

## **PART 1 GENERAL**

### **1.1 SUMMARY**

- .1 Section content.
  - .1 General requirement concerning work results and relevant sections of Division 26.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. M91 (C1997).
  - .3 CAN/CSA-C22.3 No. 1, Overhead Systems.
  - .4 CAN/CSA-C22.3 No. 7, Underground Systems.
  - .5 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
  - .6 CSA Z462-12, Workplace Electrical Safety.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
  - .2 EEMAC Y1-2-1979, Performance Specifications for Finishing Systems for Outdoor Electrical Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

### **1.3 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.

### **1.4 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
  - .2 Motors, electric, heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
    - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
  - .3 Language operating requirements: provide identification nameplates and labels for control items in English.
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## **1.5 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 01 35 43 – Environmental Procedures.
- .3 Shop drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Provinces of New Brunswick, Canada.
  - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .5 Submit 4 numbers of copies drawings and product data to Departmental representative.
  - .6 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Quality Control: in accordance with Section 01 45 00 – Testing and Quality Control.
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment is not available, submit such equipment to Departmental representative for approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental representative.
- .5 Manufacturer's Field Reports: submit to Departmental representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.
- .6 Submit for review updated single line electrical diagrams, drawing 600 x 600 mm minimum size, under Plexiglas and locate in Electrical Building.

## **1.6 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 – Testing and Quality Control.
  - .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities
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having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.

- .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
- .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Site Meetings:
  - .1 In accordance with work execution calendar.
  - .2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, in appropriate NMS Section, schedule site visits, to review Work, at stages listed.
    - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of Work, after cleaning is carried out.

#### **1.7 DELIVERY, STORAGE AND HANDLING**

- .1 Material Delivery Schedule: provide Departmental representative with schedule within two (2) weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

#### **1.8 SYSTEM STARTUP**

- .1 At the conclusion of the job, the Contractor shall review and demonstrate to the Departmental Representative, all electrical equipment and their respective functions and operation. Such demonstration shall be provided for such reasonable periods of time as the complexity of the job warrants, and as approved by the Departmental Representative. Such review and demonstration shall be made by an authorized representative of the Contractor, who shall be fully knowledgeable of the project, its installation and operation.
- .2 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

#### **1.9 OPERATING INSTRUCTIONS**

- .1 Three bound maintenance and operational manuals shall be reviewed and left with the Departmental Representative. These manuals shall be custom written for materials and systems supplied for this project.
  - .2 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
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- .3 Operating instructions to include following:
  - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  - .3 Safety precautions.
  - .4 Procedures to be followed in event of equipment failure.
  - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .4 Print operating instructions in approved laminated plastic.
- .5 Post instructions where directed.
- .6 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .7 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
- .8 Refer also to Section 01 78 00 – Closeout Submittals.
- .9 Prior to final inspection, submit these manuals to the Departmental Representative for review.

#### **1.10 GARANTIES**

- .1 The Contractor shall guarantee all work, under this Division, free from defects, for a period of one (1) year, after final acceptance of the entire project. The Contractor shall make good all defects, other than normal wear and tear, during the life of the guarantee. Notwithstanding the above, longer guarantees may be required for specific installations or equipment as indicated in other sections of the specifications.
- .2 Guarantees shall be submitted in writing, bound where more than one is required, and submitted to the Departmental Representative for review. Each guarantee shall include:
  - .1 Project name and address.
  - .2 Guarantee time period (commencement date shall be the date as shown on the project final certificate of completion, unless otherwise indicated).
  - .3 Clear and concise definition of what is guaranteed.
  - .4 Signatures of company officers of the Contractor and/or manufacturers, as applicable.

#### **1.11 MINIMUM STANDARDS**

- .1 All work shall be performed in accordance with Canadian Electrical Code, National Building Code, and CAN/ULC-S524, as minimum standards. These standards together with all Local or Municipal Rules, Regulations, and Ordinances shall be considered as the Latest
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Approved Editions at the time of Tender Closing. In no instance, shall the standard established by the drawings and specifications, be reduced by any codes.

#### **1.12 PERMIT, FEES AND INSPECTION**

- .1 The Contractor shall obtain all inspections and permits required by all laws, ordinances, rules, and regulations by public authority having jurisdiction in this district, and shall obtain certificates of such inspections and shall pay all charges in connection therewith. The final certificate of inspection shall be obtained before final payment for work shall be considered due.

#### **1.13 PROJECT RECORD DOCUMENTS**

- .1 Departmental Representative will provide 2 white print sets of contract drawings and 2 copies of Specifications Manual specifically for "as-built" purposes.
- .2 Maintain at site one set of the contract drawings and specifications to record actual as-built site conditions.
- .3 Maintain up-to-date, real time as-built drawings and specifications in good condition and make available for inspection by the Departmental Representative upon request.
- .4 Record changes in red ink on the prints. Mark only on one set of prints and at completion of work, neatly transfer notations to second set (also by use of red ink).
- .5 Submit both sets to Departmental Representative prior to application for Certificate of Substantial Performance.
- .6 Stamp all drawings with "As-Built Drawings". Label and place Contractor's signature and date.
- .7 Show all modifications, substitutions and deviations from what is shown on the contract drawings or in specifications.
- .8 All change orders issued over the course of the contract must be documented on the finished as-built documents, accurately and consistently depicting the changed condition as it applies to all affected drawing details.
- .9 Maintain As-built documents current as the contract progresses. Departmental Representative will conduct reviews and inspections of the documents on a regular basis. Failure to maintain as-built current and complete to satisfaction of the Departmental Representative shall be subject to financial penalties in the form of progress payment reductions and holdback assessments.

