refer to Section 26 24 13, and Section 26 24 16.
-

### 2.03 Molded Case Circuit Breakers – General

- .1 Molded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .2 NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- .3 Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- .4 1-, 2-, or 3-pole bolt on, single-handle common trip voltage as indicated on drawings.
- .5 Overcentre toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
- .6 Calibrate for operation in 40 degree C ambient temperature.

### 2.04 Molded Case Circuit Breakers – Up to 150 Ampere

- .1 Permanent trip unit containing individual thermal and magnetic trip elements in each pole, unless noted otherwise on drawings.

### 2.05 Molded Case Circuit Breakers – 151 to 224Ampere

- .1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

### 2.06 Additional Features

- .1 Provide as indicated on drawings:
  - .1 Shunt trip.
  - .2 Auxiliary switch.
  - .3 Motor-operated mechanism.
  - .4 Under-voltage release.
  - .5 On-off locking device.
  - .6 Handle mechanism.

### 2.07 Molded-Case Switches

- .1 Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
  - .2 Accessories:
    - .1 Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
    - .2 Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
-

**2.08 Enclosed Breakers and Enclosed Molded-Case Switches**

- .1 Molded case, front operated, automatic circuit breakers sized as specified on drawings each secured in a NEMA 1, flush wall mounting enclosure with steel front panel.
- .2 Voltage rating suitable for circuit phase to phase voltage as indicated on drawings.
- .3 Units to include solid state adjustable trip units and contactors. Contactors to be of rating and type to suit application.

**2.09 Circuit Breakers for Existing Distribution Equipment**

- .1 Products to be of types from existing equipment manufacturers.
- .2 Additional breakers for existing panelboards are to match existing device standards and be completely compatible to equipment in which they are installed.
- .3 During Bidding period, check and verify exact requirements of existing equipment to ensure that additional devices are accommodated.
- .4 Make necessary modifications to equipment to accommodate device and feeder installation.
- .5 Provide suitable engraved lamaroid identification nameplate on additional components.
- .6 Revise typed circuit directory cards on branch circuit panelboards.
- .7 Mount additional devices to standards of existing equipment manufacturer.
- .8 Refer to notes on drawings.
- .9 Provide additional retrofit work to existing equipment as noted on drawings.

**3 Execution**

**3.01 Installation**

- .1 Install circuit breakers as per related sections.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 amps to 800 amps.

### **1.02 Related Requirements**

- .1 Section 26 28 13 – Fuses.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 4-16, Enclosed and Dead-Front Switches.
  - .4 CSA C22.2 No. 248 series, Low-voltage fuses.
- .2 NETA (International Electrical Testing Association) ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

### **1.04 Submittals**

- .1 Product Data: Provide switch ratings, and enclosure dimensions.

### **1.05 Closeout Submittals**

- .1 Record actual locations of enclosed switches in project record documents.

## **2 Products**

### **2.01 Manufacturers**

- .1 Eaton Cutler-Hammer.
- .2 Siemens.
- .3 Square D by Schneider Electric.

### **2.02 Regulatory Requirements**

- .1 Products: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

### **2.03 Disconnect Switches**

- .1 Provide dedicated disconnect switches at electrical equipment.
  - .2 Fused or un-fused disconnect or safety switches: Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.
    - .1 Quick-make, quick-break.
-

- .2 Heavy duty industrial type.
- .3 Lockable with up to 3 padlocks.
- .4 Cover interlocked with switch mechanism.
- .5 Viewing window for viewing blades.
- .3 Fused switches equipped with fuse clips designed for Class "J" fuses and designed to reject standard NEC fuses.
- .4 Enclosure: CSA Type 1 sprinkler-proof, or as noted.
- .5 Switches throughout project of same manufacturer.

### **3 Execution**

#### **3.01 Installation**

- .1 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.
- .2 Install disconnect switches complete with fuses, if applicable, to CSA C22.1.
- .3 Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.
- .4 Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40 degree C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

**End of Section**

## **1 General**

### **1.01 Scope**

- .1 The Contractor shall furnish and install a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back up and distribution for critical electrical loads. The UPS shall consist of, as required by the project, the UPS module, battery cabinet(s), and accessory or "option" cabinet(s) for transformers, maintenance bypass, parallel tie, and distribution applications, and other features as described in this specification.

### **1.02 System Description**

- .1 Standard UPS system will include a minimum of (1) rectifier, (1) inverter, (1) static bypass, (1) maintenance bypass, and (1) battery system.
  - .1 Components:
    - .1 Rectifier.
    - .2 Inverter.
    - .3 Sealed Lead Acid Batteries.
    - .4 Battery Charger.
    - .5 Automatic Bypass.
    - .6 User Interface Panel.
    - .7 Serial (RS-232) Communication Interface.
    - .8 Communication Card Slots (2).
    - .9 Remote Emergency Power Off Contacts.
    - .10 Relay Output Contact (1).
    - .11 Environmental Inputs (2).
    - .12 Hardwired Input, Output.
    - .13 Input Isolation Transformer.
    - .14 External Matching Battery Cabinets.
    - .15 Maintenance Bypass Module: External MBP in matching cabinet.
    - .16 SNMP/Web Adapter.
  - .2 Modes of Operation: The UPS shall operate as an online, double-conversion UPS with the following modes:
    - .1 Normal during the Normal or Double-conversion Mode the rectifier shall derive power as needed from the commercial AC utility or generator source and supply filtered and regulated DC power to the online inverter.

The inverter shall convert the DC power to highly regulated and filtered AC power for the critical loads.

- .2 Battery Upon failure of the AC input source, the critical load must continue to be supplied by the inverter without switching. The inverter must obtain its power from the battery. There must be no interruption in power to the critical load upon failure or restoration of the AC input source.
- .3 Recharge Upon restoration of the AC input source, the rectifier/battery charger must recharge the battery. The inverter shall, without interruption of power, regulate the power to the critical load.
- .4 Bypass: The static bypass switch must be used for transferring the critical load to the AC utility supply without interruption. Automatic re-transfer to normal operation must also be accomplished without interruption of power to the critical load. The static bypass switch must be capable of manual operation.
- .5 Maintenance bypass: A wall-mountable maintenance bypass switch is available; however, in the absence of this feature, the integral maintenance bypass switch should be used. The maintenance bypass is used for supplying the load directly from the AC utility supply, while the UPS is isolated for maintenance or repair.

### 1.03 References

- .1 The UPS and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and UL as follows. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.
- .2 Safety
  - .1 IEC 62040-1-1 or EN 62040-1-1.
  - .2 EN 60950.
  - .3 UL 1778.
- .3 Emission and Immunity:
  - .1 EN 50091-2 (Emissions Class A and Harmonics)
  - .2 EN61000-4-2,-3,-4,-5 - Slow high energy surges in input/output lines: 1 kV. line/earth, 0.5 kV line/line (IEC 61000-4-5) - Fast low energy transients in power lines: 2 kV. line/earth (IEC 61000-4-4) - Fast low energy transients (burst) in control and signal lines: 1 kV line/earth (IEC 61000-4-4) - Electrostatic discharge (ESD): 8 kV air discharge, 6 kV contact discharge (IEC 61000-4-2) - Electromagnetic field: IEC 61000-4-3 level 3
  - .3 FCC Class A15J
- .4 Markings
  - .1 UL, ULC, and NOM

#### **1.04 Submittals**

- .1 Submit one copy of a concise operation and maintenance manual.

#### **1.05 Closeout Submittals**

- .1 Submit one copy of a concise operation and maintenance manual.

#### **1.06 Qualifications**

- .1 The manufacturer of the unit shall have a minimum of forty years' experience in the design, manufacture and testing of Uninterruptible Power Supplies.
- .2 For the equipment specified herein, the manufacturer shall be ISO 9001.
- .3 Provide Seismic tested equipment as follows: The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Code (CBC) through zone 4 application.

#### **1.07 Delivery, Storage, and Handling**

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

#### **1.08 Operation and Maintenance Manuals**

- .1 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

### **2 Products**

#### **2.01 Manufacturers**

- .1 Eaton 9355 kVA Series (15kVA basis of design).
- .2 APC by Schneider Electric, MGE Galaxy 3500 Series.
- .3 Emerson Network Power (Liebert) NX Series.

#### **2.02 Regulatory Requirements**

- .1 The UPS shall be CSA certified.

#### **2.03 Ratings**

- .1 System Input:
  - .1 Input Voltage Operation Range
    - .1 120/208V, 3-wire plus ground
    - .2 +10% to -15% from nominal
  - .2 Input Frequency

- .1 45 to 65 Hz.
    - .2 auto-sensing
    - .3 capable of 50 to 60 Hz or 60 to 50 Hz frequency conversion.
  - .3 Input Power Factor: 0.99 typical
  - .4 Input Current Distortion: 5% THD maximum at full rated linear load
  - .5 Inrush Current:
    - .1 < 2x branch rating without input transformer
    - .2 < 5x branch rating with input transformer
  - .6 Surge Protection:
    - .1 Line to Line 180J
    - .2 Line to Ground 450J
  - .2 System Output, Normal Mode -Nominal Output Voltage 208/120 VAC
  - .3 Voltage regulation: +/-2% of selected output voltage in steady state
  - .4 Transient Voltage Response: Meets Class 1 performance of IEC62040-3
  - .5 Voltage THD:
    - .1 2% Total Harmonic Distortion (THD) maximum phase to neutral into a maximum rated linear load (5% phase to phase)
    - .2 5% THD maximum phase to neutral into a maximum rated non-linear load (7% phase to phase)
    - .3 Nominal Frequency: 50 or 60 Hz selectable
    - .4 Frequency Regulation:
      - .1 50/60 Hz +/- 0.5 to +/- 3.0 Hz selectable, synchronized to mains, +/- 0.005 Hz free running single units
      - .2 +/- 0.15 Hz parallel units
    - .5 Slew rate:
      - .1 selectable to 1.0, 2.0, 3.0 Hz/s for single units,
      - .2 < 0.5 Hz/s for parallel units;
      - .3 Generator Mode (6 / 7.5 Hz/s) for single units selectable through software parameters that can be configured via LCD and service PC interface
    - .6 Output Current: Maximum output current (at nominal output voltage) for the UPS shall be:
-

- .1 15 kVA system: 41 A @ 208V.
    - .2 20 kVA system: 55 A @ 208 V.
    - .3 30 kVA system: 83 A @ 208 V.
  - .7 Current Overload Capability without Bypass:
    - .1 125% for 1 min.
    - .2 150% for 5 seconds.
    - .3 >150% for 300 ms.
  - .6 Bypass:
    - .1 Automatic bypass shall provide an alternate path to power in the case of overload, inverter failure or other UPS failure.
    - .2 External Maintenance Bypass can be utilized with the UPS to allow servicing of the UPS.
    - .3 Transfer time to and from any internal bypass shall be no-break.
  - .7 Efficiency: Typical >91% while in normal mode, with nominal line conditions.
  - .8 System Output, Battery Mode:
    - .1 Nominal Output Voltage: This shall be the user-selected output voltage.
    - .2 Voltage Regulation: +/-1% phase to neutral of selected nominal voltage (+/-2% phase to phase).
    - .3 Transient Voltage Response.
    - .4 Meets Class 1 performance of IEC62040-3.
    - .5 +/-5% for 100% step load change; recovery in <1 ms.
    - .6 Voltage THD:
      - .1 2% Total Harmonic Distortion (THD) maximum into a maximum rated linear load
      - .2 5% THD maximum phase to neutral into a maximum rated non-linear load (7% phase to phase)
      - .3 Frequency Regulation: +/-0.005 Hz of selected nominal frequency
    - .7 Overload Capacity:
      - .1 125% for 1 min
      - .2 150% for 5 seconds
      - .3 >150% for 300 ms
-

## 2.04 Construction

- .1 The UPS system is initially provided as a single-module, non-redundant system. The UPS shall be field-upgradeable for power rating (15 kVA to 30 kVA), additional parallel capacity or for redundant operation. The system can be configured with numerous options, including:
  - .1 External Matching Battery Cabinets
  - .2 Several Connectivity Options
  - .3 Wall-mounted Maintenance Bypass Cabinet
  - .4 Wall-mounted Hot-tie Cabinet with Bypass
  - .5 Matching Options Cabinet with:
    - .6 Maintenance Bypass Switch
    - .7 Input Transformer
    - .8 Bypass Transformer
    - .9 Output Transformer
- .2 Converter (rectifier): Incoming power shall be filtered and converted to DC by a sine-wave rectifier. The rectifier corrects the input power factor to 0.99 and draws sinusoidal current (with less than 5% THD) from the utility. In the event of utility failure, the DC-DC converter shall be supplied power without interruption from the internal or external batteries.
  - .1 Overload Capacity: The converter shall be capable of supplying up to 150% of rated load for at least five (5) seconds if no bypass is available.
- .3 Inverter: The inverter converts the DC power from the rectifier or converter to regulated AC power for output to critical loads.
  - .1 Output Voltage: The inverter output voltage is specified in elsewhere in this section.
  - .2 Voltage Regulation: The inverter steady state voltage regulation is +/- 1% phase to neutral, 2% phase to phase. Dynamic regulation meets Class 1 performance of IEC62040-3.
  - .3 Frequency Control: The inverter steady state frequency regulation is +/-0.005 Hz, free running in steady state. UPS is synchronized to Utility in normal operation.
- .4 Mechanical Construction
  - .1 All materials and components of the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state.
  - .2 The UPS unit is comprised of an input rectifier, battery charger, inverter, bypass, and battery consisting of the appropriate number of sealed battery modules, and shall be housed in a single freestanding enclosure. The UPS cabinet shall be

cleaned, primed, and painted with the manufacturer's standard color. Casters and leveling feet shall be provided as standard.

- .3 Option Cabinets match the UPS cabinet, and may contain, input, bypass, or output transformers, and may include a rotary Maintenance Bypass Switch
- .4 Matching external battery cabinets shall be available in different sizes.
- .5 Dimensions of standard UPS and external battery or option cabinets:

## **2.05 System Input and Output Connections**

- .1 AC Input:
  - .1 All UPS units shall be capable of utilizing hardwired input. Input, Bypass, and/or output terminals may be placed in Option cabinets as determined by system configuration. Option cabinets will contain sufficient power cabling to connect to the UPS power terminals when the Option cabinets are placed adjacent to the UPS.
  - .2 Input neutral is required for proper UPS operation unless input transformer option is used.
- .2 AC Output:
  - .1 All UPS units shall be capable of utilizing hardwired output
- .3 Extended Battery Connector: External battery cabinets include cable to connect each battery cabinet to the UPS or daisy chain external battery cabinets.
- .4 Remote Emergency Power Off (REPO) Connection: The UPS shall provide a built-in landing for field connection of a Remote Emergency Power Off circuit. Upon initiation of the REPO circuit, the UPS shall open its input relays, and disengage the battery converter, preventing power from being delivered to the attached loads.
- .5 Serial (RS-232) Communication Interface: A 9-pin sub-D connector shall provide capability for communicating with manufacture-supplied software package. The UPS shall also provide signals for indication of UPS alarm status.
- .6 (2) Communication Card Slots: The UPS shall provide (2) communication X-slots in the back of the UPS allowing for additional connectivity options, including SNMP/Web, AS/400 relays, Modbus/Jbus capabilities, etc.
- .7 (2) Programmable Input Connections: The UPS shall provide built-in inputs for field connection (environmental input). The inputs shall be parameter programmable to suit the needs of the application.

## **2.06 User Interface**

- .1 Front Panel Display: The UPS shall include a front panel display consisting of a graphical LCD display with backlight, four status LED's, and a four-key keypad.
  - .1 Graphical LCD display: Includes basic language (English and local selectable language), display of unit function and operating parameters. It shall be used to signify the operating state of the UPS, for indicating alarms, for changing operations control parameters and set points.

- .2 Four status LED's, which indicate:
  - .1 Alarms, with a red LED
  - .2 On Battery, with a yellow LED
  - .3 On Bypass, with a yellow LED
  - .4 Power On, with a green LED
- .3 Four-Key Multifunction Keypad: UPS shall have keypad to allow user to adjust UPS parameters, view alarm and inverter logs, change UPS operational modes, and turn the UPS on and off.
- .2 Power Management Software Package: The UPS shall include serial communications interface that provides the following communication capabilities:
  - .1 Monitor and graphically display input and output voltage and other operating characteristics
  - .2 Notify end-users in the event of a power anomaly via network, E-mail or page.
  - .3 Communication Ports:
    - .1 Communication Card Slots: The UPS shall provide (2) communication X-slots in the back of the UPS allowing for additional connectivity options, including SNMP/Web, AS/400 relays, Modbus/Jbus capabilities, etc
    - .2 Serial communications (via RS-232) with manufacturer-supplied power management software package

## **2.07 Batteries**

- .1 Battery Type: Valve Regulated Lead Acid (VRLA), minimum two-year warranted float service life at 25 degrees C
  - .2 UPS Holdover Time (Runtime): Each UPS system, consisting of a minimum of six battery strings (108 battery blocks) total run time for 15kVA of 45 minutes at 80% capacity.
  - .3 Extended Holdover Time (Runtime): Each UPS system shall have capability for addition of extra matching battery cabinets (in two cabinet configurations) to increase the total holdover time.
  - .4 Battery Recharge Time:
    - .1 Base UPS system consisting of six (6) battery strings will have a recharge time of max. 1.75 hours to 95% usable capacity @ nominal line after a full load discharge (30 kVA).
  - .5 Bus Voltage: Nominal bus voltage is 216 VDC. Each string consists of 18 battery blocks in series with 9 Ah capacity.
  - .6 Battery Protection:
    - .1 Short Circuit Protection: Over-current protection shall protect the batteries from all short circuit fault conditions
    - .2 Battery Module Protection: Internal battery circuit breaker shall be provided
-

- .3 Under-voltage Protection:
  - .1 Inverter cutoff voltage: Battery operation shall be terminated when the battery voltage drops to the 1.67 VPC set point
  - .2 Protective shutdown voltage: Inverter shall shutdown after 1 minute when the battery voltage drops below 1.7 VPC volts-per-cell typical
- .4 Over-voltage Protection: If the UPS system's battery bus voltage exceeds the predetermined set point then the UPS will disable the charger and alarm a high battery condition
- .7 Advanced Battery Management:
  - .1 Battery recharge: After recharging batteries to full capacity, the charger will enter the rest mode to increase the battery lifetime according the ABM cycle. Hence, continuous float charging of the battery shall not be allowed. The active battery charger states are constant-current (charge mode), constant-voltage (float mode) and no-charge (rest mode).
  - .2 Battery Runtime Monitoring: UPS shall monitor batteries and provide status to end user of battery runtime via front panel, serial communications, or both. Runtime calculations to be based on load demand and analysis of battery health.
  - .3 Battery Health Monitoring: UPS shall periodically test and monitor battery health and provide warnings visually, audibly and/or serially when battery capacity falls below 80% of original capacity. Battery testing may also be user initiated via front panel or serial communications.

## 2.08 Nameplates

- .1 Provide a printed nameplate for each UPS.

## 2.09 Environmental Conditions

- .1 The UPS shall be certified to the following safety standards:
    - .1 EN 62040-1-1, IEC 62040-1-1, EN 60950
  - .2 The UPS shall meet CISPR22 Class A (EN50091-2) for Emissions and EN50091-2 (IEC6100032 for 16 A or less) for Harmonics
  - .3 Audible Noise: Less than 57 dBA (A weighted) at 1 m from all sides in all system modes
  - .4 Ambient Temperature
    - .1 Operating: UPS 0°C to +40°C.
    - .2 Storage: UPS 0°C to +25°C.
  - .5 Relative Humidity
    - .1 Operating: 5 to 95% non-condensing.
    - .2 Storage: 5 to 95% non-condensing.
  - .6 Altitude
-

- .1 Operating: To 3000 m - de-rating or reducing operating temperature range may be required for higher altitudes
- .2 Transit: To 10,000 m.
- .7 Electrostatic Discharge: The UPS shall be able to withstand a minimum 8 kV without damage and without affecting the critical load.

#### **2.10 Source Quality Control**

- .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 NEMA and UL standards.
  - .1 Standard Computer-automated UPS system test.
  - .2 Hipot test.

### **3 Execution**

#### **3.01 Installation**

- .1 Install all equipment per the manufacturer's recommendations.

#### **3.02 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 7 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 (3) copies of the manufacturer's field start-up report.

**End of Section**

## **1 General**

### **1.01 Summary**

#### **.1 Section Includes**

- .1 These specifications describe pertinent material requirements and installation practices for externally mounted, Low Voltage AC Power Panel Surge Protective Devices (SPDs). Furnish and install the SPDs equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings.
- .2 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments (as tested by ANSI/IEEE C62).

#### **.2 Applicability**

- .1 SPDs shall be fully applicable for the purpose of protecting all facility AC electrical circuits from the hazardous effects of transient voltages. These transients may be generated externally by lightning induced energies, utility load factor corrections, and substation switching, or they can be internally generated due to inductive and/or capacitive load switching.

#### **.3 Suitability**

- .1 SPDs shall be suitable for all service entrance switchboards, panelboards and motor control centres as indicated on the electrical layouts and single line diagrams. Products are to be configured for parallel installation - no series designs shall be considered acceptable. Design products to allow installation as a stand-alone device allowing mounting adjacent to switchboards, panelboards, and motor control centres. Installation is to be accomplished by a qualified electrical contractor.

### **1.02 Related Requirements**

- .1 Section 26 24 16 – Panelboards.
- .2 Section 26 28 16.02 – Molded Case Circuit Breakers.

### **1.03 References**

#### **.1 CSA Group:**

- .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 269.2-17 – Surge Protective Devices - Type 2 - Permanently Connected.
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- .2 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE C62.41.1-2002 - IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
  - .2 IEEE C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
  - .3 IEEE C62.45-2002, Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
  - .4 IEEE C62.62-2010, Standard Test Specifications for Surge Protective Devices.
  - .5 IEEE 142-2007, Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book.
  - .6 IEEE 1100-2005, Recommended Practice for Powering and Grounding Electronic Equipment - Emerald Book.
- .3 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA LS-1. Document rescinded in entirety August 19, 2009. No replacement document has been issued.
- .4 Ontario Building Code and its referenced standards.
- .5 Underwriters Laboratories Inc. (UL):
  - .1 ANSI/UL 1449, (4th Edition), Standard for Safety, Surge Protective Devices.
  - .2 UL 1283 (4th Edition) - 2005, Standard for Electromagnetic Interference Filters.
- .6 Other relevant standards:
  - .1 MIL-STD-220C, Method of Insertion-Loss Measurement.

#### 1.04 Definitions

- .1 Surge Protective Device: A device composed of at least one non-linear component and intended for limiting surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs were previously known as Transient Voltage Surge Suppressors (TVSS) or secondary surge arresters.
  - .2 SPD Types:
    - .1 Type 1 – Permanently connected device installed before or after the service disconnect overcurrent device and intended to be installed with no external overcurrent protective device.
    - .2 Type 2 – Permanently connected Type 2 SPDs are intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch panel.
    - .3 Type 3 – Point of use SPDs that are installed with a minimum of 30 feet of conductor length from the service panel. These 30 feet of conductor length does not include conductors used to attach the SPD. Some examples of Type 3 SPDs are cord connected, direct plug-in and receptacle type SPDs.
-

- .4 Type 4 – component assemblies.
- .5 Type 5 – components.
- .3 L-G: measurements from phase to equipment grounding conductor as line terminals of utilization equipment.
- .4 L-L: measurements from phase to phase in a polyphase system, or from one line to another line in a single-phase system.
- .5 L-N: measurement from phase(s) to neutral for both single and three phase systems.
- .6 N-G: measurements from neutral to equipment grounding conductor at line terminal of utilization equipment.
- .7 Externally mounted SPD: Surge Protective Device (SPD) mounted outside of the power panel as a separate component.

#### 1.05 Submittals

- .1 Submit in accordance with Section 01 33 00.
  - .2 Shop Drawings:
    - .1 Line drawings or catalog sheets detailing dimensions and weight of enclosure, lifting and support points, and enclosure details.
    - .2 Internal wiring diagram illustrating all modes of protection in each type of SPD required.
    - .3 Wiring diagram showing all field connections and manufacturer's recommended wire size, recommended circuit breaker or fuse size, required overcurrent protection type, and maximum lead length.
  - .3 Provide the following product data:
    - .1 Voltage Protection Ratings (VPRs), I-nominal ratings, Short Circuit Current Ratings, SPD type designations, dimensions showing construction, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period, and replacement terms.
    - .2 List and detail all protection systems such as fuses, disconnecting means, and protective features.
  - .4 Submit product data for all components and accessories.
  - .5 Manufacturer's Installation Instructions:
    - .1 Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
    - .2 Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
  - .6 Test reports:
-

- .1 Submit cover sheet of test report from a recognized independent testing laboratory certifying compliance with CSA C22.2 No. 269.2.
- .2 Provide verification that the SPD complies with CSA C22.2 No. 269.2.
- .3 Provide spectrum analysis of each unit based on MIL-STD-220C test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds values indicated in this section.
- .4 Documentation verifying Short Circuit Current Rating (SCCR).
- .5 Proof of UL 1283 listing for EMI filters.
- .7 Upon request, present unencapsulated but complete SPD for visual inspection; proprietary technology included. MOV type and quantity shall reflect kA ratings on cut sheets, verification of monitoring, thermal, overcurrent protection, etc.
- .8 Include the following information:
  - .1 Data for each suppressor type indicating conductor sizes, conductor types, and connection configuration and lead lengths.
  - .2 Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.
  - .3 Drawings, with dimensions, indicating SPD mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.
  - .4 List and detail all protection systems such as fuses, disconnecting means and protective materials.
  - .5 Indicate SPD wiring, bonding, and grounding connections on wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.
  - .6 Wiring diagram of SPD diagnostic indicators.

#### **1.06 Closeout Submittals**

- .1 Maintenance data: submit operation and maintenance data, and engineering data for incorporation into manual specified in Section 01 78 00.
- .2 Warranty document.

#### **1.07 Environmental Requirements**

- .1 Operating temperature range: -40 degrees C to 70 degrees C (-40 degrees F to 160 degrees F).
- .2 Elevation: Operation up to 3 658 m (12 000 feet) above sea level.
- .3 Generate no appreciable magnetic fields.

#### **1.08 Delivery, Storage, and Handling**

- .1 Deliver, store, and handle in accordance with Section 01 61 00.
-

- .2 Store materials in dry, secure location and protect from weather.
- .3 Protect from moisture and humidity.
- .4 Store in accordance with manufacturer's written instructions.
- .5 Waste management and disposal in accordance with Section 01 74 00.

#### **1.09 Manufacturer Warranty**

- .1 Five-year warranty.
- .2 Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPD shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. This is, the warranty shall cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

#### **1.10 Manufacturer Qualifications**

- .1 Manufacturer regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Manufacturers requesting product approval must meet or exceed the written specification contained herein. Manufacturers requesting approval must receive written verification of product acceptance by the Consultant ten days prior to the bid date.

#### **1.11 Quality Assurance**

- .1 All SPDs manufactured by a single ISO 9001 registered company normally engaged in the design, development, and manufacture of such devices for electrical and electronic system equipment protection.
- .2 Manufacturer regularly engaged in the manufacture of surge suppression products for the specified categories for minimum of ten years.
- .3 Manufacturer shall offer repair or replacement service for all materials and components incorporated in the Surge Protective Devices.
- .4 Technical assistance (no cost to customer) provided by manufacturer through a factory representative or a local distributor and a factory staffed toll-free technical hotline.
- .5 Manufacturer shall provide a toll-free customer service phone number to facilitate all inquiries regarding product returns, warranty claims, purchasing requirements and payment or credit issues.
- .6 Listed to most recent edition of CSA C22.2 No. 269.2.
- .7 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards.
  - .1 Equipment certification by one of the following bodies:
    - .1 Listed by Underwriters Laboratories, Inc. and exhibit the cUL Listing Mark for the category "Surge Protective Devices" or SPD. Provide UL

Listing Card under category VZCA7 (SPDs certified for Canada) to confirm compliance to CSA C22.2 No. 269.2, and assigned Voltage Protection Ratings.

.2 Listed by ETL.

.3 Certified by CSA Group.

.2 SPD to be labeled with no less than a 100 kA Short Circuit Current Rating (SCCR).

## **2 Products**

### **2.01 Outdated and Defunct Specification Criteria**

.1 Selection of SPD is not be made, solely, or in part, based upon any of the following ambiguous specifications, and obsolete terminology. These terms are no longer recognized by ANSI, NEMA, IEEE, or IEC standards as bonafide suppressor performance parameters. Submittals bearing reference to any of the following will be rejected.

.1 A1 ringwave: removed in 2002 revisions of IEEE C62 documents.

.2 Joule ratings: there is no recognized standard for SPD joule ratings.

.3 NEMA LS-1: document rescinded by NEMA.

.4 Response time: not endorsed by IEEE, NEMA, or UL as a valid SPD rating parameter.

.5 Suppressed Voltage Ratings (SVR): terminology deprecated with UL 1449 third and subsequent editions.

### **2.02 Manufacturers**

.1 Manufacturer List

.1 Asco.

.2 Citel.

.3 Current Technology.

.4 Eaton.

.5 Mersen.

.6 Raycap Electrical Protection Systems.

.7 Siemens.

.8 Total Protection Solutions.

.2 Substitution Limitations: No unit will be accepted as an "approved equal" unless it meets the warranty, strength, safety features, performance ratings, and all other requirements of this specification.

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.3 Product Options:

- .1 The inclusion of a manufacturer in the following list does not indicate the manufacturer meets all the requirements in this specification. Likewise, the omission of a manufacturer is not indicative of any lack of qualification. The manufacturer and product must meet all the requirements of this specification.
- .2 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 pre-approved by the Consultant ten (10) days prior to bid date.

**2.03 Surge Protection Devices – General**

- .1 Obtain all surge suppression devices through one source from a single manufacturer.
  - .2 SPD separate from panelboards. Integral SPDs not acceptable.
  - .3 The SPD listed by recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards, and to UL's 1283 and UL's 1449 standards (latest edition, latest revision), and not merely the components or modules. Label all SPDs as a Type 2 for use in Type 1 and Type 2 locations.
  - .4 Protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N, and N-G, and have bidirectional, positive, and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only four modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
  - .5 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a minimum 100 kA symmetrical fault current with 600 VAC applied.
  - .6 Suppression Components:
    - .1 Metal Oxide Varistors (MOVs).
    - .2 Gas tubes, silicon avalanche diodes, or selenium cells: not permitted.
    - .3 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls, such as through the use of Thermally Protected MOVs (TPMOVs).
    - .4 Where SPD is not equipped with overtemperature controls, pack all surge components, current carrying paths and fusing in fuse grade silica sand or epoxy potting for arc quenching capability, minimization of smoke and contaminants in the event of failure.
  - .7 Internal Fusing - Overcurrent Protection
    - .1 Individually fuse each suppression component for safety and performance.
-

- .2 Fusing shall be present in every mode, including Neutral-to-Ground.
- .3 All overcurrent protection must be included within the device, and not require external overcurrent protection.
- .8 Surge Current Rating
  - .1 Service Entrance: 200 kA per phase.
  - .2 Distribution: 100 kA to 200 kA per phase.
  - .3 Point of Use: 100 kA per phase.
- .9 Short Circuit Current Rating (SCCR), sometimes referred to as fault current rating: minimum 100 kA.
- .10 Nominal Discharge Current (In, or I-nominal):
  - .1 UL labelled with a minimum 10 kA I-nominal.
- .11 Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage (MCOV) of all components not less than 125 per cent for a 120 V system, 120 per cent for 220 and 240 V systems, and 115 per cent for 347 and 600 V systems.
  - .1 277 V systems: 320 V MCOV.
  - .2 480 V systems: 552 V MCOV.
- .12 Voltage Protection Ratings (VPRs) to not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	800 V	800 V	800 V
480Y/277	1200 V	1200 V	1200 V
600Y/347	1500 V	1500 V	1500 V
Voltage	L-L	L-G	
480 Delta	1800 V	1800 V	
600 Delta	2500 V	2500 V	
- .13 Minimum EMI/RFI filtering of -50 dB at 100 kHz.
- .14 SPD enclosure:
  - .1 Minimum NEMA type 12 rating in indoor applications.
  - .2 Minimum NEMA type 4 in outdoor applications.
- .15 Diagnostics and Monitoring:
  - .1 Visual LED diagnostics to indicate failure of a suppression component. Monitor every suppression component of every mode, including N-G.
  - .2 Form C dry contacts (NO or NC) for remote monitoring capability to indicate the failure of any MOV in the unit.

#### 2.04 Service Entrance and Transfer Switch SPDs

- .1 CSA certified and labeled as a Type 2 device.
-

- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 CSA certified listed and labeled with a minimum I-nominal rating of 20 kA.
- .4 An approved disconnect switch provided as a means of service disconnect if a 60 A breaker is not available.
- .5 Connect SPD using the manufacturer's breaker/wire recommendations. If recommendations are not available, use a 60 amp breaker and 6 AWG cable with full size ground.
- .6 Minimum Surge Current Rating: 200 kA per phase (100 kA per mode).

#### **2.05 Distribution Panelboard and Motor Control Centre SPDs**

- .1 CSA certified listed and labeled as a Type 2 device.
- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 CSA certified listed and labeled with a minimum I-nominal rating of 20 kA.
- .4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG with full size ground will be used.
- .5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

#### **2.06 Lighting and Receptacle Branch Circuit Panelboard SPDs**

- .1 CSA certified listed and labeled as a Type 2 device.
- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 CSA certified listed and labeled with a minimum I-nominal rating of 10 kA.
- .4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG will be used.
- .5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

### **3 Execution**

#### **3.01 Pre-Installation Meetings**

- .1 Pre-installation meetings: conduct pre-installation meeting one week prior to commencing work of this Section and on-site installations to verify project requirements, substrate conditions and co-ordination with other building sub-trades, to review manufacturer's installation instructions and warranty requirements.

