

**Common Work Results for Electrical**

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**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.
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- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

**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 44 - Environmental Protection Procedure for Marine Work.
  - .3 Shop drawings:
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Provinces of Nova Scotia, 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.
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- .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 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 21 - Construction/Demolition Waste Management and Disposal.
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**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 hard copy bound maintenance and operational manuals shall be reviewed and left with the Departmental Representative. In addition submit electronic copy to 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.
  - .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.
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- .9 Prior to final inspection, submit these manuals to the Departmental Representative for review.

**1.10 GUARANTIES**

- .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 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.
- .2 The Contractor is responsible to coordinate with Nova Scotia Power to provide new service as shown on contract document and carry all required cost. Coordinate with NSPI the exact NSPI pole location where the new underground electrical service shall be routed to before starting any work.
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**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 For floor mounted electrical equipment installed inside in Electrical Building: Supply and install concrete housekeeping pads for all free standing, floor mounted, electrical equipment. Housekeeping pads to be 100mm thick, complete with 10M doweled L-bars at 457mm c/c around the perimeter. Reinforcing bars to be drilled and grouted into the slab with minimum embedment 100 mm, 100mm return and 50mm cover. Reinforce with one layer 6 x 6 4/4 WWF. Pads to be nominally 150mm larger in all dimensions than the equipment being supported, and have chamfered edges.
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Concrete slabs are to be free of any of coatings which may adversely affect bond and be purposely roughened to an amplitude of +/- 5mm prior to placement of housekeeping pads.

**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.
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**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.

- .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3mm	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.
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- .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.

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**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.

**3.5 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 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.
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- .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: 1200 mm
  - .3 Shroud receptacles and Pin & Sleeves: as shown on drawings.
  - .4 Panel boards: as required by Code or as indicated.
  - .5 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.

**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.  
Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on
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- 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.
- .3 Refer to section 01 74 11 - Cleaning for additional information.

**END OF SECTION**

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Wire and Box Connectors (0-1000V)

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**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

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

**1.2 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results For Electrical.

**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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Wire and Box Connectors (0-1000V)

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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**

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**Wires and Cables (0-1000V)**

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**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.
- .3 Section 26 05 43.01 - Installation Of Cables In Trenches And In Ducts.

**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
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**Wires and Cables (0-1000V)**

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.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 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 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Connectors: Steel set screw.

**2.3 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.
  - .2 In trenches in accordance with Section 26 05 43.01.

**3.2 INSTALLATION OF ARMOURED CABLES**

- .1 The use of AC90 cables is permitted in the following applications only:
    - .1 Device drops from ceiling mounted junction box to light fixtures provided the length of the drop does not exceed 2m.
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Wires and Cables (0-1000V)

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**3.3 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

**END OF SECTION**

**Grounding - Secondary**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results - for Electrical.

**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:
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**Grounding - Secondary**

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- .1 Remove for reuse and return by manufacturer packaging materials in accordance with Section 01 74 21 - Construction Demolition Waste Management and Disposal.

**PART 2 PRODUCTS**

**2.1 EQUIPMENT**

- .1 Clamps for grounding of conductor: size as indicated to electrically conductive underground water pipe.
- .2 Rod electrodes: galvanized steel 19 mm dia by 3m long.
- .3 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .4 Insulated grounding conductors: green, type RW90.
- .5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6 All ground rod clamps and fittings to be bronze or brass.
- .7 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Thermit welded type conductor connectors.
  - .5 Bonding jumpers, straps.
  - .6 Pressure wire connectors.

**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 complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
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**Grounding - Secondary**

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- .3 Run ground wire in PVC conduit.
- .4 Install connectors in accordance with manufacturer's instructions.
- .5 Protect exposed grounding conductors from mechanical injury.
- .6 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.
- .7 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .8 Soldered joints not permitted.
- .9 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.
- .10 Connect building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .12 Ground secondary service pedestals.

**3.2 ELECTRODES**

- .1 Ground rods shall be buried in the locations as indicated on the drawings. The maximum resistance to ground of the entire system shall not exceed 10 Ohms, and additional ground rods shall be buried, as required, to attain this value.
  - .2 A number 6 AWG insulated copper cable shall be run from the main distribution ground bus to the main water pipe and connected to the upstream side of the water meter. Water pipes shall be scraped and sanded to remove all scale, rust or paint at the location where the ground is to be made, and ground connections shall be tightened securely. Where water mains are not available, provide grounding electrode.
  - .3 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.
-

**Grounding - Secondary**

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**3.3 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of 120/208V system and 120/240V system.
- .2 The main incoming ground conductor shall run unbroken to the service entrance distribution panel ground bus and then to the wall mounted ground bus.