#### **1.14 HOUSEKEEPING PADS**

- .1 N/A
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## **PART 2 PRODUCTS**

### **2.1 MATERIALS AND EQUIPMENT**

- .1 Material and equipment shall be new and CSA certified. Where CSA certified material and equipment is not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .2 Factory assemble control panels and component assemblies.
- .3 For the purposes of uniformity similar materials shall be of one manufacturer (i.e. all panels and switchgear; all motor control equipment; transformers, all light fixtures in as much as is possible; etc.).
- .4 To avoid the possibility of the work being delayed, the Contractor shall order all materials as soon as possible, and he shall report at once to the Departmental Representative any delays in the delivery of materials which would hold up the completion of the job.

### **2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 05 21 – Wire and Cables (0 – 1 000 V) and 26 05 34 – Conduits, conduit fastenings and conduit fittings.
- .3 The Contractor shall obtain from the mechanical and other trades complete detailed wiring diagrams of equipment requiring connections and shall be responsible for pointing out any discrepancies or the reason why they cannot be adhered to.
- .4 Prior to rough in of electrical services, co-ordinate location of all mechanical equipment with the Mechanical Contractor.

### **2.3 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of Departmental representative.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.

### **2.4 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

### **2.5 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
    - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.
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- .2 Sizes as follows:

**NAMEPLATE SIZES**

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Wording on nameplates to be approved by Departmental representative prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.
- .7 Transformers: indicate capacity, primary and secondary voltages.

## **2.6 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.

## **2.7 CONDUIT AND CABLE IDENTIFICATION**

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .3 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red

Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

## **2.8 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor switchgear and distribution enclosures light gray (ASA-61) to EEMAC 2Y-1.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead systems in accordance with CSA C22.3 No.1 and underground systems in accordance with CSA C22.3 No 7, except where specified otherwise.

### **3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

### **3.3 RECEPTACLES, PIN & SLEEVES AND LIGHT SWITCHES**

- .1 Affix identification on all receptacles and switches faceplates.
- .2 Install a ribbon on the width of the faceplate and curl the ribbon behind the plate.
- .3 Mark the circuit number inside all device boxes of receptacles and switches. Use a white ribbon affixed to the wiring inside the box.
- .4 The circuit number shall be complete with the panel number from where it originate.

### **3.4 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
  - .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
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### **3.5 LOCATION OF OUTLETS**

- .1 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .3 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

### **3.6 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify with Departmental representative before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1200 mm.
  - .2 Wall receptacles in service room: 1200 mm
  - .3 Panel boards: as required by Code or as indicated.
  - .4 Telephone outlets: 1200 mm.

### **3.7 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Coordination of Protective Device: Provide a report to Departmental Representative showing all values and settings, stamped and signed by a professional Engineer. The report shall include time-current curves on a logarithmic scale and be performed by the manufacturer of the electrical distribution equipment. Arrange and pay for associated fees.
- .2 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.8 CUTTING AND PATCHING**

- .1 Cutting and patching shall be the responsibility of this Contractor and shall be performed by a skilled tradesperson.
  - .2 Make every effort to minimize cutting and patching by providing dimensions, locations and other data for bases, sleeves, boxes, etc., to be built in as construction proceeds. Set sleeves and mark openings in concrete forms and masonry before placing concrete and masonry.
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### **3.9 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 – Testing and Quality Control.
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### **3.10 CLEANING**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
  - .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
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.3 Refer to section 01 74 11 – Cleaning.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 SECTION INCLUDES**

- .1 Materials and installation for wire and box connectors.

### **1.2 RELATED SECTIONS**

- .1 Section 01 74 19 - Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results Electrical Systems.

### **1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2No.18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2No.65-03 (R2008), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
  - .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
  - .3 Bushing stud connectors: to EEMAC 1Y-2 NEMA to consist of:
    - .1 Connector body and stud clamp for stranded round copper conductors tube bar.
    - .2 Clamp for stranded round copper conductors bar.
    - .3 Clamp for stranded aluminum ACSR conductors.
    - .4 Stud clamp bolts.
    - .5 Bolts for copper conductors and bar.
    - .6 Sized for conductors as indicated.
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- .4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit and non-metallic sheathed cable as required to: CAN/CSA-C22.2No.18.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
  - .3 Install fixture type connectors and tighten. Replace insulating cap.
  - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2 and NEMA.
  - .5 No splices are allowed in panelboards or in equipment enclosures.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 26 05 20 - Wire and Box Connectors, 0 - 1000 V.
- .2 Section 26 05 00 - Common Work Results For Electrical.

### **1.2 REFERENCES**

- .1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.
- .2 CSA Standard 22.2 No. 49, Flexibles Cords and Cables.
- .3 ASTM B3 & B172-4 Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members for Electrical Conductors.
- .4 ICEA S-68-516, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

### **1.3 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

## **PART 2 PRODUCTS**

### **2.1 BUILDING WIRES**

- .1 Conductors: stranded for 8 AWG and larger. Minimum size: 12 AWG.
  - .2 Copper conductors: size as indicated, 600V insulation of chemically cross-linked thermosetting polyethylene material RW90. Aluminum conductor are forbidden.
  - .3 Wiring shall be continuously colour coded as follows:
    - .1 Phase A Red
    - .2 Phase B Black
    - .3 Phase C Blue
    - .4 Neutral – White/Grey
  - .4 Voltage drop:
    - .1 Contractor shall wire all circuit so that the maximum tension drop does not exceed 3%.
    - .2 Branch circuit wiring larger than #10 AWG must extend to the device box of the receptacle of the equipment they are feeding. Branch circuit wiring larger than #8
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AWG must extend from the distribution panelboard to the junction box mounted on the wall, shroud or ceiling above the equipment they are feeding, the #8 wiring must then be reduced to a #10 for the vertical portion of the run to the equipment or receptacle.