#### **3.02 Field Quality Control**

- .1 Have manufacturer of products supplied under this Section review Work involved in the handling, installation, application, protection, and cleaning of its products. Submit written

reports in acceptable format to verify compliance of Work with Contract in accordance with Section 01 33 00 and Section 01 78 00.

- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review work at stages listed:
  - .1 After delivery and storage of products, and when preparatory work on which the work of this Section depends is complete, but before installation begins.
  - .2 Twice during progress of work at 66 per cent and 99 per cent complete.
  - .3 Upon completion of the work, after cleaning is carried out.
- .4 Obtain reports within three (3) days of review and submit immediately to the Consultant.

### 3.03 Examination

- .1 Verify service and separately derived system Neutral to Ground bonding jumpers.

### 3.04 Installation

- .1 Do complete installation in accordance with CSA C22.1, CSA C22.2 No. 0, ANSI/IEEE C62.41, and all other applicable codes.
- .2 Manufacturer's instructions:
  - .1 Install SPD in accordance with manufacturer's installation instructions with lead lengths as short and as straight as practically possible. Lead lengths no greater than 600 mm (24 inches). Gently twist conductors together.
  - .2 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions.
- .3 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size, with a 100 A maximum.
- .4 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. Ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .5 Installation position of SPD:
  - .1 Locate SPD adjacent to the panelboard, in a position as close as possible to the neutral and ground lugs. Rearrange breaker positions for SPDs to minimize the length of the phase, neutral, and ground conductors.
  - .2 Mount SPD as close as possible to panel being protected in a position that will minimize lead lengths between suppressor and control breaker(s) to which suppressor connects. Utilize conduit, preferably metallic, to accomplish these connections with a recommended minimum wire size of 10 AWG, a maximum wire size of 4 AWG (for ease of dressing), or as noted on the single line diagram.

Do not extend suppressor leads beyond manufacturer's recommended maximum length without specific engineering approval. The rationale for this is the longer connecting leads between the SPD and the power panel, the higher the residual transient voltage.

- .3 Locate surge suppressors as indicated and mount securely, plumb, true, and square to adjoining surfaces.
- .4 Install surface mounted surge suppressors on fire-retardant plywood backboards as recommended in manufacturer's written instructions. Where practical, group SPDs on common backboard with other equipment.
- .5 Mount housings and enclosures on fire-retardant plywood backboard with top not higher than 1.8 m (6 feet) above finished floor.
- .6 Wiring:
  - .1 Install units on a breaker, sized, where indicated, that meets or exceeds the fault current rating of the switchgear or panelboard.
  - .2 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size. Connect SPD using the manufacturer's breaker/wire recommendations.
    - .1 If recommendations are not available, a 60 A breaker and 6 AWG phase, neutral, and ground conductors will be used.
    - .2 If the SPD is supplied with lead wires, match the overcurrent protection to the 75 degree C ampacity of the wiring as described in Ontario Electrical Safety Code, Table 2; i.e. a 30 A breaker to suit 10 AWG lead wires.
  - .3 Install SPD in a neat, workmanlike manner. Dress leads as short and as straight as possible and be consistent with recommended industry practices for the application on which these units are installed. Bind phase, neutral, and ground conductors tightly (one twist per 30 cm) over entire run, from suppressor to service panel, and always use the shortest length of connecting cable possible.
  - .4 If the SPD is supplied by the manufacturer with lead wires, cut excess lead length.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Solid state, light emitting diode (LED) source interior luminaires.
- .2 New, fully integrated luminaires for indoor applications.

### **1.02 Related Requirements**

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 52 13.13 – Emergency Lighting.

### **1.03 References**

- .1 CSA Group:
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
    - .3 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).
  - .2 DesignLights Consortium (DLC):
    - .1 Solid-State Lighting Technical Requirements v5.1, or latest edition.
    - .2 Where the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.
  - .3 Energy Star:
    - .1 Program Requirements for Luminaires - Eligibility Criteria, Version 1.2, or latest edition.
  - .4 Illuminating Engineering Society (IES):
    - .1 IES HB-10-11 – The Lighting Handbook, 10<sup>th</sup> Edition.
    - .2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
    - .3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
    - .4 IES TM-21-11 – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
    - .5 IES TM-30-15 – IES Method for Evaluating Light Source Color Rendition.
  - .5 IEEE 1789-2015 – IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.
  - .6 National Electrical Manufacturer's Association (NEMA):
-

- .1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.
- .2 WD 6 - Wiring Devices - Dimensional Requirements.

#### **1.04 Definitions**

- .1 CCT: Correlated colour temperature.
- .2 CRI: Colour-rendering index.
- .3 LED: Light Emitting Diode.
- .4 Lumen: Measured output of lamp and luminaire, or both.
- .5 Luminaire: Complete lighting fixture, including ballast housing if provided.

#### **1.05 Action Submittals**

- .1 Refer to Section 01 33 00.
- .2 Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):
  - .1 Maximum power in Watts.
    - .1 If a transformer is used in conjunction with a driver (for example on some 347 volt lighting circuits), the maximum power shall include the transformer losses.
  - .2 L70 in hours, when extrapolated for the worse case operating temperature. TM-21 report shall be submitted to demonstrate this.
  - .3 Product submittals shall be accompanied by performance data that is derived in accordance with appropriate IESNA testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products.

#### **1.06 Informational Submittals**

- .1 Installation instructions.

#### **1.07 Closeout Submittals**

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Submit manufacturer's operation and maintenance instructions for each product.
- .3 Warranty information.

#### **1.08 Qualifications**

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
-

## **1.09 Regulatory Requirements**

- .1 Products shall be listed and classified by CSA (Canadian Standards Association), ULC (Underwriter's Laboratories of Canada), or certified by recognized independent testing organizations that test to CSA standards.
- .2 Products shall be certified by a recognized testing agency accredited by the Standards Council of Canada and bear a certification mark from that agency.
- .3 All luminaires shall be listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.
- .4 Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

## **1.10 Delivery, Storage, and Handling**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

## **1.11 Extra Stock Materials**

- .1 Refer to Section 01 78 00.
- .2 Provide the following additional equipment as listed herein.
  - .1 Provide an additional 2 per cent spare luminaires of each new type to be provided.
  - .2 Provide 1 per cent of each plastic lens type.
  - .3 Provide three of each type of any special tools required for system use and maintenance.

## **1.12 Warranty**

- .1 Refer to Section 01 78 00 and Section 26 05 00.
- .2 The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty shall cover all components comprising the luminaire.
- .3 All warranty documentation shall be provided to customer prior to the first shipment.
- .4 LED Luminaires shall have a manufacturer's warranty for a period of not less than five years.
- .5 LED boards, drivers and associated components shall have a warranty of 5 years on the LEDs, 5 years on the driver, 10 years on the paint finish.

## **2 Products**

### **2.01 Manufacturers**

- .1 As noted on Lighting Fixture Schedule.
-

## 2.02 Indoor LED Luminaires, General

- .1 Initial delivered lumens – thermal losses should be less than 10 per cent when operated at a steady state at an average ambient operating temperature of 25 degrees C, and optical losses should be less than 15 per cent.
  - .2 All luminaires shall be tested per LM79/80 and published L70 data.
  - .3 Colour rendition:
    - .1 Interior luminaires with a CRI greater than or equal to 80, or as indicated on the lighting fixture schedule.
    - .2 Where minimum 90 CRI is indicated, the following may be considered acceptable in lieu, subject to confirmation with the Consultant by means of a Request for Interpretation during the bid period:
      - .1 CRI (Ra)  $\geq$  90.
      - .2 CRI (Ra)  $\geq$  80 and R9 (R9)  $\geq$  50.
      - .3 IES Rf  $\geq$  78, IES Rg  $\geq$  100, -1%  $\leq$  IES Rcs,h1  $\leq$  15%.
  - .4 Correlated colour temperature as indicated on the lighting fixture schedule.
  - .5 Accessibility and Maintenance:
    - .1 All LED luminaires shall be field serviceable, with LED arrays, LED modules, drivers, etc. fully serviceable and easily accessible. In the case of recessed ceiling mounted, and in the case of surface mounted ceiling fixtures, these components must be accessible from below. Luminaires in which any of these components are accessible only from above are not acceptable.
    - .2 Ballasts, drivers, LED arrays, LED modules, and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts or drivers shall not be mounted to removable reflectors or wireway covers unless so specified. In the case of ceiling mounted luminaires, the serviceable components must be accessible from below.
  - .6 Housings:
    - .1 Formed to prevent warping and sagging. Housing, trim, and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
    - .2 Sheet steel housings to be minimum 20 gauge.
    - .3 Wireways and fittings: free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
    - .4 When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
    - .5 Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
-

- .6 Drivers shall not be mounted to removable reflectors or wireway covers unless so specified.
- .7 Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- .8 Metal Finishes:
  - .1 Fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.
  - .2 All metal components of fixtures shall be painted after fabrication to mitigate raw metal edges, and thus prevent premature corrosion.
  - .3 The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
  - .4 Interior light reflecting finishes shall be white with not less than 85 per cent reflectance, except where otherwise shown on the drawing.
- .9 Wiring:
  - .1 Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
  - .2 Supplied complete with a luminaire disconnect plug.
- .10 Control of Visual Perceptions of Temporal Light Modulation (flicker):
  - .1 All electric lights (except decorative lights, emergency lights and other special-purpose lighting) used in regularly occupied spaces meet at least one of the following requirements for flicker:
    - .1 A minimum frequency of 90 Hz at all 10% intervals from 10% to 100% light output.
    - .2 LED products with a "low risk" level of flicker (light modulation) of less than 5%, especially below 90 Hz operation as defined by IEEE standard 1789-2015 LED.

### 2.03 Drivers, General

- .1 Electronic LED drivers shall be integral to the luminaire, and be designed to be accessible in the field for replacement and servicing.
  - .2 Input Voltage:
    - .1 Driver with a voltage range of (120-277) +/- 10% or (347-480) +/- 10%.
    - .2 Refer to lighting fixture schedule.
-

- .3 For luminaires connected to a 347 volt circuit and utilizing a natively 120-277 volt driver, provide an appropriately sized step down transformer.
- .3 Input frequency 60 Hz.
- .4 Load regulation: +/- 1 per cent from no load to full load.
- .5 Output ripple less than 10 per cent.
- .6 Output should be isolated.
- .7 Case temperature: rated for -40 degrees C through +80 degrees C.
- .8 Overheat protection, self-limited short circuit protection and overload protected.
- .9 Primary fused.
- .10 Driver life rating not less than 50 000 hours
- .11 Power Factor and Total Harmonic Distortion
  - .1 Power factor of greater than or equal to 0.9 at full load.
  - .2 THD of less than or equal to 20 per cent at full load.
- .12 Dimming Control:
  - .1 Coordinate with Section 26 09 23.
  - .2 0-10 V dimming control typical for all fixtures unless otherwise noted.
  - .3 Control range: 10 per cent to 100 per cent typical, unless noted otherwise.
  - .4 Provide a mock-up to demonstrate the luminaire is free of flicker throughout the dimming range when used with the dimming controllers described in related sections.

#### **2.04 Downlight Luminaires**

- .1 Minimum Light Output: 500 lm.
- .2 Zonal lumen density: Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Minimum luminaire efficacy: 45 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

#### **2.05 Nominal 610 mm by 610 mm (2 foot by 2 foot) Luminaires for Ambient Lighting of Interior Spaces**

- .1 Minimum Light Output: 2 000 lm.
-

- .2 Zonal lumen density:
  - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Spacing Criteria:
  - .1 0 degrees to 180 degrees: 1.0 to 2.0
  - .2 90 degrees to 270 degrees: 1.0 to 2.0
- .4 Minimum luminaire efficacy: 85 lumens per watt.
- .5 Correlated Colour Temperature (CCT): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

**2.06 Nominal 305 mm by 1220 mm (1 foot by 4 foot) Luminaires for Ambient Lighting of Interior Spaces**

- .1 Minimum Light Output: 1 500 lm.
- .2 Zonal lumen density:
  - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Spacing Criteria:
  - .1 0 degrees to 180 degrees: 1.0 – 2.0
  - .2 90 degrees to 270 degrees: 1.0 – 2.0
- .4 Minimum luminaire efficacy: 85 lumens per watt.
- .5 Correlated Colour Temperature (CCT): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

**2.07 Nominal 610 mm by 1220 mm (2 foot by 4 foot) Luminaires for Ambient Lighting of Interior Spaces**

- .1 Minimum Light Output: 3 000 lm.
  - .2 Zonal lumen density:
    - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
  - .3 Spacing Criteria:
    - .1 0 degrees to 180 degrees: 1.0 – 2.0
    - .2 90 degrees to 270 degrees: 1.0 – 2.0
  - .4 Minimum luminaire efficacy: 85 lumens per watt.
-

- .5 Correlated Colour Temperature (CCT): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

**2.08 Linear Ambient Luminaires: Indirect**

- .1 Minimum Light Output: 500 lm per foot.
- .2 Zonal lumen density:
  - .1 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

**2.09 Linear Ambient Luminaires: Indirect/Direct**

- .1 Minimum Light Output: 500 lm per foot.
- .2 Zonal lumen density:
  - .1 Minimum 25 per cent between 0 degrees and 60 degrees from nadir.
  - .2 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

**2.10 Linear Ambient Luminaires: Direct/Indirect**

- .1 Minimum Light Output: 500 lm per foot.
  - .2 Zonal lumen density:
    - .1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.
    - .2 Minimum 35 per cent between 90 degrees and 150 degrees from nadir.
  - .3 Minimum luminaire efficacy: 85 lumens per watt.
  - .4 Correlated Colour Temperature (CCT): 3500 K
  - .5 Colour Rendition Index (CRI): 80 CRI minimum.
-

- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

#### **2.11 Linear Ambient Luminaires: Direct**

- .1 Minimum Light Output: 375 lm per foot.
- .2 Zonal lumen density:
  - .1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

#### **2.12 High-Bay Luminaires for Commercial and Industrial Buildings**

- .1 Minimum Light Output: 10 000 lm.
- .2 Zonal lumen density:
  - .1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir..
- .3 Minimum luminaire efficacy: 80 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

#### **2.13 Low-Bay Luminaires for Commercial and Industrial Buildings**

- .1 Minimum Light Output: 5 000 lm.
- .2 Zonal lumen density:
  - .1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir.
- .3 Minimum luminaire efficacy: 80 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

#### **2.14 High-Bay Aisle Luminaires**

- .1 Minimum Light Output: 10 000 lm.
  - .2 Zonal lumen density:
-

- .1 Minimum 30 per cent between 0 degrees and 20 degrees from nadir.
- .2 Minimum 50 per cent between 20 degrees and 50 degrees from nadir.
- .3 Minimum luminaire efficacy: 80 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

### **3 Execution**

#### **3.01 Verification of Conditions**

- .1 Coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, piping, steel, etc.

#### **3.02 Installation**

- .1 Install lighting equipment, including but not limited to luminaires, controls, auxiliary devices and the integration of same in strict conformance with all manufacturers' recommendations and instructions the securing of which shall be the responsibility of the Contractor.
  - .2 Integrate luminaires with controls in accordance with respective luminaire manufacturers' and controls manufacturers' recommendations and instructions and to provide a complete, trouble-free operation without compromising safety, code and CSA requirements.
  - .3 Seal all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) as is standard industry practice to prevent water from entering luminaires.
  - .4 Luminaire Alignment:
    - .1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Install recessed luminaires to permit removal from below. Include accessories and materials to meet applicable codes and regulatory requirements.
    - .2 Align luminaires mounted in continuous rows to form straight uninterrupted line.
    - .3 Align luminaires mounted individually parallel or perpendicular to building grid lines.
    - .4 Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
    - .5 Locate and install luminaires as indicated. Mounting heights and configuration of the luminaires shall be as specified in the Luminaire Schedule portion of the Specification or indicated on the drawings, and where conflicts exist, as approved by the Consultant.
    - .6 Installed all luminaires plumb and true and level as viewed from all directions unless specifically identified otherwise in the Lighting Fixture Schedule.
-

Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.

- .7 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system greater than 1/360 of the length of the total span of the ceiling member.
- .5 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- .6 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, use a finishing ring painted to match the ceiling to conceal the junction box.
- .7 Suspended Luminaires:
  - .1 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
  - .2 Suspended luminaires shall be installed plumb and true and level unless specifically identified otherwise in the Luminaire Schedule portion of this Specification and at a height from finished floor as specified on the drawings, details and Luminaire Schedule. In cases where this is impractical, refer to the Consultant for a decision. All appurtenances shall be consistently organized for a neat, uniform appearance.
- .8 Install wall mounted luminaires at height as indicated.
- .9 Accessories:
  - .1 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.
  - .2 Install accessories provided with each luminaire.
  - .3 All accessories shall be properly installed and adjusted by Contractor in accordance with specification and installation instructions. Any spare items shall be clearly labeled (indicate type of accessory and associated luminaire types).

### 3.03 Testing and Adjustment

- .1 As required, all adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Consultant. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.
  - .2 For luminaires with field selectable lumen output and/or CCT, ensure the correct setting matches the intended set points.
  - .3 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.
  - .4 Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.
-

### **3.04 Luminaire Supports**

- .1 Provide adequate support to suit ceiling system.
- .2 Support luminaires independently of ceiling framing, unless ceiling is certified by the manufacturer to support weight of installed devices. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.
- .3 Provide chain hangers for new and existing luminaires.
- .4 Install clips to secure recessed grid-supported luminaires in place.
- .5 Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not acceptable.

### **3.05 Wiring**

- .1 Use SPC90 conductors for final connections to luminaires (including 0-10 V dimming conductors for applicable luminaires).
- .2 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.
- .3 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.
- .4 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .5 Bond products and metal accessories to branch circuit equipment grounding conductor.

### **3.06 Field Quality Control**

- .1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- .2 Make wiring connections to the branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .3 Occupancy Sensors.
  - .1 Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.
  - .2 Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room.
  - .3 Exercise proper judgment in executing the work to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

### **3.07 Cleaning**

- .1 Thoroughly clean all luminaires and accessories after installation. All fingerprints, dirt, tar, smudges, drywall mud, dust, etc. shall be removed by the Contractor from the luminaire
-

bodies, reflectors, trims, and lens or louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.

- .2 Clean electrical parts to remove conductive and deleterious materials.
- .3 Remove dirt and debris from enclosures.
- .4 Clean photometric control surfaces as recommended by manufacturer.
- .5 Clean finishes and touch up damage.
- .6 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.

### **3.08 Commissioning**

- .1 In accordance with Section 26 08 50.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Emergency lighting units with battery back-up for emergency illumination of remote emergency fixtures and internally illuminated exit signs.
- .2 Remote emergency fixtures.

**1.02 Related Requirements**

- .1 Section 26 51 19 – LED Interior Lighting.
- .2 Section 26 52 13.16 – Exit Signs.

**1.03 References**

- .1 CSA Group:
  - .1 CSA C22.2 No. 141-15 (R2020), Emergency lighting equipment.
  - .2 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .3 Ontario Electrical Safety Code (28th edition/2021).
- .2 Ontario Building Code.
- .3 National Building Code of Canada.
- .4 Underwriters Laboratories, Inc. (UL):
  - .1 UL 924 – Standard for Safety of Emergency Lighting and Power Equipment.

**1.04 Submittals**

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish, and limitations.

**1.05 Closeout Submittals**

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

**1.06 Extra Materials**

- .1 Allow the cost for material and for installation of the following to be installed as directed by the Consultant during construction:
    - .1 An additional seven dual head emergency remote units.
-

- .2 An additional two battery unit, based on the maximum battery capacity as specified.

#### **1.07 Quality Assurance**

- .1 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.
- .3 All units will be certified that they have been tested prior to shipping.

#### **1.08 Delivery, Storage, and Handling**

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect emergency lighting from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 00.

#### **1.09 Warranty**

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.
- .3 For batteries in this Section, 12 month warranty period is extended to 24 months.

### **2 Products**

#### **2.01 Emergency Battery Units**

- .1 Manufacturers:
    - .1 Lumacell RG12S series.
    - .2 Aimlite.
    - .3 BeLuce (formerly Beghelli).
    - .4 Emergi-Lite.
    - .5 Lithonia (Acuity Brands Lighting).
-

- .6 Stanpro.
  - .2 Battery Unit Features:
    - .1 Self-contained unit equipment for LED emergency lighting shall be manufactured and labeled as certified to meet CSA C22.2 No 141.
    - .2 Housing: Constructed of formed and welded 18 gauge cold rolled steel with knockouts for conduit, finished in baked white enamel. Cabinet suitable for direct or shelf mounting to wall. Removable or hinged front panel for easy access to batteries.
    - .3 Charger:
      - .1 Solid-state micro-controller PCB, Pulse-Guard charger, features include; auto-equalized, temperature compensated, current limited, short circuit and reverse polarity protected.
      - .2 Recharges battery within 24 hours in accordance with CSA requirements.
    - .4 Transfer: Upon failure of the power supply, or voltage dip below 75 per cent of nominal, a sealed relay automatically and instantaneously connects the battery to the emergency lighting load and disconnects when battery discharge reaches 87.5 per cent expectancy.
    - .5 Batteries: seal lead calcium, maintenance free, and 10 year pro-rated service life.
  - .3 Battery Electrical Features:
    - .1 Input Voltage: 120-347 VAC universal input:
      - .1 Provided with plug and receptacle when connected to 120 volt source panelboard.
      - .2 direct connected to 347 volt source panelboard.
    - .2 Output Voltage: 12 VDC; balance loads to battery unit terminals.
      - .1 Normally "Off" output: wattage capacity as indicated for emergency remotes and internally illuminated exit signs.
      - .2 Battery Run Time at full load: must meet OBC minimum minutes. Confirm OBC requirements with Architect.
      - .3 Voltage regulation:  $\pm 5$  per cent of nominal maximum.
    - .3 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
  - .4 Lamp heads:
    - .1 Integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.
    - .2 Lamp type:
      - .1 Two 12 V, 6 W MR16 LED lamps mounted on top of the battery cabinet, shall be injection molded thermoplastic, white finish.
-

- .2 Average lamp lumens: 170 lm.
- .3 Centre Beam Candlepower: 440 cd.
- .4 Beam angle: 30 degrees.
- .5 Lamp efficacy: 42.5 lm/W.
- .5 Auxiliary equipment:
  - .1 Ammeter.
  - .2 Voltmeter.
  - .3 Test switch.
  - .4 Time delay relay.
  - .5 Battery disconnect device.
  - .6 AC input and DC output terminal blocks inside cabinet.
  - .7 Shelf Bracket.
  - .8 Cord and single twist-lock plug connection for AC.
  - .9 RFI suppressors.
  - .10 Voltage Sensing Relay:
    - .1 Up to six inputs for line voltage detection from different normal lighting zone. The wire connection from each zone circuit shall be made with terminal blocks.
    - .2 Operation Sequence: In the case of power failure of one or several circuits feeding normal lighting, the output circuit will open and transfer the battery unit(s) in emergency lighting mode.
    - .3 Provide "push to test" push button and a pilot light for each zone circuit for manual testing and service.

## **2.02 Voltage Sensing Relay (VSR) Zone Control Stand-Alone Extension Module**

- .1 Manufacturers: Lumacell VSR series (basis of design).
  - .2 The equipment shall have an adequate quantity of inputs (up to 24 inputs) for line voltage detection from different building zones. The wire connection from each zone circuit shall be made with terminal blocks. The output circuit shall be a dry-contact relay, normally closed and shall be accessible for connection on a terminal block. The output circuit shall be connected at installation in series with the AC line supplying the battery unit equipment.
  - .3 Operation Sequence: In the case of power failure of one or several circuits feeding normal lighting, the output circuit will open and transfer the battery unit(s) in emergency lighting mode.
  - .4 Include a "push to test" push button and a pilot light for each zone circuit for manual testing and service.
-

## **2.03 Emergency Lighting Emergency Remote Heads**

- .1 Refer to drawings and lighting schedule.
- .2 One or two lamps, shall be injection molded thermoplastic, white finish, lamps shall be MR16 LED 12 V, 540 lumen, 25 degree beam angle, 6 watt.
- .3 Remote heads to be mounted not less than 2100 mm (6'-10") AFF.
- .4 LED MR16 lamps:
  - .1 Lumacell MQM-x-12V4W-LD10 series.
  - .2 Approved equal by Emergi-Lite.
  - .3 Approved equal by Stanpro.
  - .4 Approved equal by Beghelli.

## **3 Execution**

### **3.01 Examination**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Owner.
  - .2 Inform Owner of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Owner.

### **3.02 Installation**

- .1 Install emergency lighting in compliance with local inspection authorities.
  - .2 Wiring:
    - .1 Connect battery input to source panelboard. Balance the emergency lighting loads connected to battery output terminal blocks. Provide and connect remote fixtures and internally illuminated exit signs as specified and as required for system performance in compliance with OBC minimum egress illumination requirements. Install remotes in locations as shown on the drawings. Connect all remotes to normally "Off" output from battery units.
    - .2 Contractor is responsible for revisions to system, including relocations, aiming and additional remote heads as determined by testing results. All wiring shall be in accordance with manufacturer's recommendations.
    - .3 Use minimum #10 gauge or heavier if needed to provide a maximum voltage drop of 5 per cent. Consult manufacturer's table for sizing the minimum gage and length of wire runs permitted for connected loads to ensure a maximum voltage drop of 5 per cent from the battery unit to the farthest emergency remote, in accordance with OBC and local inspection authorities.
-

- .3 Mounting: Suitable for wall mounting, complete with bracket from manufacturer lighting heads, test switch and diagnostic LED indicator shall be visible.
- .4 Provide Voltage Sensing Relays internal or external to battery units to meet the intent of OESC Rule 46-304 (4). Unit equipment shall be installed in such a manner that it will be automatically actuated upon failure of the power supply to the normal lighting in the area covered by that unit equipment.

### **3.03 Testing and Commissioning**

- .1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.
- .2 Contractor is responsible for arranging and cost of a verification test of emergency illumination levels by the manufacturer's representative.
  - .1 Verification test shall be performed with a lux/footcandle meter at 1 m intervals along all paths of egress throughout the space, and record light level readings on floor plans provided by the consultant.
  - .2 The contractor shall also provide consultant with a letter stating the recorded emergency lighting levels meet the OBC requirements of 10 lx (1 fc) average with minimum readings not less than 1 lx (0.1 fc) on the path of egress.
  - .3 The manufacturer is to provide a letter of verification confirming testing and operation of all emergency lighting as well as installation to all applicable codes.
- .3 Contractor is to indicate in the letter the duration of emergency lighting run time that was observed.
- .4 Testing shall be performed during non-daylight hours. Contractor shall aim all remotes to optimise illumination on the floor and stair.
- .5 Contractor shall certify in writing to the consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.
- .6 Contractor shall notify Owner and consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.
- .7 Installation shall be in accordance to the electrical code and manufacturer's instructions.
- .8 The Contractor is to submit a letter on Contractor's letterhead confirming the criteria specified above is met, including light levels, and run time, and include a copy of the plans with light levels recorded.
- .9 Provide breaker lock on emergency lighting circuit at source panelboard.

### **3.04 Protection**

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

**3.05 Testing, Maintenance, and Warranty Service**

- .1 Provide complete instructions for the operation and care of the emergency power supply or unit equipment that shall specify testing at least once every month to ensure security of operation. Instructions to be framed under glass.
- .2 OBC testing obligations: Owner's facility maintenance personnel are required to document one manual test of the battery units each month, and conduct one full discharge test once a year per OBC and CSA C22.2 No.141 requirements.
- .3 Annual Maintenance: The manufacturer recommends maintenance to be performed by a qualified service provider. Contact the manufacturer for any warranty service.

**End of Section**

## **1 General**

### **1.01 Section Includes**

- .1 Internally illuminated "Running Man" exit sign units for ordinary location use.

### **1.02 Related Requirements**

- .1 Section 26 52 13.13 – Emergency Lighting: Emergency Battery Units.

### **1.03 References**

- .1 CSA Group:
  - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .3 CSA C22.2 No. 141-15 (R2020), Emergency lighting equipment.
  - .4 CAN/CSA-C860-11 (R2020), Performance of Internally Lighted Exit Signs.
- .2 International Organization for Standardization (ISO)
  - .1 ISO 7010:2011 – Graphical symbols – Safety colours and safety signs.
  - .2 ISO 3864-1:2011 – Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs and safety markings
- .3 Ontario Building Code.
- .4 Underwriters Laboratories of Canada (ULC)
  - .1 ULC/ORD-924-02, Standard for Emergency Lighting and Power Equipment.
  - .2 CAN/ULC-S572-10, First Edition Standard for Photoluminescent and Self-Luminous Exit Signs and Path Marking Systems.

### **1.04 Submittals**

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data: Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and maintenance..

### **1.05 Extra Materials**

- .1 Allow the cost for material and for installation of an additional five exit signs, single face or dual face, to be installed as directed by the Consultant during construction. Include 15.24 m (50 feet) of wire and conduit per exit sign.
-

## **1.06 Quality Assurance**

- .1 Exit signs units shall be ULC Listed and/or CSA Certified to CSA C22.2 No. 141 and CSA C860.
- .2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.
- .3 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .4 All units will be certified that they have been tested prior to shipping.

## **1.07 Delivery, Storage, and Handling**

- .1 In accordance with Section 01 61 00.

## **1.08 Waste Management and Disposal**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00.

## **1.09 Warranty**

- .1 Product is warranted free of defects in material and workmanship for a minimum of one year from substantial completion.

# **2 Products**

## **2.01 Exit Signs, General**

- .1 Manufacturers
  - .1 Aimlite.
  - .2 BeLuce (formerly Beghelli).
  - .3 Emergi-Lite.
  - .4 Lithonia (Acuity Brands Lighting).
  - .5 Lumacell.
  - .6 Stanpro.
  - .7 Other manufacturers as indicated in Section 26 52 13.13.
- .2 Substitution Limitations:
  - .1 Manufacturer of exit signs to be the same as manufacturer of emergency lighting battery units and remote heads specified in Section 26 52 13.13.
  - .2 No manufacturer substitutions.
- .3 Description
  - .1 Green and White LED Pictogram "Running Man" exit sign.

- .2 The pictogram sign shall be certified as CSA 22.2 No. 141, and meet ISO 3864-1 and ISO 7010.
- .3 The pictogram legend shall have a minimum illuminated dimension of 5.9" high and 11.13" with ISO 3864-1 and ISO 7010 pictogram printed on a pure-acrylic panel.
- .4 The sign shall include a standard single face with optional double-faceplate included.
- .5 Not acceptable:
  - .1 Red LED EXIT signs.
  - .2 Externally illuminated photoluminescent, or non-electrical radioluminescent type of pictogram signs are unacceptable.
- .4 Mounting
  - .1 The canopy shall universal to allow for wall, end, or ceiling mount.
- .5 Electrical
  - .1 The LED light source shall be long-life white Light-Emitting Diodes and shall provide uniform illumination of the pictogram in normal and emergency operation.
  - .2 The sign shall operate with universal 2-wire AC input voltage of 120 to 347 Vac at less than 3 Watts, and universal 2-wire DC input voltage from 6 to 24 Vdc at less than 2.5 Watts for single and double face legends with a single arrow either left or right.
  - .3 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.
  - .4 The pictogram edge-lit exit sign where indicated on the plans in a self-powered configuration shall use a sealed Nickel-Cadmium battery of 2.4 V nominal voltage and shall stay illuminated during emergency operation for at least two hours upon AC failure.

## **2.02 All-Plastic Pictogram Exit Sign, Commercial Grade**

- .1 Manufacturers
  - .1 Lumacell LP series.
  - .2 Beghelli VE2-RM series.
  - .3 Equivalent products from manufacturers as described in Article 2.01 of this section.
- .2 Materials
  - .1 The sign shall come standard with a canopy and shall be suitable for wall, end, or ceiling mounting. The frame, faceplates, back plate and canopy shall each be constructed of a one-piece UV-stabilized thermoplastic material colored factory white.

## **2.03 Steel Pictogram Exit Signs**

- .1 Manufacturers
  - .1 Lumacell LS series.
  - .2 Equivalent products from manufacturers as described in Article 2.01 of this section.
- .2 Materials
  - .1 The housing assembly shall be constructed of steel in factory white colour.
  - .2 The frame and back plate shall each be of a one-piece steel construction.
  - .3 The faceplate(s) shall be constructed of robust clear poly-carbonate panels with an opaque border coloured factory-white.
  - .4 Each face plate shall come standard with two legend films for pictogram and directional indicators.

## **2.04 Extruded Aluminum Pictogram Exit Signs**

- .1 Manufacturers
  - .1 Lumacell LA series.
  - .2 Beghelli QR-RM series.
  - .3 Equivalent products from manufacturers as described in Article 2.01 of this specification.
- .2 Materials
  - .1 The housing assembly shall be constructed of extruded aluminum in factory white colour.
  - .2 The housing shall be constructed of rugged extruded aluminum and have a maximum depth of 2-1/2".
  - .3 The faceplate(s) shall be constructed of extruded aluminum and shall incorporate a protective clear poly-carbonate panel.
  - .4 Each face plate shall come standard with two legend films for pictogram and directional indicators.

## **2.05 Slim Profile Edge-Lit Pictogram Exit Signs for Surface Mounted Applications**

- .1 Manufacturers
    - .1 Lumacell LAE series.
    - .2 Equivalent products from manufacturers as described in Article 2.01 of this specification.
  - .2 Materials
-

- .1 The housing assembly shall be constructed of extruded aluminum with textured finish and off-white colour.
- .2 The canopy shall be of die-cast aluminum and allow for wall, end, or ceiling mount.
- .3 The legend shall be printed on a pure-acrylic panel.
- .4 The panel shall come standard with double-face legend, for single-face and double-face applications.

