

1 General

1.1 REFERENCES

- .1 Do complete installation in accordance with CSA C22.1-15 except where specified otherwise.
- .2 Ensure that all electrical equipment is field marked to warn persons of the potential electric shock and arc flash hazards, as per CSA C22.1-15, Rule 2-306.
- .3 CSA Z462-15 Workplace Electrical Safety Standard.
- .4 Comply with CSA Certification Standards and Electrical Bulletins in force at time of tender submission.
- .5 Do underground systems in accordance with CSA C22.3 No. 7-94 except where specified otherwise.
- .6 Abbreviations for electrical terms: to CSA Z85-1983.

1.2 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.
- .2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 PERMITS, FEES AND UTILITY INSPECTION SERVICES

- .1 Electrical Permits
 - .1 Submit to the Electrical Inspection Department, Municipal Authority and supply authority the necessary number of drawings and specifications, for examination and approval prior to commencement of Work.
 - .2 Provide the Departmental Representative with a copy of the electrical Inspection Department and supply Authority Plans Review Report, immediately upon receipt. No shop drawings will be reviewed prior to receipt of the Plans Review Report from the Contractor.
 - .3 Obtain all necessary permits including an Electrical Wiring Permit for electrical work and Communications Cabling Permit for communications cabling work from the authority having jurisdiction, prior to commencement of Work. Provide a copy of each permit to the Departmental Representative upon receipt. Display permits on the Work site.
 - .4 Upon specific request, the Departmental Representative will provide, to the Contractor, up to a maximum of three (3) copies of the drawings and specifications required for submittal to the Electrical Inspection Department and Supply Authority. These drawings and specifications will be provided to the Contractor at no cost, unless otherwise specified.

- .5 Arrange for all required inspections to be conducted by the authority having jurisdiction. Provide a copy of all inspection reports to the Departmental Representative immediately upon receipt. Notify the Departmental Representative immediately of changes required by the authority having jurisdiction.
- .6 Furnish Certificates of Acceptance from Inspection Department and authorities having jurisdiction on completion of work.
- .7 Pay all associated fees for permits, fees and inspection.

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

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 01 35 22 Health & Safety Requirements.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Nova Scotia, Canada.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, and other items that must be shown to ensure coordinated 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 six (6) copies of 600 x 600 mm minimum size drawings and product data to Departmental Representative.
 - .6 If changes are required, notify Departmental Representative of these changes before they are made.
 - .7 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .8 Provide CSA certified equipment and material.
 - .9 Submit test results of installed electrical systems and instrumentation.
 - .10 Permits and fees: in accordance with General Conditions of contract.
 - .11 Submit, upon completion of Work, load balance report.

- .12 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

- .4 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 3.7 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction 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.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.8 SYSTEM STARTUP

- .1 The Contractor shall instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 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 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 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.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.10 RECORD DOCUMENTS

- .1 One (1) set of white prints will be provided for record drawing purposes.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal work until required information is recorded.
- .4 Specifications: legibly mark each item to record actual construction, including manufacturer, trade name, and catalog number of each project actually installed.
- .5 Turn over the Record documents to the Departmental Representative at the completion of the project.

1.11 GUARANTEE

- .1 The Contractor shall guarantee all work to be free from defects, for a period of one (1) year, after final acceptance of the entire project.

2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified.
- .3 Factory assembled control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.3 WARNING SIGNS

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

2.4 WIRING TERMINATIONS

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

2.5 IDENTIFICATION REQUIREMENTS

- .1 All electrical equipment shall be identified by the use of Lamicoid plates. This includes all distribution equipment.
- .2 All equipment and enclosures receiving connections to the building power distribution system shall have their panel and circuit number identified by the use of Lamicoid plates. This includes equipment supplied by the electrical contractor, the mechanical contractor and all other divisions.
- .3 All electrical junction, pull boxes and splitters shall be colour coded inside and out with appropriate coloured paint. **All paint is to be applied prior to installation and not with-in the confines of the building.**
- .4 All conduit couplings shall be colour coded with appropriate coloured paint. **All paint is to be applied prior to installation and not with-in the confines of the building.**
- .5 Where conduits are installed in a room where no conduit couplings are visible, appropriate colour bands are required to identify the conduit function.
- .6 All junction boxes shall have the panel and circuit numbers contained with-in, identified on the exterior of the cover plate.
- .7 All junction and/or pull boxes sized 150 mm x 150 mm and larger shall be identified through the use of Lamicoid nameplates.
- .8 All wiring installed under this contract shall be identified through the use of self-laminating labels.
- .9 All receptacles installed under this contract shall be identified through the use of Lamicoid plates.

2.6 IDENTIFICATION NAMEPLATES

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: lamicoid 1.5 mm thick black face, white core, lettering accurately aligned and engraved into core mechanically attached with poprivets.
 - .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	5 mm high letters
Size 2	13 x 75 mm	1 line	6 mm high letters
Size 3	16 x 75 mm	2 lines	5 mm high letters
Size 4	20 x 90 mm	1 line	10 mm high letters
Size 5	38 x 90 mm	2 lines	13 mm high letters
Size 6	25 x 100 mm	1 line	13 mm high letters
Size 7	38 x 100 mm	2 lines	6 mm high letters
Size 8	50 x 150 mm	2 lines	13 mm high letters
Size 9	75 x 150 mm	3 lines	13 mm high letters
Size 10	100 x 150 mm	5 lines	13 mm high letters
 - .3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
 - .4 Allow for minimum of twenty-five (25) letters per nameplate.
 - .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
 - .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO." as directed by Departmental Representative.
 - .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
 - .8 Terminal cabinets and pull boxes: indicate system and voltage.
 - .9 Transformers: indicate capacity, primary and secondary voltages.
- .2 Lamicoid nameplate fastening method shall be as follows:
 - .1 Concrete or concrete block:
 - .1 Contact type cement (Note: Peel off type not acceptable). Contact type cement is to be applied (battered) to complete rear side of plate, as opposed to several points or locations on same.
 - .2 Plasterboard.
 - .1 Contact type cement (Note: Peel off type not acceptable). Contact type cement is to be applied (battered) to complete rear side of plate, as opposed to several points or locations on same.
 - .3 Equipment enclosures.
 - .1 Pop rivets. (Note: Screws not acceptable).
 - .4 Ceiling and T-Bar spline.
 - .1 Contact type cement (Note: Peel off type not acceptable). Contact type cement is to be applied (battered) to complete rear side of plate, as opposed to several points or locations on same.