## **2.2 TECK 90 CABLE**

- .1 Cable: in accordance with Section 26 05 00- Common Work Results for Electrical.
  - .2 Conductors:
    - .1 Grounding conductor: copper.
    - .2 Circuit conductors: copper, size as indicated.
  - .3 Insulation:
    - .1 Cross-linked polyethylene XLPE.
    - .2 Rating: 600 V (minimum).
  - .4 Inner jacket: polyvinyl chloride material.
  - .5 Armour: interlocking aluminum.
  - .6 FT6 rated.
  - .7 Overall covering: thermoplastic polyvinyl chloride.
  - .8 Fastenings:
    - .1 One hole stainless steel straps to secure surface cables 50 mm and smaller. Two hole stainless steel straps for cables larger than 50 mm.
    - .2 Channel type supports for two or more cables at 1500mm.
    - .3 Threaded rods: 12 mm diameter to support suspended channels.
  - .9 Connectors:
    - .1 Watertight approved for TECK cable.
  - .10 Voltage drop:
    - .1 Contractor shall wire all circuit so that the maximum tension drop does not exceed 3%.
    - .2 Branch circuit wiring larger than #10 AWG must extend to the device box of the receptacle of the equipment they are feeding. Branch circuit wiring larger than #8 AWG must extend from the distribution panelboard to the junction box mounted on the wall or ceiling above the equipment they are feeding, the #8 wiring must then be reduced to a #10 for the vertical portion of the run to the equipment or receptacle.
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**2.3            ARMOURED CABLES**

- .1        N/A.

**2.4            CONTROL CABLES**

- .1        Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2        Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with PVC insulation type, TW, TWH polyethylene insulation over each pair and overall covering of polyethylene jackets.

**PART 3            EXECUTION**

**3.1    INSTALLATION OF BUILDING WIRES**

- .1        Install wiring as follows:
  - .1        In conduit systems in accordance with Section 26 05 34.

**3.2    INSTALLATION OF ARMOURED CABLES**

- .1        N/A

**3.3    INSTALLATION OF CONTROL CABLES**

- .1        N/A.

**3.4    INSTALLATION OF TECK90 CABLE**

- .1        Group cables wherever possible on channels.
- .2        Install cable concealed in finish administrative area securely supported by hangers.
- .3        Install cable exposed in un-finish area securely supported by hangers.
- .4        All supporting system used outside shall be stainless steel 316.
- .5        All supporting system used inside shall be hot dip galvanised.

**END OF SECTION**

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**PART 1        GENERAL**

**1.1            RELATED SECTIONS**

- .1        Section 01 74 19 - Waste Management And Disposal.
- .2        Section 26 05 00 - Common Work Results Electrical Systems.

**1.2            REFERENCES**

- .1        American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1        ANSI/IEEE 837-2003, Qualifying Permanent Connections Used in Substation Grounding.
- .2        Canadian Standards Association, (CSA International)

**1.3            ACTION AND INFORMATION SUBMITTALS**

- .1        Submit in accordance with Section 26 05 00 Common Work Results - Electrical.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4            DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
    - .2        Replace defective or damaged materials with new.
  - .4        Packaging Waste Management: remove for reuse and return by manufacturer packaging materials in accordance with Section 01 74 19 – Waste Management and Disposal.
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**PART 2 PRODUCTS**

**PART 3 EXECUTION**

**3.1 INSTALLATION GENERAL**

- .1 All equipment and exposed non-current-carrying metal, conduits and parts shall be permanently and effectually grounded to meet minimum requirements of the Canadian Electrical Code, and as indicated on the drawings and further specified. Standards set either by drawings or specifications which are above those covered by the CEC shall not be reduced under any circumstances.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .4 Soldered joints not permitted.
- .5 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

**3.2 ELECTRODES**

- .1 N/A.

**3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 N/A.

**3.4 EQUIPMENT BONDING**

- .1 Install bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels and receptacles.
  - .2 Generally, minimum bonding shall be provided by the metallic conduit/outlet box system and by the bond wires in cables. Additional insulated bond conductors, sized as per the drawings, shall be provided as follows:
    - .1 In all EMT feeders that supply panelboards, distribution panels and switchboards, MCCs and transformers – all sized as per CEC Table 16.
    - .2 A separate green bond conductor sized as per Table 16 of the CEC shall be installed in each EMT conduit run for branch circuit wiring.
    - .3 A separate green bond conductor sized as per Table 16 of the CEC shall be installed in non-metallic conduit systems (i.e. – rigid PVC).
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- .3 Where bond conductors terminate at ground busses in switchboards or panelboards, the connection shall be made with a compression lug, which shall be secured to the bus with nut, bolt and two Belleville washers. Size of bolts shall be to suit lug and shall be properly torqued and marked. One-hole short barrel (single crimp) lugs shall be used for wire sizes up to and including number 6 AWG. Two-hole long barrel (dual crimp) lugs shall be used for wire sizes number 4 AWG and larger.

### **3.5 GROUNDING BUS**

- .1 N/A.

### **3.6 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results Electrical Systems.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

**END OF SECTION**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 74 - Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results Electrical Systems.

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 See Section 01 74 19 Waste Management and Disposal.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