## **2.06 Die-Cast Edge-Lit Pictogram Exit Signs for Surface or Recessed Mounting Applications**

- .1 Manufacturers
  - .1 Lumacell LDE series.
  - .2 Equivalent products from manufacturers as described in Article 2.01 of this specification.
- .2 Materials
  - .1 Surface mount:
    - .1 When specified for surface mount, the unit shall come standard with a trim plate, trim ring, back box and canopy made of die-cast aluminum with factory white finish.
    - .2 The trim plate shall have a flat (fully recessed) profile and allow for wall or ceiling mount installation.
  - .2 Recessed ceiling mount:
    - .1 When specified for recessed ceiling-mount, the unit shall come standard with a flat trim plate of die-cast aluminum with factory white finish, a back box of galvanized steel, and a hardware kit for back box installation between ceiling joists. The back box shall be provided with conduit knock-outs at the top, back and end.
  - .3 The legend shall be printed on a pure-acrylic panel.
  - .4 The panel shall come standard with double-face legend, for single-face and double-face applications.

## **2.07 All-Climate, Harsh Environment Pictogram Exit Sign**

- .1 Manufacturers
    - .1 Lumacell LN series
    - .2 Beghelli FTZ-FM series.
    - .3 Equivalent products from manufacturers as described in Article 2.01 of this specification.
  - .2 Materials
-

- .1 The equipment shall be certified for NEMA-4X and designed specifically for high abuse areas, wet location, and cold weather applications.
- .2 The equipment frame shall be of industrial grade polyvinyl chloride with a gasket around lenses and canopy. The faceplate(s) shall be constructed of heavy-duty vandal resistant polycarbonate and feature an even illuminated legend.
- .3 Finish colour: Confirm with Owner prior to placing order.

### **3 Execution**

#### **3.01 Installation**

- .1 Install exit lights to manufacturer's recommendations, listing requirements, CSA standard and local regulatory requirements.
- .2 Ensure exit signs are not obscured. Where an exit sign is to be installed in an area with no ceiling, provide a suitable pendant mount.
- .3 Ensure that emergency lighting circuit breaker is locked in ON position.
- .4 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.

#### **3.02 Field Quality Control**

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

#### **3.03 Cleaning**

- .1 Proceed in accordance with Section 01 74 00.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

#### **3.04 Testing and Commissioning**

- .1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.
- .2 Contractor shall certify in writing to the consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.
- .3 Contractor shall notify owner and consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the owner.
- .4 Installation shall be in accordance to the electrical code and manufacturer's instructions.
- .5 Provide breaker lock on emergency lighting circuit at source panelboard.

#### **3.05 Protection**

- .1 Protect installed products and components from damage during construction.
-

- .2 Repair damage to adjacent materials caused by exit sign installation.

**End of Section**

## **1 General**

### **1.01 Conditions and Requirements**

- .1 Refer to the General Conditions, Supplementary General Conditions, and General Requirements.
- .2 Provisions of this Section shall apply to all Sections of Division 27.
- .3 Refer to Consultant's drawings for exact location of electrical equipment and devices. Refer to Designer drawings for additional notes which complement these specifications.
- .4 The Division 26 specification documents shall be followed in conjunction with the specification in this section.

### **1.02 Related Requirements**

- .1 Division 25 – Integrated Automation.
- .2 Division 26 – Electrical.
- .3 Division 28 – Electronic Safety and Security.

### **1.03 Intent**

- .1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter. Sections of this specification are not intended to delegate functions nor to delegate work and supply to any specific trade. Ensure that the systems specified hereafter are complete and operative.

### **1.04 Reference Standards**

- .1 The equipment, material and installation shall conform to the latest version of the applicable codes, standards (including technical service bulletins and addenda), and regulations of authorities having jurisdiction.
  - .2 BICSI
    - .1 Telecommunications Distribution Methods Manual.
    - .2 BICSI G1-17 – Outside Plant Manual.
  - .3 CSA Group:
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
    - .3 CSA T529 – Commercial Building Telecommunications Cabling Standard (ANSI/EIA/TIA-568-B).
    - .4 CSA T530 – Commercial Building Standard For Telecommunications Pathways And Spaces (TIA/EIA 569-A).
    - .5 CSA T528 – Administration Standard For The Telecommunications Infrastructure Of Commercial Buildings (ANSI/EIA/TIA-606).
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- .6 CSA T527 – Commercial Building Grounding And Bonding Requirements For Telecommunications (ANSI/EIA/TIA-607).
  - .7 CSA C22.2 No. 214 – Communications Cables.
  - .8 CSA C22.2 No. 232-M – Fibre Optic Cables.
  - .9 CSA C22.2 No. 182.4-M90 – Plugs, Receptacles, and Connectors for Communication Systems.
  - .4 TIA
    - .1 TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard
    - .2 TIA/EIA-568-B.2 – Balanced Twisted Pair Cabling Components
    - .3 TIA/EIA-568-B.3 – Optical Fibre Cabling Components Standard
  - .5 ISO
    - .1 ISO/IEC IS 11801A – Generic Cabling for Customer Premises.
  - .6 CENELEC EN 50173 – Performance Requirements for Generic Cabling Schemes.
  - .7 IEC
    - .1 IEC 603-7, PART 7 – Detailed Specification For Connectors, 8-Way, Including Fixed And Free Connectors With Common Mating Features.
    - .2 IEC 807-8 – Rectangular Connectors For Frequencies Below 3 MHz, Part 8: Detailed Specification For Connectors, Four-Signal Contacts And Earthing Contacts For Cable Screens, First Edition.
  - .8 FIPS PUB 174 – Commercial Building Telecommunications Wiring Standard. Federal Information Standard Publication.
  - .9 UL 444 and 13 – Adopted Test and Follow-Up Service Requirements For the Optional Qualification of 100Ω Twisted-Pair (Cables).
  - .10 NEMA WC 63 – Performance Standard For Field Testing Of Unshielded Twisted-Pair Cabling System.
  - .11 ANSI/EIA/TIA
    - .1 ANSI/EIA/TIA-492AAAA – Detailed Specification For 62.5µm Core Diameter / 125µm Cladding Diameter Class 1a Multimode, Graded-Index Optical Waveguide fibres.
    - .2 ANSI/EIA/TIA-492BAAA – Detailed Specifications For Class Iva Dispersion-Unshifted Singlemode Optical Waveguide Fibres Used In Communication Systems.
    - .3 ANSI/EIA/TIA-472CAAA – Detailed Specifications For All Dielectric (Construction 1) Fibre optic Communications Cable For Indoor Plenum Use, Containing Class 1a, 62.5µm Core Diameter / 125µm Cladding Diameter Fibre optic(s).
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- .4 ANSI/EIA/TIA-472DAAA – Detailed Specifications For All Dielectric Fibre optic Communications Cable For Outdoor Plant Use, Containing Class 1, 62.5µm Core Diameter / 250µm Cladding Diameter Fibre optic(s).
- .5 ANSI/EIA/TIA-455 – Test Procedures For Fibre optics, Cables And Transistors.
- .6 ANSI/EIA/TIA-598 – Colour Coding of Fibre Optic Cables.
- .7 ANSI/EIA/TIA-604-3 – FOCIS 3 Fibre Optic Connector Intermateability Standard.
- .8 ANSI/EIA/TIA-606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- .9 ANSI/EIA/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- .12 ANSI Z136.2 – American Standards For The Safe Operation of Fibre optic Communication Systems Utilizing Laser Diode And LED Sources.
- .13 ANSI/CEA
  - .1 ANSI/ICEA S-83-640 – Fibre Optic Outside Plant Communications Cable.
  - .2 ANSI/ICEA S-83-596 – Fibre Optic Premises Distribution Cable.

#### **1.05 Submittals**

- .1 Before delivery to site of any item of equipment, submit shop drawings c/w all data, pre-checked and stamped accordingly, for review to the Consultant. Indicate project name on each brochure or sheet. Submit shop drawings within 1 week after award of contract.

#### **1.06 Record Documentation**

- .1 To Section 01 78 00.
- .2 Red lines, mark-ups by this contractor.

#### **1.07 Operation and Maintenance Manuals**

- .1 Refer to Division 01.

#### **1.08 Inspections**

- .1 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

#### **1.09 Drawings and Specifications**

- .1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Engineer in writing before submitting Tender. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.
  - .2 All drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.
-

- .3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of cabling is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions shall be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.
- .4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.
- .5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
- .6 Before ordering any conduit, cable tray, cables, fittings, etc., this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

#### **1.10 Material**

- .1 This contractor is responsible to ensure that all items submitted meet all requirements of the drawings and specification, and fits in the allocated space. The final determination of a product being acceptable shall be determined by the Engineer.

#### **1.11 Testing Data**

- .1 The contractor shall provide a complete testing report utilizing a testing device as specified in the applicable TIA/EIA standard with the correct adapter and test. All copper tests shall be compliant to the current TIA/EIA standards: Perm Link or Channel.
- .2 The Summary report shall provide be provided to the end user in a universal format so that there is no need to purchase any software to read and print the report.
  - .1 Utilizing Adobe Acrobat is an acceptable manner.

#### **1.12 Painting and Finishes**

- .1 Minor damages to finish on factory finished equipment shall be touched up to the Engineer's satisfaction. Items suffering major damage to finish shall be replaced at the direction of the Engineer. Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

#### **1.13 Safety**

- .1 The Contractor shall be responsible for the safety of his workmen and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations shall prevail.

#### **1.14 Warranty**

- .1 Submit a written performance warranty to the Owner for one year for the complete installation for a period of no less than five years from the date of testing and acceptance. The system warranty shall be based on industry standards.
  - .2 The contractor shall also provide a one year labour warranty on the installation.
-

## **2 Products**

### **2.01 Material Approval**

- .1 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.
- .2 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical Inspection Services, or other government agency.

## **3 Execution**

### **3.01 Workmanship and Contractor's Qualifications**

- .1 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Engineer. Any unsatisfactory workmanship will be replaced at no extra cost.
- .2 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this Specification. This Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all equipment and materials in dry locations.
- .3 Provide foreman in charge of this work at all times.
- .4 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.

### **3.02 Work Sequence**

- .1 Prior to start of each work period in occupied area, temporary protection shall be installed to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.
- .2 Owner's representative shall approve temporary protection plan prior to use.
- .3 Necessary steps shall be taken by contractor to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

### **3.03 Coordination**

- .1 Coordinate work with other trades.
  - .2 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report all necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.
  - .3 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades.
-

Cooperate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other Trades.

### **3.04 Manufacturers' Instructions**

- .1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.
- .2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

### **3.05 Quality Assurance**

- .1 See General Provisions of the Contract.
- .2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.
- .3 The Contractor shall ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
- .4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

### **3.06 Labels and Signs**

- .1 Labelling shall be as per TIA/EIA-606.

### **3.07 Adjust and Clean-Up**

- .1 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this Trade. At the completion of this work, the installation is to be left in a clean and finished condition to the satisfaction of the Engineer.

### **3.08 Tests and Acceptance**

- .1 The operation of the equipment does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfils the requirements of the drawings and the specifications.
  - .2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.
  - .3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that
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work is complete and in perfect operating condition. In the presence of the Owner, the Contractor shall demonstration the proper operation of all miscellaneous systems.

**End of Section**

## **1 General**

### **1.01 Summary**

- .1 This Section covers the Specification and requirements for the grounding and bonding of communications systems and structured cabling infrastructures.
- .2 Contractor shall provide all services, labor, materials, tools, and equipment required for the implementation of a complete and effective grounding and bonding System, as specified this Section.
- .3 Contractor shall comply with all the requirements of Specification, Design Drawings, and all applicable Telecommunications Standards and Electrical Codes.
- .4 Grounding and bonding System shall be designed, engineered, and installed to suit the Client's premises, communications systems, and cabling infrastructure.
- .5 Grounding electrode system refers to all electrodes required by Electrical Code, including, telecommunications system grounding electrodes.
- .6 The terms "connect" and "bond" are used interchangeably in this Specification and have the same meaning.

### **1.02 Definitions**

- .1 AWG – American Wire Gauge – The standardized system for gauging the diameter of round, solid, non-ferrous, electrically-conducting wire.
  - .2 BBC – Bonding Backbone Conductor – A telecommunications bonding connection which interconnects telecommunications bonding backbones. Formerly known as the grounding equalizer.
  - .3 BN – Bonding Network – A set of interconnected conductive structures that provides a low impedance path for the associated telecommunications infrastructure.
  - .4 EF – Entrance Facility – An entrance to a building for both public and private network service cables, including wireless, that includes the entrance point of the building and continues to the entrance room or space.
  - .5 ESD – Electrostatic Discharge – The sudden flow of electricity between two electrically-charged objects caused by contact, an electrical short, or dielectric breakdown.
  - .6 Mesh-BN – Mesh Bonding Network – A bonding network to which all associated equipment, such as cabinets, frames, racks, trays, and pathways, are connected using a bonding grid that is connected to multiple points on the common bonding network.
  - .7 PBB – Primary Bonding Busbar – A busbar placed in a convenient and accessible location and bonded, by means of the Telecommunications Bonding Conductor (TBC), to the building's service equipment (power) ground. Formerly known as the Telecommunications Main Grounding Busbar (TMGB).
  - .8 RBB – Rack Bonding Busbar – A busbar within a cabinet, frame, or rack.
  - .9 RBC – Rack Bonding Conductor – A bonding conductor from the rack or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).
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- .10 SBB – Secondary Bonding Busbar – A common point of connection for telecommunications system and equipment bonding to ground, located in the distributor room. Formerly known as the Telecommunications Grounding Busbar (TGB).
- .11 TBB – Telecommunications Bonding Backbone – The conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).
- .12 TBC – Telecommunications Bonding Conductor – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground. Formerly known as the bonding conductor for telecommunications.
- .13 TEBC – Telecommunications Equipment Bonding Conductor – A conductor that connects the Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) to equipment racks or cabinets.
- .14 TR – Telecommunications Room – An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling. It is the recognized location of the cross-connect between the backbone and horizontal facilities.
- .15 UBC – Unit Bonding Conductor – A bonding conductor from equipment or a patch panel to a Rack Bonding Conductor (RBB) or a Rack Bonding Busbar (RBB).

### 1.03 References

- .1 Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this Specification to the extent referenced. Publications are referenced in the text by the basic designation only.
  - .2 American Society for Testing and Materials (ASTM):
    - .1 ASTM-B1-13(2018) – Standard Specification for Hard-Drawn Copper Wire.
    - .2 ASTM B8-11(2017) – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - .3 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - .1 IEEE 81-2012 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
  - .4 Canadian Standards Association (CSA):
    - .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
    - .2 Ontario Electrical Safety Code (28th edition/2021).
  - .5 Telecommunications Industry Association (TIA): Latest Revision of Standards
    - .1 TIA-606 – Administration Standard for Telecommunications Infrastructure
    - .2 TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
  - .6 BICSI:
    - .1 Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria – Latest Revision
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- .2 Telecommunications Distribution Methods Manual (TDMM) – Latest Revision
- .7 Underwriters Laboratories, Inc. (UL):
  - .1 UL 44 (19th Edition, 2018) – UL Standard for Safety Thermoset-Insulated Wires and Cables.
  - .2 UL 83 (16th Edition, 2017) – UL Standard for Safety Thermoplastic-Insulated Wires and Cables.
  - .3 UL 467 (11th Edition, 2022) – UL Standard for Safety Grounding and Bonding Equipment.
  - .4 UL 486A-486B (3rd Edition, 2018) – UL Standard for Safety for Wire Connectors.
- .8 International Annealed Copper Standard (IACS)

#### **1.04 Submittals**

- .1 Submit in accordance with Section 01 33 00 and Section 27 05 00.
- .2 Action Submittals: Product Data for each type of product (PBB, SBB, RBB, 2-Hole Lugs, etc.)
- .3 Shop Drawings:
  - .1 Sufficient information, clearly presented, shall be included to determine compliance with latest TIA-607 Standard and this Specification.
  - .2 Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

#### **1.05 Closeout Submittals**

- .1 Submit closeout documents in accordance with Section 27 05 00.
- .2 As-Built Data: Submit plans showing as-built locations of grounding and bonding infrastructure, including the following: PBB, SBB, RBB and routing of their bonding conductors.
- .3 Test Reports: Provide test reports of ground resistance to each primary or secondary bonding busbar (PBB/SBB) located in each telecommunications space impacted by the work.

### **2 Products**

#### **2.01 Manufacturers**

- .1 Hubbell.
  - .2 nVent Erico.
  - .3 Panduit.
  - .4 Thomas & Betts.
-

## 2.02 General Requirements

- .1 Contractor shall provide a comprehensive and effective telecommunications grounding and bonding infrastructure for the protection of personnel and equipment, in compliance with the current Canadian Electrical Code, the latest TIA-607 Standard, and all applicable codes of Authority Having Jurisdiction (AHJ).
- .2 Grounding and bonding infrastructure shall follow the latest TIA-607 design methodology, whereby within a building the generic telecommunications bonding infrastructure originates at the facility's electrical entrance ground and extends throughout the building. The infrastructure shall comprise the following major components:
  - .1 Primary bonding busbar (PBB).
  - .2 Telecommunications bonding conductor (TBC).
  - .3 Telecommunications bonding backbone (TBB).
  - .4 Secondary bonding busbar (SBB).
  - .5 Backbone bonding conductor (BBC).
- .3 All cables shall be plenum rated FT6.
- .4 External Grounding Electrodes:
  - .1 The grounding electrode system shall be designed to have a resistance to earth of 25 ohms or less for a single grounding electrode.
  - .2 For sites that are critical in nature (e.g., public safety facilities, military installations, data centers, web hosting facilities, central offices) the grounding electrode system shall be designed to have a resistance of less than 10 ohms – ideally less than 5 ohms.

## 2.03 Bonding Busbars

- .1 Bonding busbars shall be provided in each telecommunications space (room/closet) and in each equipment rack/cabinet, as specified in this Section. Bonding busbars shall provide connection or termination points for the telecommunications space's bonding conductors.
- .2 The types of bonding busbars specified in the infrastructure comprise:
  - .1 Primary Bonding Busbar (PBB).
  - .2 Secondary Bonding Busbar (SBB).
  - .3 Rack Bonding Busbar (RBB).

## 2.04 Primary Bonding Busbar (PBB)

- .1 The PBB shall be placed in a convenient and accessible location in the telecommunications entrance room or space. Typically, there should be a single PBB per building.
  - .2 The PBB shall be bonded, by means of the telecommunications bonding conductor (TBC), to the building's service equipment (electrical) ground.
-

- .3 The PBB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. It also serves as the central attachment point for the Secondary Bonding Busbars (SBB) through the Telecommunications Bonding Backbone (TBB).
- .4 The PBB shall be:
  - .1 Pre-drilled with mounting holes to accommodate matched listed lugs and hardware.
  - .2 Made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
  - .3 Of minimum dimensions of 6.35 mm (0.25 in) thick x 100 mm (4 in) wide and variable in length to accommodate design requirements.
  - .4 UL Listed.
  - .5 Cleaned with an antioxidant applied prior to fastening connectors to the busbar.
  - .6 Insulated from its support using an insulator that is listed for the purpose by a nationally recognized testing laboratory (NRTL).
  - .7 Installed a minimum of 50 mm (2 in) from the finished wall to allow access to the rear of the busbar.
  - .8 Sized for current applications and future growth.
- .5 The primary protector grounding conductor shall be connected to the PBB. This conductor is intended to conduct lightning and AC fault currents from the telecommunication primary protectors.

## **2.05 Secondary Bonding Busbar (SBB)**

- .1 The SBB shall be placed in a convenient location of the telecommunications room/closet. The SBB shall form a common bonding connection point for telecommunications systems and equipment in the area served by the telecommunications room/closet.
  - .2 The SBB shall be:
    - .1 Pre-drilled with mounting holes to accommodate matched UL Listed lugs and hardware.
    - .2 Made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
    - .3 Of minimum dimensions of 6.35 mm (0.25 in) thick x 50 mm (2 in) wide and variable in length.
    - .4 cUL Listed.
    - .5 Cleaned with an antioxidant applied prior to fastening connectors to the busbar.
    - .6 Insulated from its support using an insulator that is listed for the purpose by a nationally recognized testing laboratory (NRTL).
    - .7 Installed at a minimum of 50 mm (2 in) from the finished wall to allow access to the rear of the busbar.
-

- .8 Sized for current applications and future growth.

## **2.06 Rack Bonding Busbar (RBB)**

- .1 The RBB is a grounding busbar within a cabinet, rack, or frame.
- .2 The RBB shall be provided in cabinets and racks that support multiple equipment bonding conductors to serve as an extension of the PBB or SBB for the equipment in the cabinet.
- .3 The RBB shall meet the following requirements:
  - .1 Manufactured from copper alloy.
  - .2 cUL Listed.
  - .3 Horizontal Busbars shall be at least 19 mm (0.75 in) wide, 483 mm (19 in) long, and 5 mm (0.1875 in) thick.
  - .4 Have a minimum of 14, factory–provided #12–24 threaded holes.
  - .5 Have pre–punched EIA 310 D standard rack mounting holes.
  - .6 Vertical Busbars shall be at least 17 mm (0.67 in) wide, 2 m (78.65 in) long, and 1.27 mm (0.05 in) thick, and shall come in threaded rail and cage nut versions.

## **2.07 Bonding Conductors**

- .1 The following common requirements apply to all types of bonding conductors specified in this Section:
  - .1 All bonding conductors shall be made of stranded copper wire with a green jacket (or per CE Code depending on size), run as a continuous conductor.
  - .2 Bonding conductors may be insulated. If insulated they shall be cUL Listed for the application.
  - .3 Bonding conductors shall be protected from physical and mechanical damage.
  - .4 Bonding conductors shall be sized to meet the ANSI/TIA-607-D requirements.
- .2 Telecommunications Bonding Backbone (TBB)
  - .1 The TBB is a conductor that bonds the Secondary Bonding Busbars (SBB) to the Facility's Primary Bonding Busbar (PBB).
  - .2 The TBB shall meet the following requirements:
    - .1 The TBB shall be sized to meet the requirements of ANSI/TIA-607-D and shall be as straight as practicable avoiding bends. The TBB minimum conductor size shall be AWG 6.
    - .2 Bonding and grounding conductors may be insulated or un–insulated and shall not decrease in size as the grounding path moves closer to earth.
    - .3 Connections (bonds) between the telecommunications grounding network and associated electrical panels shall be done by a qualified

electrician in accordance with guidelines in the latest TIA-607 and applicable electrical codes.

- .4 Bonding Conductors should be continuous (splices not allowed) and routed in the shortest possible straight-line path, avoiding changes in elevation and sharp bends.
- .5 TBB grounding conductors routing through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized conduit grounding clamps as described TIA-607.
- .6 Bonding the TBB to the PBB and each SBB shall be performed with a UL listed irreversible compression (crimp) dual-lug connector.
- .7 Metallic cable shield(s) and cabling pathways, including metallic conduits, shall not be used as a TBB.
- .8 Whenever two (2) or more TBBs are used within a multistory building, the TBBs shall be bonded together with a BBC at every third floor as a minimum, and at the top floor.
- .9 Conductor sizing depends upon the Project specification, and shall be determined based on the TBB length as stipulated in TIA-607. Contractor shall ensure TBB sizing complies with the TIA-607 guidelines outlined in the Table below:

<u>Sizing of the TBB</u>	
<u>TBB Length in Linear Meters (Feet)</u>	<u>TBB Size (AWG)</u>
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil

<u>Sizing of the TBB</u>	
<u>TBB Length in Linear Meters (Feet)</u>	<u>TBB Size (AWG)</u>
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

.3 Telecommunications Bonding Conductor (TBC)

- .1 The TBC connects the telecommunications bonding infrastructure to the building's service equipment (power) ground (formerly known as the bonding conductor for telecommunications).
- .2 The TBC shall have at a minimum the same size as the largest TBB.
- .3 The TBC shall bond the PBB to the service equipment (power) ground.

.4 Backbone Bonding Conductor (BBC)

- .1 The BBC (formerly known as the grounding equalizer) is a bonding conductor which interconnects telecommunications bonding backbones.
- .2 The BBC shall have at a minimum the same size as the largest TBB to which it is bonded.

.5 Telecommunications Equipment Bonding Conductor (TEBC)

- .1 The TEBC is a bonding conductor which connects the cabinets and racks in a telecommunications room/closet to the local primary or secondary bonding busbar (PBB or SBB).
- .2 The TEBC shall have a minimum size of AWG 6.
- .3 Metallic objects and pathways shall not be used as a replacement for the TEBC.
- .4 The TEBC may be routed inside cable trays. It shall be secured at maximum intervals of 0.9 m (3 ft).
- .5 The TEBC shall be separated a minimum of 50.8 mm (2 in) from other cable groups, such as power or telecommunications cables.
- .6 The TEBC shall be connected to the cabinets/racks, to a Rack Bonding Conductor (RBC) or to a vertical/horizontal Rack Bonding Busbar (RBB).
- .7 Connections to the TEBC shall be made with UL Listed irreversible compression connectors, suitable for multiple conductors, and with the rack bonding conductors (RBCs) routed toward the PBB/SBB.

.6 Rack Bonding Conductor (RBC)

- .1 The RBC is a bonding conductor from the cabinet or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).
  - .1 The RBC shall have a minimum size of AWG 6.

- .2 The RBC shall be bonded to the Telecommunications Equipment Bonding Conductor (TEBC) using UL Listed irreversible compression (crimp) connectors.
  - .1 Where connected to a server cabinet, the RBC extends to the bottom of the server cabinet allowing Equipment Bonding Conductors to be attached at any point in the cabinet.
  - .2 Where connected to a network rack/cabinet, the Rack Bonding Conductor (RBC) is bonded to the Rack Bonding Busbar (RBB) via a UL Listed two-hole compression lug.
- .2 Unit Bonding Conductor (UBC)
  - .1 The Unit Bonding Conductor (UBC) connects individual equipment in a cabinet or rack to the Rack Bonding Conductor (RBC) or Rack Bonding Busbar (RBB).
  - .2 The UBC shall also be used for bonding cable tray sections to the Telecommunications Equipment Bonding Conductor (TEBC).
  - .3 The UBC shall have a minimum size of AWG 6.
  - .4 Bonding.
    - .1 Where used in a server cabinet, UBC shall be bonded to the Rack Bonding Connector (RBC) using UL Listed irreversible compression (crimp) connectors and to IT equipment via a UL Listed two-hole compression lug. (Some IT equipment may require one-hole lugs.)
    - .2 Where used in a network cabinet/rack, UBC shall be bonded to the Rack Bonding Busbar (RBB) via a UL Listed two-hole compression lug and to IT equipment via a UL Listed two-hole compression lug. (Some IT equipment may require one-hole lugs.)
    - .3 Where used as a cable tray bonding conductor connecting cable tray sections, UBC shall be bonded to each adjoining section of the cable tray using UL Listed two-hole compression lugs.
    - .4 Where used as a cable tray bonding conductor connecting cable tray sections to the Telecommunications Equipment Bonding Conductor (TEBC), UBC shall be bonded to the TEBC using UL Listed irreversible compression (crimp) connectors and to the cable tray via a UL Listed two-hole compression lug.

### **3 Execution**

#### **3.01 General**

- .1 Ground in compliance with the CE Code, the latest TIA-607 Standard, and as specified in this Section and the Drawings.
  - .2 Components of the telecommunications bonding system shall be installed and connected using materials and techniques as specified in the latest TIA-607 Standard.
-

- .3 Follow equipment manufacturer's grounding instructions.

### **3.02 Examination**

- .1 Contractor shall check the AC grounding electrode system and equipment grounding for compliance with the requirements for maximum ground-resistance level, and other conditions affecting performance of grounding and bonding of the telecommunications system.
- .2 Inspect the test results of the AC grounding system.
- .3 Prepare written report listing all conditions detrimental to the performance of the Work.
- .4 Proceed with Work only after unsatisfactory conditions have been corrected.

### **3.03 Corrosion Inhibitors**

- .1 When making ground and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- .2 PBB and SBB shall always have tinned surfaces to restrain oxidation and shall be cleaned and have an antioxidant paste applied to both bonding surfaces prior to fastening conductors.

### **3.04 Telecommunications System Grounding**

- .1 Bond the telecommunications grounding system to the electrical grounding electrode system.
  - .2 Provide dedicated telecommunications grounding busbars for the following locations/spaces:
    - .1 Telecom entrance facility rooms
    - .2 Server rooms
    - .3 IT rooms/closets
  - .3 Provide bonding to all telecom cabinets, racks, metallic cable shields, junction/pull boxes, enclosures, and communications/security equipment, as required by Standards and Code.
  - .4 Provide bonding to all metallic cable trays and conduits to building ground.
  - .5 Bond incoming carrier armor sheath to building ground.
  - .6 Furnish and install all busbars and bonding conductors required to properly ground and bond all communications raceways, cable trays, metallic cable shields, and equipment, in compliance with design, Codes and Standards.
  - .7 Bonding jumpers/conductors shall be continuous with no splices. Use the shortest possible length of bonding jumper.
  - .8 Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.
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- .9 Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding conductors, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- .10 Bonding Conductors:
  - .1 Use insulated ground wire of the size and type shown on the Drawings or use a minimum of #6 AWG insulated copper wire.
  - .2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
  - .3 Use compression connectors of proper size for the specified conductors. Use connector manufacturer's compression tool.
- .11 Bonding Jumper Fasteners:
  - .1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
  - .2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
  - .3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
  - .4 Strut Channel and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

### **3.05 Raceway Grounding**

- .1 Conduit: Use insulated #6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- .2 Cable Tray: Use insulated #6 AWG bonding jumpers to ground metallic cable tray at:
  - .1 Each end
  - .2 All intermediate metallic enclosures/boxes
  - .3 All cable tray section junctions

### **3.06 Identification and Administration**

- .1 Provide complete grounding system labeling in accordance with the requirements of:
    - .1 ANSI/TIA-606, Latest Revision.
    - .2 Section 27 05 53 – Identification for Communications Systems.
-

- .2 Primary Bonding Busbar (PBB): Label with "PBB".
- .3 Secondary Bonding Busbar (SBB): Label with "SBB".
- .4 Telecommunications Bonding Backbone (TBB): Label with "WARNING! TELECOMMUNICATIONS BONDING BACKBONE. DO NOT REMOVE OR DISCONNECT" Labels shall be affixed at both ends and at accessible intermediate points.

### **3.07 Testing**

- .1 Perform tests as specified in BICSI Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.
- .2 Perform two-point bond testing to be performed by qualified technicians.
- .3 Conduct continuity tests to verify that all metallic pathways and pathway sections are bonded to PBB or SBB.
- .4 Conduct electrical continuity test to verify that PBB is effectively bonded to the facility grounding electrode conductor.
- .5 Perform resistance tests to ensure rack and cabinet bonding connection resistance measures less than 4  $\Omega$  to PBB or SBB.
- .6 Provide a complete test report to Consultant and Owner.

**End of Section**

## 1 General

### 1.01 Summary

- .1 Provide a complete system of empty conduit, pull boxes, outlets, and sleeves for enclosure of communications cabling.

### 1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

### 1.03 References

- .1 BISCI Telecommunications Distribution Methods Manual, 14th Edition.

### 1.04 Closeout Submittals

- .1 Record documentation:
  - .1 Records of underground utility locates.
  - .2 Record as-constructed location of all underground conduits and telecommunications pathways on as-built drawings regardless of conduit size.

## 2 Products

### 2.01 Outlets

- .1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.
- .2 Provide 53 mm conduit through walls as noted.

### 2.02 Conduits

- .1 Conduit size shall be in accordance with recommended standard for conduits in Building as published by BICSI.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

<u>Maximum conduit size</u>	<u>Size of pull boxes in millimetres</u>			<u>For each additional conduit size increase width by:</u>
	<u>Width</u>	<u>Length</u>	<u>Depth</u>	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .4 Plenum cables are permitted in accessible ceilings. Provide 'J' hooks in these locations for later cable installation.

- .5 Provide plywood backboards, shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
- .6 Provide a minimum of two 5-20R duplex receptacles on separate circuits at each backboard.

### 3 Execution

#### 3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 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 3.2 mm (1/8") nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
- .3 Conduit 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 m in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

<u>Maximum conduit size</u>	<u>Size of pull boxes in millimetres</u>			<u>For each additional conduit size increase width by:</u>
	<u>Width</u>	<u>Length</u>	<u>Depth</u>	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by future installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

**End of Section**

## 1 General

### 1.01 Summary

- .1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlets for enclosure of wiring by Security Contractor.

### 1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

## 2 Products

### 2.01 Outlets

- .1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted. Coordinate with Security Contractor.

### 2.02 Conduits

- .1 Provide conduit in all walls, exposed areas, and inaccessible ceilings. All conduit work shall be concealed.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Provide J hooks in accessible ceilings for plenum rated wiring.
- .4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

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

## 3 Execution

### 3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 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 3.2 mm (1/8") nylon pull cord 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 m in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

<u>Maximum conduit size</u>	<u>Size of pull boxes in millimetres</u>			<u>For each additional conduit size increase width by:</u>
	<u>Width</u>	<u>Length</u>	<u>Depth</u>	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

**End of Section**

## 1 General

### 1.01 Summary

- .1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes, and outlet boxes for enclosure of cabling by Owner under a separate contract.

### 1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

## 2 Products

### 2.01 Video Surveillance Equipment by Owner

- .1 Video Surveillance equipment shall be based on IP cameras. Size conduits based on industry practices based on Category 6 communications cabling.

### 2.02 Outlets

- .1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted. Coordinate with the Owner's video surveillance contractor.

### 2.03 Conduits

- .1 Provide conduit in all walls, exposed areas, and inaccessible ceilings. All conduit work shall be concealed.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Provide J hooks in accessible ceilings for plenum rated wiring.
- .4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

<u>Maximum conduit size</u>	<u>Size of pull boxes in millimetres</u>			<u>For each additional conduit size increase width by:</u>
	<u>Width</u>	<u>Length</u>	<u>Depth</u>	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
  - .6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.
-

### 3 Execution

#### 3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 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 3.2 mm (1/8") nylon pull cord 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. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

<u>Maximum conduit size</u>	<u>Size of pull boxes in millimetres</u>			<u>For each additional conduit size increase width by:</u>
	<u>Width</u>	<u>Length</u>	<u>Depth</u>	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

**End of Section**

## **1 General**

### **1.01 Summary**

- .1 The work covered under this section consists of the furnishing of all necessary labour, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports ("J-Hooks") as described in this specification.