**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, receptacles, Pin & Sleeves and shrouds.
- .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).
- .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 Install copper grounding bus mounted on insulated supports on wall of electrical building.
  - .2 Ground items of electrical equipment in electrical building to ground bus with individual bare stranded copper connections size as indicated.
-

Grounding - Secondary

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**3.6 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - for Electrical.
- .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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Hangers and Supports For  
Electrical Systems

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results For Electrical.

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 See Section 01 74 21 Construction Demolition 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 10 mm 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 indoor shall be galvanized.
  - .6 All support channels assembly installed outdoor including the wharf area shall be stainless steel 316 without any exceptions.
  - .7 All pull and junction boxes, wire ways, and multiple conduits shall be supported by a galvanized channel support system with all components, hangers, wall supports, cable clamps, etc., specifically manufactured and approved for their application. supporting system installed out shall be stainless steel 316.
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**Hangers and Supports For  
Electrical Systems**

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- .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.
- .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 galvanized straps to secure surface conduits and cables 53mm and smaller.
    - .2 Two-hole galvanized straps for conduits and cables larger than 53mm.
    - .3 Beam clamps to secure conduit to exposed steel work.
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Hangers and Supports For  
Electrical Systems

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- .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 1200mm (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.
- .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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Splitters, Junction, Pull Boxes  
and Cabinets

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 26 05 00 - Common Work Results - for Electrical.

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

**2.2 JUNCTION AND PULL BOXES**

- .1 For outdoor application, use junction and pull boxes rated: non-metallic CSA Type 4x construction rated for exterior use for surface mounting application.
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Splitters, Junction, Pull Boxes  
and Cabinets

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- .2 For indoor application, use junction and pull boxes rated: CSA Type 1.
- .3 Mounting feet.
- .4 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 drawings. Type "T" cabinets shall be complete with hinged door, lock, two keys, and handle, and be lined with 21mm plywood.
- .2 Cabinets installed outdoors shall be CSA Type 4x stainless steel 316.
- .3 Cabinets installed outdoors shall be CSA Type 1.

## **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 and to wharf 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.
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Splitters, Junction, Pull Boxes  
and Cabinets

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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 - for Electrical.
- .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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Outlet Boxes Conduit  
Boxes And Fittings

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**PART 1 GENERAL**

**1.1 REFERENCES**

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

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 See Section 01 74 21 Construction Demolition 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 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 103 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

**2.2 GALVANIZED STEEL OUTLET BOXES**

- .1 One-piece electro-galvanized construction.
  - .2 Minimum size 91 mm x 53 mm x 41 mm or as indicated. 103 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
  - .3 Utility boxes for outlets connected to surface-mounted PVC conduit, minimum size 103 mm x 54 x 53 mm.
-

Outlet Boxes Conduit  
Boxes And Fittings

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- .4 103 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished tile walls.
- .6 Surface outlet boxes installed below 2438 mm shall be hot dipped galvanized cast "FS", or "FD" series boxes with metal cover plates.

### **2.3 CONDUIT BOXES**

- .1 Cast FS or FD boxes with factory hubs and mounting feet for surface wiring of devices.
- .2 Provide gasketed covers for exterior boxes.

### **2.4 FITTINGS - GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
  - .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
  - .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
  - .4 Provide correct size of openings in boxes for conduit connections. Reducing washers are not allowed.
  - .5 At each local switch, convenience outlet, receptacle, ceiling or wall fixture, continuous row of fixtures, or system unit (i.e. fire alarm, etc.) provide and install a standard pressed steel outlet box unless specifically noted otherwise. All outlet
-

Outlet Boxes Conduit  
Boxes And Fittings

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boxes shall be galvanized inside and out and set flush with finished surfaces. They shall be rigidly and securely set. Boxes shall not be mounted back to back, but separated by a minimum of 300mm, to prevent noise transmission.

- .6 Install FD non-metallic boxes at each shroud receptacles as shown on drawings.
- .7 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .8 Identify systems for outlet boxes as required.