**PART 2 PRODUCTS**

**2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted for suspended application.
  - .2 10mm diameter threaded rods for supporting suspended channel.
  - .3 Specific purpose, corrosion resistant, heat treated, fasteners to be used to support boxes, conduit and cable from support channel and/or directly from structure.
  - .4 Two holes corrosion resistant straps for conduits.
  - .5 All support channels assembly installed outside shall be made of stainless steel 316.
  - .6 All support channels assembly installed inside shall be made of hot dip galvanised steel.
  - .7 All pull and junction boxes, wire ways, and multiple conduits installed outside shall be supported by a stainless steel channel support system with all components, hangers, wall supports, cable clamps, etc., specifically manufactured and approved for their application. Supporting system installed inside shall be hot dip galvanised.
  - .8 Fastening devices for cabinets, boxes, supports etc., shall be nut and bolt, expansion shields, wedge anchors, or toggle bolts, size and number to suit the application or as detailed on the drawings. Toggle bolts may not be used in plasterboard construction.
  - .9 Fastening devices for outlet boxes shall be nut and bolt, expansion shields, wedge anchors or caddy clips, size and number to suit the application or as detailed on the drawings.
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- .10 Where outlet boxes are set in drywall construction, a piece of steel stud shall be secured to either side of the outlet box or use applicable quick-mount box supports, or approved side box supports.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Secure all equipment in a manner so as not to distort or cause undue stress on any components.
  - .2 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
  - .3 Secure equipment to poured concrete with expandable inserts.
  - .4 Secure surface mounted equipment with fasteners.
  - .5 Secure equipment to poured concrete with expandable inserts.
  - .6 Secure equipment to hollow masonry walls with toggle bolts. Toggle bolts shall not be used to secure equipment to plasterboard, drywall, or acoustic tile surfaces.
  - .7 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
  - .8 Fasten exposed conduit or cables to building construction or support system using straps.
    - .1 One-hole stainless steel straps to secure surface conduits and cables 53mm and smaller.
    - .2 Two-hole stainless steel straps for conduits and cables larger than 53mm.
    - .3 Beam clamps to secure conduit to exposed steel work.
  - .9 Suspended support systems.
    - .1 Support individual cable or conduit runs with 12mm dia threaded rods and spring clips.
    - .2 Support 2 or more cables or conduits on channels supported by 12mm dia threaded rod hangers where direct fastening to building construction is impractical.
  - .10 For surface mounting of two or more conduits use channels at 1500mm (maximum) on centre spacing.
  - .11 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
  - .12 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
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- .13 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .14 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Departmental Representative.
- .15 Do not support any electrical conduits, wire or equipment from ceiling system support cables.
- .16 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .17 In addition to the C.E.C. conduit support requirements, all suspended conduit runs containing horizontal or vertical elbows shall have one additional support installed not greater than 300mm from the midpoint of the 90° bend.

**END OF SECTION**

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**PART 1        GENERAL**

**1.1            RELATED SECTIONS**

- .1    Section 01 74 19 - Waste Management And Disposal.
- .2    Section 26 05 00 - Common Work Results Electrical Systems.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1    Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Canadian Standards Association (CSA International)

**1.3            REFERENCES**

- .1    CSA C22.1-18, Canadian Electrical Code, Part 1, 24<sup>th</sup> Edition.

**PART 2        PRODUCTS**

**2.1            SPLITTERS**

- .1    CSA Type 4x, Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position for Aeration Tower installation.
- .2    Main copper bus.
- .3    Main and branch lugs connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .4    At least three spare terminals on each set of lugs in splitters less than 400A.

**2.2            JUNCTION AND PULL BOXES**

- .1    For any installation into the Aeration Tower or outdoor, use junction and pull boxes rated: non-metallic CSA Type 4x construction rated for exterior use for surface mounting application.
- .2    Mounting feet.
- .3    Mounting Plate where terminal blocks are installed.

**2.3            CABINETS**

- .1    Cabinets shall be steel, fabricated to C.S.A. & EEMAC Standards with baked enamel finish. Cabinet shall be EEMAC Standard Types "C", "D", or "T" as indicated on the
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drawings. Type "T" cabinets shall be complete with hinged door, lock, two keys, and handle, and be lined with 21mm plywood.

- .2 Cabinets installed into Aeration Tower shall be CSA Type 4x stainless steel 316.

## **PART 3 EXECUTION**

### **3.1 SPLITTER INSTALLATION**

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

### **3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations and secure them adequately to the building structure. Pull boxes installed in the middle of conduit runs without backing are not acceptable.
- .2 The location of junction and/or pull boxes in suspended ceiling spaces, i.e. - dry wall, T-Bar, etc., is not to be greater than 760mm above the finished ceiling and must be easily accessible.
- .3 All suspended junction, pull and outlet boxes shall be supported with minimum size 10mm threaded rods, nuts and flat washers. Threaded rods shall be secured to boxes with one flat washer and nut installed on both sides of box. One rod required for all boxes sized up to and including 119mm square. Two rods required for boxes larger than 119mm square, up to and including 203mm square. A minimum of four rods required for all boxes larger than 203mm square.
- .4 Mount cabinets with top not higher than 2000mm above finished floor.
- .5 Install terminal blocks as required.
- .6 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

### **3.3 IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results Electrical Systems.
- .2 Install size 2 identification labels indicating system name, voltage, phase and circuit numbers where applicable.
- .3 Install size 2 identification labels indicating system name, voltage and phase.

**END OF SECTION**

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**PART 1        GENERAL**

**1.1            REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.2 No. 18.2-06, Nonmetallic Outlet Boxes.
  - .2 CSA C22.2 No. 45-M1981 (R2007), Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56-04 (R2009), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 211.1-06(R2011), Rigid Types EB1 and DB2/ES2 PVC conduit.

**1.2            SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.

**PART 2        PRODUCTS**

**2.1            CONDUITS**

- .1 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .2 Flexible galvanized steel liquid tight conduit shall conform to C.S.A. C22.2 No. 56, sized as indicated.
- .3 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3, sized as indicated.

**2.2            CONDUIT FASTENINGS**

- .1 One stainless steel straps to secure surface conduits 50 mm and smaller. Two stainless steel straps for conduits larger than 50 mm.
  - .2 Beam clamps to secure conduits to exposed work.
  - .3 Steel channel type supports for two or more conduits at 1.5 m on centre.
  - .4 Steel threaded rods, 12 mm diameter, to support suspended channels.
  - .5 Complete conduit fastening system installed into the Aeration Tower shall be hot dip galvanised.
  - .6 Complete conduit fastening system installed outside shall be stainless steel 316.
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**2.3 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Weatherproof and watertight connectors and couplings as indicated for all installation indoor the Aeration Tower and outdoor. Provide sealing O'ring gasket to positively protect against damage.
- .4 Couplings and connectors for P.V.C. rigid conduit shall be C.S.A. Approved for their respective use. All P.V.C. fittings shall be solvent weld type. Push-fit type fittings are not acceptable.
- .5 Connectors for flexible conduit, armoured cable shall be watertight galvanized steel and be complete with case hardened locknuts.
- .6 Connectors for liquid tight flexible conduit shall be watertight, compression type galvanized steel or aluminum. Locknuts shall be case hardened. Dry type connectors may be used in dry indoor areas not exposed to liquids or moisture, if approved for use.
- .7 Utilize watertight connectors and couplings for exposed vertical runs.