### **1.02 Scope**

- .1 Non-continuous cable supports.
- .2 Adjustable non-continuous cable support sling.
- .3 Multi-tiered non-continuous cable support assemblies.
- .4 Non-continuous cable support assemblies from tee bar.
- .5 Non-continuous cable support assemblies from drop wire/ceiling.
- .6 Non-continuous cable support assemblies from beam, flange.
- .7 Non-continuous cable support assemblies from C & Z Purlin.
- .8 Non-continuous cable support assemblies from wall, concrete, or joist.
- .9 Non-continuous cable support assemblies from threaded rod.
- .10 Raised floor non-continuous cable support assemblies.
- .11 Cantilever-Mounted Option for non-continuous cable supports.
- .12 Installation accessories for non-continuous cable supports.

### **1.03 Definitions**

- .1 UTP: Unshielded twisted pair.
- .2 ANSI: American National Standards Institute.
- .3 ASTM: American Society for Testing and Materials.
- .4 EIA: Electronic Industries Alliance.
- .5 TIA: Telecommunications Industry Association.
- .6 cULus: Listed by Underwriters Laboratories based on both Canadian and US (United States) standards requirements.

### **1.04 Submittals**

- .1 Submit product data on non-continuous cable support devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
-

## **1.05 Quality Assurance**

- .1 Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).
- .2 Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.
- .3 Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of five years documented experience in the industry, and certified ISO 9000.

## **2 Products**

### **2.01 Manufacturers**

- .1 ERICO, Inc.
- .2 Approved equal.

### **2.02 References**

- .1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel
  - .2 ASTM B 695-90 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
  - .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - .4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  - .5 ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled
  - .6 ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - .7 ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
  - .8 ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy Hot-Rolled and Cold-Rolled
  - .9 A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip process
  - .10 ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  - .11 ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality
  - .12 ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
-

- .13 ASTM B117 Standard Method of Salt Spray (Fog) Testing
- .14 ASTM D610 Standard test Method for Evaluating Degree of Rusting on Painted Steel Surfaces UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- .15 ANSI/ TIA/ EIA 568 Commercial Building Telecommunications Cabling Standard, current revision level.
- .16 ANSI/ TIA/ EIA 569 Commercial Building Standard for Telecommunications Pathways and Spaces, current revision level.
- .17 NFPA 70 National Electrical Code®

### **2.03 Non-Continuous Cable Support Systems**

- .1 Non-continuous cable supports
    - .1 Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
    - .2 Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
    - .3 Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
    - .4 Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
    - .5 Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
    - .6 Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.
  - .2 Adjustable non-continuous cable support sling
    - .1 Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable; cULus Listed.
    - .2 Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
    - .3 Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
    - .4 If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
-

- .5 Acceptable products: ERICO CADDY CableCat™ CAT425; or approved equal.
  - .3 Multi-tiered non-continuous cable support assemblies
    - .1 Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
    - .2 If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
    - .3 The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
  - .4 Non-continuous cable support assemblies from tee bar
    - .1 Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
    - .2 Acceptable products: ERICO CADDY CAT12TS, CAT21528, CAT32528; or approved equal.
  - .5 Non-continuous cable support assemblies from drop wire/ceiling
    - .1 Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
    - .2 Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.
  - .6 Non-continuous cable support assemblies from beam, flange
    - .1 Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
    - .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
  - .7 Non-continuous cable support assemblies from C & Z Purlin
    - .1 Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
    - .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.
  - .8 Non-continuous cable support assemblies from wall, concrete, or joist
    - .1 Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
-

- .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.
  - .9 Non-continuous cable support assemblies from threaded rod
    - .1 Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
    - .2 The multi-tiered support bracket shall have a static load limit of 300 lbs.
    - .3 U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
    - .4 Acceptable products: ERICO CableCat™ J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.
  - .10 Raised floor non-continuous cable support assemblies
    - .1 Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed.
    - .2 Acceptable products: ERICO CADDY CAT12CD1B, CAT21CD1B or CAT32CD1B; CAT64CD1B; or approved equal.
  - .11 Cantilever-Mounted cable supports
    - .1 U-hook shall be able to be assembled to a wide variety of wall mount brackets.
    - .2 Spacing of individual U-hooks as needed, max of 4' to 5' apart.
    - .3 U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
    - .4 Acceptable products: ERICO CAT-CMTM U-hooks CAT200CMLN, CAT300CMLN; CAT-CM roller assemblies CATRL200CM, CATRL300CM; CATWMCM bracket; or approved equal.
  - .12 Installation accessories for non-continuous cable supports
    - .1 Cable Pulley
      - .1 Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
      - .2 The pin and roller assembly must be removed after cables are installed.
      - .3 Acceptable products: ERICO CADDY CAT32PLR, CAT64PLR, or approved equal.
    - .2 Cable Protector
-

- .1 The protective steel tube shall fit over threaded rod and be at least 4" in length.
- .2 The tube shall prevent damage to cables placed in or pulled through CAT-CMTM U-hooks. The tube shall not inhibit the pulling of cables.
- .3 Acceptable products: ERICO CAT-CMTM CATTBCM, or approved equal.

## **2.04 Finishes**

- .1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel
- .2 ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
- .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- .5 Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

## **3 Execution**

### **3.01 Installation**

- .1 Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- .2 Install cables using techniques, practices, and methods that are consistent with Category 5 or higher requirements and that supports Category 5 or higher performance of completed and linked signal paths, end to end.
- .3 Install cables without damaging conductors, shield, or jacket.
- .4 Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- .5 Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
- .6 Do not exceed load ratings specified by manufacturer.
- .7 Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- .8 Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Cable trays, including ladder rack, wire mesh, optical fibre trough, and accessories.

### **1.02 Related Requirements**

- .1 Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- .2 Section 26 05 29 – Hangers and Supports for Electrical Systems.

### **1.03 References**

- .1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (28th edition/2021).
- .3 CSA C22.2 No. 126.1-17 (CSA/NEMA) - Metal Cable Tray Systems (Binational standard with NEMA VE 1-2017).

### **1.04 Action Submittals**

- .1 Product Data: Provide data for fittings and accessories.
- .2 Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

### **1.05 Informational Submittals**

- .1 Manufacturer's Instructions:
  - .1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
  - .2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

### **1.06 Closeout Submittals**

- .1 Project Record Documents: Record actual routing of cable tray and locations of supports.

### **1.07 Regulatory Requirements**

- .1 Products: Listed and classified by CSA (Canadian Standards Association as suitable for the purpose specified and indicated.

## **2 Products**

### **2.01 Ladder Rack-Type Cable Tray**

- .1 Description: CSA 22.2 No. 126.1, Class ladder type tray.
  - .2 Material: Aluminum.
  - .3 Inside width: As indicated.
  - .4 Inside depth: As indicated.
-

- .5 Straight section rung spacing: 152 mm (6 in) on centre.
- .6 Inside Radius of Fittings: As indicated.
- .7 Unless otherwise noted, provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- .8 Refer to drawings for details.
- .9 Manufacturers:
  - .1 Hubbell Nextframe Ladder Rack.
  - .2 Canadian Electrical Raceways "Telecom Cable Rack".
  - .3 Approved equal.

## **2.02 Wire Basket Cable Tray**

- .1 Description: CSA 22.2 No. 126.1, Class Basket type tray.
- .2 Material: Carbon Steel, Hot Dipped Galvanized to ASTM A 123.
- .3 Inside Width: As indicated.
- .4 Inside Depth: As indicated.
- .5 Straight Section Rung Spacing: refer to drawings.
- .6 Inside Radius of Fittings: As indicated.
- .7 Unless otherwise noted, provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- .8 Refer to drawings for details.
- .9 Rung spacing 152 mm (6 in).
- .10 Radius for tees 305 mm (12 in) minimum. Exact size to be verified on site.
- .11 Do not employ tray elbows. Use Tees to permit future extension of tray.
- .12 Radius for the dropouts 125 mm (5 in) minimum. Exact size to be verified on site.
- .13 Manufacturers:
  - .1 Cablofil.
  - .2 Canadian Electrical Raceways Inc.
  - .3 Hubbell.
  - .4 Thomas & Betts.

## **2.03 Optical Fibre Routing System (Fibre Tray)**

- .1 The optical fiber routing system shall be used to route, segregate, and protect fiber optic communication cabling.
-

- .2 ULC Listed (UL2024A)
- .3 Size:
  - .1 100 mm x 100 mm (4 in x 4 in).
  - .2 As otherwise indicated on drawings.
- .4 50 mm (2") minimum bend radius through-out pathway.
- .5 Impact resistant and flame-retardant material (UL94-V0 Flammability).
- .6 Color: Black.
- .7 Will include all mounting hardware, waterfalls, directional fittings, and other accessories required for installation.
- .8 Manufacturers:
  - .1 Panduit Fiberrunner series.
  - .2 ADC FiberGuide series.
  - .3 Commscope SpeedPRO series.

### **3 Execution**

#### **3.01 Installation**

- .1 Trays to be sized to 40 per cent maximum capacity.
- .2 Install metallic cable tray to CSA C22.1 SB-02 and C22.2 No. 126.1.
- .3 Install fibreglass cable tray to CSA C22.1 SB-02 and C22.2 No. 126.2.
- .4 Support trays to Section 26 05 29. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports.
- .5 Use expansion connectors where required.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Firestopping through penetrations in fire rated assemblies.

**1.02 Related Requirements**

- .1 Section 07 84 00 – Firestopping.

**1.03 References**

- .1 ASTM E 84, “Surface Burning Characteristics of Building Materials”.
- .2 ASTM E 119, “Fire Tests of Building Construction and Materials”.
- .3 ASTM E 814, “Fire Tests of Penetration Firestop Systems”.
- .4 ANSI/UL263, “Fire Tests of Building Construction and Materials”.
- .5 ANSI/UL723, “Surface Burning Characteristics of Building Materials”.
- .6 ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.
- .7 Underwriters Laboratories Inc. (UL) – Fire Resistance Directory

**1.04 Performance Requirements**

- .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur, such devices shall:
    - .1 Meet the hourly rating of the floor or wall penetrated.
    - .2 Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
    - .3 Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:
      - .1 Opening or closing of doors.
      - .2 Twisting an inner liner.
      - .3 Removal or replacement of any material such as, but not limited to, sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.
    - .4 Permit multiple devices to be ganged together to increase overall cable capacity.
    - .5 Allow for retrofit to install around existing cables.
    - .6 Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes.
-

- .2 Where single cables (up to 7 mm (0.27 in) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted. Acceptable products shall be molded from plenum-grade polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.
- .3 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during or after construction.
- .4 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
- .5 Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

#### **1.05 Submittals**

- .1 Submit under provisions of Section 01 33 00.
- .2 Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- .3 Shop Drawings: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .4 Certificates: Product certificates signed by firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- .5 Installation Instructions: Submit manufacturer's printed installation instructions.

#### **1.06 Quality Assurance**

- .1 Products/Systems: Provide firestopping systems that comply with the following requirements:
  - .1 Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
  - .2 Firestopping products bear the classification marking of qualified testing and inspection agency.
- .2 Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

#### **1.07 Delivery, Storage, and Handling**

- .1 Delivery:
-

- .1 Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multicomponent products.
- .2 Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- .2 Storage and Protection:
  - .1 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

## **1.08 Project Conditions**

- .1 Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- .2 Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- .7 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

## **2 Products**

### **2.01 Manufacturers**

- .1 Specified Technologies Inc.  
200 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: [specseal@stifirestop.com](mailto:specseal@stifirestop.com), Website: [www.stifirestop.com](http://www.stifirestop.com).
- .2 Substitutions: as approved by the Consultant prior to tender closing.
- .3 Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

### **2.02 Materials**

- .1 General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
-

### **2.03 Fire Rated Cable Pathways**

- .1 Steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
  - .1 Specified Technologies Inc. (STI) EZ-PATH Fire Rated Pathway.

## **3 Execution**

### **3.01 Examination**

- .1 Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- .2 Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- .3 Provide masking and temporary covering to protect adjacent surfaces.
- .4 Do not proceed until unsatisfactory conditions have been corrected.

### **3.02 Installation**

- .1 General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

### **3.03 Field Quality Control**

- .1 Inspections: Engage qualified independent inspection agency to inspect through-penetration firestop systems.
- .2 Keep areas of work accessible until inspection by authorities having jurisdiction.
- .3 Where deficiencies are found, repair firestopping products so they comply with requirements.

### **3.04 Adjusting and Cleaning**

- .1 Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- .2 Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

**End of Section**

---

## **1 General**

### **1.01 Section Includes**

- .1 Labelling and identification requirements for communications systems.

### **1.02 References**

- .1 ANSI/TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure.
- .2 UL 969 – Marking and Labeling Systems.

## **2 Products**

### **2.01 Summary**

- .1 Adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.
- .2 Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
- .3 ANSI/EIA/TIA-606 for colour codes shall be followed. Labels are to be mechanically printed using a laser printer. Hand written labels will not be acceptable.

### **2.02 Label Printer**

- .1 Thermal Transfer Printer shall print high quality, industrial labels on a wide variety of materials for electrical and network applications such as wire/cable, components, safety, and facility identification.
- .2 Laminated Adhesive Label Cassettes:
  - .1 For flat label applications.
  - .2 Polyester material.
- .3 Non-Laminated Adhesive Label Cassettes:
  - .1 For marking wire and cable and flat label applications.
  - .2 Polyester material
- .4 Example Products:
  - .1 Panduit LS7 series hand-held printer.
  - .2 Panduit LS8 series hand-held printer.

### **2.03 Nameplates**

- .1 Engraved three-layer laminated plastic, letters on contrasting background:
  - .2 Rack and Cabinet ID labels: 25 mm (1") high White Text on Black Background
-

### **3 Execution**

#### **3.01 Installation**

- .1 Cable identification labels should appear at the following locations with the numbers indicated on the cable schedule and drawings:
  - .1 300 mm (12 inches) from each end of the cable – after termination.
  - .2 Front of patch panels.
  - .3 Front of IDC termination blocks.
  - .4 Front of workstation/communications outlet faceplates.
  - .5 Each end of each Telecommunications Conduit.
- .2 Fibre Optic safety labels shall appear at the following locations:
  - .1 Along the length of the conduit or innerduct at 3 m (10 foot) intervals.
  - .2 At all junction boxes
  - .3 At all pull boxes.
  - .4 On all fibre optic patch panels.
- .3 Provide 25 per cent additional labels to be left in each telecommunications room on site for future growth.
- .4 Provide two Rack/Cabinet nameplates. Mount one on the front, and one on the rear of the rack.

#### **3.02 Identification Conventions**

- .1 All cabling will be labelled with the closet letter, followed by a dash and the wire number (i.e. A-001 would be the first wire in closet A).
- .2 Labelling for backbone wiring will be preceded with BB followed by the wire number (i.e. BB-001 would be the first backbone).

**End of Section**

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## **1 General**

### **1.01 Section Includes**

- .1 Commissioning Requirements.

### **1.02 References**

- .1 Refer to Section 27 05 00 for references.

### **1.03 Closeout Submittals**

- .1 The Telecommunications Cabling Contractor is required to submit test results in native tester format or a format which can be read with a text reader (i.e. ".txt" extension). Paper results shall not be submitted for projects with 100 or more horizontal cable drops and/or fibre cables.
- .2 The Telecommunications Cabling Contractor is required to provide the software required to view the results.
- .3 The report should be divided into sections by Telecommunications Room.
- .4 The report should indicate for each cable when it was tested successfully, the result, and the length.
- .5 The Telecommunications Cabling Contractor shall sign off on the entire test report prior to submitting to the Consultant.
- .6 The test result documentation is to be submitted to the Consultant for review no later than 10 working days following the completion of the installation.
- .7 All deficiencies must be corrected before the Consultant will provide a certificate to release the Holdback on the project.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Installation**

- .1 Testing of all horizontal copper cables are to be completed in accordance with the follow test criteria:
    - .1 Basic Link
    - .2 Grounds
    - .3 NEXT
    - .4 ELFEXT
    - .5 Continuity
    - .6 correct polarity
    - .7 PSNEXT
-

- .8 PSELFEXT
- .9 Shorts
- .10 Length
- .11 ACR
- .12 Return Loss
- .13 Opens
- .14 Attenuation
- .15 PSACR
- .16 Resistance
- .2 Fibre strands in excess of 122 m (400 ft) shall be tested with an Optical Time Domain Reflectometer for length and attenuation.
- .3 Test each stand of fibre, bi-directionally, with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres.
- .4 Maximum multi-mode passive link loss (including patch cords) is not to exceed -2.35 dB.
- .5 Maximum single-mode passive link loss (including patch cords) is not to exceed -1.0 dB.

### **3.02 Record Drawings**

- .1 The Telecommunications Cabling Contractor is required to maintain one set of correct and accurate record drawings on-site at all times. These drawings are to be made available to the General Contractor/Construction Manager or the Consultant for review during the project.
  - .2 The Telecommunications Cabling Contractor is required to provide record drawings of the telecommunication cabling installation in relation to the drawings provided in this specification.
  - .3 The record drawings shall be updated electronically and include, but are not limited to;
    - .1 Horizontal cable numbers on the floor plans
    - .2 Horizontal Cable Routing on the floor plans
    - .3 Changes on the floor plans
    - .4 Backbone cable Routing between Telecommunications Rooms
    - .5 Paging Speaker Locations including daisy chain cable run
    - .6 Wireless Access Points and Cell coverage
    - .7 Cabinet/Rack Elevation drawings
    - .8 Backboard Elevation Drawing
-

- .4 The Telecommunications Cabling Contractor shall provide one soft copy in AutoCAD 2007 and one plotted copy for the Consultant to review prior to complete substantial performance and close-out documentation submission.
- .5 After approval, the Telecommunications Cabling Contractor shall submit one plotted copy of the drawings for;
  - .1 The Main Computer Room
  - .2 Each Telecommunications Room
- .6 All close-out documentation must be submitted to the General Contractor/Construction Manager or The Consultant within 10 working days of the completion of the project before the documentation holdback will be released.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Wireless Access Points for Wi-Fi network communications.

**1.02 Related Requirements**

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.
- .3 Section 27 05 28.00 – Pathways for Communication Systems

**1.03 References**

- .1 BISCI Telecommunications Distribution Methods Manual, 14th Edition.

**2 Products**

**2.01 Owner-Supplied Products**

- .1 WAP (Wireless Access Points).
  - .1 Free issued by Owner to this Contractor for installation at locations as indicated on the drawings.
  - .2 Power Over Ethernet (PoE) powered.

**3 Execution**

**3.01 Installation**

- .1 Allow for site wireless survey for the final locations of WAPs.
- .2 Allow for 5 m cable slack at WAP outlets end for final location adjustment.
- .3 Allow for 10 WAP's additional to what is indicated in drawings.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Modifications to existing access control system, including provision of new hardware, software licences, etc. to make a complete and functional system.

**1.02 Related Requirements**

- .1 Section 28 10 00 – Access Control.

**1.03 Warranty**

- .1 All new material and equipment furnished under this section shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

**2 Products**

**2.01 Existing Systems**

- .1 Contractor to allow for the cost of investigation of the existing access control system. Owner to provide details.

**3 Execution**

**3.01 Installation**

- .1 Install new components in accordance with manufacturer's instructions.
- .2 Maintain operation of the existing system at all times.

**End of Section**

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**1 General**

**1.01 Section Includes**

- .1 Modifications to existing video surveillance, including provision of new hardware, software licences, etc. to make a complete and functional system.

**1.02 Related Requirements**

- .1 Section 28 21 00 – Surveillance Cameras.
- .2 Section 28 23 00 – Video Management System.

**1.03 Warranty**

- .1 All new material and equipment furnished under this section shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

**2 Products**

**2.01 Existing Systems**

- .1 Contractor to allow for the cost of investigation of the existing video surveillance system. Owner to provide details.

**3 Execution**

**3.01 Installation**

- .1 Install new components in accordance with manufacturer's instructions.
- .2 Maintain operation of the existing system at all times.

**End of Section**

**1 General**

**1.01 Section Includes**

- .1 Modifications to existing fire alarm system, including provision of new zones as indicated, relocating and new fire alarm devices as indicated on the drawings, and system verification. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .2 Update annunciators / passive graphic to include additions and renovated areas, as applicable.
- .3 New devices connected directly to the existing fire alarm system shall of the manufacturer's current product selection, and to match the existing system EDWARDS EST 3X.

**1.02 Related Requirements**

- .1 Section 21 12 00 – Fire-Suppression Standpipes.
- .2 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .3 Section 26 05 33.13 – Conduit for Electrical Systems.
- .4 Section 26 05 33.16 – Boxes for Electrical Systems.
- .5 Section 26 05 33.23 – Surface Raceways for Electrical Systems.
- .6 Latest fire alarm verification or annual inspection report.

**1.03 Unit Prices**

- .1 Refer to Document 00 43 00.26.
  - .2 Submit with Tender unit prices to provide the following:
    - .1 Provide manual pull station complete with wiring and conduit based on 30 metre distance.
    - .2 Provide fire alarm horn/strobe complete with wiring and conduit, based on 30 metre distance.
    - .3 Provide smoke detector complete with wiring and conduit, based on 30 metre distance.
    - .4 Provide duct type smoke detector complete with wiring and conduit on a separate zone, based on 30 metre distance.
    - .5 Provide unit rate cost of new conduit and wire for initiation or signal circuits based on 30 metre length.
    - .6 Provide unit rate cost to replace existing heat detector.
    - .7 Provide unit rate cost to replace existing manual pull station.
    - .8 Provide unit rate cost to replace existing end of line resistors.
-

- .9 Provide magnetic lock relay complete with wiring and conduit, based on 30 metre distance.

#### 1.04 Alternates

- .1 Refer to Document 00 43 00.26.
- .2 Base bid design entails the provision of new fire alarm initiation and signal circuit wiring, unless noted otherwise on plans.
- .3 Submit with Tender as an alternate (separate) price to delete the removal of all existing fire alarm wiring, and delete the replacement of same with new wiring in existing conduits. This price will be actioned as a Change Order if it is determined during construction that the existing wiring can be re-used.

#### 1.05 References

- .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. Comply with latest edition/amendment referenced Code/Publication.
  - .1 2012 Ontario Building Code.
  - .2 2007 Ontario Fire Code.
  - .3 CAN/ULC-S524-14, Standard for Installation of Fire Alarm Systems.
  - .4 CAN/ULC-S537-13, Standard for Verification of Fire Alarm Systems.
  - .5 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.
  - .6 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
  - .7 Ontario Electrical Safety Code (28th edition/2021).
  - .8 All requirements of the Authority Having Jurisdiction (AHJ).

#### 1.06 Submittals

- .1 Provide submittals to the Consultant for review in accordance with Section 01 33 00.
  - .2 Submit to the Fire Department, drawings showing bells, manual pull stations, complete wiring diagrams and annunciator details and obtain their approval.
  - .3 Shop Drawings
    - .1 Include sufficient information, clearly presented, to determine compliance with drawings and specifications.
    - .2 Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, and device arrangement.
    - .3 Show annunciator layout and main control panel module layout, configurations and terminations.
    - .4 Show device layout, complete riser diagram, and auxiliary functions.
-

- .5 The supplier of the system shall prepare a complete zoning schedule and artwork layout for active graphic to be included with submittal package.
- .4 Manuals
  - .1 Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets (with model numbers to be used indicated).
  - .2 Wiring diagrams indicating terminals and the interconnections between the items of equipment.
  - .3 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

#### **1.07 Closeout Submittals**

- .1 Fire Alarm Verification Report.
- .2 Operation and Maintenance Manual.
- .3 Training session attendance list.

#### **1.08 Quality Assurance**

- .1 Approvals
  - .1 The system shall have proper listing and/or approval from the following nationally recognized agencies:
    - .1 ULC Underwriters Laboratories Canada.
  - .2 The fire alarm control, panel shall meet the modular listing requirements of ULC. Each subassembly of the FACP, including all printed circuit boards, shall include the appropriate ULC modular label.
- .2 All devices/components shall be suitable for the locations, environment, temperatures in which they are to be installed.

#### **1.09 Warranty**

- .1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

### **2 Products**

#### **2.01 Existing System**

- .1 The existing Fire Alarm System is as indicated on drawings Edwards EST 3X single-stage fire alarm system.
    - .1 The location of the Fire Alarm Control Panel is as indicated on the drawings.
    - .2 There is one passive graphic annunciator to be updated, location as indicated on the drawings. Located at the buildings main entrance.
-

## **2.02 Manufacturers**

- .1 The system components shall be selected so as to match and be compatible with the existing Fire Alarm system.

## **2.03 Equipment and Material, General**

- .1 Review latest verification report, and review existing system during tender walkthrough and note all required modifications.
- .2 All equipment and components shall be new, and the manufacturer's current model.
- .3 All equipment and components shall be installed in strict compliance with manufacturers' recommendations.
- .4 All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

## **2.04 Conduit and Wire**

- .1 Existing conventional zone wiring is existing to remain.
- .2 New conduit and wire for new zones and new devices to Section 27 15 01.19.
- .3 Conduit
  - .1 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.
  - .2 All wiring shall be installed in conduit or raceway to Section 26 05 33.13 and Section 26 05 33.23.
- .4 Wire
  - .1 All fire alarm system wiring to suit new devices shall be new.
  - .2 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code and as recommended by the fire alarm system manufacturer.
  - .3 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.
- .5 Terminal Boxes, Junction Boxes and Cabinets:
  - .1 All boxes and cabinets shall be listed for their purpose and use.]

## **2.05 Main Fire Alarm Control Panel**

- .1 Add new zones, zone modules, etc., for new work as required, and connect all new devices to Fire Alarm Control Panel.
  - .2 Remote Annunciator and Passive Graphic
    - .1 Connect all new zones for the new work to annunciators.
-

## 2.06 Components

- .1 Programmable Electronic Sounders:
    - .1 Electronic sounders shall match existing system.
    - .2 Shall be flush mounted as required.
  - .2 Audible/Visual Combination Devices:
    - .1 Shall meet the applicable requirements of sounders listed above for audibility.
    - .2 Shall have a built-in strobe, 15 candela.
  - .3 Strobe Synchronizing Modules:
    - .1 Synchronize strobes at 1 Hz and horns at temporal over single wire pan.
  - .4 Manual Fire Alarm Stations
    - .1 Manual fire alarm stations shall be non-coded, non-breakable glass type.
    - .2 Stations must be designed such that after an actual activation, they cannot be restored to normal without the use of a special tool.
    - .3 An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 30.5 m (100 feet) front or side.
    - .4 Manual stations constructed of metal, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters 12.7 mm (1/2 inch) in size or larger.
  - .5 Conventional Photoelectric Area Smoke Detectors
    - .1 Photoelectric smoke detectors shall be two wire, ceiling-mounted, light scattering type using an LED light source.
    - .2 Each detector shall contain a remote LED output and a built-in test switch.
    - .3 Detector shall be provided on a twist-lock base.
    - .4 It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
    - .5 A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash every 10 seconds, indicating that power is applied to the detector.
    - .6 The detector shall not go into alarm when exposed to air velocities of up to 914.4 m (3000 feet) per minute.
    - .7 The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
    - .8 All field wire connections shall be made to the base through the use of a clamping plate and screw.
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- .6 Duct Smoke Detectors
  - .1 Duct smoke detectors shall be complete with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the with properly sized air sampling tubes.
- .7 Automatic Conventional Heat Detectors
  - .1 Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees F (57.2 degrees C) for areas where ambient temperatures do not exceed 100 degrees F (37.7 degrees C), and 200 degrees F (93.33 degrees C) for areas where the temperature does not exceed 150 degrees F (65.5 degrees C).
  - .2 Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
  - .3 The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
  - .4 The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
  - .5 Automatic heat detectors shall have a smooth ceiling rating of 2 500 square feet (762 square metres).

## 2.07 Operation Sequences

- .1 The fire alarm system shall be a Zoned Single Stage Non-Coded System as defined in the Ontario Building Code.
- .2 Basic Performance:
  - .1 Initiation Device Circuits (IDC) shall be wired Class A.
  - .2 Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y).
  - .3 Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
- .3 Basic System Functional Operation:
  - .1 An alarm is caused by actuation of any one of the following devices:
    - .1 Pulling a manual station
    - .2 Operation of an automatic fire alarm detector
    - .3 Operation of a sprinkler flow switch
    - .4 Operation of a smoke detector
  - .2 If, in any area of the building, an alarm is caused by actuation of the aforementioned devices, the following shall occur:
    - .1 Signals in the building shall sound.

- .2 Annunciators shall indicate exact zone where alarm originated
- .3 Fans shall be automatically turned off.
- .3 Central station shall be automatically alerted via telephone lines connected for fire alarm system.
- .4 If, in any area of the building, supervised valves of the sprinkler, systems are operated or exhibit short or open circuits, the following shall occur:
  - .1 The annunciator shall identify, as a separate zone, the item causing the trouble signal.
  - .2 The trouble buzzer on the annunciator(s) shall sound.
  - .3 The signals in the building shall not be sounded.

### **3 Execution**

#### **3.01 Examination**

- .1 Do not disturb any existing devices unless absolutely necessary to facilitate installation of a new device. No existing devices are to be disturbed without specific authorization by the Project Manager.
- .2 Conduct an impedance test of initiation and signal circuits, and submit report to the Consultant. Report any discrepancies in circuit loading.

#### **3.02 Installation**

- .1 Maintain continuity of the existing fire alarm system at all times. In the event that a shutdown is required of the fire alarm system, provide a fire watch.
- .2 Install fire alarm system devices in accordance with applicable codes, and manufacturer's instructions.
- .3 Entire installation shall be done under supervision of manufacturer. Upon completion of installation, check entire system to approval and correct any malfunction immediately.
- .4 Standpipe System Connections.
  - .1 Refer to Section 21 12 00.
  - .2 Connect contact of supervisory switches to fire alarm zones indicated.
- .5 Sprinkler System Connections.
  - .1 Refer to Section 21 13 00.
  - .2 Connect contact of sprinkler flow switches and supervisory switches to fire alarm zones indicated.
- .6 Align alarm devices and signals, where grouped together, one above the other.
- .7 Mount devices at the following heights unless otherwise shown:
  - .1 Signal devices:

- .1 300 mm below finished ceiling
- .2 2050 mm above floor in unfinished areas.
- .2 Manual Pull Stations:
  - .1 1200 mm above finished floor level.
- .3 In areas with separate signal devices for fire suppression and/or pre-action, provide a lamacoid nameplate for base building signalling devices.
- .8 Manufacturer shall examine Drawings and Specifications prior to award of Contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.

### **3.03 Field Quality Control**

- .1 Testing and Verification
    - .1 Test each automatic detector to ensure correct wiring and zoning by setting off its rate of rise component and sounding the bells or by ringing it out. Test each smoke detector, sprinkler system and standpipe valves to ensure correct wiring.
    - .2 Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with CAN/ULC-S537.
    - .3 Check for correct connections and test for short circuits, ground faults, continuity, and insulation.
    - .4 Perform audibility test of space and provide annunciation devices to suit ambient sound levels. Ensure coverage for fire alarm signalling devices on base building fire alarm system. Provide audible test of signaling devices after other systems have been commissioned to verify operation at computer room ambient sound level.
    - .5 Verify activation of all relocated devices, including flow switches, trouble, and supervisory signals from the relocated pre-action assembly.
    - .6 Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
    - .7 All initial testing shall be in accordance with CAN/ULC-S537. A representative of the electrical contractor shall be present to participate and assist the manufacturer representative during the course of the verification. The electrical contractor shall make good any deficiencies discovered during the verification. All devices, new and existing, shall be verified. The electrical contractor shall provide one person for assistance with the verification.
    - .8 Include associated costs in Tender Price.
    - .9 Carry out a complete audibility test and submit report.
    - .10 On completion of the verification the manufacturer shall supply a certificate, together with detailed inspection record sheets showing location of each device
-

and certifying the test results per unit, confirming that the system is installed, supervised and operational.

- .11 Provide functional testing of interconnected systems in accordance with CAN/ULC-S1001.

.2 Manufacturer Services

- .1 The manufacturer(s) of the fire alarm shall make a complete inspection of all existing and new components installed for system(s), such as manual stations, horns, and annunciators and sprinkler and standpipe valves and smoke detectors to ensure the following:

- .1 That the system is complete in accordance with Specifications.
  - .2 That the system is connected according to ULC requirements.
  - .3 That the system is connected in accordance with the Manufacturer's recommendations.
  - .4 That the regulations concerning the supervision of components have been adhered to (e.g. stations, detectors, supervised valves, bells), and are properly wired and supervised.
  - .5 That all valves are properly connected and displayed correctly on each annunciator.
  - .6 That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the manufacturer.
  - .7 That all thermal detectors, smoke detectors and manual pull stations have been operated and are in good working order.
  - .8 That all sprinkler system and standpipe system valves have been operated and are in good working order.
  - .9 That all annunciators correctly pinpoint the origin of any fire alarm.
  - .10 That actual smoke concentration of sufficient density, have been applied to each smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set.
  - .11 That all existing devices are in good working order. Include for replacement of any defective/damaged devices at no extra cost to Owner.
  - .12 That signal audibility is acceptable in all areas. Submit audibility readings for every room.
  - .13 If existing audible signal devices have been discontinued by the manufacturer (for example mechanical horns), allow for replacement of all audible devices so that all devices generate similar sounds and sound patterns when activated.
-

**3.04 Closeout Activities**

- .1 At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.
- .2 Provide instruction as required to the building personnel and fire and safety personnel. "Hands-on" demonstrations of the operation of the system shall be provided.

**End of Section**

**Appendix A1**

**City of Brampton - Security System Specifications V11 February 2023**

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**Appendix A2**

**City of Brampton - Security System Specifications V11 February 2023**

**1 General**

**1.01 Section Includes**

- .1 Procedures for preparation of integrated systems testing and coordination of all sub-trades in the execution of this testing to ensure life safety systems meet code requirements.

**1.02 Related Requirements**

- .1 Division 08 – Openings.
- .2 Division 21 – Fire Suppression.
- .3 Division 23 – Heating, Ventilating, and Air Conditioning.
- .4 Division 26 – Electrical.
- .5 This section describes requirements applicable to all Sections within Division 02 to Division 49.