**END OF SECTION**

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Conduits, Conduit Fastenings  
And Conduit Fittings

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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. 83-M1985 (R2003), Electrical Metallic Tubing.
  - .5 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 Thinwall Type "EMT" conduit shall conform to C.S.A. C22.2 No. 83, galvanized, sized as indicated.
- .3 Flexible galvanized steel liquid tight conduit shall conform to C.S.A. C22.2 No. 56, sized as indicated.
- .4 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3, sized as indicated.

### **2.2 CONDUIT FASTENINGS**

- .1 One hole galvanized straps to secure surface conduits 50 mm and smaller. Two steel straps for conduits larger than 50 mm.
  - .2 Beam clamps to secure conduits to exposed work.
  - .3 Galvanized channel type supports for two or more conduits at 1.2 m on centre.
-



Conduits, Conduit Fastenings  
And Conduit Fittings

- 
- .4 Galvanized threaded rods, 12 mm diameter, to support suspended channels.
  - .5 Complete conduit fastening system installed indoor shall be galvanized.
  - .6 Complete conduit fastening system installed outdoor shall be stainless steel 316.

**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 outdoor installation. Provide sealing O'ring gasket to positively protect against damage.
  - .4 Couplings for thin wall Type "EMT" shall be set screw type, zinc with matching locknuts.
  - .5 Connectors for thin wall Type "EMT" shall be set screw type, zinc with matching locknuts.
    - .1 Connectors 32mm and larger shall be complete with threaded plastic bushings. Connectors less than 32mm shall be complete with insulated throats.
  - .6 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.
  - .7 Connectors for flexible conduit, armoured cable shall be set screw galvanized steel and be complete with case hardened locknuts.
  - .8 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.
  - .9 Utilize watertight connectors and couplings for exposed vertical runs of EMT.
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Conduits, Conduit Fastenings  
And Conduit Fittings

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**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.

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.

- .2 Fittings shall be of watertight strain relief type. Fittings shall be equipped with a beveled moisture water resistant synthetic rubber bushing.
- .3 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.
- .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**

Polypropylene, 6 mm diameter.

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Conduits, Conduit Fastenings  
And Conduit Fittings

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## 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 and to wharf lines. All conduits shall be securely held in place at intervals and with supports as required by the Canadian Electrical Code.
  - .2 Use DBII PVC conduit in reinforced concrete ductbanks. Use EMT conduit inside Electrical Building.
  - .3 Use Rigid PVC Conduit (Schedule 40) from grade level pull-pit to all shroud, pole and future derrick locations.
  - .4 Minimum conduit size for lighting and power circuits: 21 mm.
  - .5 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 EMT conduit straps shall be steel. Cast straps are not acceptable. EMT 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 EMT;
    - .2 Less than 2286mm for 27mm and 35mm EMT;
    - .3 Less than 3048mm for 41mm EMT or larger.
    - .4 Maximum 1200mm for any size of conduit routed under the wharf deck area.
  - .6 Bend conduit cold:
    - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
  - .7 Mechanically bend steel conduit over 19 mm diameter.
  - .8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
  - .9 Install fish cord in empty conduits.
-

Conduits, Conduit Fastenings  
And Conduit Fittings

- 
- .10 Dry conduits out before installing wire.
  - .11 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.

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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**Installation of Cable in  
Trenches and Ducts**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Section 31 23 10 - Excavating and Backfill.
- .3 Section 33 65 73 - Concrete Encased Duct Banks.
- .4 Section 26 05 00 - Common Work Results - for Electrical.

**1.2 REFERENCES**

- .1 Canadian Standards Association, (CSA International)
- .2 Insulated Cable Engineers Association, Inc. (ICEA)

**PART 2 PRODUCTS**

**2.1 CABLE PROTECTION**

- .1 38 x 140 mm planks pressure treated with coloured, or copper napthenate or 5 % pentachlorophenol solution, water repellent preservative.
- .2 Install a polyethylene ribbon in the trench indicating «Danger underground electrical line».

**PART 3 EXECUTION**

**3.1 CABLES IN DUCTS**

- .1 Install cables in ducts as indicated.
    - .1 It is not permitted to pull spliced cables in ducts
  - .2 Pull all cables in conduit simultaneously.
  - .3 To reduce pulling tension use CSA approved lubricants and compatibles with the cable envelope.
  - .4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
-

**Installation of Cable in  
Trenches and Ducts**

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- .5 Before pulling cables in conduits and, before final termination, seal lead jacket cable ends by soldering, other cable ends to be sealed using waterproof tape.
- .6 After installation of cables, seal duct ends with duct sealing compound.