**2.4 FLEXIBLE CABLES FITTINGS**

- .1 Flexible cable and associated fittings used for shore power shall be stainless steel 316 suitable for outdoor wet location conditions.
- .2 Ensure when flexible cable connected to the device or fitting that tension will not be transmitted to joints or terminal screws. Sufficient slack shall be provided to avoid sharp flexing and straining. Cord or cable shall be installed in such a manner that liquid will tend to run off the surface instead of draining towards the fitting.
- .3 Fittings shall be of watertight strain relief type. Fittings shall be equipped with a beveled moisture water resistant synthetic rubber bushing.
- .4 Provide sealing O'ring gasket to positively protect against damage.

**2.5 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
  - .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
  - .3 Weatherproof expansion fittings for linear expansion at entry to panel.
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- .4 Expansion joints shall be installed in any conduit run where the conduit make a transition from underground to above ground.

## **2.6 FISH CORD**

- .1 Polypropylene, 6 mm diameter.

## **PART 3 EXECUTION**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION**

- .1 All conduits and cables shall be kept parallel or perpendicular to building lines. All conduits shall be securely held in place at intervals and with supports as required by the Canadian Electrical Code.
- .2 Use rigid steel hot dipped galvanized conduit and fittings for all surface and exposed works, devices and equipment on the Aeration Tower. Install in accordance with manufacturer's recommendations. All fastenings used outdoor shall be 316 stainless steel.
- .3 Minimum conduit size for lighting and power circuits: 21 mm.
- .4 All conduits shall be securely held in place by means of approved supports and in accordance with C.E.C. Sections 12-1010, 12-1114 and 12-1404. All conduit straps shall be stainless steel. Cast straps are not acceptable. Conduit shall be installed as a complete system and shall be securely fastened in place within 914 mm of each outlet box, junction box, cabinet, couplings or fittings and the spacing between supports as follows:
  - .1 Less than 1500mm for 16mm and 21mm;
  - .2 Less than 2286mm for 27mm and 35mm;
  - .3 Less than 3048mm for 41mm or larger.
- .5 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .6 Mechanically bend steel conduit over 19 mm diameter.
- .7 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .8 Install fish cord in empty conduits.
- .9 Dry conduits out before installing wire.

- .10 Install a green isolated copper wire in each conduit for bounding. The conductor size shall be as required by the Canadian Electrical Code.

### **3.3 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Run conduits in flanged portion of structural steel.
- .3 Group conduits wherever possible on suspended channels.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.4 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

### **3.5 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Touch up any damaged PVC coating on conduits and fittings with manufacturer's approved coating touch up compounds.
- .3 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

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**PART 1        GENERAL**

**1.1            RELATED SECTIONS**

- .1    Section 01 33 00 - Submittal Procedures.
- .2    Section 01 74 19 - Waste Management And Disposal.
- .3    Section 26 05 00 - Common Work Results Electrical Systems.
- .4    Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .5    Section 26 80 00 – Commissioning of Electrical Systems.

**1.2            REFERENCES**

- .1    Canadian Standards Association (CSA International)
  - .1    CSA C22.2 No.29-M1989 (R2000), Panelboards and enclosed Panelboards.

**1.3            SHOP DRAWINGS**

- .1    Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

**PART 2        PRODUCTS**

**2.1            PANELBOARDS**

- .1    Panelboards and distribution panels: to CSA C22.2 No.29 and product of one manufacturer.
    - .1    Install circuit breakers in panelboards or distribution panels before shipment.
    - .2    Panelboards and distribution panels shall have 25% free slots and 10% spare breakers.
    - .3    In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
  - .2    225A, 120/208V, 3 Ph, 4W, panelboards: bus and breakers rated for symmetrical interrupting capacity rated 10kaic.
  - .3    Incoming conductors to accommodate up to 250kcmil conductor size. Refer to drawing for exact size.
  - .4    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.
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- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
  - .6 Minimum of 2 flush locks for each panel board.
  - .7 Two keys for each panelboard and key panelboards alike.
  - .8 Copper bus with neutral of same ampere rating as mains.
  - .9 Copper ground bus
  - .10 Mains: suitable for bolt-on breakers.
  - .11 Trim with concealed front bolts and hinges.
  - .12 Trim and door finish: baked grey enamel air dried grey enamel.
  - .13 Industrial type.
  - .14 CSA Type 4x stainless steel 316.
  - .15 Approved manufacturer for new panel is "Schneider Electric". Restriction of existing assembly: to ensure the compatibility and consistence between new panel and existing panels, the new panel shall be compatible with existing Square D panel installed at North valve Building and Garage Building.

## **2.2 BREAKERS**

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices as indicated on drawings. Turn over unused lock-on devices to Departmental Representative.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results Electrical Systems.
  - .2 Nameplate for each panelboard size 4 engraved as indicated.
  - .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
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- .4 Complete circuit directory with typewritten legend showing location, load of each circuit and the room number where the load is located.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Locate panelboards and distribution panels as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Install surface mounted panelboards and distribution panels on plywood backboards. Where practical, group panelboards on common backboard.
- .3 Mount to height specified in Section 26 05 00 - Common Work Results Electrical Systems or as indicated.
- .4 Connect loads to circuits.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Perform a thermal infrared inspection 10 days after commissioning Provide inspection results to Departmental representative.