**1.03 References**

- .1 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.
- .2 2012 Ontario Building Code.

**1.04 Submittals**

- .1 The Integrated Testing Report shall include all documentation described in Subsection 7.3 of CAN/ULC-S1001. This includes:
  - .1 The Integrated Testing Plan.
  - .2 Integrated Testing Forms.
  - .3 Integrated Testing Forms for Re-tests.
  - .4 Documentation required by Section 5.3 of CAN/ULC-S1001.

**1.05 Closeout Submittals**

- .1 The Integrated Testing Report shall be provided to the following:
  - .1 The Consultant.
  - .2 The Owner.
  - .3 Municipal fire inspector as requested.
- .2 Maintain a copy of the CAN/ULC-S1001 functional test report on site.

**1.06 Qualifications**

- .1 Integrated Testing Coordinator:
-

- .1 Must have all licenses and certifications required by contractual obligations, as well as those required by federal, provincial, and other regulations.
- .2 Must have the competencies listed in CAN/ULC-S1001.
- .3 Must prepare an Integrated Testing Plan.
- .4 Must provide the Integrated Testing Plan to the professional designers for review/acceptance prior to the test.
- .5 Collect the required pre-test documentation (e.g. confirmation from designers/installers/verifiers that systems are ready for testing, confirmation that building occupants have been notified and that safety measures are in place, etc.).
- .6 Determine what previous testing of the systems can be accepted to avoid duplication of testing.
- .7 Determine which parties are required to participate in the Integrated Systems Test.
- .8 Implement the Integrated Testing Plan (perform the tests) and record the results to show proper integration (ensure re-testing is performed as needed).
- .9 Compile all the documentation into an Integrated Testing Report and provide it to the building owner, Authority Having Jurisdiction (as required), and keep a copy on the building site.

## **2 Products – Not Used**

## **3 Execution**

### **3.01 Responsibility**

- .1 The General Contractor is responsible for coordinating integrated systems testing to meet the requirements of CAN/ULC-S1001. Time is to be allocated in the construction schedule for these tests, and the General Contractor is to ensure that the key sub-trades are a part of this testing.
  - .2 Pre-requisites for integrated systems testing are individual verification reports such as fire alarm verification report, sprinkler sign off, elevator sign off, fire/smoke/life safety fan balancing reports, and others.
  - .3 The intent is not to replicate the tests of each device, but to test the operation of the life safety system as a whole. Examples include but are not limited to the following:
    - .1 Fan shutdown on duct smoke detector.
    - .2 Activation of fans (stair pressurization, vestibule pressurization, smoke evacuation) on fire alarm.
    - .3 Successful integration of sprinkler devices, pre-action systems, etc.
    - .4 Proper operation of door hold-open devices, mag locks, fire shutters, etc.
-

- .5 Elevators recall to home and alternate home floors.
- .6 Operation of life safety systems upon loss of power or on generator power.
- .4 Based on the level of 3<sup>rd</sup> party commissioning hired by the Owner required for the project, the Commissioning Authority may require to witness these tests.

### 3.02 Examples from CAN/ULC-S1001 of Systems that Require Integrated Testing

- .1 Door Hardware:
    - .1 Electromagnetic hold-opens:
      - .1 Each door tested to ensure returns to closed and latched position upon signal from fire alarm or from actuation of local smoke detectors.
    - .2 Electromagnetic locks:
      - .1 Each must de-energize upon activation of the fire alarm system or from actuation of the local manual pull station.
    - .3 Fire shutter doors close upon activation of the fire alarm system.
    - .4 Power door operators on doors located on fire separations deactivate when fire alarm system is activated.
  - .2 Fire Suppression:
    - .1 Freeze Protection Systems: annunciates on fire alarm annunciator panel upon loss of power to heat tracing for sprinkler piping.
    - .2 Sprinkler systems:
      - .1 Flow switches and other water flow indicating devices annunciate as alarm on fire alarm control panel when water flow is detected.
      - .2 Supervised valves annunciate as supervisory on fire alarm control panel when valves are closed.
    - .3 Standpipe systems: Supervised valves annunciate as supervisory on fire alarm control panel when valves are closed.
    - .4 Fire pumps: Operate as required.
    - .5 Water supplies (test responses to pressure sensors, level sensors, etc.):
      - .1 Loss of pressure in sprinkler piping will trigger the fire alarm. This pressure loss indicates that either an active fire has started, or the integrity of the sprinkler piping has been compromised.
    - .6 Water supply control valves.
    - .7 Fixed fire suppression systems (release of suppression agent not required).
  - .3 HVAC:
    - .1 Smoke control systems.
-

- .2 Emergency pressurization systems.
  - .3 Smoke exhaust systems.
  - .4 High-Volume Low-Speed (HVLS) fans shut down on sprinkler flow.
  - .5 Parking garage ventilation system and controls.
  - .6 Confirm and document that the air handling unit disengages when fire or smoke is detected. Preventing the conveyance of smoke, ash, particulates, or the fire itself through the air system substantially strengthens a building resilience in an emergency, and protects personnel.
  - .7 Confirm and document that areas requiring pressurization (such as stairwells and other emergency routes) are functioning as designed during emergency conditions.
- .4 Electrical:
- .1 Emergency generators (e.g. startup test, loss of power simulations)
    - .1 Confirm and document that emergency generators engage, and alarm is announced during a fire or low-fuel conditions. It is critical to the functioning of all life safety systems that the backup power generation be capable of indicating when its operability has been compromised, including low-fuel alarms for diesel or propane fuelled generator sets, and supervision of valves for natural gas fuelled generator sets.
    - .2 Confirm and document that when primary power is interrupted the emergency generators engage and powers critical life saving systems such as alarms, sprinkler pumps, elevators, and air handling units. Ensuring backup power generation is timely, of sufficient strength and properly functioning can be the difference between an incident and a disaster.
  - .2 Automatic Transfer Switches: Operate as required.
  - .3 A/V and lighting control systems: Systems deactivate upon fire alarm signal.
- .5 Public Address and Paging Systems: de-activate system upon actuation of the fire alarm system.
- .6 Sound Masking System: de-active system upon actuation of the fire alarm system.
- .7 Fire Alarm System:
- .1 Transmissions with fire signal receiving centre (e.g. receipt of signals).
    - .1 Confirm and document that the fire alarm monitoring centre is receiving these various alarms in a timely fashion. With legacy buildings, a risk exists that physical lines may have been cut and/or subscriptions have elapsed.
    - .2 Confirm and document that manual pull fire stations are functioning as designed. Quick action from the first person to notice a fire will minimize the impact to people and structures.
-

- .8 Smoke and carbon monoxide alarms.
- .9 Hazardous protection monitoring.

**3.03 Site Tests and Inspections**

- .1 In accordance with CAN/ULC-S1001.

**End of Section**

# York Region Information Technology Services

## Standards and Guidelines



### Corporate ITS Cabling & Wiring Standard

**Current Published Version**

February 2, 2024

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## Document History

### Revision & Schedule History

Revision	Changed By	Last Reviewed	Review Scheduled
1.0	Simon Yates	March, 2012	
1.5	David Borsato	April, 2012	
1.6	David Borsato	June 25, 2014	
1.7	Orville Pitter	July 9, 2015	July 9, 2016
2.0	Orville Pitter	April 19, 2016	April 19, 2017
2.1	Orville Pitter	July 28, 2016	April, 2017
2.2	Orville Pitter	Jun 22, 2017	April, 2018
2.3	Orville Pitter	May 9, 2018	April, 2019
2.4	Orville Pitter	June 28, 2018	April, 2019
2.5	Orville Pitter	January 22, 2019	April, 2020
2.6	Orville Pitter	December 19, 2020	April, 2021
2.7	Simon Yates	March 25, 2020	April, 2021
2.8	Orville Pitter	April 21, 2020	April, 2021
2.9	Orville Pitter	July 6, 2020	July, 2021
2.10	Orville Pitter	September 15, 2020	September, 2021
2.11	Orville Pitter	November 16, 2020	March, 2022
2.12	Orville Pitter	March 1, 2021	March, 2022
3.1	Orville Pitter	June 21, 2021	March, 2022
3.2	Orville Pitter	February 8, 2022	March, 2022
3.3	Orville Pitter	February 3, 2023	March, 2023
3.4	Orville Pitter	May 12, 2023	March, 2024
3.5	Orville Pitter	June 18, 2024	March, 2025

### Change Summary

Date	Summary
July 28, 2016	Minor grammar and syntax updates. Fax Lines Requirement – Deleted. Appendix D & E updated.
January 9, 2017	Replaced must with shall, and added Document Changes table to document history.
August 28, 2017	Changed cabling 6A to 6A F/UTP.
April 24, 2018	Changed in-building renovations in scope, multimode optical fibre to OM4, added appendix B, changed BAS, Security Panel (Honeywell), rack cabinet installation, and applied new corporate writing style.
May 9, 2018	Updated contact information.
June 28, 2018	Added Appendix K.
January 22, 2019	Updated technical specifications.
December 19, 2019	Renamed from Cabling and Wiring for Voice and Data Communications to Corporate ITS Cabling & Wiring Standard. Updated network equipment.
March 25, 2020	Formatting, grammar, spelling updates.
April 21, 2020	Updated Appendix 2, and general requirements for network equipment.
July 9, 2020	Updated network devices on York Networks, category patch cords, and vertical cable managers.

September 14, 2020	Minor grammar and syntax updates. Removed duplicate heading product specifications n page 18. Promoted second and first level heading, fibre optical cable page 20. Added Appendix L – WAP/Mounting.
November 9, 2020	Updated appendices H with cable talk 2 post rack; M with WAN/ISP duct bank; N with WAN/ISP ducts inside communications room; updated network equipment; and updated communication rack and cabinet.
March 1, 2021	Background & Purpose, Network Devices on York Network, updated to Securing Network Devices on York Network,c, d, and e added. Technical Specifications, updated to Structured Cabling Technical Specifications Termination Hardware, updated to Termination Specification Horizontal Cables, updated to Category Patch Panels Fibre Optic Cable, Connectors moved to section Termination Specification PS Security section updated Enclosure Wiring, changed to Labeling Guidelines Update: Property Services – Security Panel, Building Automation System (BAS)
April 12, 2021	Minor update and changes.
June 28, 2021	The following has sections that have been modified, relocated or deleted: Enforcement Language; Background and Purpose, Contact, Objectives, Scope; Structured Cabling Technical Specification, Recognized Media, Regulatory References & Standards, Waste Management & Disposal, Testing & Commissioning; Product Specification, Backbone Cabling, Conduits, Backbone Interconnect, Fibre Optic Cable, Fibre Optic Connectors, Category Patch Cord; Network Access Closet has been changed to Network Access Room; Execution, Horizontal Cable Installation, Fibre Optic Cable Installation; Appendix; References
July 21, 2021	Further changes to grammar, syntax and tightening of language through the standard.
February 8, 2022	Minor spelling, grammar changes.
February 6, 2023	Updates to the following sections: Site Walk through; Telecom Contractor to provide port count; Structural Cabling Technical Cabling update to include end-to-end by specified color and single contractor for cabling; Cabinets for small deployment and for ENV NEMA4 inserted Appendix F, Category Cabling Color Scheme for Services inserted Appendix L; Sample Matrix of Port Count Report inserted Appendix M; Network Closet Checklist for Standard Sites inserted Appendix N, and remaining adjusted accordingly;
May 12, 2023	Added wall mount cabinet to Appendix D; updated Appendix K, and changed underscore to hyphen.
June 18, 2024	Updates to the Environmental section #3.; Appendix G: removed Hammond and replace with Hoffman Cabinet; and updated the URL in Appendix E.

## Additional Information

Enterprise Architecture manages annual reviews and promotion of the standard.

## Contact

This standard is updated frequently. Contact the person below to ensure that you have the most recent version of this document.

Orville Pitter, Senior Network Analyst, Infrastructure, Planning & Operations  
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## Consulted Organizations

The following individuals and groups were consulted in the formation of this standard.

Organization Consulted	Division	Branch	Date
Ministry of Government Services	Infrastructure Technology Services	Corporate Architecture Branch	April 2011
Belden			May 18, 2021

Committee or Working Group Consulted	Date
Enterprise Architecture	March 2012
Infrastructure and Operations	March 22, 2011
ITS Branch Review	April, 2012

## Enforcement Language

The meaning of the words shall or should or must and recommend are clearly define here:

- Shall: this word, or the terms required or must, means that the statement is an absolute requirement.
- Should: this word, or the adjective recommended, means that there may exist valid reasons in particular circumstances to ignore the recommendations, but the full implications must be understood and carefully weighed.

Cabling and its installation shall comply with the requirements of the authority having jurisdiction (AHJ) and applicable regulations. This includes, but is not limited to, the cabling jacket ratings.

# Cabling and Wiring for Voice & Data Communications v3.5

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## Introduction

### Background & Purpose

This standard defines the design minimum technical and quality requirements for wiring of voice and data communications rooms in all buildings that are managed by, or on behalf of The Regional Municipality of York.

This standard includes new developments, revisions, and updates in cabling plant such as Power over Ethernet (PoE) data centre specific standards, cabling for wireless access points, digital signage, security, and other operational technologies (O/T) that use structured cabling for their infrastructure and the administration standard for cabling plant management. Four topic areas include:

1. **Data centres that are managed by or on behalf of the Regional Municipality of York.** Data centres are included to provide requirements and guidelines for the data centre design and installation. These requirements and guidance are found in ANSI/TIA-942: Telecommunications Infrastructure Standard for Data Centres.
2. **The Cabling of buildings for wireless access points.** Provides requirements and guidelines on the installation of a customer premises cabling system infrastructure for an array of coverage areas that form a wireless network grid within a building. These requirements and guidelines are found in TIA TSB-162: Telecommunications Cabling Guidelines for Wireless Access Points.
3. **Specific adherence to the IEEE 802.3 standards** provides for the implementation of power over Ethernet or data lines within the plant owned by, or managed on behalf of the Regional Municipality of York.
4. Specifies a uniform administration approach to the management of a telecommunications cabling system as found in ANSI/TIA -606: Administration Standard for Telecommunications Infrastructure.

This standard applies to all new or major retrofit wiring of data and voice communications in existing Regional Municipality of York buildings.

1. Network equipment:
  - a. Project will provide the budget for all network equipment including network switches, wireless access points, wireless controller, uninterrupted power supply, firewalls and any other network equipment that ITS considers mandatory to support the setup and configuration the network to meet ITS standards
  - b. ITS will procure all network equipment including network switches, wireless access points, wireless controller, uninterrupted power supply, firewalls and any

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other network equipment that ITS considers mandatory to support the setup and configuration the network to meet ITS standards based on the budget.

- c. Telecom contractor shall supply network racks, cables, patch panels, cable trays and any associated supplies for cabling based on ITS Cabling and Wiring Standards.
- d. Telecom contractor shall provide port count by network closet and by device type (data/voice, WAP, BAS, Energy, Camera, IoT) to enable Corporate ITS requested quotes for network equipment and to assign IP-addresses (see Appendix M).
- e. Telecom contractor shall provide any emulated Wi-Fi surveys with input, review and acceptance for Corporate ITS.
- f. Telecom shall install racks, run network cables and terminate to patch panels, install UPS and WAPs based on instructions provided by Corporate ITS.
- g. Backbone and horizontal infrastructure cabling shall be completed by an installer certified by the cabling system manufacturer, and the cabling shall be certified upon completion.
- h. ITS recommends that category cable patch panels be from manufacturers that meets or exceeds ANSI/TIA 568.2 Category 6A performance requirements and design specifications.

### 2. Securing Network Devices on York Network:

- a. All devices that require connectivity to York Networks shall be direct network run.
- b. A list of all devices not issued by York ITS that will connection to the York Network must be provided to Corporate ITS. The list must include the make, model and specification and function.
- c. ITS Security must conduct ITS security testing on all devices prior to connection to the York Region Network.
- d. If testing of device is not done prior to connection, then it is done when the first device is added to the network.
- e. If York ITS identifies security issues, these issues need to be resolved by the vendor.
- f. ITS Security and Enterprise Architecture will review and make recommendations as well as provide a path to ensure that the device is a safe device to be on the York Region network.

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## Objectives

The Objectives of this standard are to

1. Provide safe, reliable, uniform and up to date facilities for the convenient connection of telephones, computers, computer terminals and other communications related technologies utilizing cabling and wiring in Regional offices;
2. Achieve significant cost savings in the rearrangement of government offices and the relocation of government services and personnel by uniform and flexibly arranged communications connections; and
3. Increase the value of the investment in the cabling infrastructure by reducing the labour expense of maintaining the system, extending the useful life of the system and providing effective service to users.

## Scope of Standard

The following platforms, and facilities are in scope of this standard.

- Horizontal and vertical structured cabling platforms
- Data centre structured cabling platforms
- In-building facilities including
  - Main telecommunications room
  - Telecommunications rooms
  - Workstations
- In-building renovations
  - If cabling is less than Category 6 standard or older than 10 years, must be replaced with current standard including the patch panel and all related connectivity.

## Out of Scope

Electrical cabling is not covered by this standard.

## Education & Training

Data Centre and technical staff shall be trained and experienced on the technologies used pertaining to structure cabling infrastructure.

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### Authority, Exceptions and Exemptions

Any change, exception, exemption or deviation from this standard shall be reviewed by the Region's Strategy & Architecture, Technology Planning units and approved by the Technology Standards Working Group (TSWG). Any change to this standard shall be submitted to the TSWG.

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## Structured Cabling Technical Specification

The contractor shall provide a complete and operating Structured Cabling Platform to support existing and future communication systems in Regional facilities. This includes all horizontal cabling for voice and data applications as well as backbone.

All cabling for the network shall be completed by one cabling contractor that is able to provide cable as built and test results.

Network (horizontal) cabling shall adhere to York ITS Network Standard Category cabling color specification and installed end-to-end including keystone and patch cables.

If product specifications, design and installation guidelines are not provided or in conflict with references listed below. The more stringent requirement shall apply.

The Horizontal Structured Cabling Platform installed shall meet or exceed the channel requirements for voice and data transmissions as defined by ANSI/TIA-568.2.

Any Structured Cabling Platform installed in a Data Centre or Communications Room shall follow the mandatory requirements, guidelines and best practices for data centre cabling systems, pathways and design considerations found in Regulatory References and Standards: Telecommunications Infrastructure Standard for Data Centres. Category 6A UTP (500MHz) 23AWG cabling shall be used as the minimum rated twisted pair cable. Horizontal cabling should be installed point-to-point, no network consolidation point.

Cables, associated connecting hardware, jumpers, patch cords, equipment cords and zone area cords shall meet all applicable requirements specified in ANSI/TIA-568.2.2 and ANSI/TIA-568.3.

## Recognized Media

1. 100 ohm twisted-pair cable, ANSI/TIA-568.2, Category 6A UTP 23AWG.
2. Patch cables of minimum Category 6A F/UTP 26AWG.
3. Multimode optical fibre cable OM4, ANSI/TIA-568.3.
4. Single-mode optical fibre cable, ANSI/TIA-568.3.

## Regulatory References & Standards

The standard defines specific categories of cabling, components, transmission performance, system models, and measurement procedures. These are needed for verification of cabling performance that shall be used at a minimum for any new or major retrofit wiring of data and voice communications in existing York Region buildings. These are the requirements found in recognized telecommunications industry standards:

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## Cabling Systems

1. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises
2. ANSI/TIA-568.1: Commercial Building Telecommunications Infrastructure Standard
3. ANSI/TIA-568.2: Balanced Twisted Pair Telecommunications Cabling and Components Standard
4. ANSI/TIA-568.3: Optical Fibre Cabling and Component Standard

## Spaces and Pathways

5. ANSI/TIA-569: Telecommunications Pathways and Spaces.

## Cabling Administration

6. ANSI/TIA606: Administration Standard for Telecommunications Infrastructure.

## Telecommunications Infrastructure Standard for Industrial Premises

7. ANSI/TIA-1005: Telecommunications Infrastructure for Industrial Premises.

## Telecommunications Infrastructure Standard for Data Centers

8. ANSI/TIA-942: Telecommunications Infrastructure Standard for Data Centres.

## Wireless Access Points

9. TIA TSB-162: Telecommunications Cabling Guidelines for Wireless Access Points

In addition, coverage of this standard includes new developments and updates in cabling plant such as Power Over Ethernet (PoE) data centre specific standards, cabling for wireless access points and the administration standard for cabling plant management.

All work shall conform to industry accepted practices, manufacturer's component installation guidelines, the Ontario building code, the Canadian Electrical Code, and all applicable standards. The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies. Furthermore, compliance with the AHJ will supersede all other specifications.

This standard applies to all new or major retrofit wiring of data and voice communications in existing Regional Municipality of York buildings.

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## Documentation

Documentation related to the installation, maintenance and disposal of cabling plant shall be created and maintained by the parties responsible for installing and maintaining the cabling infrastructure on behalf of the Regional Municipality of York. This administration of the cabling plant is governed by the mandatory use of Standard Update to Administration for the telecommunications infrastructure; and the labelling convention described in Regulatory References and Standards under Cabling Administration.

The following line items describe individual requirements that are to be applied to all Communications Cabling projects. The line items are meant to serve as a guideline for the Regional requirements.

All horizontal cabling shall be installed from the workstation location, or on modular patch panels installed into racks or cabinets. For small sites, the customer can specify wall-mounted patch panels in lieu of racks where appropriate due to site constraints and capacity requirements.

## Allowances

Devices, racks, cabinets, backboards or outlets may be relocated, prior to installation, from the location shown on the contract drawings, to a maximum distance of 3.05 meters (10 feet) without adjustment to the contract price.

## Waste Management & Disposal

The cabling contractor shall remove and dispose of all abandoned horizontal voice, data and coaxial cabling. If the cabling contractor is unsure of the status of the cables, they shall confirm the removal with the project manager prior to performing the work.

## Testing & Commissioning

Provide two copies of testing and commissioning documentation for all items and their related components to the project manager prior to the completion of the project or at the project manager's request. Include maintenance manuals, operating instructions for the Region's staff. All test data, including daily equipment reference checks, shall be submitted in native tester format (e.g. FLW files for Fluke) and summary in PDF.

## Warranty

The structure cabling platform in each individual building or site shall be manufactured and warranted by a single manufacturer for all components of the structured cabling platform including backbones.

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The successful bidder shall install a complete structured cabling platform that is manufactured and warranted by a single vendor. The successful bidder shall be authorized by the cable vendor to install and warranty the system. If a sub-contractor is used for the installation, it is mandatory that the sub-contractor be currently authorized to install and warranty the system.

### Site Walkthrough

The cabling contractor shall participate in network cabling walkthroughs:

- a. 0% walkthrough: Initial pre-construction walkthrough with ITS, York Region and General Contractor (GC) to ensure that the scope of work is understood and for questions regarding ITS Network cabling standards.
- b. 50% walkthrough: to confirm the project is on track and the cabling standards are adhered to.
- c. 100% walkthrough: for the network closet acceptance (cabling is completed, Network closet is free of all debris, testing results and has builds have been provided, etc) with ITS, York Region, GC and cabling contractor. The acceptance is contingent on satisfying the criteria outlined in "ITS New/Renovated Site Networking Provisioning Checklist" (Appendix N).

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## Product Specifications

### Backbone Cabling

#### Optical Cabling Backbone

OM4 fibre backbone cabling shall comply to ANSI/TIA-568.3.

Each Fibre backbone cable shall have a minimum of 12 strands OM4 distribution type fibre. The OM4 distribution type fibre will perform as per industry standards over the required distance defined for the site. Mated connector loss for OM4 shall not to exceed 0.25 dB.

#### Conduits

Conduit fill ratios shall never exceed the recommendations of ANSI/TIA-569.

#### Backbone Interconnect

1. If there is a requirement for an interconnection between wiring closets on the same floor, or multiple floors, it shall be interconnected with minimum of six fibre OM4 rated fibre optic backbone terminated with LC connectors.
2. All connectors for the termination of the fibre optic backbone cable shall be duplex LC connectors.
3. Fibre optic enclosure shall meet the following requirements:
  - Enclosure shall include a slide-out drawer for front access of the terminations.
  - Enclosure shall support LC connectors.
4. For multimode fibre optic terminations inside access closets fibre patch panels the connectors shall be preloaded adapters configured with LC duplex multimode adapters.
5. Provide duplex OM4 fibre optic patch cables LC to LC.

## Termination Specification

### Category Patch Panels

All horizontal cables are to be terminated on RJ45 jacks, inserted into modular category patch panels, and placed in the telecommunications room for that floor. The modular patch panel should minimise the rack space used, and should not exceed two rack units in height.

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## Fibre Patch Panels

If required, the number of strands to be supplied and installed is a minimum of 12. The project manager, in consultation with the Region, will finalize quantity and type of fibre to be installed.

All Fibre backbone is to be terminated using a fibre patch panel on a communications rack. The 12 strands of fibre shall be installed in the fibre patch panel and placed in a rack in the telecommunications room for that floor. The fibre patch panel should minimize the rack space used, it cannot exceed three rack units in height. The fibre patch panel shall be serviceable from the front by allowing the fibre patch panel to slide or pivot away from the rack. The fibre patch panels are to be mounted at the upper most position on the racks of each floor.

Provide all necessary accessories for a complete fibre patch panel including, but not limited to: clear cover plates, mounting brackets and hardware, LC duplex fibre bulkheads, LC connectors and fibre cable management.

The physical fibre optic cabling topology and the type of fibre connectors shall be determined and finalized during design build of project.

## Fibre Optic Cable

1. Provide all fibre optic cable, connectors and appurtenances that make up the backbone cable segments.
2. The fibre optic backbone cable segments shall meet the requirements of the TIA/EIA-568.3 specifications.
3. Multi-mode fibre optic backbone cable shall be OM4.
4. Single mode fibre optic backbone cable shall be OS2.

## Connectivity

### Category Patch Cord

Three patch cords seven feet in length per drop shall be provided on site, two for the IP phone/desktop connectivity, and one for the patch panel to network switch. These cords shall match the cabling category being installed. Further small OD patch cords shall be used where the performance of the network will not be negatively affected: i.e. channel length and configuration, data transmission and power delivery.

The project manager, in conjunction with the ITS planner, shall determine and put forth request if additional lengths are required.

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## Fibre Patch Cord

All fibre patch cords shall be connected to the customer supplied active equipment using LC duplex zip cords. The fibre patch cords are to be seven feet in length. LC duplex zip cords are to be consistent with the grade and manufacturer of the fibre cable that is being warranted.

## Communications Rack & Cabinet

All racks and cabinets to be supplied and installed to be bolted to the floor or otherwise secured to prevent tipping, 19" floor mounted with 44U of rack mounting space. Both racks and cabinets shall be tapped both front and back with mounting holes as per EIA-310-C, size 10-32, as well as include a ground lug to accept a #6 AWG grounding wire.

All network access spaces dedicated to York Region ITS network and Security should utilize 2-Post open frame rack (see Appendix H). If other services beyond ITS Network/Security is to be hosted, types of rack/cabinet installation should be discussed and determined by York Region IT Services.

## Vertical Cable Managers

Network cabinet shall come complete with two vertical cable managers installed: one mounted on each side. Network rack cable managers shall be one of two dimensions. Micro and small sites four inches wide by four inches deep. Medium and large sites 7.5 inches width by six inches deep. The vertical cable manager shall have hinged front door(s), back and side cut outs to allow for patch cords. It shall also have lancets along the back of the cable manager to allow for the fastening of the horizontal cable to the outside of the manager itself. Higher density drops may require vertical cable management with increased width and depth.

## Overhead Cable Manager & Chimney

Each cabinet and rack shall come complete with a hinged overhead cable manager installed, with minimum dimensions of eight inches wide by two inches deep. Where racks are ganged, the overhead cable manager is to be continuous across the gang of racks; both ends of the ganged racks are to be completed with end caps. At the right side of each rack a cable management chimney shall be installed. They shall extend from the top of the overhead cable manager to the underside of the ladder tray/ceiling tile above.

## Equipment Shelves

Each cabinet and rack is to be supplied with, at a minimum, one equipment shelf if requested; this is to be installed at the direction of the customer. The equipment shelf is to be centre mounted and have a minimum of 18 inches of depth.

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### Vertical Switched Zero PDU

Each cabinet and rack is to come complete with two vertical switched Zero U PDU mounted to the back of the rack. Each PDU is to have a minimum of eight outlets rated at 110V, 15A. The power bars are to have a minimum power cord length of six feet. The power bars are not to have reset breakers or an on/off switch.

The Customer may require additional power requirements over and above what is detailed above. It is the responsibility of the Project Manager to provide these requirements to the Cabling Contractor.

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## General Enclosure Requirements

1. All indoor enclosures containing network components are to be installed in a two-post, four-post open rack frame, or cabinet.
2. All screws, bolts, fasteners etc. are to be corrosion resistant stainless steel.
3. All wall-mounted panels are to be separated from the wall by stainless steel spacers or galvanised steel struts.
4. Doors shall have continuous hinges with removable pin and oil resistance cellular neoprene gasket secured by gasket retainers. Door handles shall be recessed type (freestanding enclosures) or three-point external latch wall mount, complete with key locks. All key locks are to be identically keyed. The key number shall be provided to the Contractor during construction.
5. Cable bundles shall be neatly laced, run in ducting or approved cable managers and secured to 19-inch rack or mounting back-panel.
6. All enclosure doors shall open through 180 degrees without restriction.
7. Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.
8. All freestanding, floor-mounted enclosures shall have removable CSA eyebolts to facilitate sling handling of each enclosure. Eyebolt mounting shall be a part of the structural support bracing to distribute stresses and enclosure weight while sling handling enclosures during installation.
9. All enclosures shall have sufficient structural reinforcements to ensure a limited plane surface vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the enclosure, mounting panel or mounted instruments.
10. All enclosure seams shall be continuously welded and ground smooth to be undetectable after painting.
11. Devices shall be installed on the enclosure back-panel or 19-inch rack.
12. There shall be no devices installed on the side plates of the enclosure.

## Enclosure Wiring

1. All enclosure wiring shall run through cable management. All cabling is managed, protected, and enclosed.
2. Cable managers shall not be filled to more than 50 percent of their volume upon initial installation.

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3. All wires and cables, including spares, shall be identified at each end and at any connection. Use durable non-fading sleeve type wire markers to identify all network cables as follows:
  - a. Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor).
  - b. Hand-written labels will not be accepted.
  - c. Lettering shall be black on a white background. Characters shall be a minimum of four millimetre high.
  - d. Wire markers are required on each conductor in panel board gutters, and at load connections. The identification shall include branch circuit or feeder number for power and lighting circuits, and control wire numbers for control wiring.
  - e. All field wires and cables terminated within enclosures shall be identified at each termination with a marking that corresponds with the drawings and supporting documentation.
  - f. Power wiring insulation shall be rated at 600 volts at 90 C and be type RW 90 THHN. Conductors shall be stranded copper. No wire smaller than 12 AWG shall be used for power wiring, unless noted otherwise on the drawings.

### Rack/Cabinet Installation

1. All cable is to enter through the bottom or top of the cabinets. If coring of the floor is required for the passage of cable the Contractor is to X-Ray the floor in accordance with Division 1.
2. Provide a 12" wide minimum cable tray segregated for power, fibre and horizontal UTP cables for overhead cabling as shown on the Contract drawings. Cable management is to be provided from the cable tray to the enclosure to ensure that the minimum bend radius for each cable is maintained and the cable is rigidly supported.
3. Electrical
  - a. Provide the electrical distribution for each core and server closet as per the related Electrical Distribution drawings and relevant standards.
  - b. Provide each core and server closet with required number of duplex 15A, 120 VAC.
  - c. The project manager will provide UPS Receptacle specification to the contractor, typically one of the following which will be dependent on Load/Runtime requirement or if building generator/UPS is in scope.

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UPS Receptacle Option	UPS Series	Input Power
Option 1	APC UPS 1500	NEMA 5-15R
Option 2	APC UPS 2200	NEMA 5-20R
Option 3	APC UPS 3000	NEMA L5-30R
Option 4	APC UPS 5000	NEMA L6-30R

- d. Secure each rack and cabinet to ground.
- e. The duplex receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
- f. Power distribution within the enclosure shall be via vertically mounted power bars.
- g. Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.

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## Network Access Room

Network Access Rooms (NAR) shall be large enough to accommodate all of the equipment and wiring that will be placed in it, and include extra space to accommodate any future growth. NAR shall meet the requirement of ANSI/TIA-569

## Environmental Specifications

1. Shall satisfy environmental requirements that include, but not be limited to power supply, heating, ventilation, and air conditioning.
2. NAR should maintain a room temperature between 19 to 23 degrees Celsius for the cold zone with the assumption that air flow is from front to back (cold to hot) when all LAN equipment is in full operation and a relative humidity of between 30 to 50 percent.
3. Open water sources are prohibited. Sources include but are not limited to hose bibs, slop sinks, plumbing fixtures and maintenance drains in hydronic heating and cooling.
4. The wiring closet shall not double as a storage area for cleaning products, chemicals, equipment, cardboard or furniture. The wiring closet shall be kept clean and free of any debris.
5. There should be at least one duplex power outlet positioned every 1.8 meters along each wall of the room, and should be positioned 15 cm above the floor. A wall switch that controls the room's main lighting should be placed immediately inside the door.
6. UPS plug type and BTU for equipment shall be provided by York Region ITS.

## Cable Access and Support

1. If data closet serves as a Main Distribution Facility/Facilities (MDF), all cables running from it to Intermediate Distribution Facility/Facilities (IDF), computers and communications rooms on other floors of the same building should be protected by a four inch conduit or sleeved core.
2. The exact amount of conduit that is required is determined by the amount of fibre optic, UTP, and STP cable that shall be supported in each NAR.
3. Cabling should be run through four-inch sleeves that are placed above the door level. To ensure proper support, the cable should be run from the sleeve directly onto a 12-inch ladder racked in the room.
4. Supply and install all horizontal wiring, jack boxes, raceway, wall plates, telephone punch-down blocks and identification labels.
5. Identify all wiring at both ends, at the jack end and in wiring closet.
6. Terminate, test and certify all installed wiring in accordance with industry standards.
7. Include additional lengths of conduit to provide for future growth.