2.7 WIRING IDENTIFICATION

- .1 Wiring Labels:
 - .1 Write on self-laminating labels.
 - .2 Panduit No's PLD-1, PLD-2.
- .2 Identification of wiring:
 - .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
 - .2 Label each neutral conductor to indicate its associated phase conductors in each panelboard, distribution panel, pullbox and junction box it appears in. These labels are to be installed in a 'flagged' manner.
 - .3 All circuit conductors are to be individually tie wrapped to their corresponding labeled neutral conductor in all panelboards, pull boxes and junction boxes. Each neutral conductor is to be identified to indicate its corresponding phase conductors.
 - .4 Labeling of all branch circuit wiring including phase conductors, neutral, ground and/or bonding conductors to be done on both ends of all circuit wires plus in any junction and/or pull boxes located in between using approved product (refer to 2.3). These labels are to be installed in a 'flagged' manner around individual conductors.
 - .5 Indicate panel and circuit number i.e.: Panel '1101', cct. #10.
- .3 Wiring Insulation Colour:
 - .1 Grounding and bonding conductors to have green coloured RW90 X-link insulation.
 - .2 Unless noted otherwise, phase colour coding as per C.E.C. rule 4-036, will apply.
 - .3 All phase conductors sized from #12 AWG up to and including #2 AWG to have appropriate coloured insulation (red, black & blue).
 - .4 All neutral, grounds and/or bond conductors sized #12 AWG up to and including #3/0 AWG to have appropriate coloured insulation (white or green).
 - .5 Coloured tape may only be utilized when phase conductors sized larger than noted in item 3 are used. Apply tape on both ends of conductor, for a minimum of 300mm from conductor termination.
 - .6 Coloured tape may only be utilized when neutral, grounds or bond conductors sized larger than noted in item 4 are used. Apply tape on both ends of conductor, every location where conductor is visible and for a minimum of 300 mm from conductor termination.

2.8 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 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
0-50 VOLTS	Violet	
51 up to 250 V	Yellow	
260 V to 600 V	Yellow	Green

Fire Alarm	Orange	
Energy Management	Red	White
Data	Black	White
Bond/Ground	Green	
Voice	Black	

2.9 IDENTIFICATION OF JUNCTION BOXES, PULL BOXES, SPLITTER TROUGHS AND OUTLET BOXES

- .1 Colour Coding
 - .1 Identification of electrical junction boxes, pull boxes, splitter troughs.
 - .1 Colour code as per 2.2.
 - .2 Apply colour coding prior to pulling conductors into boxes.
 - .3 Where primary colour only is indicated:
 - .1 Colour inside and outside of box.
 - .2 Colour all cover plates.
 - .4 Where primary and secondary colours are indicated:
 - .1 Paint inside and outside of box with the primary colour.
 - .2 Diagonally apply to each half of the cover plate the primary and secondary colours.
 - .3 Provide a legend of colour coding used under Plexiglas.
Locate in main electrical room.
- .2 Voltage and Originating Source Identification
 - .1 Identification of electrical junction boxes, pull boxes, splitter troughs: smaller than 150 mm x 150 mm.
 - .1 Identify on the coverplate, using permanent indelible black marker the panel and circuit numbers contained with.
 - .2 Group phase conductors with associated neutral conductor.
 - .2 Identification of electrical junction boxes, pull boxes, splitter troughs: 150 mm x 150 mm and larger.
 - .1 Provide Lamicoid plate fastened to coverplate, indicating:
 - .1 Voltage and phase.
 - .2 Originating panel.
 - .3 Size 6.
 - .4 Example: "120/208 v, 3Ø, 4w, panel 'A'."
 - .2 Using permanent indelible black marker, identify the circuits contained within.

2.10 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 to EEMAC 2Y-1.

3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.
- .3 Follow written electrical lockout procedures equal to or better than that as described in the Canadian Labor Code – Safety Procedures 8.5

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 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Panel boards are to be equipped in the factory with proper sized lugs to suit the conductor size.
- .3 All stranded conductors (including phase, neutrals, grounds and bonds) prior to terminating under device bolts; i.e. light switches, receptacles, circuit breakers, etc., are to be twisted together so as to form a single conductor.
- .4 Ensure all bonding conductors entering electrical enclosures, such as panel tubs, splitters, junction and pull boxes 150 mm x 150 mm and larger, etc. are terminated on terminal strips which are electrically continuous and fastened to the metal non-current carrying portion of the enclosure with a minimum of two bolts, c/w lock washers.

3.4 LOADBALANCE

- .1 Measure phase current to panelboards with normal loads and lighting operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Test and record phase and neutral currents on panelboards, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.5 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.6 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following mounting heights, unless indicated otherwise:
 - .1 Local switches: 1200mm
 - .2 Wall receptacles:
 - .1 General: 460mm
 - .2 Above top of continuous baseboard heater: 200mm, minimum 460mm AFF.
 - .3 Above top of counters or counter backsplash: 150mm
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Wall mounted telephone, data and outlets:
 - .1 General: 460mm
 - .2 Above top of continuous baseboard heater: 200mm, minimum 460mm AFF.
 - .3 Above top of counters or counter backsplash: 150mm
 - .5 Fire alarm stations: 1200mm
 - .6 Fire alarm signals: 2300mm

3.7 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8 SUPPLY CONDUCTOR INSULATION

- .1 Ensure that the insulation rating on branch circuits feeding all electrical loads comply with the 2015 edition of the CEC, and the manufacturer's recommendations.

3.9 DRAWINGS

- .1 Electrical drawings are not intended to show structural details or architectural features. The drawings accompanying this specification are to be considered as diagrammatic only and do not show all the structural and construction details. Any information involving measurements of the building shall be taken at the building site. Make without additional charge any necessary changes or additions to the runs to accommodate structural conditions.

- .2 The electrical drawings are not to be scaled.
- .3 Electrical drawings, except where dimensioned, indicate general layouts only. Investigate structural and finish conditions and the work of all other trades affecting this work and arrange work accordingly.
- .4 Coordinate the elevation of all outlet boxes with architectural drawings and report any conflicts to Departmental Representative prior to installation.
- .5 All electrical junction boxes must be accessible at the completion of the project. Coordinate the location of each junction box with the proposed location of mechanical services prior to installation.