**END OF SECTION**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Waste Management and Disposal.
- .3 Section 26 05 00 - Common Work Results Electrical Systems.
- .4 Section 26 24 16.01 – Panels boards breaker type.
- .5 Section 26 80 00 – Commissioning of Electrical Systems.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA-C22.2 No. 5-13, Moulded Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

**1.3 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 400 A and over or with interrupting capacity of 35,000 A symmetrical (rms) and over at system voltage.

**PART 2 PRODUCTS**

**2.1 BREAKERS GENERAL**

- .1 Moulded-case circuit breakers: to CSA C22.2 No. 5.
  - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
  - .3 Common-trip breakers: with single handle for multi-pole applications.
  - .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .5 Circuit breakers with interchangeable trips as indicated.
  - .6 Circuit breakers to have symmetrical rms interrupting capacity rating as indicated on drawings.
  - .7 Circuit breakers shall be supplied integral to their associated panels.
  - .8 New circuit breakers require to be installed in existing panels shall be provided by this contractor. New circuit breakers shall be compatible with existing panels as shown on drawings.
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**2.2 THERMAL MAGNETIC BREAKERS**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.

**END OF SECTION**

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## **PART 1      IGENERAL**

### **1.1    RELATED SECTIONS**

- .1    Section 26 05 00 - Common Work Results Electrical Systems.
- .2    Section 26 80 00 – Commissioning of Electrical Systems.

### **1.2    REFERENCES**

- .1    Canadian Standards Association (CSA International).
  - .1    CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
  - .2    CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

### **1.3    ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Shop Drawings: Indicate on shop drawings:
  - .1    Fuse clip arrangement/class.
  - .2    Overall length, height and depth of each type of switch.
  - .3    Number of poles, including neutrals where required, amperage rating, and voltage rating of each type of disconnect required.

### **1.4    CLOSEOUT SUBMITTALS**

- .1    Provide maintenance materials in accordance with Section 01 78 10 – Closeout Submittals.
- .2    Submit operation and maintenance data for each type and style of disconnect switch for incorporation into maintenance manual.

## **PART 2      PRODUCTS**

### **2.1    DISCONNECT SWITCHES**

- .1    Fusible and non-fusible disconnect switches in CSA rated enclosures.
  - .2    Provision for padlocking in "ON" and "OFF" position.
  - .3    Mechanically interlocked door to prevent opening when handle in "ON" position.
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- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.
- .6 Neutral lugs.
- .7 Disconnect switch shall be installed inside the VFD control cabinet.

## **2.2 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results Electrical Systems.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results Electrical Systems.
- .2 Indicate name of load controlled on size 4 nameplate.

# **PART 3 EXECUTION**

## **3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses if applicable.
- .2 Supply all necessary mounting hardware and channel as required to mount switches.

## **3.2 CLEANING**

- .1 Clean in accordance with Section 01 74 11 – Cleaning.
- .2 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Waste Management and Disposal.

**END OF SECTION**

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## **PART 1 GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 77 00 – Closeout Procedures.
- .3 Section 26 05 00 - Common Work Results Electrical Systems.
- .4 Section 26 80 00 – Commissioning of Electrical Systems.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
- .2 CSA marking according to CSA C22.2 No.274-13
- .3 CSA C22.2 No. 14-M91 : Industrial Control Equipment
- .4 NECA "Standard of Installation."
- .5 NEMA – National Electrical Manufacturers Association:
  - .1 NEMA ICS 3.1 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
- .6 IEC 60068-2: Environment compliance for humidity, vibration, and shock.
- .7 IEC 61800 : Adjustable speed Electrical power drive systems.
- .8 IEC 61000-3-12: Limits for Harmonic Current.

### **1.3 DEFINITION**

- .1 VFD: Variable Frequency Drive.
- .2 VFD control cabinet: Refer to the cabinet to house the VFD unit, VFD accessories and all related controls. The Aeration Tower building is not heated or insulated. The intent is to install all components inside a ventilated and heater cabinet to protect the VFD and all related components against harsh environment.

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Product Data:
    - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, warranty, finish and limitations.
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- .2 Indicate front and side views of variable frequency drive enclosures and cabinet with overall dimensions and mounting method. Include conduit entrance locations and requirements; nameplate legends; electrical characteristics including voltage, frame size and trip ratings; layout of identified internal and front panel component, wiring diagram for VFD unit and complete VFD control cabinet; termination numbers and identification of purpose; and time-current curves of equipment and components. Drawings prepared by the Subcontractor shall be developed using the AutoCAD™ computer-aided drafting software.
- .3 Provide engineering drawing showing the vfd control cabinet assembly included all required components, overall dimensions, inner / outer panel, elevation, wiring diagram, bill of material and product literature.
- .4 VFD Product Data: Provide complete product data on the variable frequency drive.

## **1.5 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 78 10 – Closeout Submittals.
- .2 Submit operation and maintenance data for the assembly for incorporation into maintenance manual.

## **1.6 WARRANTY**

- .1 Warranty shall be 18 month starting from the date of final commissioning. The Departmental Representative shall accept the final test result to be considered final commissioning. Warranty period shall start at the date the equipment is energized after acceptance by the Departmental Representative
- .2 Submit a copy of the warranty certificate as part of the shop drawing review submission. The warranty shall refer to VFD control cabinet as an assembly with include all components and shall include labor, material and travel.

## **1.7 VFD AND VFD CONTROL CABINET TEST**

- .1 Upon completion of manufacture and assembly, the drive shall be subjected to a complete factory test to demonstrate compliance with specified features and characteristics. The testing procedure shall be the manufacturer standard procedure to assure maintenance free service. All equipment, devices, instrumentation, and personnel required to perform the tests shall be supplied by the manufacturer.