**3.2 UNDERGROUND DUCTS INSTALLED IN A CONCRETE DUCT BANK**

- .1 Refer to section 33 65 73 - Encased Duct Banks.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - for Electrical.
  - .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 at in accordance with manufacturer's recommendations.
-

**Installation of Cable in  
Trenches and Ducts**

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- .7 Leakage Current Testing.
  - .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
  - .2 Hold maximum voltage for specified time period by manufacturer.
  - .3 Record leakage current at each step.
- .8 Provide departmental Representative with list of test results showing location at which each test was made, circuit tested and result of each test.
- .9 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

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**Lighting Control Devices**

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**PART 1 GENERAL**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International).

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Testing And Quality Control.
- .4 Section 26 05 00 - Common Work Results for Electrical
- .5 Section 26 50 00 - Lighting
- .6 Section 26 29 01 - Contactors

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings to include manufacturer's instructions, printed product literature and data sheets including characteristics, physical size, finish and limitations.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 10 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

**PART 2 PRODUCTS**

**2.1 PHOTOELECTRIC LIGHTING CONTROLS**

- .1 Capable of switching 1800W LED lighting load at 120V.
  - .2 Top lens.
  - .3 Plastic housing.
  - .4 Fit standard 16mm knockouts.
  - .5 Stem and Swivel Mount.
-



**Lighting Control Devices**

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- .6 Voltage variation: plus or minus 10%.
- .7 Temperature range: minus -40°C to +70°C.
- .8 Switching on lights at 16 lx.
- .9 Switching off lights at 110 lx.
- .10 Rated for 10000 operations.
- .11 255 Joule MOV surge protection component.
- .12 Fail-safe circuit completed when relay de-energized.
- .13 Sensitivity adjustment.
- .14 Turn OFF to ON ratio 1.5:1 with 2-5 second delay.
- .15 CSA or cUL certified.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install photoelectric controls in accordance with manufacturer's instructions.
- .2 Wire photocell to lighting contactor control circuit.
- .3 Install digital time switches in Electrical Building.
- .4 Install switches in gang type outlet box when more than one switch is required in one location.
- .5 Mount switches at height in accordance with Section 26 05 00 - Common Work Results - for Electrical.
- .6 Demonstrate operation to Departmental representative.

**END OF SECTION**

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**Service Entrance Equipment**

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**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for service entrance equipment.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 26 05 00 - Common Work Results - for Electrical.
- .5 Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .6 Section 26 41 00 - Surge Protection Devices.

**1.3 REFERENCES**

- .1 CAN/CSA-C22.2 No.31-M89 (R2000), Switchgear Assemblies.
- .2 NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

**1.4 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Indicate on shop drawings.
    - .1 Anchoring method and foundation template.
    - .2 Dimensioned cable entry and exit locations.
    - .3 Dimensioned position and size of bus.
    - .4 Overall length, height and depth.
    - .5 Dimensioned layout of internal and front panel mounted components.
  - .3 Include time-current characteristic curves for circuit breakers and fuses.
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**Service Entrance Equipment**

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**1.5 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for service entrance board for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Submit 3 copies maintenance data for complete assembly including components.

**1.6 EXTRA MATERIALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include spare parts.

**PART 2 PRODUCTS**

**1.1 POWER SUPPLY**

- .1 Main service equipment suitable for incoming power supply: 347/600V, 800A, 60Hz, three phase, 4 wire, and grounded neutral.

**1.2 SERVICE ENTRANCE BOARD**

- .1 To CAN/CSA-C22.2 No.31.
  - .2 Rating: 347/600V, 3 phases, 4 wire, short circuit current 42kA (rms symmetrical).
  - .3 Equipment: dead front, size as indicated. Enclosure to provide a degree of environmental protection equal to or higher than CSA Type 1.
  - .4 100% service entrance rated.
  - .5 Bottom entry.
  - .6 Separate section for utility metering instrument transformers. Dimension to NSPI requirement.
  - .7 Distribution section.
  - .8 Hinged access panels with captive knurled thumb screws.
  - .9 Bus bars and main connections: 99.3% copper.
  - .10 Enclosure maximum height 2026mm.
-

**Service Entrance Equipment**

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.11 Identify phases with colour coding.