3.10 CONTRACT DOCUMENTS

- .1 Before submitting a tender for his work, each Contractor shall examine the contract documents to ascertain that the work can be carried out as shown on these drawings and herein specified. No extra will subsequently be allowed to cover any omission and/or oversight for not having made a thorough inspection of the contract documents.

3.11 ACCESS DOORS

- .1 The electrical contractor is to provide access doors to concealed electrical junction boxes, pull boxes and miscellaneous equipment for operating, inspecting, adjusting and servicing. Access doors are to be supplied which meet or exceed the fire resistance rating of the partition or ceiling in which they are being installed.

3.12 INSTALLATION REQUIREMENTS

- .1 Install all products and services to follow building planes. Installation shall permit free use of space and maximum headroom to the satisfaction of the Departmental Representative.
- .2 Confirm the exact location of fixtures, outlets and connections. Confirm location of connection points for equipment supplied under other Divisions.
- .3 Install all equipment and appurtenances to allow free access for adjustment, maintenance and/or replacement.
- .4 Provide all hangers, supports and fasteners such that no undue stresses are imposed on the structure and systems. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on structural drawings. Equipment supports not supplied by equipment manufacturer are to be fabricated using structural grade steel.
- .5 Exterior supports are to be galvanized, unless noted otherwise.
- .6 Install all products and services in accordance with the respective manufacturer's recommendations.

- .7 High velocity explosive activated tools shall not be used. Only low velocity system types are permitted.
- .8 Provide caps and seal all open ends of installed conduits to prevent the entrance of foreign substances.
- .9 Install all services capped for future possible use such that easy access is provided for future connections.

3.13 CUTTING AND PATCHING

- .1 It is the responsibility of the Electrical Contractor to provide all required cutting and patching associated with the installation of electrical systems, devices, conduit, wire, etc., unless noted otherwise. Refer to Division 1 for more information.
- .2 Restore all surfaces to a finish acceptable to the Owner.

3.14 TORQUES FOR WIRING TERMINATIONS

- .1 For proper termination of conductors, it is very important that field connections be made properly tight.
- .2 Where possible, obtain and comply with Manufacturer's instructions on the equipment.
- .3 In the absence of Manufacturer's instructions, make terminations in conformance with the values given in Tables D6 and D7 of the 2015 CEC.

3.15 CABLE TIES AND TYE WRAPS

- .1 Cable ties and tye wraps are only permitted to be used to provide limited support for bundling purposes only. These devices are not intended to provide the primary support for conduits or cables.
- .2 Cable Ties are not to be used for the support of cable or conductor runs between boxes and fittings.

3.16 WORKING SPACE ABOUT ELECTRICAL EQUIPMENT

- .1 Arrange installation as required to maintain minimum working space around electrical equipment in conformance with CSAC22.1-15.

3.17 LOW VOC MATERIALS

- .1 All site applied coatings, adhesives & sealants must be low VOC content.
- .2 Provide Material Safety Data Sheets for all products & materials of these types incorporated into the work.

3.18 PLYWOOD BACKBOARDS

- .1 Fire retardant plywood backboards for mounting electrical equipment will be provided by the electrical Contractor.

3.19 EXISTING SERVICES

- .1 The Electrical Contractor shall ensure that all light, power, heat, fire alarm, telephone and other electrical systems and services remain operational during the course of the work in the existing buildings, and if necessary, this Contractor shall be responsible for providing such temporary services by cutting off, altering, adapting, relocating and connecting existing services and disconnecting and removing such temporary or existing services upon providing new permanent services as detailed on all drawings. The site shall be examined to determine the extent of the temporary services and all co-ordination shall be made with the Owner's Representative. All costs shall be included in the Tender Price.
- .2 Existing redundant equipment, wiring etc. not being re-used under new schemes, shall be removed whether shown on drawings or not. This contractor shall repair all openings resulting from the removal of existing electrical equipment and services. All unused outlet boxes (where it is not practical to remove same) shall be blanked with stainless steel cover plates. All costs shall be included in the Tender.

3.20 PROJECT PHASING AND ELECTRICAL SERVICE INTERRUPTIONS

- .1 Work within occupied areas and work causing a disruption to Facility operations will be performed outside regular business hours as determined by Departmental Representative.
- .2 The work required on the electrical distribution system will require that building electrical service will be disrupted periodically. The electrical contractor will provide at least 72 hours' notice of any service interruption to the Departmental Representative.

3.21 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panel boards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards and dry-core transformers 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 - 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.

3.22 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.

END OF SECTION

1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2 No.65-93(R1999), Wire Connectors.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

2 Products

2.1 MATERIALS

Pressure type wire connectors: with current carrying parts of sized to fit conductors as required.

- .1 Fixture type splicing connectors: with current carrying parts sized to fit conductors 10 AWG or less.
- .2 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp as required.
 - .2 Stud clamp bolts as required.
 - .3 Sized for conductors as required.
- .3 Clamps or connectors for armoured cable, flexible conduit, as required.

3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

1 General

1.1 REFERENCES

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

1.2 PRODUCT DATA

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

1.3 WASTE MANAGEMENT

- .1 Packaging Waste Management: remove for reuse packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 Products

2.1 BUILDING WIRES

- .1 Unless indicated conductors (phase, neutral, bond, isolated ground) installed on this project shall be stranded, soft drawn copper, with RW90 XLPE insulation rated for a minimum of 600 VAC. The minimum wire size will be #12 AWG.
- .2 Grounding and bonding conductors to have green coloured RW90 X-link insulation.
- .3 Unless noted otherwise, phase colour coding as per C.E.C. rule 4-036, will apply.
- .4 All phase conductors sized from #12 AWG up to and including #2 AWG to have appropriate coloured insulation (red, black & blue).
- .5 All neutral, grounds and/or bond conductors sized #12 AWG up to and including #3/0 AWG to have appropriate coloured insulation (white or green).
- .6 Coloured tape may only be utilized when phase conductors sized larger than noted in item 4 are used.
- .7 Coloured tape may only be utilized when neutral, grounds or bond conductors sized larger than noted in item 5 are used.

2.2 ARMORED CABLE

- .1 Conductor: copper, size as indicated.
- .2 Type AC-90.
- .3 Bonding conductor sized to CEC Table 16.
- .4 AC-90 cable connectors shall be as follows:

- .1 Two-screw, steel-type similar to T & B #3301, 3312.