## **PART 2 PRODUCT**

### **2.1 VARIABLE FREQUENCY DRIVE (VFD)**

- .1 Horsepower Rating: as shown on the drawing, and compatible with the motors to be driven. Suitable for HVAC application.
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- .2 Adjustable speed drive to accept three phase input 208 V  $\pm 10\%$ . Voltage variation of  $\pm 10\%$  and frequency  $\pm 2$  Hz.
  - .3 The drive shall have a minimum six-diode bridge rectifier on the front end to minimize the generation of electrical noise back into the line and to provide near unity Power Factor.
  - .4 Integrated Equipment Short Circuit Rating: 100,000 amperes rms symmetrical at 208 volts.
  - .5 The drive horsepower rating shall match the driven load horsepower at 208 V with a speed range of 0.1 to 60 Hz for both constant and variable torque applications. The drive shall be capable of 110% full load (continuous) with plugging from full speed one direction to fullspeed reverse.
  - .6 Variable Torque: In the event of a sustained power loss, the control shall shut down safely without component failure. Upon return to power, the system shall automatically return to normal operations. In the event of a momentary power loss, the control shall shut down safely without component failure. Upon return of power, the system shall automatically return to normal operations. The drive shall be capable of starting into a rotating motor.
  - .7 Overload Capacity: 110% for 60 seconds. Current Limit circuitry phases back voltage and frequency until current decreases.
  - .8 The efficiency of the AC Drive at 100% speed and load shall not be less than 98%.
  - .9 Frequency Range: 1 to 72 Hz adjustable by programming from keypad.
  - .10 Volts per Hertz: 3 to 60 Hz, V/Hz Constant Rating 60 Hz and up, Voltage Constant.
  - .11 The variable speed drive system shall include a minimum six-diode bridge converter, filter network and a transistorized inverter section. The output shall be a sinusoidal wave, pulse width modulated, voltage waveform for reduced harmonic heating in the motor. Harmonics generated, either into the system or into the load, shall not exceed levels permitted by IEEE 519-1993. The system shall include all the necessary control circuits, synchronizing the equipment and protective devices as required by design.
    - Current Limit-Adjustable from 10 to 150%;
    - Electronic Motor Overload-Adjustable from 10 to 100%.
    - Overcurrent - 240% IET (trips fault).
    - Short Circuit - phase to phase (trip fault).
    - Over Voltage - High DC Bus Voltage (trips fault).
    - Under Voltage - 20% below Line Voltage.
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- Ground Fault - phase to ground (trips fault).
  - Momentary Power Failure: 30 Milliseconds standard; Option 100 Milliseconds maximum.
  - Burn-Out-DC Bus Fuse Protection or 3 Phase Input Fusing.
  - Solid state single-phasing protection.
- .12 Remote Control and Feedback Terminals: Provide for Class 2 wiring terminations to accept a dry contact closure for external "VFD Run Forward Push Button – Supply Air", "VFD Stop Push Button", "VFD Run Reverse Push Button – Exhaust Air", Overload Alarm", "Damper Control"
- .13 Provide VFD c/w with all required relays to achieve the sequence of operation described on the contract document.
- .14 4 x form C Programmable Relay output.
- .15 The AC Drive shall have internal configurable damper control functionality. One form C relay to open and close the motorized damper as per the sequence of operation.
- .16 On-board communication Modbus RTU.
- .17 The VFD shall incorporate a disconnect switch sensing function. This sensing function shall allow the VFD to shut down normally when a power disconnect switch located between the main panel and the VFD is opened during operation.
- .18 Enclosure: CSA Type 1. Refer to section 2.2 for vfd control cabinet external enclosure rating.
- .19 Upon a fault detection and VFD trip, the alarm contact shall open on the VFD, for external connection and remote indication, to signify a fault condition (contact rating of 0.5 amps resistive at 120 VAC).
- .20 Upon a fault detection and VFD trip. Upon a restoration of the VFD, the VFD shall automatically resume operation.
- .21 Protection type: Thermal protection motor, safe torque off motor, motor phase break motor, thermal protection drive, safe torque off drive, overheating drive, overcurrent between output phases and earth drive, overload of output voltage drive, short-circuit protection drive, motor phase break drive, overvoltages on the DC bus drive, line supply overvoltage drive, line supply undervoltage drive, line supply phase loss drive, overspeed drive, break on the control circuit drive.
- .22 The adjustable frequency drive shall be configured to shut down upon opening of a remote dry contact in the event of an alarm condition in another system.
- .23 Relative humidity 5...95 % without condensation IEC 60068-2-3
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- .24 Ambient air temperature for operation -15...40 °C without derating factor.
- .25 Remote keypad with LCD graphic display c/w with remote mounting kit to be mounted on the VFD cabinet external door. Keypad shall be rated CSA Type 4x. The keypad shall be capable of reading the VFD parameters as well as capable to program the Drive. Keypad shall have local control key including Run, Stop/Reset, Forward Direction and Reverse the direction. The digital LED display shall be capable to illustrate all fault conditions.
- .26 The AC Drive shall have an integrated RJ45 port, for connection to a remote keypad, Bluetooth receiver, or PC Software.
- .27 Integral 3% line reactor to reduce the harmonics.
- .28 CSA certified.
- .29 Install VFD inside the VFD control Cabinet as shown on drawing.