**1.3 SERVICE ENTRANCE MAIN CIRCUIT BREAKER 'LSI'**

.1 Main circuit Breaker as follow:

- .1 Frame size: as indicated on drawing.
- .2 Voltage and system: 347/600 V, 3 phase, 4 wire.
- .3 Service entrance, continuous duty 100 %.
- .4 Frequency: 60 Hz.
- .5 Interrupting rating: 42 kA RMS symmetrical.
- .6 800A Solid state trip unit c/w:

- .1 Long-time pickup and delay.
- .2 Adjustable short-time pickup and delay.
- .3 Instantaneous trip setting.

**1.4 MOULDED CASE CIRCUIT BREAKERS**

- .1 Moulded case circuit breakers to Section 26 28 16.02 - Moulded Case Circuit Breakers.

**1.5 GROUNDING**

- .1 Copper ground bus extending full width and located at bottom.
- .2 Provide a factory installed ground termination block sized for the grounding conductor indicated on the Drawings.

**1.6 SURGE PROTECTION DEVICES**

- .1 Surge protection devices integral to service entrance equipment and in accordance with Section 26 41 00 - Surge Protection Devices.

**1.7 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
  - .1 Service entrance board exterior: gray.

**1.8 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
  - .2 Nameplates:
-

**Service Entrance Equipment**

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- .1 White plate, black letters, size 7.
- .2 Complete board labelled: as indicated on drawings.

**1.9 SOURCE QUALITY CONTROL**

- .1 Departmental Representative to witness final factory tests.
- .2 Notify Departmental representative in writing 5 days in advance that service entrance board is ready for testing.

**1.10 MANUFACTURES APPROVED**

- .1 All electrical distribution equipment from the same manufacturer.

**PART 3 EXECUTION**

**1.1 INSTALLATION**

- .1 Locate service entrance board on new Electrical Building.
- .2 Install on plywood backboards. Where practical, group on common backboard.
- .3 Install on a 103mm housekeeping pad.
- .4 Connect main secondary service to line terminals of main breaker.
- .5 Connect load terminals to distribution breaker's feeders.
- .6 Check factory made connections for mechanical security and electrical continuity.
- .7 Run grounding conductor as indicated on drawings.
- .8 Check trip unit settings to ensure proper working and protection of components.
- .9 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.

**END OF SECTION**

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**Panelboards - Breaker Type**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 26 05 00 - Common Work Results For Electrical.
- .4 Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .5 Section 26 28 20 - Ground Fault Circuit Interrupters - Class A.

**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: to CSA C22.2 No.29 and product of one manufacturer.
    - .1 Install circuit breakers in panelboards before shipment.
    - .2 Panelboards 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.
  - .2 120/240 V, 1 Ph, 3 W, panelboards: bus and breakers rated for symmetrical interrupting capacity as indicated on drawings.
  - .3 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.
-

**Panelboards - Breaker Type**

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- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Two keys for each panelboard and key panelboards alike.
- .6 Copper bus with neutral of same ampere rating as mains.
- .7 Mains: suitable for bolt-on breakers.
- .8 Trim with concealed front bolts and hinges.
- .9 Trim and door finish: baked grey enamel air dried grey enamel.
- .10 Industrial type.
- .11 CSA Type 1 for panels installed indoor.
- .12 CSA Type 4x stainless steel 316 for panels installed outdoor.

**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.
  - .2 Nameplate for each panelboard size 4 engraved as indicated.
  - .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
  - .4 Complete circuit directory with typewritten legend showing location, load of each circuit and the room number where the load is located.
-

**Panelboards - Breaker Type**

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**2.4 MANUFACTURES APPROVED**

- .1 All electrical distribution equipment from the same manufacturer.

**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 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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**Wiring Devices**

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**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 26 05 00 - Common Work Results - for Electrical.

**1.3 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CSA-C22.2 No.42.1-00 (R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA-C22.2 No.55-M1986 (R2008), Special Use Switches.
  - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).
- .2 Canadian General Standards Board (CGSB).
- .3 ASTM International.

**1.4 SHOP DRAWINGS AND PRODUCT DATA**

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

**PART 2 PRODUCTS**

**2.1 SWITCHES**

- .1 20 A, 120 V, single pole, three-way, switches to CSA-C22.2 No.111.
  - .2 Manually-operated general purpose ac switches with following features:
    - .1 Terminal holes approved for No. 10 AWG wire.
    - .2 Silver alloy contacts.
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**Wiring Devices**

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- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .5 White toggle.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 120% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.