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## Property Services — Security Panel

1. Lenel solutions is used for access control, Bosch for Intrusion and Milestone for CCTV for all new sites. CCTV system is a requirement for facilities accessed by the public unless otherwise specified (examples. Court Services, YRT, ENV and Corporate Sites). This will include an onsite video server, UPS back-up and the XProtect application connected to the database servers at 17250 Yonge Street, Newmarket.
2. Security cabinets shall be placed in the NAR or Electrical room and will require a standard wall space of four feet high by eight feet wide. This may increase depending on the size of the facility and requirements for card access and panic alarms.
3. The following requirements shall be adhered to:
  - There shall be 32 square feet of wall space;
  - Be eight-inch in depth, and require an additional 28 inches of clearance for a total of three feet;
  - Panel area should be situated three feet vertically from the floor and the panel should be installed on fire retardant backboard;
  - Security panels should not be placed in mechanical rooms, or general areas opened to staff or other personal; and
  - Security panels are to be supplied with dedicated emergency power.
4. Category 6A cable, Purple in color should be used for end-to-end horizontal cabling, patch cable and keystone.
5. Facilities with on-site security guards will require an XProtect Smart Client workstation with monitors. The quantity referenced in site specific design and are to be located in the security office.

## Building Automation System (BAS)

1. Building automation equipment may be in various locations including, but not limited to the following areas.
  - NAR
  - Ceiling
  - Mechanical Room
  - Electrical Room
2. Typical cabinet size that would be expected to be in the NAR.

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- Two feet wide by three feet high and six inches in depth with a door swing of two feet, seven inches
  - Eighteen inches wide by eighteen inches high and six inches in depth with a door swing of nineteen inches
  - Quantity maybe one to three depending on number of points Panels should be situated six feet vertically from the panel top to floor and should be installed on fire retardant backboard.
3. Conduits should be used to join the larger cabinets.
  4. Power Supply to BAS panel should be separate and has its own junction box or panel.
  5. Category 6A cable, Orange in color should be used for end-to-end horizontal cabling, patch cable and keystone.
  6. All BAS Category 6A drops shall be terminated to a patch panel in the network rack.
  7. Requirement of one data jack per IP device located beside the cabinets in which the devices are located.
  8. If placed in the vicinity of a network racks, there should be an additional two feet of clearance.
  9. All enclosure wiring shall run through cable management. All cabling is managed, protected, and enclosed.
  10. Cable managers shall not be filled to more than 50 percent of their volume upon initial installation.

### Labeling Guidelines

1. All wires and cables shall be identified at each end, and at any connection. Use durable non-fading sleeve type wire markers to identify all network cables as follows:
  - a. Labels for cabling shall be laser printed, self-laminating, adhesive, polyester suitable for indoor and outdoor use.
  - b. Hand-written labels will not be accepted.
  - c. Lettering shall be black on a white background. Characters shall be a minimum of four millimeters high.
  - d. Wire markers are required on each conductor in panel board gutters, and at load connections. The identification shall include branch circuit or feeder number for power and lighting circuits, and control wire numbers for control wiring.

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- e. All field wires and cables terminated within enclosures shall be identified at each termination with a marking that corresponds with the drawings and supporting documentation.

### Category & Fibre Patch Panel Identification

York Region Category and fibre patch panels identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.

1. Labels for patch panels shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
2. Hand-written labels will not be accepted.
3. Lettering shall be black on a white background, and shall be a minimum of six millimetres high.
4. Labels shall be applied to be readily visible, and not obscured by structured cabling or patch cords.
5. The tagging convention for network closet patch panels will employ a six-character alphanumeric tag. The first three characters will indicate location consisting of floor and access closet identifier. The last three characters shall use a unique number incrementing with each drop within each closet.

### Face Plate

York Region UTP patch panel termination point identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.

1. Labels for faceplate shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
2. Hand-written labels will not be accepted.
3. Lettering shall be black on a white background and shall be a minimum of four millimetres high.
4. A label shall be applied to the top of each faceplate indicating the destination of the faceplate.

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## Fibre Optic Patch Panel

York Region fibre optic patch panel termination point identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.

1. Terminate all fibres of each fibre optic cable in either 36/72 Fibre Enclosures for access closets, or 36/72/144 Fibre Enclosures for core closets.
2. The ordering and colour of individual fibres will be the same for each fibre cable and compliant with ANSI/EIATIA-568.3.
3. Labels shall be laser printed, self-laminating, adhesive, and polyester or polyolefin.
4. Hand-written labels will not be accepted.
5. Lettering shall be black on a white background and shall be a minimum of four millimetres high.
6. A label shall be applied to the top of the fibre duplex adapter modules associated with a single fibre cable indicating the destination of the cable.

## Backbone & Horizontal

York Region network cable identification shall follow the standards outlined below. Any exceptions to the following requirements shall be approved by the Region's project manager.

1. Use durable non-fading sleeve type wire markers to identify all network cables.
2. Labels for cabling shall be laser printed, self-laminating, adhesive, and polyester for indoor and outdoor use.
3. Hand-written labels will not be accepted.
4. Lettering shall be black on a white background and shall be a minimum of four millimetres in height.
5. Fibre Optic Backbone Cables
  - a. All fibre optic backbone cables are to be labelled at both ends of the cable.
  - b. The fibre backbone cables are to be labelled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
  - c. If the fibre cable is run in conduit, then the transition labels shall be applied to the conduit.

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- d. The tagging convention for identification of fibre optic backbone cables shall indicate the source and destination of the cable.
- 6. Horizontal Cables
  - a. As a minimum, all horizontal Category 6A UTP cable is to be labelled at both ends of the cable.
  - b. The tagging convention for identification of horizontal cables shall indicate the drop sequence and Telecommunications Room (TR) of the cable.

## Execution

- 1. Provide all components and appurtenances necessary to ensure that the network closets are functional and meet the intent of this specification.
- 2. Locate work area outlets where the length of the horizontal cable runs from the access closet interconnect to the work area outlet shall be less than 90 meters. For work area outlets where this proves impossible the Contract Administrator will authorize in writing an exception if the link still meets the performance requirements of this specification.
- 3. The Contract Administrator reserves the right to relocate access closets and work area outlets within three metres of the locations identified in the contract drawings at no additional cost to the Region.
- 4. The contractor is responsible to size all power supply cables to meet the requirements of the Ontario Hydro Safety Code based on field verified length of cable run and power supply load.
- 5. Cable and Conduit
  - a. Provide one Category 6A UTP, horizontal cables to each work area outlet from an access closet in a Electric Magnetic Tube (EMT) conduit, sized to accommodate quantity of cabling and a minimum trade size of 35 1-1/4.
  - b. Conduit carrying horizontal cables shall enter the work area outlet through the top or bottom.
  - c. Conduit shall be Electric Magnetic Tube conduit (EMT). Corrosive environments will be noted on the access closet Installation drawings. Conduit running through corrosive environments shall be Rigid PVC.

## Work Area Outlets

- 1. Work Area Outlets
  - a. Horizontal cabling installed using wall outlets and floor boxes are to use single gang, or double gang if required, and they are to match the decora straps. Each

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decora style strap is to have a minimum of two positions for communications modules. Each outlet is to be equipped with the appropriate modules. Any unused communication positions in wall outlets shall be filled with a blank. The colours of the UTP modules and furniture adapter plates may be changed at the discretion of the project manager.

- b. Provide one one-port, single-gang, metal work-area outlets, connectors and appurtenances for termination of the horizontal Category 6A UTP cables. If four Category 6A UTP cables are consolidated at the Work Area Outlet, then one four-port work-area outlet is required. If eight Category 6A UTP cables are consolidated at the Work Area Outlet, then one eight-port work-area outlets is required.
- c. Each work-area outlet will be associated with a one-port, snap-in faceplate installed in the access closet or Core Closet patch panel.
- d. All Category 6A UTP connectors shall be modular jacks and wired for a T568A wire-map.
- e. All Category 6A UTP shielded connectors shall be bonded to ground.

### Horizontal Cable Installation

1. All horizontal cabling from the access closet to the work area shall comply with the manufacturer's certification requirements and recommendations; as well as meet the performance parameters of ANSI/TIA-568.2 and the design requirements of ANSI/TIA-568.1.
2. Pathways shall be in EMT conduit minimum trades size 1-1/4 or as specified by the AHJ. Pathways shall be sized according to the requirements of the AHJ in addition to the recommendations of ANSI/TIA-569 with a planned capacity threshold of initial installation requirements +20%.
3. All labeling to confirm to ANSI/TIA-606 and a sample of the proposed labeling scheme to be submitted to the client for approval.

### Fibre Optic Cable Installation

1. All fiber optic cabling from the access closet to the work area shall comply with the manufacturer's certification requirements and recommendations. They shall meet the performance parameters of ANSI/TIA-568.3 and the design requirements of ANSI/TIA-568.1. For outside plant installations, the requirements of ANSI/TIA-758 shall be followed. No cable splices are allowed for inbuilding fiber optic cabling.
2. Indoor pathways shall be in EMT conduit minimum trades size 1-1/4 or as specified by the AHJ. Pathways shall be sized according to the requirements of the AHJ in addition to

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the recommendations of ANSI/TIA-569 with a planned capacity threshold of initial installation requirements +20%.

3. All labeling to confirm to ANSI/TIA-606 and a sample of the proposed labeling scheme to be submitted to the client for approval.

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## Appendix A — Horizontal Cable Labelling Format

First Floor with one data closet

D1-0000 to D1-nnnn

First Floor with multiple data closets

D1A-0000 to D1A-nnnn

D1B-0000 to D1B-nnnn

Second Floor with one data closet

D2-0000 to D2-nnnn

Second Floor with multiple data closets

D2A-0000 to D2A-nnnn

D2B-0000 to D2B-nnnn

Multiple Floors with multiple data closets

Increment the 2<sup>nd</sup> position of the format above for each floor.

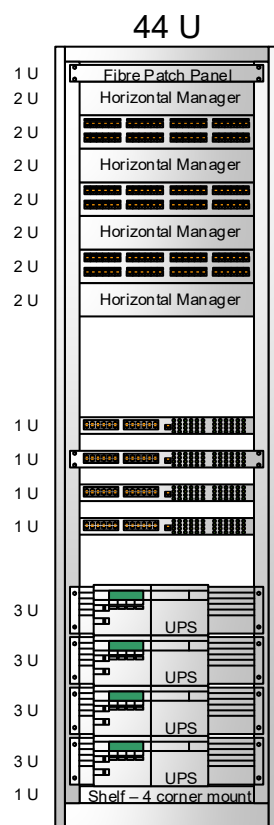
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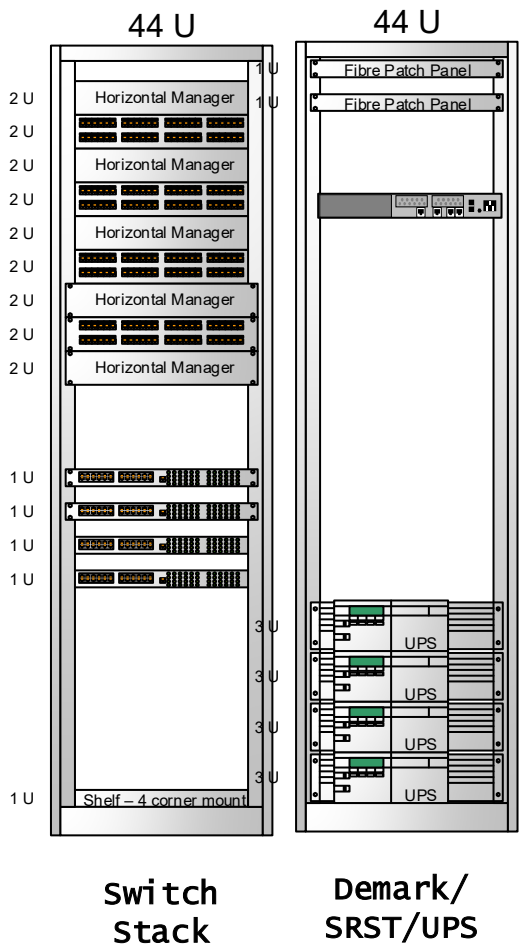
## Appendix B — Network Rack/Cabinet Layout (Single)

Typical Single Network rack/cabinet layout.



Appendix C — Network Rack and Cabinet Layout (Dual Rack)

Typical Dual Network rack/cabinet layout.



# Cabling and Wiring for Voice & Data Communications v3.5

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## Appendix D – Network CableTalk Cabinets

<https://www.cabletalk.com/cabinet-solutions>

30"x 42"x 83" - 44U

CTC3-3042K-03PF-B		
CTC3-3042K-B	Cabinet Frame <b>30"x 42"x 83" - 44U</b>	1
CTC3-30-05-PF-B	Perf Lockable Front Door	1
CTC3-30-03-PF-B	Perf Lockable Split Door	1
CTC3-42-11-B	Solid Side Panels	2
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

30"x 36"x 83" - 44U

CTC3-3036K-03PF-B		
CTC3-3036K-B	Cabinet Frame <b>30"x 36"x 83" - 44U</b>	1
CTC3-30-05-PF-B	Perf Lockable Front Door	1
CTC3-30-03-PF-B	Perf Lockable Split Door	1
CTC3-36-11-B	Solid Side Panels	2
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

## Network Wall Mount Cabinet

<https://www.cabletalk.com/wall-mount-solutions>

CTCWH-2524-DSO-B		
CTCWH-2524-DSO-B	Commercial Wall Mount Cabinet 11U	1
CTPBH-069-B	6 Outlet 15A Powerbar	1
CTC-FS-2	2 Fan Assembly	1

CTCWH-3428-DSO-DR		
CTCWH-3428-DSO-DR	3428 WINDOW FROND DOOR	1
CTCWH-3428-DS0-MB	MID-BODY, 3428-DSO	1
CTCWH-3428-DS0-004	REAR BODY	1
CTCWH-3428-CMS	3428 WALL MOUNT CMS	2

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MTG ANGLE		2
CTCWD-D-HINGE-BKT	HINGE BKT MALE	2
CTCWH-2524-DSO-B-014	MID HOUSING, BOLT-ON-HINGE, FEMALE	2
CTC-44-B	COVER PLATE	4

## Cabling and Wiring for Voice & Data Communications v3.5

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### Appendix E — Network CableTalk 4-Post Open Frame Racks

<https://www.cabletalk.com/4-post-racks>

30"x 36"x 83

<b>CTC3-3036-03-B</b>		
CTC3-3036K-B	Cabinet Frame <b>30"x 36"x 83" - 44U</b>	1
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

30"x 42"x 83"

<b>CTC3-3042-03-B</b>		
CTC3-3042K-B	Cabinet Frame <b>30"x 42"x 83" - 44U</b>	1
CTC3-MA-16L-B	19" EIA Mounting Angles - Tapped 10/32	2
CTC3-CMS-11-B	Vertical Cable Management	1
CTPBV-1277-B	12 Outlet 15A PowerBar	2

## Cabling and Wiring for Voice & Data Communications v3.5

eDOCS: 5708119

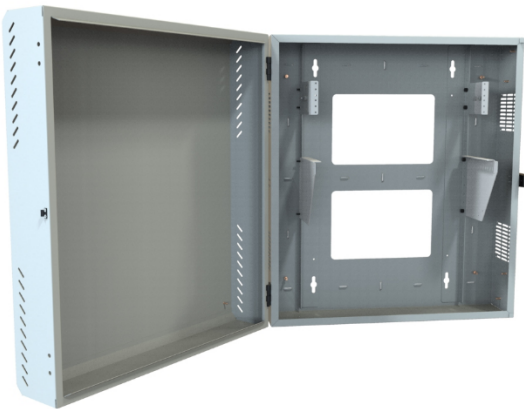
**First published:** July 9, 2012  
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**Approved by:** TSB

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### Appendix F – Network Small Site Deployment Cabinets

Where wall space is limited utilize Hammond HLP Series Low-Profile Wall Mount Rack Cabinet of application-appropriate size and configuration **complete with HWCF Cabinet Sealing and Filter Kit and padlock/lock hasp or equivalent to be approved by York Region.**

<https://www.hamdfq.com/dci/products/wall-mount/hlp#similar-products>



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### Appendix G — Network Environmental Services Facilities NEMA4

For Environmental Services' facilities, utilize Nema4 Hoffman ProTek Double-Hinge Solid Door PTHW242424G4 ( or other application appropriate size). Complete with rack-mount, steel shelf vented, back plate, cable management and padlock handle.

<https://hoffman.nvent.com/products/protek-single-door-ul-and-nema-type-4-12-0>  
[https://hoffman.nvent.com/sites/g/files/hdkjer316/files/acquiadam\\_assets/2021-09/Spec-00713.pdf?asset\\_type=Data%20Sheet](https://hoffman.nvent.com/sites/g/files/hdkjer316/files/acquiadam_assets/2021-09/Spec-00713.pdf?asset_type=Data%20Sheet)



## Cabling and Wiring for Voice & Data Communications v3.5

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**Last Reviewed:** February 2, 2024  
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### Appendix H – HP Server Rack

HP 42U 600mm x 1075mm Enterprise Pallet Rack		
HPE-P9K37A	HPE 42U 600x1075 Ent G2 Pallet Rack	1
HPE-P9L15A	HPE G2 Rack 42U 1075mm Side Panel Kit	1
Option - Shelves for HP		
234672-B21	HP 100Kg Sliding Shelf (Sliding)	1
253449-B21	HP Mon/Util Shelf (Fixed)	1

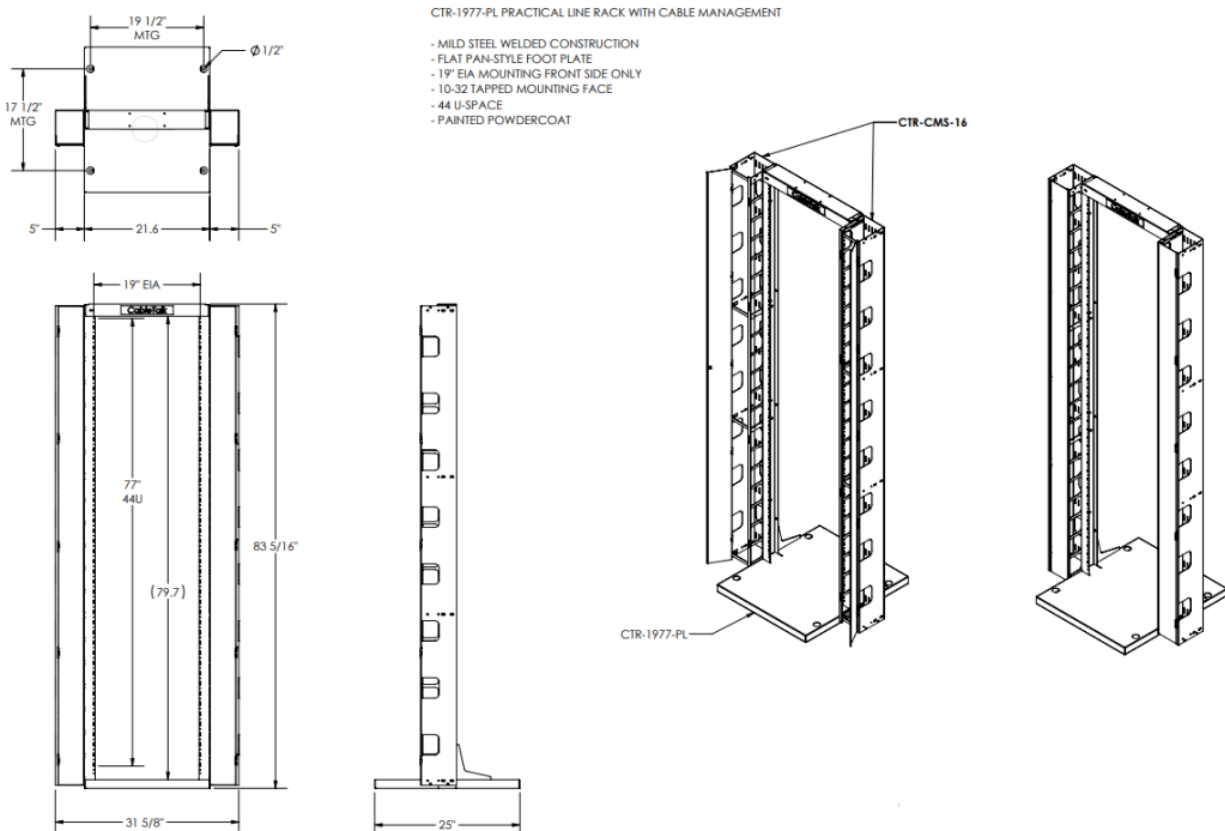
# Cabling and Wiring for Voice & Data Communications v3.5

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## Appendix I – Network CableTalk 2-Post Rack

Part Number and Description: CTR-1977-PL Practical Line Rack with Cable Management



### Appendix J – Naming Convention for Wi-Fi Access Point (AP)

#### Staff Wi-Fi

1. AP should be labelled: **Site-FL-RM-AP#**. Where Site is Site Name, FL is the floor, RM is the Network Closet Room Number, AP# is the number of AP on that floor and numbering should restart on each floor.
  - a. Ie: AP number 16 on the first floor in the Annex that is cabled back to room 1-006 would be labelled as follows: ANNEX-1-1-006-AP16
2. Data Jack labelling: **RM-AP#**
  - a. Ie: data jack that is used for AP number 16 on the first floor of the Annex that is cabled back to room 1-006 would be labelled as follows: 1-006-AP16
3. Patch Panel should be labelled: **AP#**
  - a. Ie: patch panel that is used for AP number 16 on the first floor of the Annex that is patched back to room 1-006 would be labelled as follows: AP16

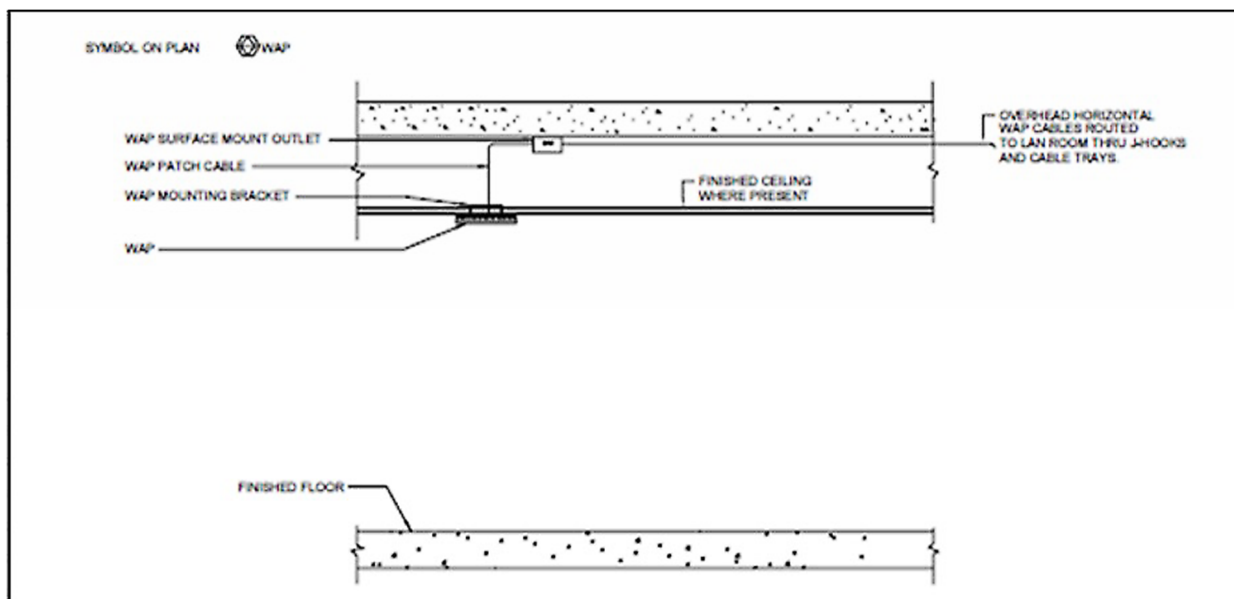
#### Public Wi-Fi

4. Public AP should be labelled: **PUB-FL-RM-AP#**. Where PUB represents Public Wi-Fi, FL is the floor, RM is the Network Closet Room Number, AP# is the number of AP on that floor and numbering should restart on each floor.
  - a. Ie: Public Wi-Fi AP number 16 on the first floor in the Annex that is cabled back to room 1-006 would be labelled as follows: PUB-1-1-006-AP16
5. Data Jack labelling: **PUB-RM-AP#**
  - a. Ie: data jack that is used for Public Wi-Fi AP number 16 on the first floor of the Annex that is cabled back to room 1-006 would be labelled as follows:  
PUB-1-006-AP16
6. Patch Panel should be labelled: **PUB-AP#**
  - a. Ie: patch panel that is used for Public AP number 16 on the first floor of the Annex that is patched back to room 1-006 would be labelled as follows:  
PUB-AP16
7. Cabling for Public Wi-Fi shall on a separate patch panel from the York Region internal network.

### Appendix K – Wireless Access Point (WAP) Installation & Mounting

Installation of WAP shall meet the requirements of manufacturer and follow recommendations of TIA-TSB-162.

1. The communication contractor shall install all wireless access points (WAP) which shall be supplied by York Region.
2. Provide patch cable and all necessary hardware to mount WAP's as shown.
3. Communication contractor shall
  - a. Receive WAP's
  - b. Unpack the WAP's
  - c. Attach the WAP's mounting bracket
  - d. Mount the WAP's
  - e. Patch the WAP's at both ends
  - f. Record AP MAC address and WAP Cable ID that AP was patched into. Record this into the AP Connectivity Table that shall be submitted upon AP installation completion of each floor.



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### Appendix L – Category Cabling Color Scheme for Services

Blue	Data/WiFi/Clock/IoT Category Cable and anything that is not specified.
Purple	Security Category Cable
Orange	BAS Category Cable
Green	Energy Category Cable

# Cabling and Wiring for Voice & Data Communications v3.5

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## Appendix M – Sample Matrix of Port Count Report

For ITS and Cabling Contractor Use

NAC	Data					WAP	IoT	Security Camera		BAS			Energy			TOTAL DATA
Network Access Closets	1-DATA OUTLETS	2-DATA OUTLETS	3-DATA OUTLETS	4-DATA OUTLETS	DATA DROPS	WAP	CLOCK/IOT	SECURITY DEVICE	INTERCOM	BAS	ELEVATOR CONTROL RM	ELECT HOT WATER HEATER	WATER METER	GAS METER	METERS FOR ELECT PANELS	
- N.A. -	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEL P1-006																0
TEL G-006																0
TEL 1-108																0
TEL 2-108																0
TEL 2-109																0
TEL 2-006																0
TEL 3-021																0
TEL 3-022																0
TEL 3-006																0
TR located on 4th floor																0
TR located on 5th floor																0
TR located on 6th floor																0
TR located on 7th floor																0
TR located on 8th floor																0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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## Appendix N – Network Closet Checklist for Standard Sites

For ITS and Cabling Contractor Use

Walkthrough: 100% ☐ Final ☐

Network Closet : New/Renovated Closet *			
Details (Y/N)	T1	T2	Comment
Cabling Trays or J hooks			
Fire Rated Plywood Wallboard			
Power Receptacles NEMA L5-20R			
HVAC (with central monitoring)			
Rack Installation (clearance for vertical and horizontal cable management)			
Patch Panels			
Fibre Backbone (York Net Sites Only) (shielded/protected/labeled)			
Copper/analog line installed			
Verify that network closets are secure by lock or proximity scanners			
Electrical Grounding			
Room sweep/clean and all refuse/garbage is removed			
Network Closet ready for setup			
Network Closet setup complete			
Cabling Test Submitted and Accepted			
As-Built Diagram Submitted & Accepted			

\* Each network closet must have a completed checklist

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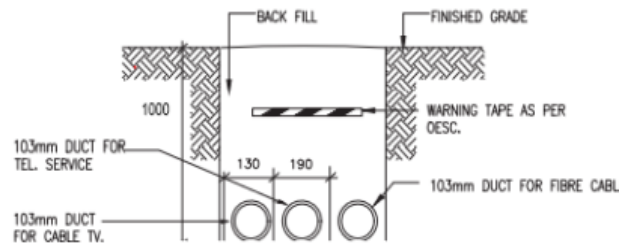
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### Appendix O - WAN/ISP Duct Bank

Communication conduits can be placed on top of electrical conduits

NOTES:

- .1 PROVIDE DUCTBANK TO OESC STANDARDS AND APPROVAL.
- .2 PROVIDE BELL FITTINGS AT EACH END. PROVIDE DUCT SPACERS AT 1.0M INTERVALS.
- .3 REFER TO SPECIFICATIONS FOR DETAILED DESCRIPTION.
- .4 ALL DIMENSIONS ARE TYPICAL IN MM.



## Cabling and Wiring for Voice & Data Communications v3.5

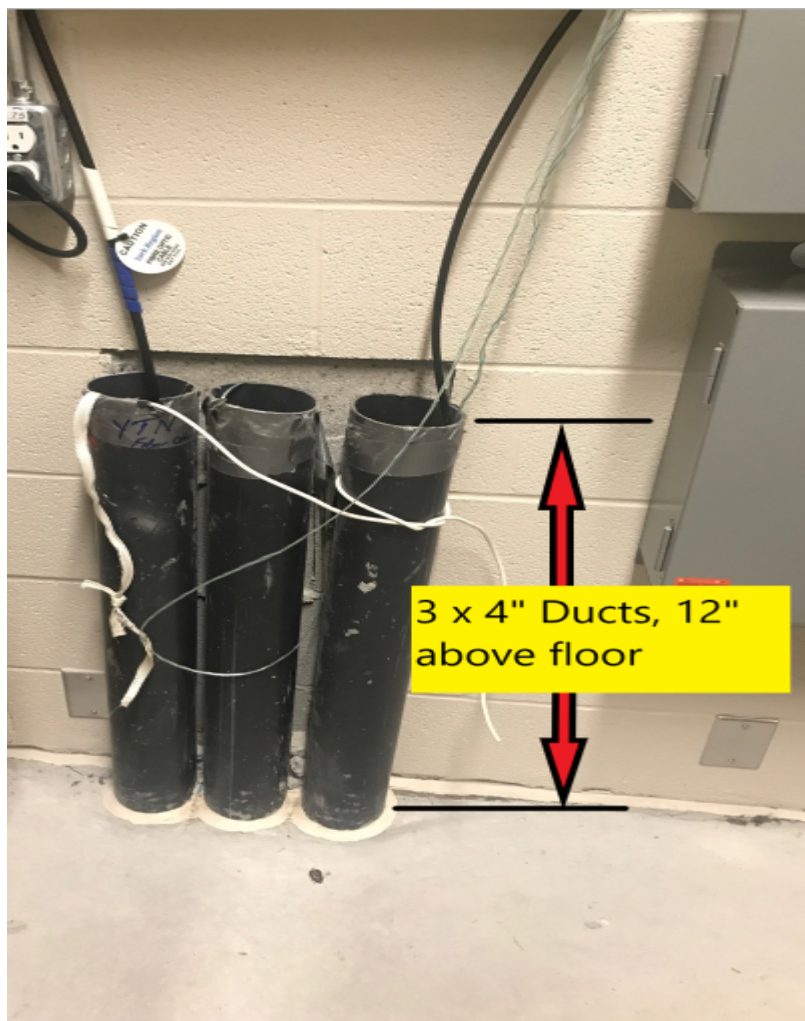
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Last Reviewed: February 2, 2024  
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### Appendix P - WAN/ISP Ducts Inside Communication Room

Three 4" ducts stubbed inside communication room, preferred height minimum 12" above the floor.



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**Approved by:** TSB

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### References

York Region Transit local area network      eDocs: 1027531

American National Standards Institute      <http://www.ansi.org>

Canadian Standards Association      <http://www.csa.ca>

Construction Specifications Institute/Construction Specifications Canada  
<http://www.masterformat.com>

European Committee for Electrotechnical Standardization (ECES)  
<http://www.cenelec.eu/Cenelec/Homepage.htm>

International Electrotechnical Commission (IEC)      <http://www.iec.ch>

International Organization for Standardization  
<http://www.iso.ch/iso/en/ISOOnline.frontpage>

Internet Engineering Task Force      <http://www.ietf.org>

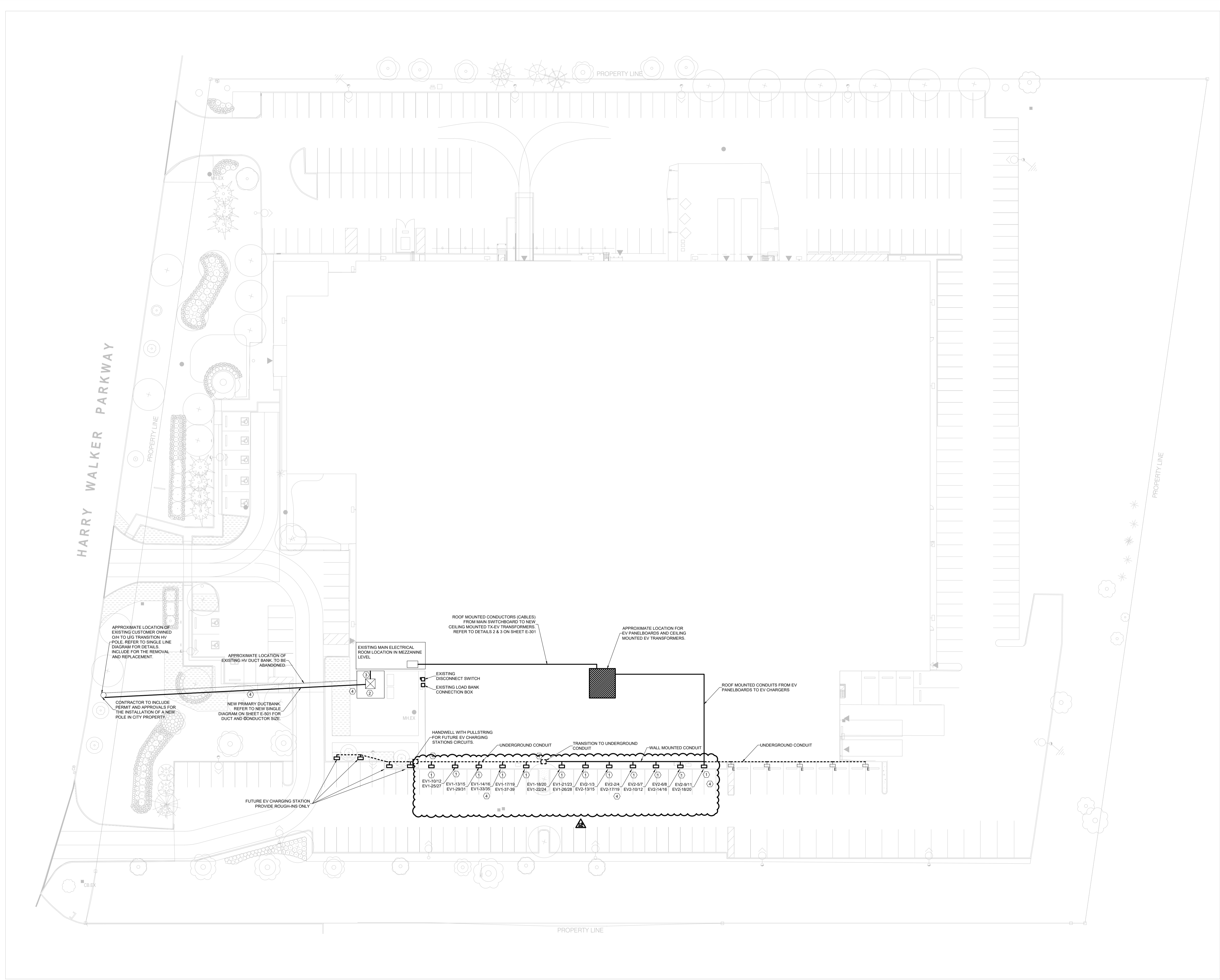
IEEE      <http://www.ieee.org>

Ontario Realty Corporation      <http://www.orc.on.ca/site3.aspx>

Telecordia Technologies Inc.      <http://telecom-info.telecordia.com>

Telecommunications Industry Association      <http://www.tiaonline.org>

Underwriters Laboratories Inc.      <http://www.ul.com>



- SHEET KEYNOTES
1.

EV CHARGING STATION TO BE FED FROM TRANSITION BOX MOUNTED ON WALL. ROUTING THE CONDUIT UNDERGROUND TO THE EV STATION. REFER TO DETAIL 2 ON SHEET E-302.
2.

EXISTING 1000KVA PADMOUNTED CUSTOMER OWNED TRANSFORMER TO BE REPLACED WITH NEW CUSTOMER OWNED TRANSFORMER FOR THE NEW ELECTRICAL SERVICE UPGRADE. EXISTING TRANSFORMER TO BE REMOVED AND STORED ON SITE AT A LOCATION INSTRUCTED BY OWNER. REFER TO DETAIL 1 ON SHEET E-302 AND DETAILS 3 AND 4 ON SHEET E-304.  
  
REPLACE CONCRETE PAD. CONTRACTOR TO INCLUDE COST OF NEW PAD MOUNTED TRANSFORMER VAULT AND GROUNDING. CONFIRM THE RECOMMENDED TRANSFORMER VAULT MAKE AND MODEL WITH TRANSFORMER MANUFACTURER AND PROVIDE THE CONSULTANT WITH SHOP DRAWING PRIOR TO PURCHASE.
3.

CONDUCTORS TO TRANSITION FROM UNDERGROUND TO EXTERIOR WALL AND RUN UP SURFACED TO ELECTRICAL ROOM LOCATED ON SECOND LEVEL. RE-USE EXISTING CONDUCTORS ROUTE IF POSSIBLE. REMOVE EXISTING SECONDARY CONDUCTORS AND REPLACE WITH NEW. RE-USE EXISTING CONDUCTOR ROUTING TO EXISTING MAIN SWITCHBOARD.
4.

CONTRACTOR TO RESTORE ALL LANDSCAPE AND HARDSCAPE SURFACES IMPACTED IN THE ELECTRICAL SCOPE OF WORK. REFER TO ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR DETAILS.

12	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
11	2024-10-28	ISSUED FOR ADDENDUM-E01	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D

REVISIONS		
THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.		
PROJECT NORTH		

250 ROWNTREE DAIRY RD, WOODBRIDGE, ON  
TEL: 905-507-0800  
WEB: WWW.QUASARCG.COM

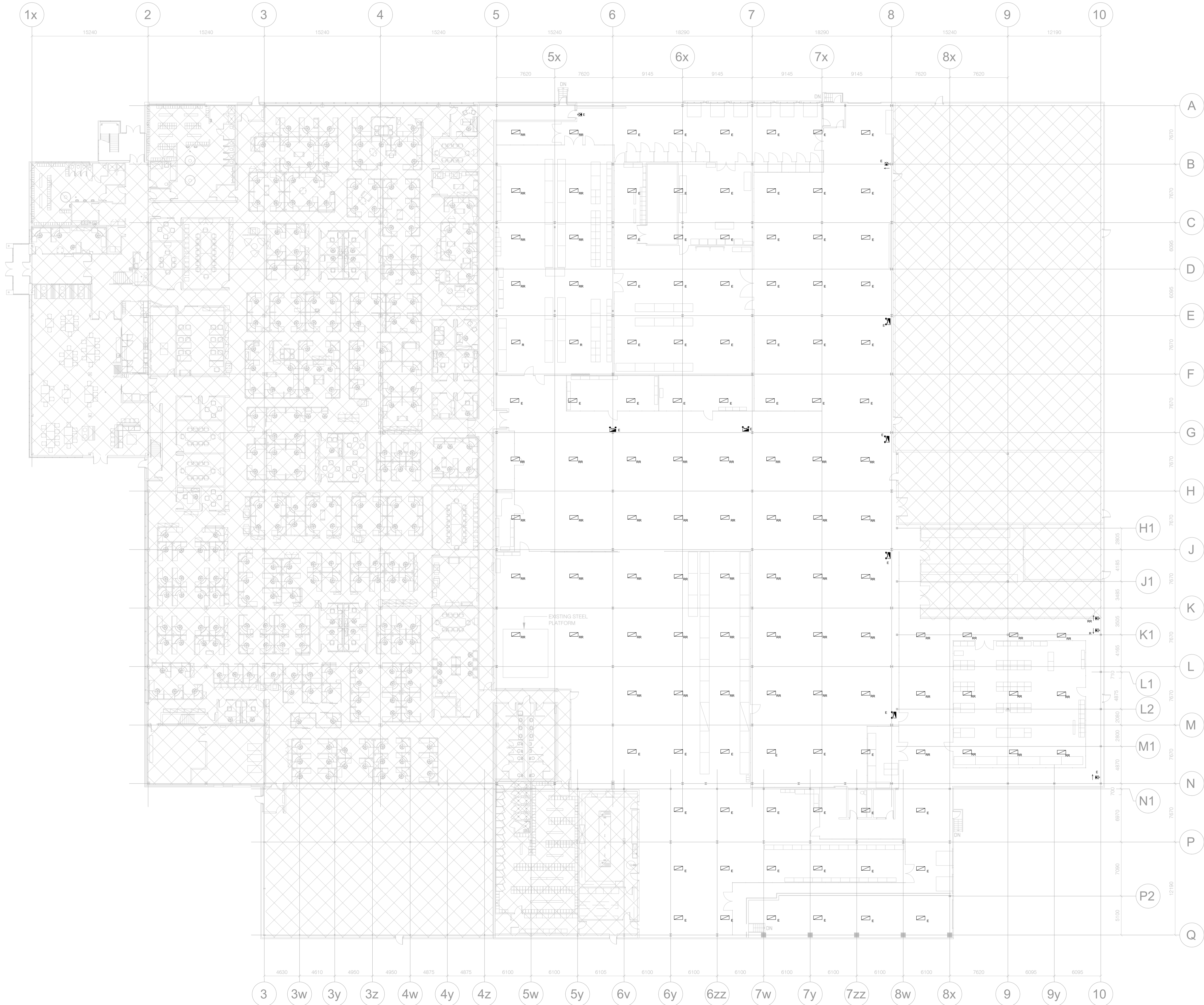
QUASAR  
CONSULTING GROUP

FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL:  
CM-22-149@QUASARCG.COM

PROJECT  
**HWP WAREHOUSE UPGRADE**  
**145 HARRY WALKER PARKWAY**  
**NEWMARKET**  
ON L3Y 7B3

TITLE  
**EV CHARGER SITE PLAN**

CHECKED	TS	PROJECT No.	CM-22-149
SCALE	AS SHOWN	DRAWING No.	E-002



### GENERAL SHEET NOTES

1. ALL LIGHTING FIXTURES ARE EXISTING IN THIS DRAWING.
2. HATCHED AREA NOT IN CONTRACT.
3. CONTRACTOR TO INVESTIGATE AND CONFIRM LIGHTING PANELBOARD FEEDING EXISTING LUMINARIES, EXIT SIGNS & EMERGENCY BATTERY UNITS FOR EMERGENCY LIGHTING.
4. ALL LIGHTING FIXTURES SHOWN TO BE REMOVED TO BE STORED IN A DRY AND SAFE LOCATION. TO BE REUSED IN NEW LIGHTING LAYOUT.
5. WHERE LIGHTING FIXTURES ARE SHOWN TO BE REMOVED THE LIGHTING BRANCH CIRCUIT SHALL REMAIN TO BE REUSED FOR NEW SPECIFICATION FIXTURES.
6. EXISTING HIGH BAY FIXTURES ARE CONNECTED TO A LUTRON LIGHTING CONTROL SYSTEMS AND SHALL REMAIN CONNECTED. ALLOW FOR THE RE-PROGRAMMING AND COMMISSIONING OF THE SYSTEM FOR LAYOUT MODIFICATIONS SHOWN IN DRAWINGS.

8

8	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
7	2024-09-30	RE-ISSUED FOR TENDER	TS
6	2024-08-29	ISSUED FOR TENDER	TS
5	2024-07-18	ISSUED FOR PERMIT	TS
4	2024-06-11	ISSUED FOR 100% CD	AZ
3	2024-05-15	ISSUED FOR 50% CD	AZC
2	2024-03-28	ISSUED FOR 100% DD R1	AZC
1	2024-02-27	ISSUED FOR 50% DD	TS
No.	DATE	DESCRIPTION	CH D

#### REVISIONS

THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.

PROJECT NORTH



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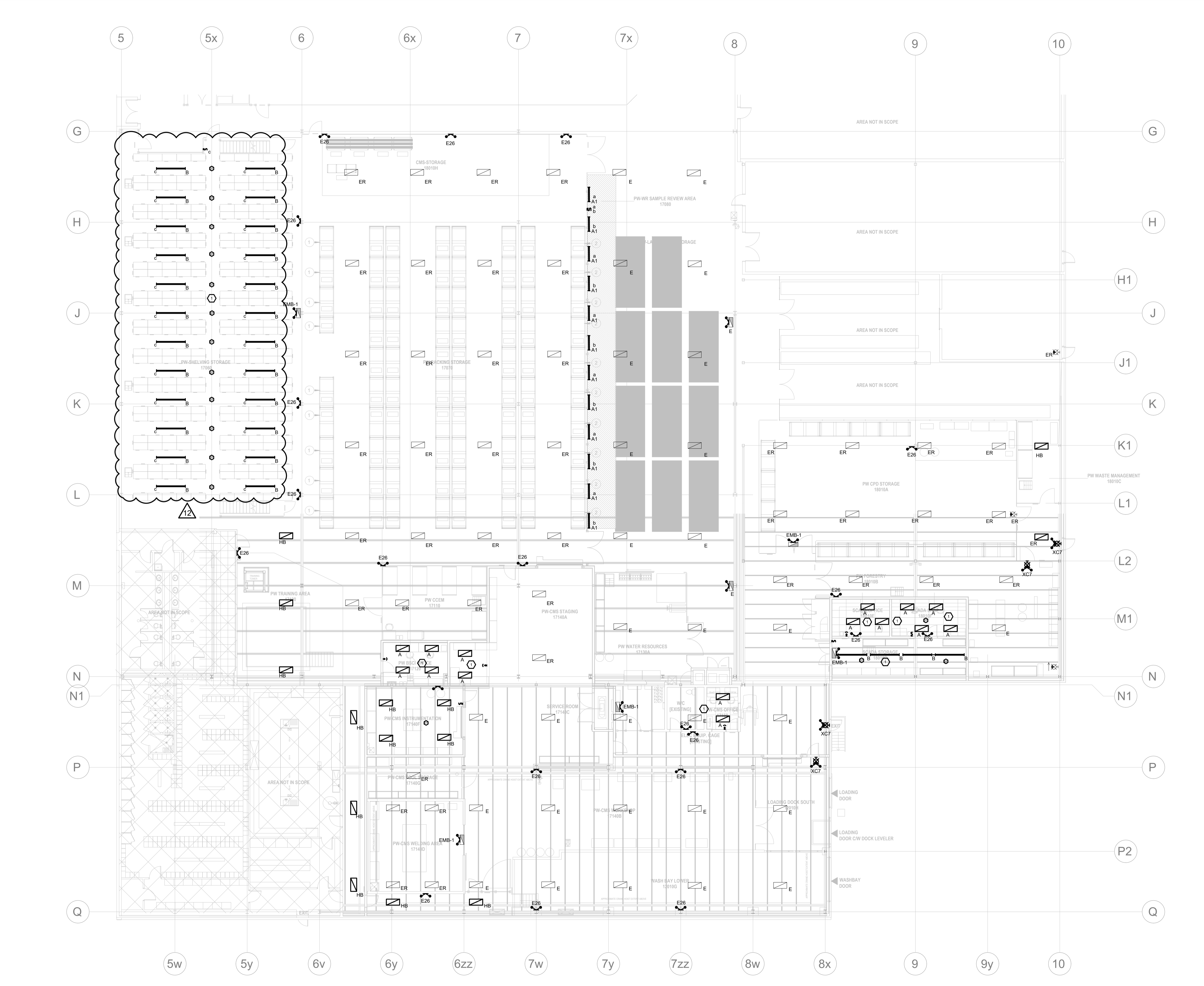
PROJECT

**HWP WAREHOUSE UPGRADE**  
**145 HARRY WALKER PARKWAY**  
**NEWMARKET**  
ON L3Y 7B3

TITLE  
**PUBLIC WORKS DEMOLITION LIGHTING PLAN - MAIN FLOOR**

CHECKED TS PROJECT No. CM-22-149

SCALE 1:250 DRAWING No. E-200



- GENERAL SHEET NOTES**
- ELECTRICAL CONTRACTOR TO CONNECT NEW LIGHTING FIXTURES TO EXISTING LIGHTING CONTROLS. MANUFACTURER: **RELIABLE CONTROLS**. PROVIDE ALL NECESSARY DEVICES AND WIRING TO EACH NEW LIGHTING FIXTURE. ENSURE ALL NEW LIGHTING CONTROLS ARE CONNECTED TO THE EXISTING BAS.
  - HATCHED AREA NOT IN CONTRACT.
  - CONTRACTOR TO INVESTIGATE AND CONFIRM LIGHTING PANELBOARD FEEDING EXISTING LUMINAIRES, EXIT SIGNS & EMERGENCY BATTERY UNITS FOR EMERGENCY LIGHTING AND EXTEND WIRING TO NEW & RELOCATED LIGHTING FIXTURES.
  - CONNECT NEW LIGHTING FIXTURES TO EXISTING CIRCUITS OBTAINED DURING DEMOLITION.
  - NEW HIGH BAY FIXTURES TO BE MOUNTED ON A HIGHER LEVEL THAN RACKING. COORDINATE HEIGHT INTERFERENCES WITH RACKING ON SITE.

12	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
11	2024-10-28	ISSUED FOR ADDENDUM-E01	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D

**REVISIONS**

THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.

**PROJECT NORTH**

**QUASAR CONSULTING GROUP**

250 ROWNTREE DAIRY RD, WOODBRIDGE, ON  
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FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL:  
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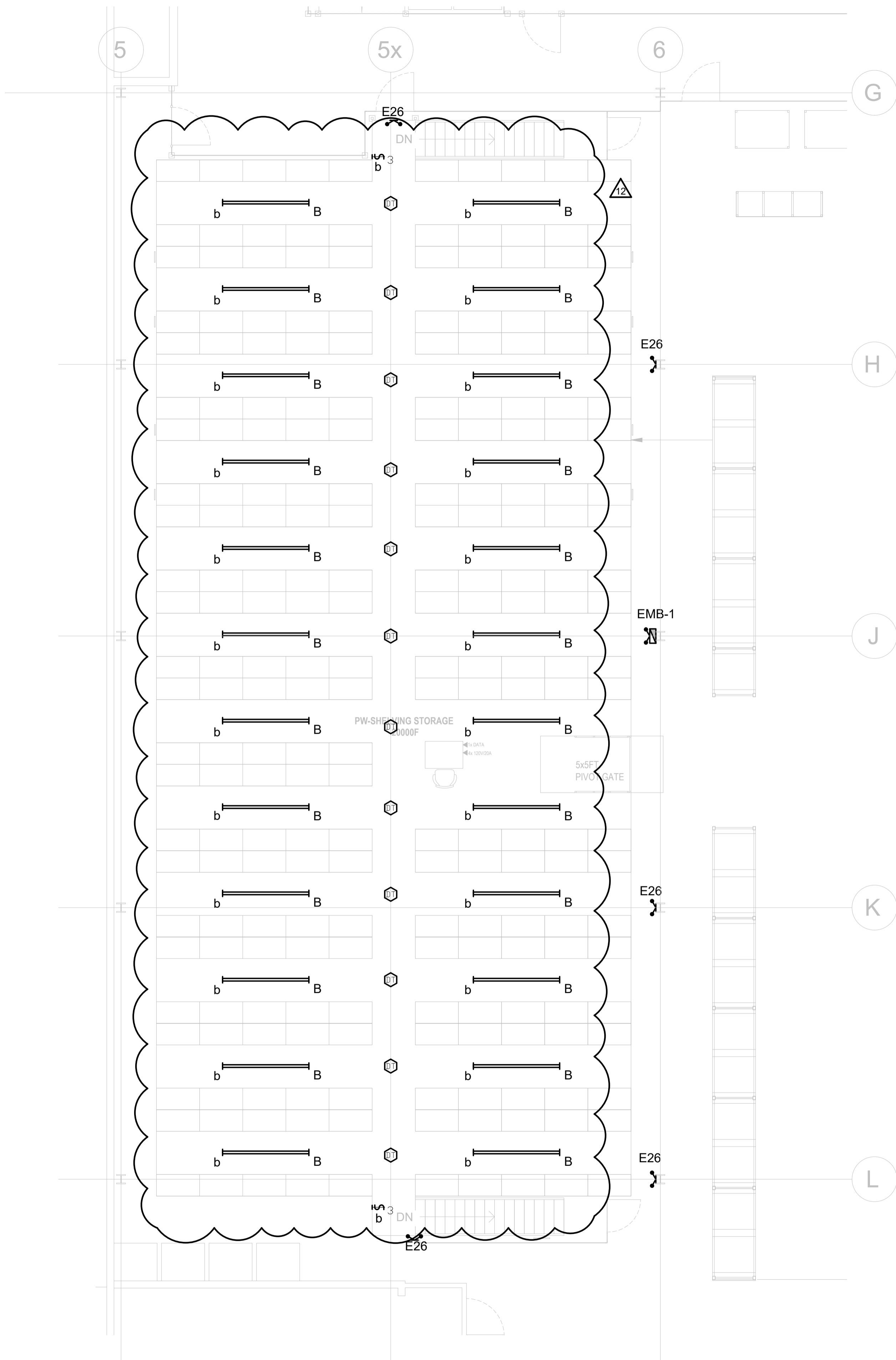
**PROJECT**

**HWP WAREHOUSE UPGRADE**  
**145 HARRY WALKER PARKWAY**  
**NEWMARKET**  
ON L3Y 7B3

**TITLE**

**PUBLIC WORKS NEW LIGHTING PLAN - MAIN FLOOR**

CHECKED	TS	PROJECT No.	CM-22-149
SCALE	1:150	DRAWING No.	E-201



GENERAL SHEET NOTES

1. ELECTRICAL CONTRACTOR TO CONNECT NEW LIGHTING FIXTURES TO EXISTING LIGHTING CONTROLS
2. HATCHED AREA NOT IN CONTRACT.
3. CONTRACTOR TO INVESTIGATE AND CONFIRM LIGHTING PANELBOARD FEEDING EXISTING LUMINARIES, EXIT SIGNS & EMERGENCY BATTERY UNITS FOR EMERGENCY LIGHTING AND EXTEND WIRING TO NEW & RELOCATED LIGHTING FIXTURES.
4. CONNECT NEW LIGHTING FIXTURES TO EXISTING CIRCUITS OBTAINED DURING DEMOLITION.
5. ELECTRICAL CONTRACTOR TO PROVIDE 2 ADDITIONAL 20A/1P CIRCUITS FOR MEZZANINE LIGHTING, FROM NEAREST LIGHTING PANELBOARD. USE ONLY IF EXISTING CIRCUITS ARE LOADED TO MAXIMUM CAPACITY.
6. NEW HIGH BAY FIXTURES TO BE MOUNTED ON A HIGHER LEVEL THAN RACKING. COORDINATE HEIGHT INTERFERENCES WITH RACKING ON SITE.

12	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
11	2024-10-28	ISSUED FOR ADDENDUM-E01	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D

REVISIONS		
THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.		
PROJECT NORTH		



**QUASAR**  
CONSULTING GROUP

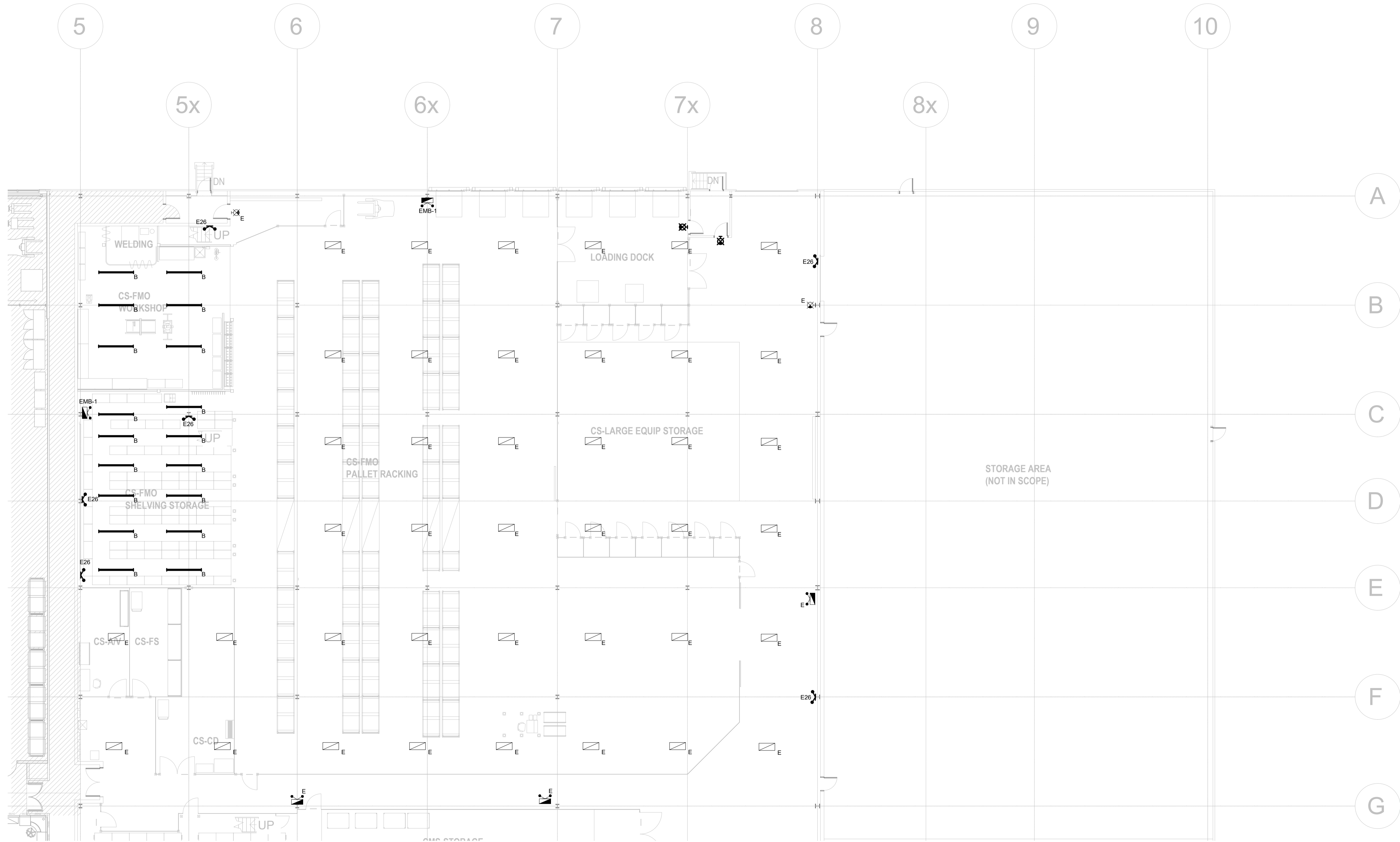
250 ROWNTREE DAIRY RD, WOODBRIDGE, ON  
TEL: 905-507-0800  
WEB: WWW.QUASARCG.COM

FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL:  
CM-22-149@QUASARCG.COM

PROJECT  
**HWP WAREHOUSE UPGRADE**  
**145 HARRY WALKER PARKWAY**  
**NEWMARKET**  
ON L3Y 7B3

TITLE  
LIGHTING LAYOUT - PUBLIC WORKS LEVEL 2

CHECKED	TS	PROJECT No.	CM-22-149
SCALE	1:100	DRAWING No.	E-202



GENERAL SHEET NOTES

- ELECTRICAL CONTRACTOR TO CONNECT NEW LIGHTING FIXTURES TO EXISTING LIGHTING CONTROLS. MANUFACTURER: **RELIABLE CONTROLS**. PROVIDE ALL NECESSARY DEVICES AND AND WIRING TO EACH NEW LIGHTING FIXTURE. ENSURE ALL NEW LIGHTING CONTROLS ARE CONNECTED TO THE EXISTING BAS.
- WATCHED AREA NOT IN CONTRACT
- CONTRACTOR TO INVESTIGATE AND CONFIRM LIGHTING PANELBOARD FEEDING EXISTING LUMINAIRES, EXIT SIGNS & EMERGENCY BATTERY UNITS FOR EMERGENCY LIGHTING AND EXTEND WIRING TO NEW & RELOCATED LIGHTING FIXTURES.
- CONNECT NEW LIGHTING FIXTURES TO EXISTING CIRCUITS OBTAINED DURING DEMOLITION.
- NEW HIGH BAY FIXTURES TO BE MOUNTED ON A HIGHER LEVEL THAN RACKING. COORDINATE HEIGHT INTERFERENCES WITH RACKING ON SITE.

11	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH D

REVISIONS		
THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.		
PROJECT NORTH		

**QUASAR**  
CONSULTING GROUP

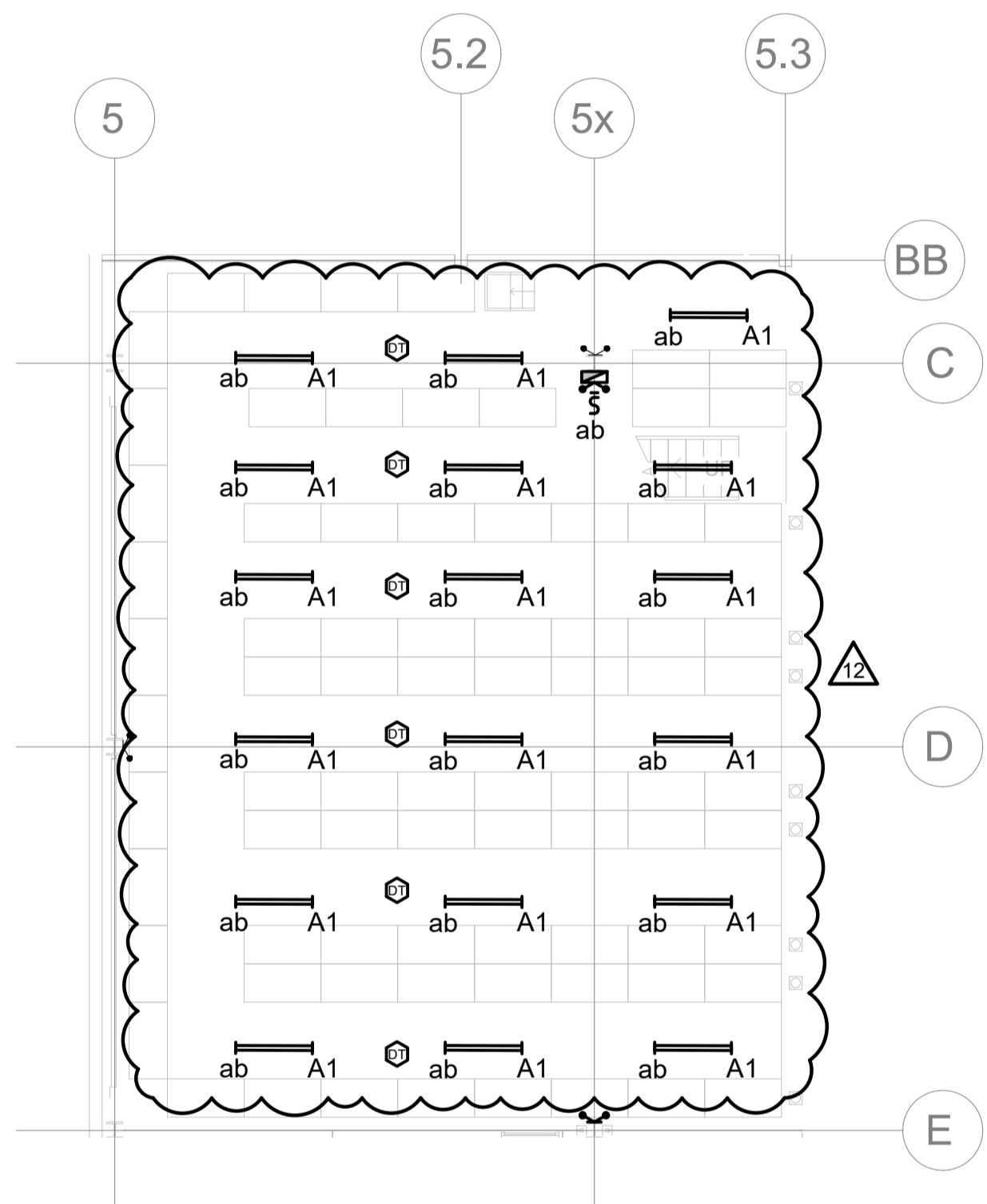
250 ROWNTREE DAIRY RD, WOODBRIDGE, ON  
TEL: 905-507-0800  
WEB: WWW.QUASARCG.COM

FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL: CM-22-149@QUASARCG.COM

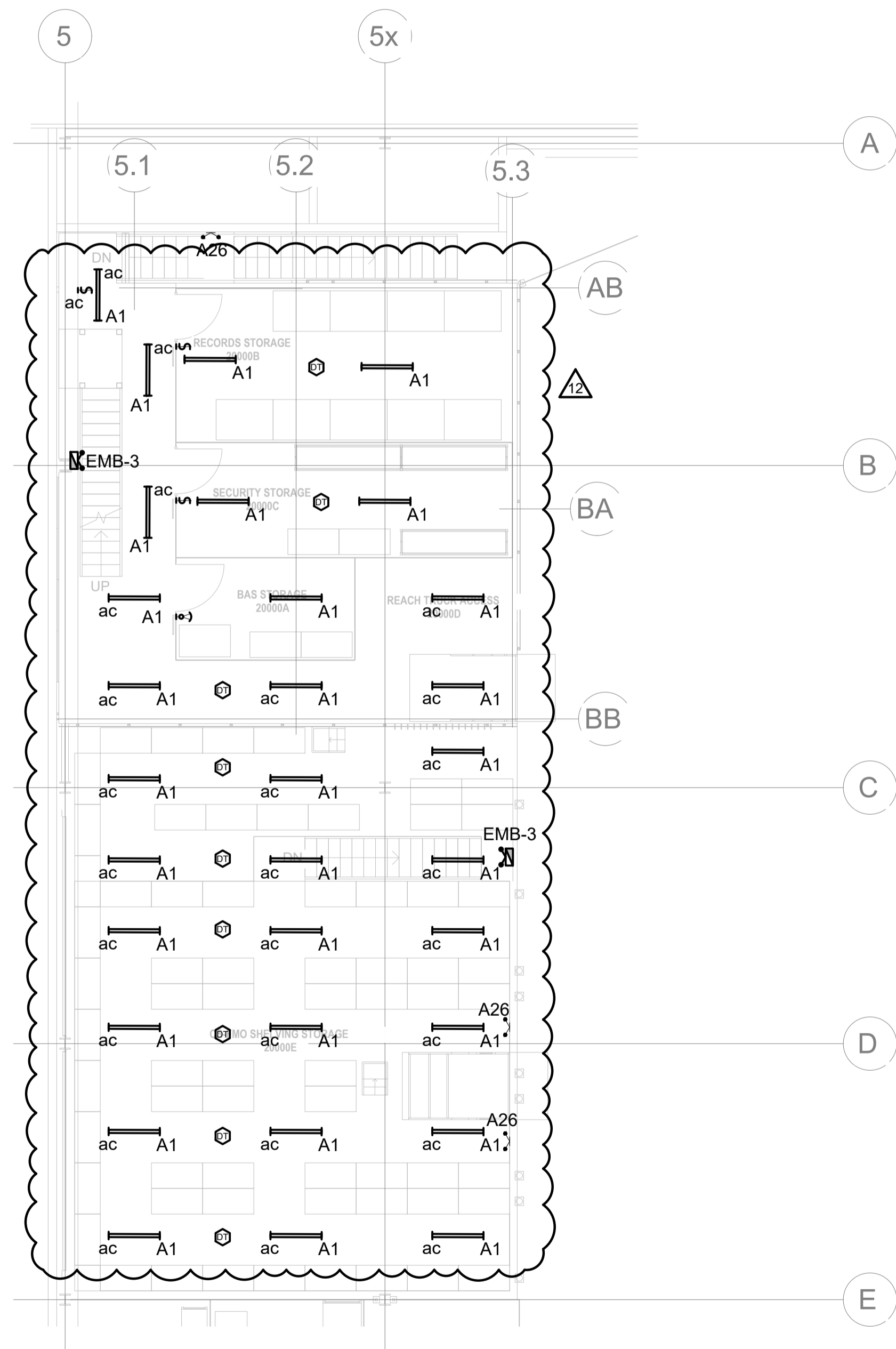
PROJECT  
**HWP WAREHOUSE UPGRADE**  
**145 HARRY WALKER PARKWAY**  
**NEWMARKET**  
ON L3Y 7B3

TITLE  
**NEW LIGHTING LAYOUT - CORPORATE SERVICE**

CHECKED	TS	PROJECT No.	CM-22-149
SCALE	1:150	DRAWING No.	<b>E-203</b>



1 LIGHTING LAYOUT - MEZZANINE LEVEL 1  
SCALE: 1:100



2 LIGHTING LAYOUT - MEZANINE LEVEL 2  
SCALE: 1:100

#### GENERAL SHEET NOTES

- ELECTRICAL CONTRACTOR TO CONNECT NEW LIGHTING FIXTURES TO EXISTING LIGHTING CONTROLS. MANUFACTURER: **RELIABLE CONTROLS**. PROVIDE ALL NECESSARY DEVICES AND WIRING TO EACH NEW LIGHTING FIXTURE. ENSURE ALL NEW LIGHTING CONTROLS ARE CONNECTED TO THE EXISTING BAS.
- CONTRACTOR TO INVESTIGATE AND CORRECT LIGHTING PANELBOARD FEEDING EXISTING LUMINAIRES, EXIT SIGNS & EMERGENCY BATTERY UNITS FOR EMERGENCY LIGHTING AND EXTEND WIRING TO NEW & RELOCATED LIGHTING FIXTURES.
- CONNECT NEW LIGHTING FIXTURES TO EXISTING CIRCUITS OBTAINED DURING DEMOLITION.
- ELECTRICAL CONTRACTOR TO PROVIDE 2 ADDITIONAL 20A/1P CIRCUITS FOR MEZZANINE LIGHTING, FROM NEAREST LIGHTING PANELBOARD. USE ONLY IF EXISTING CIRCUITS ARE LOADED TO MAXIMUM CAPACITY.
- NEW HIGH BAY FIXTURES TO BE MOUNTED ON A HIGHER LEVEL THAN RACKING. COORDINATE HEIGHT INTERFERENCES WITH RACKING ON SITE.