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 All stranded conductors, (neutrals, bonds and phase conductors) prior to terminating under device bolts i.e., circuit breakers, light switches receptacles etc., to be twisted together so as to form a single conductor.
 - .3 All branch circuit phase conductors feeding light fixtures via junction and/or outlet boxes are to be complete with "pigtail" type leads to ensure minimal disruption of lighting circuits if fixtures are removed for future maintenance.
 - .4 Each line voltage switch is to be wired with the neutral conductor extended to the device box.
 - .5 All branch circuit phase conductors feeding receptacles via junction and/or outlet boxes are to be complete with "pigtail" type leads to ensure minimal disruption of receptacle circuits if receptacles are removed for future maintenance.
 - .6 All branch circuit wiring feeding light fixtures will be installed complete with a separate neutral conductor for each circuit.
 - .7 Where the application of coloured tape has been approved, apply as follows:
 - .1 Both ends of the conductor must be taped for all installed segments.
 - .2 Each location where the conductor is visible, i.e.; all junction and pull boxes.
 - .3 A minimum of 305 mm of tape to be applied for all phase conductors.
 - .4 All neutral, grounds and/or bond conductors must be taped for their entire visible length in all enclosures.
- .2 Use of AC-90 Cable.
- .1 The use of AC-90 cable is acceptable for this project as a general wiring method with several exceptions. Refer to Section 26 05 34, Item 3.1.7 where conduit requirements are defined.
 - .2 AC-90 cable is to be installed as per the following guidelines:
 - .1 All types of armoured cables are to be installed concealed, parallel and perpendicular to building lines and shall be adequately secured to the building structure at not less than 1.5M intervals or as otherwise indicated, in such manner as to ensure they are protected from potential mechanical damage. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical systems piping or ducts, suspended ceiling support wires. The laying of cables directly atop ceiling grid system is strictly prohibited.
 - .2 Where possible, always install and secure cables directly to underside of metal decking and/or ceiling slabs where located in concealed ceiling spaces. Install supports to firmly secure AC90 to metal decking midway between OWSJ and when any change in direction occurs.
 - .3 The grouping together of AC-90 cables to form a "bundle" for securing purposes is acceptable providing the following procedures are adhered:

- .1 In addition to securing type AC-90 cables at 1.5 M intervals to structure, multiple or bundled groups of armoured cables shall be tie-wrapped together at mid-point between each structure support and are to be secured together (between each structure support).
- .2 Grouping of AC-90 cables shall be limited to a maximum of eight (8) current carrying conductors, including associated oversized neutral conductors where phase sharing occurs.
- .4 The following examples incorporate uses of both, common and dedicated (separate) branch circuit neutral conductors:
 - .1 Maximum of two runs of #12/4 conductor cables, including common (oversized) branch circuit neutral in each.
 - .2 Maximum of two runs of #12/3 conductor cables, including (oversized) branch circuit neutrals (if not 3 phase, 3 wire), plus one run of #12/2 cable.
 - .3 Maximum of four runs of #12/2 conductor cables, each including a separate, dedicated branch circuit neutral conductor.
- .5 Where dedicated or separate branch circuit neutral conductors are non phase sharing, they need not be sized larger than phase conductors they accompany unless specifically indicated otherwise.
- .6 All AC-90 fixture feeds shall originate from the sides of outlet boxes and not from the box cover. Where 3 and/or 4 fixture drops extend from any one outlet box, the box shall not be sized smaller than 120 mmsquare.
- .7 Fixture drop is defined as that portion of AC-90 cable or flexible conduit being used to make final connection between accessible type junction or outlet box located in ceiling space (above T-Bar ceiling only) and its respective light fixture.
 - .1 Fixture drops are not to exceed 4.5 M in total length unless specifically indicated otherwise.
 - .2 There shall be not more than 4 drops permitted to be fed from any one box regardless of its size. All AC-90 cables used for fixture drops are to be secured within 300 mm of the junction box and the light fixture connection point. Each light fixture is to be complete with its own separate fixture drop originating from a junction box located within the ceiling of the same room as the fixture.
- .8 Separate pig-tail type leads shall be provided in each light fixture junction/outlet box for final connections to fixture drops. These pig-tail leads are to be only connected to light fixture returns and associated neutral conductors.
- .3 The use of AC-90 cable for branch circuit home runs is not acceptable.
 - .1 A home run is defined as that portion of the branch circuit wiring that runs between the applicable panelboard and the room or area in which it terminates, and/or makes its final splice, for drop off, to the applicable branch circuit device. The home run conduit shall be continued until the final room destination splice or drop off is reached.
 - .2 Where the branch circuit has multiple splices and/or drop offs to multiple rooms, the use of AC90 for the drop off is permitted, however, the home

- run conduit shall be continued until the final room destination or drop off is reached.
- .3 The use of AC-90 cable between rooms is not permitted.
- .4 AC90 cables are not permitted to enter panelboards under any circumstances.
- .3 Conductor Tie-wrapping:
 - .1 All circuit conductors are to be individually tie wrapped to their corresponding labeled neutral conductor in all panelboards, pullboxes and junction boxes. Suitable slack conductor length should be left to enable the ability to clamp the ground detector around the individually tie-wrapped circuit conductor and its corresponding labeled neutral. This wiring method is to be neat and of good workmanship quality.
 - .2 The tie-wrapping of the neutral with its respective phase conductors is to be made at the closest point of entry into panelboards, pullboxes and junction boxes.
 - .3 The main switchboard, CDP's, panelboards, MCC's etc. are to have their respective feeder phase and neutral conductors tie-wrapped together and enough slack conductor length to enable the ability to clamp the ground detector around each set of feeders. This wiring method is to be neat and of good workmanship quality.
- .4 Final connection to receptacles and light fixtures:
 - .1 Separate pig-tail type leads shall be provided in each receptacle outlet box for final connections to receptacles and in each light fixture outlet box for final connection to the light fixture. These pig-tail leads are to be only connected to the phase and associated neutral conductors.
- .5 Final connection to motors:
 - .1 The conductor phase colour coding as per C.E.C. rule 4-036 will carry through from the incoming service point to the motor starter and to the final connection to each motor. In the instance that a three phase motor requires transposition of phase conductors to achieve proper rotation, the change is to take place at the motor terminal box. Changing the motor feeder phase conductors at any other point in the distribution system (for example at the MCC or starter) will not be acceptable.
- .6 When a circuit enters a junction box, the bonding conductor on the line side shall terminate on the box bonding screw, or terminal strip as applicable, prior to connecting other bonding conductors present in the junction box.
- .7 Testing:
 - .1 Perform testing in conformance with NSP Electrical Inspection Bulletin B-2-132 and CEC Rule 2-136. Contractors are to verify by testing that all interior wiring is; free from shorts, broken, open, or incorrect connections, proper polarity, and that neutrals are free from connections to ground beyond the supply side of the consumer's service box except as permitted in section 10 of the Canadian Electrical Code Part 1. (CEC).
 - .2 Prior to testing, ensure that all feeders or branch circuits which do not have neutral conductors are to have their respective phase conductors tie-wrapped together in accordance to the methods described previously.
 - .3 Prior to testing, ensure that voltage-sensitive devices such as ground fault circuit