**2.2 RECEPTACLES**

- .1 Electrical Building indoor duplex receptacles, CSA type 5-20R, 125 V, 20 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.
  - .2 Electrical Building outdoor wall and wharf duplex receptacles, CSA type 5-20R, GFCI, 125 V, 20 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 Eight back wired entrances, four side wiring screws.
    - .4 Triple wipe contacts and riveted grounding contacts.
    - .5 Weatherproof.
    - .6 GFCI duplex u-ground receptacles shall be heavy duty grade, A.C. rated 20 amperes at 125 volts, U ground, having parallel slots with double wiping contacts, ground terminal, and one piece body.
    - .7 GFCI receptacles shall be white complete with LED indication with Metal, hinged and gasketted "In-Use" cover.
  - .3 20 amp, 120 volt, 60Hz, ground fault circuit interrupter module. Yellow in colour. Automatic trip adjustment.
    - .1 Trip level: 4 to 6 ma.
    - .2 Trip time: 0.025 seconds. Nominal.
    - .3 High impact, UV stabilized rigid PVC housing.
    - .4 Power "ON" neon indicator light.
    - .5 CSA certified, UV listed.
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**Wiring Devices**

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- .6 Device box; duplex device box surface mounted complete with a polycarbonate, hinged and gasketed cover.
- .4 20 amp, 125 V, single, locking, female receptacle. CSA Configuration L5 - 20R to CSA C22.2 No.42 with following features:
  - .1 Approved for wet applications (marine environment); Corrosion Resistant.
  - .2 Yellow nylon face.
  - .3 Device Box - "Watertight" device box with hinged and gasketed, weatherproof coverplate. Both yellow in colour.
- .5 Electrical Building outdoor wall welding receptacle, CSA type L6-50R, 240 V, 50 A, Twist-Lock, to: CSA C22.2 No.42 with following features:
  - .1 Approved for wet applications (marine environment); Corrosion Resistant.
  - .2 Yellow nylon face.
  - .3 Device Box - "Watertight" device box with hinged and gasketed, weatherproof coverplate. Both yellow in colour.

**2.3 COVER PLATES**

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
  - .2 Cover plates from one manufacturer throughout project.
  - .3 Weatherproof utility box cover for wiring devices installed in surface-mounted utility boxes.
  - .4 Weatherproof spring-loaded complete with gaskets for single receptacles or switches.
  - .5 Weatherproof cover plate for all receptacle and switches installed outdoor. Outdoor cover plate shall be suitable for wet locations, whether or not a plug is inserted into the receptacle, and marked "Extra Duty".
-

**Wiring Devices**

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**PART 3 EXECUTION**

**3.1 INSTALLATION**

.1 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.
- .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results - for Electrical.

.2 Receptacles:

- .1 Install receptacles in wharf as indicated on drawings.
- .2 Install receptacles in Electrical building as indicated on drawings.
- .3 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results - for Electrical.

.3 Cover plates:

- .1 Protect 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.

**END OF SECTION**

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**Moulded Case Circuit Breakers**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 05 00 - Common Work Results - for Electrical.
- .4 Section 26 24 02 - Service Entrance Equipment.
- .5 Section 26 24 16.01 - Panels boards breaker type.
- .6 Section 26 28 20 - Ground Fault Equipment Protection - Class A.

**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.
-

**Moulded Case Circuit Breakers**

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- .6 Circuit breakers to have symmetrical rms interrupting capacity rating as indicated on drawings.

**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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**Ground Fault Circuit Interrupters - Class A**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Testing and Quality Control.
- .4 Section 26 05 00 - Common Work Results for Electrical.
- .5 Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .6 Section 26 27 26 - Wiring Devices.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2 No.144-M91 (R2011), Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA PG 2.2-1999 (R2009), Application Guide for Ground Fault Protection Devices for Equipment.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and shop drawings.
- .3 Submit test report for field testing of ground fault equipment to Departmental representative and a certificate that system as installed meets criteria specified herein.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144
  - .2 Components comprising ground fault protective system to be of same manufacturer.
-

**Ground Fault Circuit Interrupters - Class A**

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**2.2 BREAKER TYPE GROUND FAULT INTERRUPTER**

- .1 Single pole ground fault circuit interrupter for 20A, 120V, 1 phase circuit c/w test and reset facilities. CSA listed as Class "A" with sensitivity of 5 milliamps or greater.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

**3.2 INSTALLATION**

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - for Electrical and co-ordinate with Section 01 45 00 - Testing and Quality Control if required.
- .2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.
- .3 Demonstrate simulated ground fault tests.