12	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
11	2024-10-28	ISSUED FOR ADDENDUM-E01	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D

#### REVISIONS

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PROJECT NORTH



250 ROWNTREE DAIRY RD, WOODBRIDGE, ON  
TEL: 905-507-0800  
WEB: WWW.QUASARCG.COM

FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL:  
CM-22-149@QUASARCG.COM

PROJECT

HWP WAREHOUSE UPGRADE  
145 HARRY WALKER PARKWAY  
NEWMARKET  
ON L3Y 7B3

TITLE

LIGHTING LAYOUT - MEZZANINE LEVEL

CHECKED

TS

PROJECT No.

CM-22-149





SCALE

AS SHOWN

DRAWING No.

E-204



SCHEDULE 26 06 50.16.B - LED LIGHTING FIXTURE SCHEDULE								
SYMBOL	TYPE	DESCRIPTION	MANUFACTURER AND CAT NO. SEE NOTE 1	VOLTAGE/ INPUT WATTS	LUMEN PACKAGE (3000 K CCT UNLESS NOTED OTHERWISE) MINIMUM 80 CRI	MOUNTING	REFERENCE	REMARKS
	HB	INDUSTRIAL HIGH BAY LIGHTING FIXTURE LED	DAY-BRITE CFI BY SIGNIFY - FBX LED HIGH BAY	347 V	MATCH EXISTING FIXTURES LUMEN PACKAGE	SUSPENDED AT THE SAME HEIGHT AS EXISTING HIGH BAY FIXTURES		REFER TO NOTE 4. ALLOW FOR THE COST OF INVESTIGATING THE EXISTING FIXTURES TECHNICAL DETAILS.
	A	RECESSED 2'x4' TROFFER OR FLAT PANEL LUMINAIRE, COMPATIBLE WITH LAY-IN CEILING. REFER TO CEILING SPECIFICATION FOR SPECIAL REQUIREMENTS.	CPXL LED FLAT PANEL SWITCHABLE LUMEN PANEL	347 V	4000/5000/6000 LM 35/40/50 K	RECESSED IN LAY-IN CEILING MH-10FT		
	B	8FT LED STRIP LIGHT	SIGNIFY FLUX STREAM MODEL NO FSS-8-60L-940-347	347V 25 WATTS	6000 LUMENS 4000K 80+ CRI	SURFACE MH-9FT		
	A1	4FT LED STRIP LIGHT	SIGNIFY FLUX STREAM MODEL NO FSS-4-60L-940-347	347V 18 WATTS	4000 LUMENS 4000K 80+ CRI	SURFACE MH-9FT		
<div>LIGHTING FIXTURE SCHEDULE NOTES:</div> <div>1. UNLESS NOTED OTHERWISE, ACCEPTED SUBSTITUTE MANUFACTURERS AND SUPPLIERS: ACUTY BRANDS LIGHTING, COOPER LIGHTING SOLUTIONS, DREE CANADA, HUBBELL LIGHTING, PESTRESS ELECTRIC, SIGNIFY (FORMERLY PHILIPS LIGHTING), VISCO/VISIONERING.</div> <div>2. WHERE AN INCOMPLETE MODEL/CAT NO. IS LISTED, MANUFACTURERS/SUPPLIERS MUST CONFIRM THE PROPOSED FIXTURE WITH THE CONSULTANT A MINIMUM OF ONE WEEK PRIOR TO TENDER CLOSE.</div> <div>3. SUBMIT SHOP DRAWINGS FOR CONSULTANT'S REVIEW PRIOR TO PLACING ANY ORDER.</div> <div>4. REUSE EXISTING REMOVED FIXTURES WHERE HB FIXTURES ARE SHOWN. PROVIDE NEW HB FIXTURES IF EXISTING REMOVED HB FIXTURES ARE NOT SUFFICIENT. ALLOW FOR THE SUPPLY AND INSTALLATION OF AN ADDITIONAL 8 NEW HB FIXTURES.</div> <div>5. CONTRACTOR TO ALLOW FOR THE INVESTIGATION OF EXISTING HIGH BAY LIGHT FIXTURES MAKE MODEL AND PHOTOMETRIC ANALYSIS TO MATCH EXISTING LIGHTING LEVELS.</div> <div>6. CONTRACTOR TO COORDINATE LIGHTING FIXTURE MOUNTING KIT WITH ARCHITECTURAL REFLECTED CEILING PLANS PRIOR TO PURCHASING.</div> <div>7. CONTRACTOR TO ALLOW FOR 6000 LUMENS FOR ALL HB LIGHTING FIXTURES FOR COSTING PURPOSES. ELECTRICAL CONTRACTOR TO PROVIDE PHOTOMETRIC CALCULATIONS TO CONFIRM AN AVERAGE OF 300 LUX. FINAL PHOTOMETRIC CALCULATIONS TO BE CONFIRMED WITH LUMEN PACKAGE.</div>								

1

LIGHTING FIXTURE SCHEDULE

SCALE: N.T.S.




12

LIGHTING CONTROLS MATRIX																				
SPACE TYPE	CONTROLS INTEGRATED INTO LUMINAIRES	STANDALONE CONTROL DEVICES	NETWORKED LIGHTING CONTROLS	MANUAL (ON/OFF) ONE ZONE ONLY FOR SPACE	MANUAL (ON/OFF) a, b ZONED SWITCHING	MANUAL DIMMING CONTROL	KEY SWITCH (KS)	SCENE CONTROL (SC) OR GRAPHIC TOUCHSCREEN	VACANCY MODE (MANUAL ON) (ASHRAE 90.1-2013 9.4.1.1b)	OCCUPANCY MODE (AUTO ON) (FULL)	OCCUPANCY MODE (AUTO ON) (PARTIAL)	AUTOMATIC PARTIAL OFF SENSOR TIME OUT (MINUTES) (ASHRAE 90.1-2013 9.4.1.1g)	AUTOMATIC PARTIAL OFF LUMINAIRE DIMMING LEVEL	FULL OFF SENSOR TIME OUT PERIOD (MINUTES) (ASHRAE 90.1-2013 9.4.1.1h)	TIME SCHEDULE		DAYLIGHT SENSOR		OTHER	REMARKS
															SCHEDULE ON TIME	SCHEDULE OFF TIME	SCHEDULE OVERRIDE SWITCH SWITCHING (ON/OFF)	DIMMING		
ELECTRICAL ROOMS AND SERVICE ROOMS		X	X																	MANUAL CONTROLS ONLY.
OFFICE, SCADA LAB, SCADA SHOP		X				X			X		(3)			20 MINS						
STORAGE ROOMS, MEZZANINE LEVEL		X	X						X	(2)				20 MINS						
WAREHOUSE GENERAL EXISTING LIGHTING																				EXISTING LIGHTING TO BE CONTROLLED WITH EXISTING LIGHTING CONTROL SYSTEM
NOTES: 1. LIGHTING CONTROL SEQUENCES OF OPERATION TO ASHRAE 90.1-2013. 2. SENSOR MAY BE CONFIGURED FOR FULL AUTO-ON AT OWNER'S PREFERENCE IN LIEU OF MANUAL ON. 3. SENSOR MAY BE CONFIGURED FOR PARTIAL AUTO-ON AT OWNER'S PREFERENCE IN LIEU OF MANUAL ON. 4. ELECTRICAL CONTRACTOR TO ALLOW FOR THE COST OF INVESTIGATING EXISTING LIGHTING CONTROL SYSTEM. CONNECT NEW WAREHOUSE AND STORAGE LIGHTING TO EXISTING CONTROLS.																				

2

LIGHTING CONTROLS MATRIX

SCALE: N.T.S.

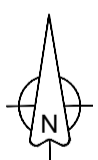

SCHEDULE 26 06 50.19 - EMERGENCY LIGHTING AND EXIT SIGN SCHEDULE								
SYMBOL	TYPE	DESCRIPTION	MANUFACTURER AND PRODUCT SERIES	VOLTAGE	LAMPS	MOUNTING	SPEC SECTION	REMARKS
	E26	COMPACT REMOTE UNIT WITH DOUBLE HEAD LAMPS: MR16 LED LAMP, 12 V, 6 W, 540 LUMEN, 25 DEGREE BEAM ANGLE, FACTORY WHITE FINISH.	- LUMACELL MQM-2-LD10-BK SERIES LAMP PART NUMBER 580.0106-L - EMERGLITE EF9M SERIES	12 V	2 x 6 W MR16 LED 540 LUMEN / LAMP	WALL OR CEILING SURFACE	26 52 13.13	RECOMMENDED MAXIMUM SPACING 15 m (50 FEET) WHEN MOUNTED BETWEEN 2.1 AND 2.7 m (7 FEET TO 9 FEET) AFF.
	EMB-3	12 V EMERGENCY LIGHTING BATTERY UNIT C/W AUTO TEST, WITH DOUBLE HEADS, FACTORY WHITE FINISH, UNIVERSAL 120/347 VAC INPUT, AND SIX-ZONE VOLTAGE SENSING RELAY. TWO LAMPS: MR16 LED LAMP, 12 V, 6 W, 540 LUMEN, 25 DEGREE BEAM ANGLE.	-LUMACELL RG12S-[360]-2-LD10-AT-VSR SERIES -EMERGLITE ESL SERIES	120V-347V IN 12V OUT	2 x 6 W MR16 LED 540 LUMEN / LAMP	WALL	26 52 13.13	
	X1	PLASTIC PICTOGRAM EXIT SIGN, UNIVERSAL MOUNTING, FACTORY WHITE FINISH.	-LUMACELL LP SERIES -STANPRO RMPN SERIES	SEE NOTE 2	3W LED	CEILING OR WALL, SURFACE	26 52 13.16	
EMERGENCY LIGHTING FIXTURE & EXIT SIGN SCHEDULE NOTES: 1. WHERE AN INCOMPLETE MODEL/CAT NO. IS LISTED, MANUFACTURERS/SUPPLIES MUST CONFIRM THE PROPOSED FIXTURE WITH THE CONSULTANT A MINIMUM OF ONE WEEK PRIOR TO TENDER CLOSE. 2. EXIT SIGNS SHALL BE CAPABLE OF UNIVERSAL 120/347V AC AND 6 TO 48V DC INPUT. BATTERY UNITS SHALL BE CAPABLE OF UNIVERSAL 120/347V AC INPUT. 3. FOR EXIT SIGNS, REFER TO ARROWS AND NUMBER OF SHADED FACES AS DIRECTED ON LIGHTING LAYOUT. WHERE ARROWS INDICATE TWO DIRECTIONS, PROVIDE TWO PICTOGRAM STYLE EXIT SIGNS. 4. SUBMIT SHOP DRAWINGS FOR CONSULTANTS REVIEW PRIOR TO PLACING ANY ORDER. 5. MANUFACTURERS AS NOTED IN SECTION 26 52 13.13 AND SECTION 26 52 13.16. [OR] 5. MANUFACTURERS: AIMLITE, BELUCE (FORMERLY BEGHELLI), EMERGLITE, LITHONIA, LUMACELL, STANPRO. 6. REMOTE HEADS CERTIFIED TO CSA C22.2 No. 141. 7. CBCB - "CENTRE BEAM CANDLE POWER." 8. CONFIRM RECOMMENDED SPACING WITH EMERGENCY LIGHTING MANUFACTURER PRIOR TO START OF ROUGH-IN. 9. WHERE AN EXIT SIGN IS TO BE INSTALLED IN AN AREA WITH NO CEILING, PROVIDE SUITABLE PENDANT MOUNT SUCH THAT THE SIGN IS VISIBLE AND NOT OBSCURED.								

3

EMERGENCY LIGHTING AND EXIT SIGN SCHEDULE

SCALE: N.T.S.

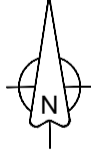

12	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
11	2024-10-28	ISSUED FOR ADDENDUM-E01	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
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1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D


REVISIONS	
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 250 ROWNTREE DAIRY RD, WOODBRIDGE, ON TEL: 905-507-0800 WEB: WWW.QUASARCG.COM	
FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL: CM-22-149@QUASARCG.COM	
PROJECT  HWP WAREHOSE UPGRADE 145 HARRY WALKER PARKWAY NEWMARKET ON L3Y 7B3	
TITLE  LIGHTING SCHEDULES	
CHECKED  TS	PROJECT No. CM-22-149
SCALE  AS SHOWN	DRAWING No. E-306


26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: DP-WS				VOLTS: 347/600V				LOCATION: REFER TO PLANS					
MAIN BUS: 225A				PHASE: 3				FED FROM: EX 4000A MAIN SWBD					
MAIN BREAKER: 200A/3P				WIRE: 4				FEEDER ENTRY AT: TOP					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:				REMARKS:					
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	RECEPTACLE	0	-	-	30A 3P	A	30A 3P	0	-	-	RECEPTACLE	2	
3		-	0	-		B		-	0	-		4	
5		-	-	0		C		-	-	0		6	
7	RECEPTACLE	0	-	-	30A 3P	A	30A 3P	0	-	-	RECEPTACLE	8	
9		-	0	-		B		-	0	-		10	
11		-	-	0		C		-	-	0		12	
13	RECEPTACLE	0	-	-	30A 3P	A	30A 3P	0	-	-	RECEPTACLE	14	
15		-	0	-		B		-	0	-		16	
17		-	-	0		C		-	-	0		18	
19	RECEPTACLE	0	-	-	30A 3P	A	30A 3P	0	-	-	RECEPTACLE	20	
21		-	0	-		B		-	0	-		22	
23		-	-	0		C		-	-	0		24	
25	RECEPTACLE	0	-	-	30A 3P	A	30A 3P	0	-	-	RECEPTACLE	26	
27		-	0	-		B		-	0	-		28	
29		-	-	0		C		-	-	0		30	
31	RECEPTACLE	0	-	-	30A 3P	A	90A	25000	-	-	TX-WS/RP-WS	32	
33		-	0	-		B		-	25000	-		34	
35		-	-	0		C		-	-	25000		36	
37		0	-	-		A		0	-	-		38	
39		-	0	-		B		-	0	-		40	
41		-	-	0		C		-	-	0		42	
TOTAL ØA: ____ W, TOTAL ØB: ____ W, TOTAL ØC: ____ W													

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE												
PANEL ID: RP-WD				VOLTS: 139/240V				LOCATION: REFER TO PLANS				
MAIN BUS: 225A				PHASE: 3				FED FROM: EX 4000A MAIN SWBD				
MAIN BREAKER: 150A/3P				WIRE: 4				FEEDER ENTRY AT: TOP				
TYPE:				MOUNTING: SURFACE				FEEDER:				
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:				REMARKS:				
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.
		ØA	ØB	ØC				ØA	ØB	ØC		
1	RECEPTACLE	0	-	-	50A 3P	A	50A 3P	0	-	-	RECEPTACLE	2
3		-	0	-		B		-	0	-		4
5		-	-	0		C		-	-	0		6
7	RECEPTACLE	0	-	-	50A 3P	A		0	-	-		8
9		-	0	-		B		-	0	-		10
11		-	-	0		C		-	-	0		12
13		0	-	-		A		0	-	-		14
15		-	0	-		B		-	0	-		16
17		-	-	0		C		-	-	0		18
19		0	-	-		A		0	-	-		20
21		-	0	-		B		-	0	-		22
23		-	-	0		C		-	-	0		24
25		0	-	-		A		0	-	-		26
27		-	0	-		B		-	0	-		28
29		-	-	0		C		-	-	0		30
31		0	-	-		A		0	-	-		32
33		-	0	-		B		-	0	-		34
35		-	-	0		C		-	-	0		36
37		0	-	-		A		0	-	-		38
39		-	0	-		B		-	0	-		40
41		-	-	0		C		-	-	0		42
TOTAL ØA: ____ W , TOTAL ØB: ____ W , TOTAL ØC: ____ W												

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: RP-WS				VOLTS: 120/208V				LOCATION: REFER TO PLANS					
MAIN BUS: 400A				PHASE: 3				FED FROM:DP-WS/TX-WS					
MAIN BREAKER: 400A/3P				WIRE: 4				FEEDER ENTRY AT: TOP					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:NEMA 2				REMARKS:					
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	2	
3	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	4	
5	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	6	
7	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	8	
9	2R: QUAD	-	720	-	20A	B	20A	-	0	-	SPARE	10	
11	SPARE	-	-	0	20A	C	20A	-	-	0	SPARE	12	
13	2R: QUAD	720	-	-	20A	A	20A	0	-	-	SPARE	14	
15	2R: QUAD/DUPLEX	-	540	-	20A	B	20A	-	720	-	2R: QUAD	16	
17	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	18	
19	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	20	
21	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	22	
23	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	24	
25	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	26	
27	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	28	
29	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	30	
31	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	32	
33	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	34	
35	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	36	
37	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	38	
39	2R: QUAD	-	720	-	20A	B	20A	-	540	-	2R: QUAD/DUPLEX	40	
41	SPARE	-	-	0	20A	C	20A	-	-	0	SPARE	42	
43	SPARE	0	-	-	20A	A	20A	360	-	-	2R: 20A DUPLEX	44	
45	2R: 20A DUPLEX	-	360	-	20A	B	20A	-	360	-	2R: 20A DUPLEX	46	
47	2R: 20A DUPLEX	-	-	360	20A	C	20A	-	-	360	2R: 20A DUPLEX	48	
49	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	50	
51	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	52	
53	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	54	
55	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	56	
57	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	58	
59	2R: QUAD	-	-	720	20A	C	20A	-	-	720	2R: QUAD	60	
61	2R: QUAD	720	-	-	20A	A	20A	720	-	-	2R: QUAD	62	
63	2R: QUAD	-	720	-	20A	B	20A	-	360	-	1R: QUAD	64	
65	2R: DUPLEX	-	-	360	20A	C	15A	-	-	540	3R: DUPLEX	66	
67	2R: DUPLEX	360	-	-	15A	A	20A	720	-	-	2R: QUAD	68	
69	2R: QUAD	-	720	-	20A	B	20A	-	720	-	2R: QUAD	70	
71	2R: DUPLEX	-	-	360	20A	C	20A	-	-	360	2R: CORD REEL	72	
73	2R: CORD REEL	350	-	-	20A	A	20A	360	-	-	2R:CORD REEL	74	
75	SPARE	-	0	-	20A	B	30A 2P	-	2500	-	DRYER	76	
77	WASHER	-	-	1400	15A	C						78	
79	PANEL RP-SC/UPS 15KVA	5000	-	-	60A	B	20A	0	-	-	MITRE SAW	80	
81		-	5000	-		20A	-	0	-	TABLE SAW	82		
83		-	-	5000					0			84	
TOTAL ØA: 18360W , TOTAL ØB: 18360W , TOTAL ØC: 14880W													
NOTES: * - PROVIDE LOCKABLE BREAKER ** - PROVIDE GFI TYPE BREAKER *** - COORDINATE EXACT BREAKER SIZE WITH EQUIPMENT SHOP DRAWINGS R - RECEPTACLE L - LIGHTING													
CIRCUIT NUMBERS ARE GIVEN FOR GROUPING ONLY. SITE VERIFY AVAILABLE CIRCUIT BREAKER SPACES IN PANELS DURING TENDER WALKTHROUGH.													

11	2024-11-12	ISSUED FOR ADDENDUM-E02	TS
10	2024-09-30	RE-ISSUED FOR TENDER	
9	2024-08-29	ISSUED FOR TENDER	TS
8	2024-07-18	ISSUED FOR PERMIT	TS
7	2024-06-11	ISSUED FOR 100% CD	AZ
6	2024-05-15	ISSUED FOR 50% CD	AZC
5	2024-04-01	RE-ISSUED FOR 100% DD	AZC
4	2024-02-27	RE-ISSUED FOR 50% DD	TS
3	2023-10-30	ISSUED FOR 100% DD	AZ
2	2023-10-11	ISSUED FOR COORDINATION	AZ
1	2023-08-01	ISSUED FOR 60% DD COSTING	AZ
No.	DATE	DESCRIPTION	CH'D
REVISIONS			
THE SPECIFICATIONS ARE TO BE CONSIDERED AS AN INTEGRAL PART OF THESE DRAWINGS AND NEITHER THE DRAWINGS NOR THE SPECIFICATIONS SHALL BE USED ALONE. REFER TO ARCHITECTURAL DRAWINGS FOR DIMENSIONS. DO NOT SCALE.		PROJECT NORTH	
			
250 ROWNTREE DAIRY RD, WOODBRIDGE, ON TEL: 905-507-0800 WEB: WWW.QUASARCG.COM			
FOR QUESTIONS REGARDING THIS PROJECT, PLEASE EMAIL: CM-22-149@QUASARCG.COM			
PROJECT			
HWP WAREHOUSE UPGRADE 145 HARRY WALKER PARKWAY NEWMARKET  ON L3Y 7B3			
TITLE			
ELECTRICAL PANEL SCHEDULES			
CHECKED  TS		PROJECT No.  CM-22-149	
SCALE  AS SHOWN		DRAWING No.  E-307	

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: DP-EV1				VOLTS: 120/208V				LOCATION: REFER TO PLANS					
MAIN BUS: 225A				PHASE: 3				FED FROM: EX 4000A MAIN SWBD					
MAIN BREAKER: 300A/3P				WIRE: 4				FEEDER ENTRY AT: TOP					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:				REMARKS:					
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	EV CHARGER	0	-	-	50A 2P	A	50A 2P	0	-	-	EV CHARGER	2	
3		-	0	-	B	50A 2P	-	0	-	4			
5	EV CHARGER	-	-	0	50A 2P	C	50A 2P	-	-	0	EV CHARGER	6	
7		0	-	-	A	50A 2P	0	-	-	8			
9	EV CHARGER	-	0	-	50A 2P	B	50A 2P	-	0	-	EV CHARGER	10	
11		-	-	0	C	50A 2P	-	-	0	12			
13	EV CHARGER	0	-	-	50A 2P	A	50A 2P	0	-	-	EV CHARGER	14	
15		-	0	-	B	50A 2P	-	0	-	16			
17	EV CHARGER	-	-	0	50A 2P	C	50A 2P	-	-	0	EV CHARGER	18	
19		0	-	-	A	50A 2P	0	-	-	20			
21	EV CHARGER	-	0	-	50A 2P	B	50A 2P	-	0	-	EV CHARGER	22	
23		-	-	0	C	50A 2P	-	-	0	24			
25	EV CHARGER	0	-	-	50A 2P	A	50A 2P	0	-	-	EV CHARGER	26	
27		-	0	-	B	50A 2P	-	0	-	28			
29	EV CHARGER	-	-	0	50A 2P	C	-	-	0			30	
31		0	-	-	A	0	-	-		32			
33	EV CHARGER	-	0	-	50A 2P	B	-	0	-			34	
35		-	-	0	C	-	-	0		36			
37	EV CHARGER	0	-	-	50A 2P	A	0	-	-			38	
39		-	0	-	B	-	0	-		40			
41				0		C	-	-	0			42	
43		0	-	-		A	0	-	-			44	

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: DP-EV2				VOLTS: 120/208V				LOCATION: REFER TO PLANS					
MAIN BUS: 225A				PHASE: 3				FED FROM: EX 4000A MAIN SWBD					
MAIN BREAKER: 300A/3P				WIRE: 4				FEEDER ENTRY AT: TOP					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:				REMARKS:					
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	EV CHARGER	0	-	-	50A 2P	A	50A 2P	0	-	-	EV CHARGER	2	
3		-	0	-	B		-	0	-	4			
5	EV CHARGER	-	-	0	50A 2P	C	50A 2P	-	-	0	EV CHARGER	6	
7		0	-	-	A		0	-	-	8			
9	EV CHARGER	-	0	-	50A 2P	B	50A 2P	-	0	-	EV CHARGER	10	
11		-	-	0	C		-	-	0	12			
13	EV CHARGER	0	-	-	50A 2P	A	50A 2P	0	-	-	EV CHARGER	14	
15		-	0	-	B		-	0	-	16			
17	EV CHARGER	-	-	0	50A 2P	C	50A 2P	-	-	0	EV CHARGER	18	
19		0	-	-	A		0	-	-	20			
21		-	0	-	B		-	0	-		22		
23		-	-	0	C		-	-	0		24		
25		0	-	-	A		0	-	-		26		
27		-	0	-	B		-	0	-		28		
29		-	-	0	C		-	-	0		30		
31		0	-	-	A		0	-	-		32		
33		-	0	-	B		-	0	-		34		
35		-	-	0	C		-	-	0		36		
37		0	-	-	A		0	-	-		38		
39		-	0	-	B		-	0	-		40		
41		-	-	0	C		-	-	0		42		
43		0	-	-			0	-	-		44		

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: RP-M				VOLTS: 120/208V				LOCATION: REFER TO PLANS					
MAIN BUS: 400A				PHASE: 3				FED FROM: DP-M/TX-M					
MAIN BREAKER: 250A/3P				WIRE: 4				FEEDER ENTRY AT: BOTTOM					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING: NEMA 2				REMARKS:					
CIR NO.	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO.	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	BBH-1	2000	-	-	20A	A	15A 2P	1000	-	-	FFWH-1	2	
3	BBH-2	-	2000	-	20A	B	2P	-	1000	-		4	
5	FFWH-3	-	-	1500	20A	C	15A 2P	-	-	1000	FFWH-2	6	
7		1500	-	-	20A 2P	A		1000	-	-		8	
9	EF-1/EF-2/EF-3	-	638	-	20A	B	15A	-	746	-	EF-4	10	
11	EF-6	-	-	373	15A	C	15A	-	-	186	EF-7	12	
13	EF-8	373	-	-	15A	A	15A	100	-	-	EF-10	14	
15	SAC-1	-	1248	-	15A 2P	B	15A 2P	-	1248	-	SAC-2	16	
17		-	-	1248	C		-	-	1248			18	
19	SAC-3	2496	-	-	30A 2P	A	15A 2P	1248	-	-	SAC-4	20	
21		-	2496	-	B	2P	-	1248	-			22	
23	SCU-1	-	-	3744	45A 2P	C	45A 2P	-	-	3744	SCU-2	24	
25		3744	-	-	A		3744	-	-			26	
27	DBF-1	-	0	-	15A	B	40A 2P	-	2629	-	DHW-1	28	
29	MD-1	-	-	100	15A	C		-	-	2629		30	
31	MD-2	100	-	-	15A	A	15A	100	-	-	MD-6	32	
33	MD-3	-	100	-	15A	B	15A	-	100	-	MD-7	34	
35	1R: ROOF	-	-	180	20A	C	20A	-	-	180	1R: ROOF	36	
37	1R: ROOF	180	-	-	20A	A	20A	180	-	-	1R: ROOF	38	
39	1R: ROOF	-	180	-	20A	B	20A	-	180	-	1R: ROOF	40	
41	1R: ROOF	-	-	180	20A	C	20A	-	-	180	1R: ROOF	42	
43	CF-1	0	-	-	15A	A	15A	100	-	-	IR-1/IR-2	44	
45		-	0	-		B		-	0	-		46	
47		-	-	0		C	15A	-	-	0		CF-4	48
49	CF-2	0	-	-	15A	A		0	-	-		50	
51		-	0	-		B		-	0	-		52	
53		-	-	0		C	15A	-	-	0		CF-5	54
55	CF-3	0	-	-	15A	A		0	-	-		56	
57		-	0	-		B		-	0	-		58	
59		-	-	0		C	15A	-	-	0		CF-6	60
61	CF-1 CONTROLS	0	-	-	15A	A		0	-	-		62	
63	CF-2 CONTROLS	-	0	-	15A	B	15A	-	0	-	CF-4 CONTROLS	64	
65	CF-3 CONTROLS	-	-	0	15A	C	15A	-	-	0	CF-5 CONTROLS	66	
67	SPARE	0	-	-	15A	A	15A	0	-	-	CF-6 CONTROLS	68	
69	SPARE	-	0	-	15A	B	20A	-	0	-	SPARE	70	
71	SPARE	-	-	0	15A	C	20A	-	-	0	SPARE	72	
TOTAL ØA: 19685W , TOTAL ØB: 13813W , TOTAL ØC: 16412W													
NOTES: * - PROVIDE LOCKABLE BREAKER ** - PROVIDE GFI TYPE BREAKER *** - COORDINATE EXACT BREAKER SIZE WITH EQUIPMENT SHOP DRAWINGS R - RECEPTACLE L - LIGHTING CIRCUIT NUMBERS ARE GIVEN FOR GROUPING ONLY. SITE VERIFY AVAILABLE CIRCUIT BREAKER SPACES IN PANELS DURING TENDER WALKTHROUGH.													

26 06 20.16 - ELECTRICAL PANELBOARD SCHEDULE													
PANEL ID: DP-M				VOLTS: 347/600V				LOCATION: REFER TO PLANS					
MAIN BUS: 225A				PHASE: 3				FED FROM: EX 4000A MAIN SWBD					
MAIN BREAKER: 150A/3P				WIRE: 4				FEEDER ENTRY AT: TOP					
TYPE:				MOUNTING: SURFACE				FEEDER:					
INTERRUPTING CAPACITY: REFER TO SPECS				ENCLOSURE RATING:NEMA 2				REMARKS:					
CIR NO	DESCRIPTION	WATTAGE			BRK R	Ø	BRK R	WATTAGE			DESCRIPTION	CIR NO	
		ØA	ØB	ØC				ØA	ØB	ØC			
1	EF-5	1000	-	-	15A 3P	A	15A 3P	500	-	-	EF-9	2	
3		-	1000	-	B	-	500	-	-	4			
5		-	-	1000	C	-	-	500	-	-		6	
7	MAU-1	900	-	-	15A 3P	A	15A 3P	900	-	-	MAU-2	8	
9		-	900	-	B	-	900	-	-	10			
11		-	-	900	C	-	-	900	-	-		12	
13	MAU-3	1300	-	-	15A 3P	A	15A 3P	900	-	-	MAU-4	14	
15		-	1300	-	B	-	900	-	-	16			
17		-	-	1300	C	-	-	900	-	-		18	
19	MAU-5	1300	-	-	15A 3P	A	15A 3P	900	-	-	MAU-6	20	
21		-	1300	-	B	-	900	-	-	22			
23		-	-	1300	C	-	-	900	-	-		24	
25	DOCK LEVELER	500	-	-	20A 3P	A	-	500	-	-	REACH TRUCK CHARGER	26	
27		-	500	-	B	-	500	-	-	28			
29		-	-	500	C	-	-	500	-	-		30	
31	CA-1	0	-	-	30A 3P	A	-	0	-	-		32	
33		-	0	-	B	-	0	-	-	34			
35		-	-	0	C	-	-	0	-	-		36	
37		0	-	-		A		0	-	-		38	
39		-	0	-		B		-	0	-		40	
41		-	-	0		C		-	-	0		42	
TOTAL ØA: 8700W , TOTAL ØB: 8700W , TOTAL ØC: 8700W													