## **2.2 VFD CONTROL CABINET (VFD).**

- .1 The VFD control cabinet shall include an inner and outer panels. All equipment to be housed in a lockable cabinet enclosure with hinged outer door and inner door with indicating lamps, devices and switches. Enclosure rated CSA Type 4X stainless steel 316 cabinet.
  - .2 The entire VFD control cabinet assembly shall carry a CSA certification. CSA certification shall be submitted for review as part of the shop drawing. CSA certification shall be provided at the factory and not on site. VFD control cabinet assembly refer to the complete control cabinet and all equipment mounted inside the cabinet or mounted on the exterior door of the cabinet.
  - .3 Cabinet shall be wall mounted or floor mounted as required. Provided mounting brackets as required.
  - .4 **The entire cabinet assembly shall be built, tested and shipped by one manufacturer, so there is one source of supply.**
  - .5 Cabinet dimension as required to accommodate the equipment.
  - .6 The cabinet shall include a heater, thermostat, exhaust fan, reverse acting thermostat, and exhaust grills. Exhaust grills shall be provided and located to allow circulation of air inside the cabinet to reduce overheating. Exhaust grills shall be supplied with finger guard protection.
  - .7 Enclosure heater to maintain 5 degree C temperature. Cooling fan to ensure the temperature inside the cabinet will never be higher than the maximum temperature as recommended by VFD manufacturer. Size of exhaust fan to suit and to ensure a safe operation of all equipment.
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- .8 Provide grounding kits, wireways, metal data pocket, drip shield, terminal blocks as required.
- .9 The following control and display shall be mounted on the external face of the cabinet:
  - VFD Run Forward Push Button – Supply Air.
  - VFD Stop Push Button.
  - VFD Run Reverse Push Button – Exhaust Air.
  - Motor Overload Alarm (LED Pilot Light).
  - Main disconnect switch on/Off control.
  - Remote VFD Keypad.
- .10 Refer to drawings for fan sequence of operation and additional requirement.

## **2.3 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results Electrical Systems.

## **2.4 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results Electrical Systems.
- .2 Indicate name of load controlled on size 4 nameplate. Provide identification nameplate for all display and control installed on the exterior face of the VFD control cabinet.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Install control cabinet assembly as shown on drawing.
  - .2 Install control cabinet in accordance with manufacturer's installation standards and make power connections.
  - .3 Supply all necessary mounting hardware and channel as required to mount the control cabinet. All required mounting hardware and channel shall be hot dip galvanised or stainless steel 316.
  - .4 Perform all calibration, programming and setup operations. Demonstrate operation of the control cabinet assembly throughout full range and shut down on safety conditions.
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- .5 The VFD manufacturer shall provide the services of trained personnel to assist in the installation and start-up of the complete control cabinet and demonstrate the operation of the assembly to the building operators. Electrical contractor shall carry all associated cost.
- .6 Static, start up and functional performance testing shall be provided by a factory certified technician. Electrical contractor shall pay for all associated fees.
- .7 Demonstrate operation to Departmental Representative.
- .8 Provide 6h training for a group of 4 peoples. Training shall be witness by the Departmental Representative.

### **3.2 CLEANING**

- .1 Clean in accordance with Section 01 74 11 – Cleaning.
- .2 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Waste Managing and Disposal.

**END OF SECTION**

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## **PART 1      GENERAL**

### **1.1 INTRODUCTION**

- .1 This Contractor is responsible to provide 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.

### **1.2 SECTION INCLUDES**

- .1 Commissioning of all Aeration Tower and North Valve Building electrical systems and component included as part of this project including:
  - .1 Testing and adjustment.
  - .2 Demonstrations and Training.
  - .3 Instructions of all procedures for the Departmental Representative personnel.
  - .4 Updating as-built data.
  - .5 Co-ordination of Operation and Maintenance material.

### **1.3 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 77 00 – Closeout Procedures.
- .3 Section 26 05 00 - Common Work Results Electrical Systems.

### **1.4 REFERENCES**

- .1 Canadian Standards Association (CSA International)
- .2 Underwriters Laboratories of Canada.

### **1.5 EQUIPMENT AND MATERIALS**

- .1 The Contractor shall provide all equipment and testing tools as required to perform all commissioning tasks.

### **1.6 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 for Departmental Representative Approval.
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## **1.7 COMMISSIONING**

- .1 The purpose of the commissioning process is to fully test all building systems electrical components under the scope of this project as well as the operating procedures by challenging these systems to realistic operation conditions.
- .2 The Commissioning activities shall be co-ordinated by the General Contractor.
- .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.

## **1.8 SUBMITTALS**

- .1 All required commissioning document shall be prepared by the electrical contractor prior to conducting these activities for use by the Commissioning Team. This include the Functional Performance Test (FPT) forms.
- .2 The electrical contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.
- .3 The contractor shall submit the following documentation prior functional performance testing.
  - .1 Record drawings.
  - .2 Operation and Maintenance Manuals.
  - .3 Letter of acceptance from the inspection authority.
  - .4 Letter of guarantee.
  - .5 Copies of the following test results:
    - .1 Insulation/megger tests.
    - .2 Load balance tests on the main switchboard, distribution panels, transformers and panels.
    - .3 Voltage regulation/tap tests on transformers.
    - .4 Load tests on motors.
    - .5 A Commissioning and/or Certification Report from the manufacturer.
    - .6 Written verification from the end user that staff training has been performed according to the manufacturer's recommendations.

## **1.9 PREPARATION**

- .1 Provide test instruments required for all commissioning activities.
- .2 Confirm all scheduled activities have identified personnel available.
- .3 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

## **1.10 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. FPT's shall be performed on all electrical systems in the contract documents which may include, but not limited to, the following:
  - .1 Electrical Panel.
  - .2 Circuit breaker.
  - .3 VFD and VFD control cabinet.
  - .4 Sequence of operation of Exhaust fan as stated in mechanical drawings and specification.
  - .5 Electrical conductors.
- .2 The Departmental Representative 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 job site.

## **1.11 FINAL REPORT**

- .1 This trade shall assemble all testing data and commissioning reports and submit them to the Departmental Representative.
- .2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

## **1.12 SCHEDULE OF ACTIVITIES**

- .1 Commissioning activities shall be conducted based on pre-established schedule with all members of the Departmental Representative team.
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- .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 of the Commissioning process.
  - .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 coordination 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.

**END OF SECTION**

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