interrupters, arc-fault circuit interrupters, electronic ballasts, Surge Protective Devices (SPD) and other electronic equipment are not subjected to voltages that will damage the device.

- .4 Megger testing is to be performed on all branch circuit wiring on the load side of a consumer's main overcurrent device, including main feeders and sub-feeders. Contractors shall record their results for all testing performed and shall have the testing results available for viewing by the inspection department upon request at the time of inspection. Ensure that the Megger reports are submitted to the Engineer for review and are incorporated into the O & M manuals.

3.2 VOLTAGEDROP

- .1 It is the intent of this specification that each branch circuit will be strategically planned and installed to ensure that when tested, the CEC requirement that the voltage drop will not exceed 3% in a feeder or branch circuit; and 5% from the supply side of the Consumer's service to the point of utilization. The contractor will account for distance and routing for each branch circuit and that appropriate wire sizes will be employed to allow an acceptable voltage drop test to be carried out during commissioning. When testing for voltage drop, each branch circuit fed from a 15 amp circuit breaker will be subjected to a 12 ampere load, and branch circuit fed from a 20 amp circuit breaker will be subjected to a 16 ampere load.
- .2 The following table is to include both vertical and horizontal lengths of conductor runs. Minimum size of branch circuit neutral where phase sharing occurs shall not be smaller than #10 AWG. Minimum size of branch circuit neutral where dedicated to its own branch circuit phase conductor shall be not be less than #12 AWG. Note that minimum size #10 AWG bond conductors to accompany #8 branch circuit conductors.
- .3 AS A MINIMUM, THE FOLLOWING TABLE SHALL BE ADHERED TO:
- | Branch Circuit
Length of Run
Mm (feet) | Phase
Wire Size | Dedicated
Neutral | Shared
Neutral | Bond Wire
Size |
|--|--------------------|----------------------|-------------------|-------------------|
| Up to 24,384 | #12 | #12 | #10 | #12 |
| Up to 38,100 | #10 | #10 | #8 | #12 |
| Up to 56,390 | #8 | #8 | #6 | #10 |
- .4 Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed (including switch legs). Oversized #8 AWG branch circuit wiring conductors to be extended from panelboard to junction box located on wall or ceiling directly above wall light switches and/or receptacles. #8 AWG wire to be reduced to #10 AWG for vertical portion of drop only.

END OF SECTION

1 General

1.1 REFERENCES

- .1 Canadian Standards Association, (CSA International)

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

2 Products

2.1 EQUIPMENT

- .1 Insulated grounding conductors: green, insulation to Section 26 05 21 Wires and Cables 0-1000 V.
- .2 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.

3 Execution

3.1 INSTALLATION GENERAL

- .1 Where EMT is used, install bonding conductor in each and every conduit.
- .2 Install connectors in accordance with manufacturer's instructions.

- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 All metal raceways shall be bonded to ground including communications conduits.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw.
- .8 Install separate bonding conductor to outdoor lighting standards.
- .9 Make bonding connections in radial configuration only. Avoid loop connections.
- .10 Every metal conduit used to house a system ground conductor must be bonded to ground at each end.

3.2 EQUIPMENT BONDING

- .1 Install bonding connections to typical equipment included in, but not necessarily limited to following list.
 - .1 Duct systems.
 - .2 Frames of motors, motor control centres, starters, Control panels.
 - .3 Building steel work
 - .4 Distribution panels.
 - .5 Metallic waste water piping systems, metallic rain water leader systems.
 - .6 Metallic gas fuel piping systems.
- .2 Bond all metallic back boxes and metal enclosures to ground that are installed in ceiling spaces or in partitions in conformance with CEC Rule 10-404, including, but not limited to :
 - .1 Public address speaker back boxes.
 - .2 Occupancy sensor back boxes.
 - .3 Communications systems device back boxes and conduit sleeves.

3.3 COMMUNICATON SYSTEMS

- .1 Install a bonding and grounding system extending to all communications rooms in conformance with J-STD-607A and BICSI TDMM (13th edition).

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results -Electrical.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

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

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 45 mm X 45 mm, 3 mm thick, galvanized.

2.2 BEAM CLAMPS

- .1 Beam clamp for 10 mm threaded rod.
- .2 cUL listed.
- .3 Malleable iron, complete with hardened steel cup point setscrew.
- .4 Rated for a minimum of 227 Kg (400 pounds).
- .5 Push-on type conduit clips are not to be used on this project.

3 Exectuion

3.1 INSTALLATION

- .1 Secure equipment to hollow and solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Support equipment, conduit or cables using clips, spring-loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 35 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables 41 mm and larger.
 - .3 Beam clamps to secure conduit to exposed steelwork.
- .5 Suspended supports systems.
 - .1 Support single or multiple cables or conduits on a common steel support channel system supported by 10 mm diameter threaded rod hangers, washers and nuts where direct fastening to building construction is impractical. Channel is to be sandwiched between nuts and washers located on both upper and underside portions of channels.