**END OF SECTION**

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**Disconnect Switches  
Fused and Non-Fused**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

**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.
-

**Disconnect Switches  
Fused and Non-Fused**

- 
- .3 Mechanically interlocked door to prevent opening when handle in "ON" position.
  - .4 Quick-make, quick-break action.
  - .5 ON-OFF switch position indication on switch enclosure cover.
  - .6 Neutral lugs.
  - .7 All disconnect switch installed indoor shall be rated CSA Type 1.
  - .8 All disconnect switch installed outdoor shall be rated CSA Type 4x stainless steel 316.

**2.2 FINISHES**

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

**2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .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.

Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Managing and Disposal.

**END OF SECTION**

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**Contactors**

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**PART 1 GENERAL**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.14-10, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 2-2000 (R2005), Controllers, Contactors and Overload Relays Rated 600 V.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Testing and Quality Control.
- .4 Section 26 05 00 - Common Work Results for Electrical
- .5 Section 26 50 00 - Lighting

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings to include manufacturer's instructions, printed product literature and data sheets including characteristics, physical size, finish and limitations.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 10 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for contactors for incorporation into manual.

**PART 2 PRODUCTS**

**2.1 CONTACTORS**

- .1 Contactors: to CSA C22.2 No.14.
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**Contactors**

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- .2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Minimum 6 pole, 30A rating. Half size contactors not accepted.
- .3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .4 Mount in CSA Enclosure 4x stainless steel for contactor installed outdoor.
- .5 Mount in CSA Enclosure Type 1 for contactor installed indoor.
- .6 Include following options in cover:
  - .1 Red LED indicating lamp.
  - .2 H-O-A selector switch.
- .7 From the same manufacturer as the electrical distribution equipment.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Identification Section 26 05 00 - Common Work Results - Electrical.
- .2 Size 4 nameplate indicating name of load controlled as indicated.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- .1 Install contactors and connect auxiliary control devices.
- .1 Install surface mounted contactors on plywood backboards. Where practical, group on common backboard.
- .2 Identify contactors with nameplates or labels indicating panel and circuit number.
- .3 Test contactors in accordance with 26 05 00 - Common Work Results for Electrical.

**END OF SECTION**

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**Lighting**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Quality Control.

**1.2 REFERENCES**

- .1 Illuminating Engineering Society of North America (IESNA):
  - .1 IES-LM-79-08, Electrical and Photometric Measurements of Solid-State
  - .2 Lighting Products.
  - .3 IES-LM-80-15, Measuring Luminous Flux and Color Maintenance of LED
  - .4 Packages, Arrays and Modules.
  - .5 IES-TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.
- .2 Laboratoires des assureurs du Canada (ULC).
- .3 American National Standards Institute (ANSI)
- .4 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41-1991, Surge Voltages in Low-Voltage AC Power Circuits.
- .5 American Society for Testing and Materials (ASTM)
  - .1 ASTM F1137-88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .6 United States of America, Federal Communications Commission (FCC)
  - .1 FCC (CFR47) EM and RF Interference Suppression.

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by the departmental representative.
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**Lighting**

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- .3 Photometric data to include: spacing criterion.

**1.4 JOB MOCK-UP**

- .1 Submit mock-ups in accordance with Section 01 45 00 - Testing and Quality Control.

**PART 2 PRODUCTS**

**2.1 DRIVERS AND LED**

- .1 Refer to lighting schedule on drawings.
- .2 Integral to the fixture and from the same manufacturer.
- .3 LEDs of the same luminaire supplied from the same batch during manufacturing.

**2.2 FINISHES**

- .1 Baked enamel finish:
  - .1 Conditioning of metal before painting:
    - .1 For corrosion resistance conversion coating to ASTM F1137.
    - .2 For paint base, conversion coating to ASTM F1137.
  - .2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel to give smooth, uniform appearance, free from pinholes or defects.
  - .3 Reflector and other inside surfaces finished as follows:
    - .1 White, minimum reflection factor 85%.
    - .2 Colour fastness: yellowness factor not above 0.02 and after 250 hours exposure in Atlas fade-ometer not to exceed 0.05.
    - .3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025 mm.
    - .4 Gloss not less than 80 units as measured with Gardner 60° gloss meter.
    - .5 Flexibility: withstand bending over 12 mm mandrel without showing signs of cracking or flaking under 10 times magnification.
    - .6 Adhesion: 24 mm square lattice made of 3 mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.