- .2 Do not support a single conduit using a threaded rod and a beam clamp. This is not an acceptable means of installation as no lateral support is provided.
- .6 For surface mounting of single and multiple conduits use channels. Channels are to be securely attached to hangers with the maximum spacing not greater than:
 - .1 Conduits of one size only:
 - .1 27 mm & 35 mm conduit 1980 mm
 - .2 41 mm & larger conduit 3050 mm
 - .2 Conduits of mixed size:
 - .1 Arrange supports so that maximum spacing of supports conforms to above, based on smallest conduit diameter.
- .7 All suspended types of junction and pull boxes are to be supported using a minimum of 10 mm threaded rod c/w nuts and flat washers. Secure threaded rods to boxes using one flat washer and nut installed on both sides of box. Provide as follows:
 - .1 One rod required for all types of boxes sized 150 X 150 mm or smaller.
 - .2 Two rods required for all types of boxes larger than 150 X 150 mm but less than 254 X 254 mm.
 - .3 Four rods required for all types of boxes 304 X 304 mm and larger.
- .8 In addition to C.E.C. minimum conduit spacing requirements, all suspended conduit runs containing horizontal or vertical elbows are to have one additional support rod installed not greater than 300mm from the midpoint of each bend.
- .9 All excess threaded rod is to be cut-off within 13 mm of channel bottom.
- .10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .12 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .13 **Do not use supports or equipment installed by other trade contractors for conduit or cable support except with permission of other trade and approval of Departmental Representative.**
- .14 **Do not attach electrical conduit and cable to supports installed as part of a suspended ceiling installation (gypsum board or T-Bar for example).**
- .15 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1, 21st Edition.

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 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, minimum 14 gauge with continuously welded corner seams, and formed hinged cover suitable for locking in closed position. Suitable for exterior and/or interior use. Heat fused powder paint applied to enclosure.
- .2 Splitter opening to have curled lip around all sides with poured in place gasket.
- .3 Concealed hinges with captive pins. Quarter turn mechanisms to ensure positive closing.
- .4 Bus bars for power distribution, neutral and ground. Tin plated copper material, drilled and tapped at 150 mm intervals, mounted on slanted insulators mounted on an interior panel.
- .5 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .6 Complete with a bonding terminal strip for individual bonding conductor connections for each feeder.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surfacemounting.
- .2 Covers with 25 mm (1 inch) minimum extension all around, for flush-mounted pull and junction boxes.
- .3 Junction boxes larger than 120 mm to have a bonding terminal strip installed.

2.3 CABINETS

- .1 Type D: 1.6 mm steel cabinet, built for surface or flush mounting. Flush cover lip 25 mm all around. Finish - ASA-61 grey enamel. Complete with screw on cover. Complete with bonding terminal strip.
- .2 Type E: 1.6 mm steel cabinet, surface mount. Formed steel hinge with pull ring catch. Finish ASA-61 grey enamel. Complete with bonding terminal strip.
- .3 Type T: 1.6 mm steel cabinet, 1.9 mm cover, latch lock, 2 keys. Finish - ASA - 61 grey enamel. Complete with bonding terminal strip.

3 Execution

3.1 SPLITTER INSTALLATION

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

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install all raceways in conformance with CEC, Section 12.
- .2 Install pull boxes in inconspicuous but accessible locations. Box cover to be hinged on the side. **Do not install boxes with hinge on top.**
- .3 Install pull boxes so as not to exceed 27 m of conduit run between pull boxes. Each run of raceway shall not have more than the equivalent of four 90 degree bends installed, including the bends located at an outlet or fitting. Pull boxes are to be sized in accordance with CEC Rule 12-3036.
- .4 Terminate all bonding conductors on bonding terminal strip installed inside junction box.
- .5 Where junction and or pull boxes are required to be 150 mm X 150 mm or larger Type E cabinets (hinged cover) shall be used. Do not use splitter troughs in lieu of pull boxes.
- .6 Type T cabinets shall be used when equipment is required to be housed in a lockable enclosure.

- .7 Where construction consists of metal Q deck and steel joists (Roof deck only), conduit boxes are to be installed in such a manner that the nearest outside surface of the electrical box is not less than 38 mm from the nearest surface of the metal roof deck.
- .8 Location of junctions and/or pull boxes in suspended ceiling spaces, i.e., gyp-rock, T-bar, etc., are not to be greater than 760 mm (30 inch) above finish ceiling.
- .9 All suspended types of junction and pull boxes are to be supported using a minimum of 10 mm threaded rod c/w nuts and flat washers. Secure threaded rods to boxes using one flat washer and nut installed on both sides of box. Provide as follows:
 - .1 One rod required for all types of boxes sized 150 X 150 mm or smaller.
 - .2 Two rods required for all types of boxes larger than 150 X 150 mm but less than 254 X 254 mm.
 - .3 Four rods required for all types of boxes 304 X 304 mm and larger.
- .10 Where junction boxes and pull boxes are secured to building structural components, they shall be mounted and secured in such a manner so as not to be “cantilevered” (ie, only supported on one side of the box). In rare instances where site constraints dictate the installation of a “cantilevered” box, threaded rods shall be installed to provide additional support on the opposite end.
- .11 Colour Coding: Refer to 26 05 00. All electrical junction, pull boxes, splitters and cabinets shall be colour coded inside and out with appropriate coloured paint. **All paint is to be applied prior to installation and not with-in the confines of the building.**

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1, 21st Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL DEVICE BOXES

- .1 One or Two Device, Flush Installation, Suitable for Conduit Entry:
 - .1 For general use:
 - .1 Electro-galvanized steel single, flush device boxes for use in dry flush installation, shall be pressed steel, minimum size 100 mm square x 54 mm deep, minimum volume of 490 cubic centimetres.

2.3 SURFACE MOUNTED CONDUIT BOXES

- .1 Cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.
- .2 Metal type "FS" device plates to be used on all type "FS" boxes unless noted otherwise.

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 35mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

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 construction material.
- .3 Where outlet boxes are installed in stud walls and not installed in multiple box mounting brackets, secure the box to a stud, and provide additional support on the opposite side of the box via a bracket or some other acceptable means so the box is firmly secured. Where stud walls are deeper than 100 mm, this may require additional brackets to provide the required support.
- .4 For flush installations mount outlets flush with finished wall using tile rings to permit wall finish to come within 6 mm of opening.
- .5 The front edges of boxes, cabinets and fittings installed in noncombustible walls or ceilings shall not be set in more than 6 mm.
- .6 The front edges of boxes, cabinets and fittings installed in combustible walls (ie, millwork) shall be flush with surface. Application of non-conductive box extenders, similar to Arlington BE Series can be employed where no other practical solution exists.
- .7 Provide correct size of openings in boxes for conduit, mineral insulated and armored cable connections. Reducing washers not to be used.
- .8 Install multi-gang boxes where more than one device is required. Sectional (gangable) boxes are not to be used on this project.

3.2 IDENTIFICATION

- .1 All outlet boxes shall be colour coded as per Specification Section 26 05 00.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, 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. 211.2-M1984 (R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.3 ACTION AND INFORMATIONAL 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.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel-threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, steel liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

- .1 Fasten conduit to building construction or support system using straps, as follows:
 - .1 One-hole steel straps to secure surface conduits and cables 35 mm and smaller.
 - .2 Two hole steel straps for conduits and cables 41 mm and larger.
- .2 Beam clamps to secure conduits to exposed steelwork.
- .3 Channel type supports for one or more conduits.
- .4 10-mm diameter threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating same as conduit.
- .2 Couplings for thinwall type EMT conduits shall be concrete tight, set screw, steel type.
- .3 Conduits exiting equipment enclosures equipped with drip hoods shall be installed with rain tight EMT connectors. These connectors will be equipped with a rubber "O" Ring gasket. In addition, any conduit couplings in the vertical portion of the conduit run over equipment enclosures equipped with drip hoods shall be rain tight.
- .4 Connectors for thinwall type EMT conduits shall be concrete tight, set screw, steel, c/w case hardened steel locknuts. Insulated throats are to be provided on connectors up to and including 27 mm. Metal thread on bushings to be installed on all EMT connectors sized 35 mm or larger.
- .5 Flexible metal conduit connectors shall be nylon insulated, steel or malleable iron type. Provide insulating bushings (anti-shorts) for flexible metal conduit connectors. Plastic thread on bushings to be installed on all flexible metal conduit connectors sized 35 mm or larger.
- .6 Liquid-tight flexible metal conduit fittings:
 - .1 Specifically listed for liquid tight flexible metal conduit.
 - .2 Steel type, to match conduit size.
 - .3 Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
 - .4 Safe edge ground type.
 - .5 Connectors shall have insulated throats.

2.4 FISH CORD

- .1 Polypropylene.

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 Unless noted otherwise, conduits are to be installed as high as possible to conserve headroom, to reduce interference with other trades and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits where practical.
- .3 All wiring on this project is to be installed in an EMT conduit system, unless noted otherwise. Use rigid galvanized steel threaded conduit where subject to injury.
- .4 Use electrical metallic tubing (EMT) for the following:
 - .1 All distribution and branch circuit wiring, unless noted otherwise.
- .5 EMT shall be installed as a complete system and shall be securely fastened in place within 1 metre of each outlet box, junction box, cabinet, couplings, fittings and changes in direction and the spacing between supports as follows:
 - .1 Not greater than 1500 mm for 16 mm and 21 mm EMT
 - .2 Not greater than 1800 mm for 27 mm (1 inch) and 35 mm EMT
 - .3 Not greater than 3050 mm for 41 mm EMT or larger.
- .6 Install supports to firmly secure conduits to metal decking when any change in direction occurs.
- .7 All conduit runs shall be a maximum of 30 meters in length with a maximum of four (4) 90 degree bends between pull points. A pull box shall be placed in conduit runs where the sum of the bends exceeds 360 degrees, where the overall run exceeds 30 meters (100 feet) or there is a reverse bend in the run.
- .8 Pull boxes shall be placed in straight sections of conduit run and shall not be used in lieu of a bend. Conduit fittings shall not be used in place of pull boxes or bends. The use of C, LB, LL, LR and T type fittings are prohibited on this project unless written permission is provided by the Departmental Representative.
- .9 Pull boxes are to be sized in conformance with CEC Rule 12-3036, unless noted otherwise.
- .10 The use of corner pulling ELLs or corner pulling elbows is not permitted.
- .11 Conduits shall be installed in a neat and ordered manner. When installed in a group, conduits shall be parallel and evenly spaced apart.
- .12 Liquid tight metal flexible conduit is not to be used as a general purpose raceway. Use liquid tight flexible metal conduit (maximum length permitted to be 1.5 M) and liquid tight conduit fittings for:
 - .1 Final connection to all mechanical equipment (fans, pumps, terminal units, etc.) and all vibrating equipment.

- .13 Metal flexible conduit may be used for short runs for final connections unless noted otherwise. It must be securely fastened in place within 300 mm of each junction box, cabinet and device. Install specified connectors and bushings. Where supports are required, do not derive support from ceiling support wires on supports of other trades. Do not use liquid tight metal flexible conduit in lieu of metal flexible conduit unless specifically approved by the Departmental Representative for that application.
- .14 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .15 Mechanically bend steel conduit over 19-mm diameter.
- .16 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .17 Install fish cord in empty conduits.
- .18 Where conduits become blocked, remove and replace blocked section.
- .19 Dry conduits out before installing wire.
- .20 The installation of conduits above the structure, directly below roof insulation is strictly prohibited.
- .21 All conduits to be complete with minimum #12 green insulated bond conductor.
- .22 Ensure all metal raceways are bonded to ground, including those used for communication systems, fire alarm systems. Where a separate bonding conductor is run to a bonding bushing on an open end of a metal raceway, a #6 green RW90 shall be used.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines. When installed in a wall cavity, conduit is to be installed vertically from outlet box to ceiling space, not run in an angled manner through the studs.
- .2 Run conduits in flanged portion of structural steel, where possible.
- .3 Group conduits wherever possible.
- .4 Do not pass conduits through structural members except as indicated.
- .5 Do not locate conduits closer than 75-mm parallel to hot water lines with a minimum of 25 mm at crossovers.
- .6 Support of electrical systems raceway shall be independent of any type of suspended ceiling support rods, wires, etc. Toggle bolts shall not be used in Gypsum board construction.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in concrete toppings.
- .4 Protect conduits from damage where they stub out of concrete.
- .5 Install sleeves where conduits pass through slab or wall.
- .6 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.
 - .1 Use cold mastic between sleeve and conduit.
- .7 Organize conduits to minimize cross-overs.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 – Common Work Results -Electrical.
- .2 Section 26 28 16.02 - Moulded Case Circuit Breakers

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42-99(R2002), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.
 - .4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 Products

2.1 SWITCHES

- .1 20 A, 120 V or 347 V single pole, three-way, four-way switches as indicated.
- .2 Manually-operated general purpose AC switches, industrial, specification grade, toggle type, as indicated and with the following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle.
- .3 Maximum continuous current: 20 Amps.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 Reinforced thermoplastic base and deep nylon body.
 - .2 Two pole, three wire grounding type.