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**Lighting**

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.2 Alzak finish:

.1 Aluminum sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:

.1 Finish for mild commercial service, minimum density of coating 7.8 g/m<sup>2</sup>, minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.

.2 Finish for regular industrial service, minimum density of coating 14.8 g/m<sup>2</sup>, minimum reflectivity 82% for specular and 73% for diffuse.

.3 Finish for heavy duty service, minimum density of coating 21.8 g/m<sup>2</sup>, minimum reflectivity 85% for specular, 65% for diffuse.

**2.3 LUMINAIRES**

.1 As indicated on the lighting drawings

**PART 3 EXECUTION**

**3.1 INSTALLATION**

.1 Locate and install luminaires as indicated.

**3.2 WIRING**

.1 Connect luminaires to lighting circuits:

.1 Through SOOW cable outdoor.

.2 Through AC90 Cable inside the Electrical Building. The use of AC90 cables is permitted in the following applications only:

.1 Device drops from ceiling mounted junction box to light fixtures provided the length of the drop does not exceed 2m

**3.3 LUMINAIRE ALIGNMENT**

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to wharf grid lines.

**END OF SECTION**

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**Commissioning of Electrical Systems**

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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 building and wharf area electrical and mechanical systems and component 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 - for Electrical.

**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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**Commissioning of Electrical Systems**

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**1.7 COMMISSIONING**

- .1 The purpose of the commissioning process is to fully test all building and wharf systems including architectural, mechanical and electrical components and 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 and mechanical 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.
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**Commissioning of Electrical Systems**

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- .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 including and not limited to:
  - .1 Receptacles testing: use a tool capable of voltage drop measurement under load for 20A and 30A receptacles respectively as well as to test GFCI functionality testing. Use a tool equivalent to wire tester "Amprobe INSP-3'' to test all 20A receptacles under load. Provide a dummy load as required to test all 50A receptacles.
  - .2 Digital light meter to measure lighting level at ground level.
- .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 and mechanical systems in the contract documents which may include, but not limited to, the following:
    - .1 Shore power and Electrical Building receptacles.
    - .2 Power distribution system.
    - .4 Emergency lighting.
    - .5 Lighting and lighting control.
    - .6 Heating.
    - .7 HVAC system.
    - .9 Electrical conductor.
  - .2 The Departmental Representative will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.
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**Commissioning of Electrical Systems**

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- .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.
- .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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**Electric Heaters**

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**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 45 00 - Testing and Quality Control.
- .4 Section 26 05 01 Common Work Results - Electrical.

**1.2 REFERENCES**

- .1 CSA International:
- .2 CSA C22.2 No.46-M1988 (R2006), Electric Air-Heaters.
- .3 Underwriters' Laboratories (UL) Inc.:
  - .1 UL 1042-2009, Standard for Electric Baseboard Heating Equipment.

**1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for forced air electric baseboard heaters and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures.

**PART 2 PRODUCTS**

**2.1 FORCED AIR BASEBOARD HEATER**

- .1 Heaters: to CSA C22.2 No.46 wattage density as indicated with connection box both ends.
  - .2 Voltage 208V, 1 Ph., 2000W
  - .3 Wall mount c/w surface adapter.
  - .4 Dimensions: 408 mm (width) x 578 mm (high) x 109 mm (depth).
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**Electric Heaters**

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- .5 White colour.
- .6 Finish: Epoxy-polyester powder coat.
- .7 Top air intake with bottom air discharge.
- .8 Thermal protection with automatic reset.
- .9 CSA approved.
  
- .10 Approved wiring channel for interconnection of heaters and components.
- .11 Knock-outs for conduit connection.
- .12 Additional accessories as indicated:
  - .1 Relay section.

**2.2 CONTROLS**

- .1 Wall mounted thermostats: type electronic, programmable, Energy Star certified.
- .2 Line voltage 208V, able to accommodate up to 2600W at 208V.
- .3 Relays and transformers to switch loads in excess of thermostat rating.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for convectors installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative 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 Departmental Representative.

**3.2 INSTALLATION**

- .1 Attach baseboard heaters surface mount to wall in Electrical building.
  - .2 Install thermostats in locations indicated in electrical building.
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**Electric Heaters**

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- .3 Make power and control connections.
- .4 Install all wiring in conduit.
- .5 Provide identification with lamicoid nameplate in accordance with Section 26 05 00 Common Work Results - Electrical.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Ensure that heaters and controls operate correctly.

**3.4 PROTECTION**

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

**END OF SECTION**

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