- .3 Impact resistant nylon face.
- .4 One piece brass mounting strap with integral ground contacts.
- .5 Suitable for No. 10 AWG for back and side wiring.
- .6 Break-off links for use as split receptacles.
- .7 Eight back wired entrances, four side wiring screws.
- .8 Double wipe contacts.
- .9 White in color.
- .2 Duplex receptacles, CSA type 5-20 R, 125 V, 15/20 A, U ground, with following features:
 - .1 Reinforced thermoplastic base and deep nylon body.
 - .2 Two pole, three wire grounding type.
 - .3 Impact resistant nylon face.
 - .4 One piece brass mounting strap with integral ground contacts.
 - .5 Suitable for No. 10 AWG for back and side wiring.
 - .6 Break-off links for use as split receptacles.
 - .7 Eight back wired entrances, four side wiring screws.
 - .8 Double wipe contacts.
 - .9 White in color.
- .3 GFI Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features:

Reinforced thermoplastic base and deep nylon body.

 - .1 Two pole, three wire grounding type.
 - .2 Impact resistant nylon face.
 - .3 Suitable for No. 10 AWG for back and side wiring.
 - .4 Break-off links for use as split receptacles.
 - .5 Eight back wired entrances, four side wiring screws.
 - .6 Double wipe contacts.
 - .7 GFI test and reset buttons.
 - .8 Trip level: 4 to 6 mA.
 - .9 White in color.
- .4 GFI Duplex receptacles, CSA type 5-20 R, 125 V, 15/20 A, U ground, with following features:
 - .1 Reinforced thermoplastic base and deep nylon body.
 - .2 Two pole, three wire grounding type.
 - .3 Impact resistant nylon face.
 - .4 Suitable for No. 10 AWG for back and side wiring.
 - .5 Break-off links for use as split receptacles.
 - .6 Eight back wired entrances, four side wiring screws.
 - .7 Double wipe contacts.
 - .8 GFI test and reset buttons.
 - .9 Trip level: 4 to 6 mA.
 - .10 White in color.
- .5 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.

- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, vertically brushed, 1 mm thick cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

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 specified in Section 26 05 00 or as indicated.
 - .4 **Each line voltage switch is to be wired with the neutral conductor extended to the device box.**
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Review shop drawings for each item of equipment supplied for this project and confirm electrical requirements and recommended rough-in location for appropriate connections (ranges, cook tops, wall ovens, etc.).
 - .3 Mount receptacles at height specified in Section 26 05 00 or as indicated.
 - .4 All receptacles to be polarity tested.
 - .5 Install with U-ground up, unless noted otherwise.
 - .6 Receptacles shall project a minimum of 3 mm (.125 in) from metal face plates.
 - .7 All receptacles to be mounted level and plumb.
 - .8 For above ceiling applications, outlet box is to be 100 mm (4 inch) square, c/w with raised surface covers.
- .3 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
 - .4 Use "FS" coverplates for all "FS" boxes.
- .4 Identification:
 - .1 Identify all receptacles as per 26 05 00.

END OF SECTION

1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-09, 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 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers and Ground-fault circuit-interrupters, 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.
- .5 Circuit breakers to have minimum KA symmetrical RMS interrupting capacity rating, to match the existing circuit breakers in the panelboard being modified.

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.

3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.
- .2 Circuit breakers shall be securely mounted in the panel.
- .3 For proper termination of conductors, it is very important that field connections be properly tightened. Obtain manufacturer's recommended torque for the type of connection and wire type and gauge. Using a properly set up torque wrench, torque each termination to manufacturer's setting.

END OF SECTION

1 General

1.1 REFERENCES

- .1 CAN/CSA C22.1-15, Canadian Electrical Code, Part I.
- .2 CAN/CSA C22.2 No.9.0, General Requirements for Luminaires.

1.2 PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit complete photometric and heat dissipation data prepared by independent testing laboratory for proposed luminaires.

1.3 INTENT

- .1 Provide lighting fixtures and accessories for all outlets as listed in the Luminaire Schedule and as shown on drawings.
- .2 Lighting fixtures shall be structurally well designed and constructed, using new parts and materials of the highest commercial grade available.
- .3 Bond all lighting equipment.
- .4 Verify all ceiling types and finishes before ordering fixtures and provide fixtures suitable for mounting in or on ceilings being installed in each area, as specified. Where fixture types specified are not suitable for ceiling being installed, obtain written instructions from the Departmental Representative before ordering fixtures.
- .5 Fixtures of the same or similar type shall be supplied by the same manufacturer.

2 Products

2.1 LED DRIVERS

- .1 Electronic type
- .2 Thermally protected
- .3 Dimmable.

2.2 LUMINAIRES

- .1 Accessories and components shall comply with relevant CSA Standards.
- .2 All fixture diffusers, lens panels, lens frames, etc., shall be securely and adequately supported and shall be removable without the use of tools for cleaning.

- .3 Fixtures shall be designed for adequate dissipation of driver and lamp heat to avoid shortened life, nuisance thermal tripping and decreased lamp output.
- .4 The construction and performance of all LED fixtures shall be subject to the acceptance of the Departmental Representative. Full photometric data from independent testing laboratory shall be provided when requested by the Departmental Representative.

2.3 ELECTRICAL CHARACTERISTICS

- .1 Rating: 347 V, 60 Hz.
- .2 Integral LED driver.

2.4 LIGHT SOURCE

- .1 Light Emitting Diode.
- .2 Colour temperature: 4000 K

3 Execution

3.1 INSTALLATION

- .1 Provide complete and proper support for all fixtures, fixture hangers, etc., including headers in ceiling space, where required, for proper support of outlet boxes and fixture hanger assemblies.
- .2 Support fixtures as shown on the drawings, level, plumb and true with the structure and other equipment in a horizontal or vertical position as intended. Wall or side bracket mounted fixture housings shall be rigidly installed and adjusted to give a neat flush fit to the surface on which it is mounted.
- .3 All hangers, supports, fastenings or accessory fittings shall be protected against corrosion. Care shall be taken during the installation.
- .4 Connect to existing wiring and controls.
- .5 Turn over existing light fixtures to Owner.

3.2 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.

3.3 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION