DIVISION 26 ELECTRICAL

Section 26 00 00 Electrical General Requirements

1. Design Basis:

1.1 Varying, or deviating from any item(s) indicated in this document must be approved by the Minister's Representative. The Minister's Representative will not grant a deviation from these requirements unless the deviation has been submitted in writing for review and approved prior to proceeding with the design.

1.2 Base the electrical design on providing the following features:

1.2.1 Safety to personnel during operation and maintenance of equipment.
1.2.2 Optimum performance of electrical systems.
1.2.3 Compatibility width other design elements.
1.2.4 Ease of maintenance of equipment to be maintained by non-specialized personnel.
1.2.5 Flexibility of electrical services.
1.2.6 Proper coordination of all elements of the system as per the following:
1.2.6.1 Insulation Levels.
1.2.6.2 Interrupting Capacities - Provide the interrupting capacity on a single line diagram required for all equipment fed from each bus based upon a calculated fault level and indicate as per the following examples: 10 kAIC, 18 kAIC, etc.
1.2.6.3 Protective Relaying.
1.2.6.4 Mechanical Strength.
1.2.6.5 Hazardous Location Classification.
1.2.6.6 Allowance for future growth and expansion.
1.2.6.7 Compliance with all governing standards and codes - In no instance shall the minimum standards established by this document be reduced by the application of any other codes.
1.2.6.8 Perform In order to confirm code compliance and to provide a record for OH&S purposes that safety to personnel during operation and maintenance of equipment has been considered during electrical system design; the designer shall provide a coordination study to justify selection of fuses and breakers. Perform the coordination study on the electrical distribution system, using the available site utility information such as Grid MVA, X/R ratio, fault current and voltage obtained from electrical utility. This study shall indicate the available fault current levels at each major distribution component. All overcurrent devices are to be properly coordinated. Where the distribution system is existing, the coordination study need only be performed on the portions of the system being modified. Provide a

copy of this study no later than with the 80% complete document review submission, the submitted coordination study is to be stamped / signed by a professional engineer licensed to practice in the Province of Nova Scotia.

1.3 Arc Flash Hazard Analysis

1.3.1 In order to provide a record for OH&S purposes that safety to personnel during the operation and maintenance of electrical equipment has been taken into consideration during the system design; the designer shall carry out an Arc Flash Hazard Analysis during design in accordance with CSA Z462 and IEEE Std 1584, in conjunction with the short circuit and protective device coordination studies to justify selection of fuses and breakers. The study will include fault current momentary duty and protective device clearing times and will define the flash protection boundary and the incident energy at any position or level in the electrical distribution system where work could be performed on the energized parts. Where the downstream electrical equipment cannot be deenergized for maintenance or the available incident energy level is deemed to be excessive, the use of arc flash mitigating / reducing maintenance switch(s) is to be considered during the design of the distribution system. If the distribution system is existing, the analysis need only be performed on the portions of the system being modified. Provide a copy of this study no later than with the 80% complete document review submission.

1.3.2 The study will provide the following for each circuit condition and location analyzed:

1.3.2.1 Arcing fault magnitude
1.3.2.2 Device clearing time
1.3.2.3 Duration of arc
1.3.2.4 Arc flash boundary
1.3.2.5 Working distance
1.3.2.6 Incident energy
1.3.2.7 CSA Z462 compliant warning label listing incident energy, arc flash boundary, and hazard risk category.

1.3.3 Provide and install appropriate warning labels to each piece of distribution equipment identified in the Arc Flash Hazard Analysis. Labels are to include information in conformance with CSA Z462, including but not limited to:

1.3.3.1 Available incident energy level.
1.3.3.2 The arc flash boundary distance.
1.3.3.3 Voltage of equipment
1.3.3.4 Minimum glove class.

1.3.4 Provide and install appropriate warning labels to each piece of distribution equipment identified in the Arc Flash Hazard Analysis. Labels are to include information in conformance with NFPA 70E, including but not limited to:

1.3.4.1 The severity of the arc flash hazard
1.3.4.2 The distances involved

1.4 Thermographic Assessment - Electrical Systems

1.4.1 Provide a Thermographic Assessment on Electrical Systems where the electrical service is rated 600V and 600A or larger. Where electrical systems are rated less than 600V and 600A, a thermographic assessment need not be provided unless this distribution system contains ACM feeders, provide a Thermographic Assessment on the ACM conductor terminations only in these systems.

1.4.2 Thermographic assessment of the building electrical distribution system shall include but not be limited to:
1.4.2.1 Service entrance equipment,
1.4.2.2 Main switchboard,
1.4.2.3 Distribution panels,
1.4.2.4 Panelboards,
1.4.2.5 Disconnect switches,
1.4.2.6 Transformers,
1.4.2.7 Motor Control Centres, etc.

1.4.3 This work is to be performed after the complete installation of the electrical distribution and the system equipment is operating and under normal load conditions. The report shall contain an analysis of electrical equipment, termination and components using thermal imaging equipment to observe thermal anomalies providing specific information indicating localized, abnormally warm or cool connections that could indicate potential problems.

1.4.4 Thermographic Inspection Report shall be an organized document stating the description of components being inspected, general findings, and any recommendations including, but not limited to appropriately analyzed thermal images with corresponding visual photographs to express observed conditions, with statements interpreting observed deficient conditions. Recommendations identify complete with recommended corrective measures to fix deficient conditions.

1.4.4.1 Report to include as a minimum the following information for each item of equipment:.

1.4.4.1.1 Description of component being inspected.
1.4.4.1.2 Colour photograph of component.
1.4.4.1.3 IR photograph of component.
1.4.4.1.4 Voltage, amperage rating and phase of component.
1.4.4.1.5 Exact location of component.
1.4.4.1.6 Date and time of inspection.
1.4.4.1.7 Surface temperature of component being inspected.
1.4.4.1.8 Actual load condition on electrical equipment.
1.4.4.1.9 Abnormal physical conditions based on visual inspection.
1.4.4.1.10 Difference in temperature between inspected component and defined reference component / ambient air temperature.
1.4.4.1.11 Provide Identification and Diagnoses of any suspected

problems including photographs and

1.4.4.1.12 Commentary indicating severity and types of thermal anomalies detected.

1.4.4.1.13 Provide Interpretation of observed conditions and suspected deficiencies including probable causes of the thermal anomaly(s) detected.

1.4.4.1.14 Personnel Performing thermographic scans shall be certified in accordance with ASNT SNT-TC-1A

1.4.4.2 Include the Thermographic Assessment report in the O&M manuals for the facility

1.5 Provide a riser diagram for each system (including a power distribution single line diagram) on the drawings. All items are to be grouped by floor level. Risers are not to contain electrical floor plan layouts with or without the architectural floor plan in the background. Show ALL system components in this riser. Where the design is provided for a renovation, partial riser diagrams for the affected portions of these systems are acceptable.

1.6 All exterior lighting is to be shown on the electrical site plan.

1.7 Exit signs and emergency lighting layouts shall be shown on the same drawings as the fire alarm layouts so as to keep the electrical life safety systems on the same drawings, where practical. If these systems are not able to be shown on the same floor plan, provide a separate floor plan for each system.

1.8 Provide match lines for all partial floor plans.

1.9 Building Renovation and Upgrade Projects:

1.9.1 Existing electrical condition and demolition drawings shall be based on thorough site investigations of existing devices / equipment for all systems within the project scope. Existing condition / demolition drawings for each system shall indicate the source for all equipment and devices within the project scope. Existing condition / demolition drawings shall indicate all electrical power sources complete with circuit identification (where possible) and source power panel locations for those devices and equipment being reused, removed or relocated.

1.9.2 All Telecommunication outlets to be removed or relocated shall also be included on existing condition / demolition drawings; additionally, include in their identification information on the drawing and the Telecommunication room feeding them.

1.9.3 In case site information is absent, inaccessible or uncertain, the consultant shall seek guidance from the Ministers representative first, and facility personnel if directed to do so by the Ministers representative, The consultant

may also refer to record drawings (if available) to assist them in making reasonable assumptions. Clearly indicate in the documents where the contractor will undertake specific, additional site review to determine actual site conditions.

2. Overhead Electrical Service:

   2.1 Refer to Section 33 71 00.1 - Overhead Electrical Service

3. Underground Electrical Service**:**

   3.1 Refer to Section 33 71 00.2 - Underground Electrical Service

4. Security System:

   4.1 Refer to Division 28 for Security System.

5. Lighting Control Equipment - Low Voltage:

   5.1 Refer to Section 26 09 24 - Instrumentation and Control for Electrical Systems

6. Fire Alarm System:

   6.1 Refer to Section 28 31 00 - Fire Detection and Alarm.

7. Electric Heat:

   7.1 Refer to Section 23 80 00 - Decentralized HVAC Equipment.

8. General:

   8.1 Extend wiring to, and connect all wiring for motors, control equipment and other electrical or mechanical equipment indicated on the working drawings. Do not include low voltage control wiring 50 volts and less. The mechanical consultant will provide a list of mechanical equipment requiring electrical wiring to the electrical consultant. The electrical consultant is to incorporate this information in a mechanical equipment schedule on an electrical drawing. All mechanical equipment wiring, except that under 50V for controls, shall be installed by a certified electrician.

   8.2 Extend wiring to, and connect all equipment furnished by the building owner.

   8.3 Electrical equipment located in areas where corrosive materials may be used shall be suitable for that particular type of application.

8.4 Fire barrier materials are to be used when penetrations are made through fire rated walls, floors or ceilings. These materials are to be applied in strict accordance with manufacturer's instructions.

8.5 Provide concrete housekeeping pads for all free-standing electrical equipment, i.e. switchboards, motor control centres, dry type transformers, generators, transfer switches, etc. Pads are to be a minimum of 150mm (6") larger than outside dimensions of equipment they support, not less than 100mm (4") thick, and be complete with chamfered edges.

8.6 Locate fans, electrical or mechanical fixtures, and/or other types of wall mounted building appendages, not less than 3660mm (12') above finished grade to bottom of units.

8.7 In new construction, all light switches are to be a maximum of 1220mm (48") A.F.F.

8.8 In new construction, all power/voice/data/CATV/multimedia outlets are to be a minimum of 450mm (18") A.F.F.

8.9 All free standing switchboards and/or motor control centres rated 600 Amps and "larger," and located on ground floors or slabs-on-grade, shall be c/w concrete encased "troughs" located directly beneath same as follows:

8.9.1 Unless specifically indicated otherwise, concrete troughs are to be extended under all combined sections making up main switchboard, with the exception of that portion of board containing "main overcurrent" breaker/fuses and metering sections.

8.9.2 Underground PVC rigid (feeder) conduit(s) installed between exterior padmount transformer/overhead poles, are to be extended a minimum of not less than 50mm (2") up through housekeeping pad below section of board containing said overcurrent protection, and have non-flared type "bell-ends" installed.

8.9.3 Unless specifically indicated otherwise, concrete troughs are to be extended under all combined sections making up a motor control centre(s).

8.9.4 Ends, sides and bottom to be of concrete construction and not less than 510mm (20") in total depth from underside of floor slab to inside bottom of trough.

8.9.5 Bell-end flare type fittings are to be used where terminations of underground rigid PVC conduits to sides or ends of concrete troughs takes place.

8.9.6 Provide a minimum of two spare 63mm (2-1/2") PVC rigid conduits from "concrete trough" to nearest available clear wall space. Both 63mm (2-1/2") conduits are to terminate in shared or common 450mm high x 300mm wide x 150mm (18" high x 12" wide x 6") deep type "E" box, with transition from PVC to rigid threaded steel conduit to take place "below" finish concrete floor slab and transition from rigid steel conduit to EMT conduit taking

place “above” concrete floor slab.

8.10 All designated “fire rated” walls and/or separations indicated on architectural drawings, are to also be identified (with bolded lines) on electrical life safety system floor plans.

8.11 Q-Deck Installation:

8.11.1 Where metal type Q-Deck is being used, all cables/conduits are to be installed on room sides of upper portions of the Q-Deck (directly above tops of, and at right angles to steel joists) and secured directly to sides of metal flutes and/or structure.

8.11.2 Where cables/conduits are installed in same direction as steel joists, they are also to be secured as high as possible to underside of metal decking and/or structural steel, with approved type supports intended for the particular application.

8.11.3 Under no circumstances are cables/conduits to be laid in, fished in, or otherwise installed in top or upper (roof) sides of metal flutes. All wiring is to be surface installed on, or to, the underside of room structure.

8.11.4 Where the Q-Deck forms part of the roof framework, and the conduits are installed in an enclosed ceiling area, the contractor has the option of installing the conduits on the underside of the uppermost angle iron support of the OWS Joist, with the use of an approved type support, intended for the particular application.

8.12 Provide conduit sleeves for conduit penetrations through floor assemblies. Terminate sleeves flush with floor assemblies except in mechanical rooms, where sleeves will terminate 50 mm (2 in.) above finished floor.

8.13 Where “tilt-up” construction is utilized, all outlets indicated in tender documents and addendums are to be installed flush. In existing installations where the wall has been poured, utilize aesthetic type surface raceway in finished areas and surface conduit/boxes in unfinished areas.

8.14 The chain hanging of lighting fixtures shall be limited to unfinished areas.

8.15 Firestopping

8.15.1 Caulking should not be used as a method for firestopping PVC conduits.

8.15.2 Firestopping listings/shop drawings should be reviewed by the engineer/consultant as part of the shop drawing process.

8.16 Open ceiling Concept:

8.16.1 Where finished ceilings (T-bar, drywall, etc.) are not provided, please note that all exposed wiring shall be run in conduit/EMT.

8.17 All electrical equipment is to be installed as per manufacturer's recommendations.

8.18 All electrical controls (thermostats, light switches, TOL switches, etc.) located in public areas are to have appropriate measures (keys, plastic guards, etc.) implemented to prevent unauthorized manipulation.

8.19 Equipment shall not carry any logos or text which identifies the equipment manufacturer / supplier; exception: equipment located in service spaces.

9. Identification:

9.1 All switchboards, panels, disconnect switches, power/voice/data/CATV/multimedia outlets, MCC's, transformers, control panels, magnetic starters, TOL's, time clocks, are to be provided with "lamicoid" nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true, level, and plumb in all instances.

9.2 Where a lamicoid identified item is installed "within" ceiling spaces, two (2) lamicoid plates are to be provided - one at the item location and one on room side of T-Bar grid spline or access cover frames.

9.3 Nameplates are to be affixed to all "metal" surfaces with metal type "pop-rivets."

9.4 Nameplates are to be affixed to other types of surfaces with contact type cement.

9.5 Nameplates are to be affixed to building "exterior" surfaces with nylon inserts and self tapping screws unless specifically indicated otherwise.

9.6 Contact type cement is to be applied (buttered) to "complete" rear side of plate, as opposed to several points or locations on same.

9.6.1 The use of water activated polyurethane glue is permissible in place of contact cement, however, ensure support for the lamicoid is provided during the curing cycle of the product. Excessive glue "squeeze out" or "product expansion" will necessitate replacement of the lamicoid.

9.7 Lamicoid nameplates installed on switchboards, distribution panelboards, motor control centres, splitter troughs, transformers, shall indicate the following:

9.7.1 Designated name of equipment.

9.7.2 Amperage of overcurrent protection device.

9.7.3 Voltages, number of phases and wires.

9.7.4 Designation of power source.

EX A M PLE
PANEL H -150 AMPS
120/208V - 3PH - 4W
FED FROM MAIN SWITCHBOARD # CDP-A

9.8 Lamicoid nameplates installed on combination starters, magnetic starters, manual starter and all various systems controls, control panels, disconnect switches, shall contain the following information:

9.8.1 Designated name of equipment.

9.8.2 Designated name of power source.

9.8.3 Branch circuit breaker number(s) where possible.

9.8.4 Voltage(s) and number of phases.

EX A M PLE:
EXHAUST FAN NO. 5
PANEL H - CCT. NO. 17
120V - 1 PH

EX A M PLE:
SUPPLY FAN NO. 3
M.C.C. NO. 1
600V - 3 PH

9.9 Lamicoid nameplates installed on fusible type disconnect switches are to also indicate installed fusing and “maximum” fuse size.

9.10 Lamicoid nameplates are to be installed on all junction and/or pull boxes sized 6" x 6" and larger indicating name of system, designated panel name and electrical characteristics where applicable.

9.11 Lamicoid nameplates are to be installed adjacent to each overcurrent devices located in switchboards, CDP panels, MCC’s, etc. They need only indicate designated name and/or number of equipment they feed. Each unused or spare overcurrent device is to be identified with a “Lamicoid” plate indicating “spare.”

9.12 Lamicoid nameplates installed on "main" service entrance switches, or "main" entrance switchboards to indicate the following information on minimum size 15mm x 50mm (6" x 2") plate c/w two lines of 12.5mm (1/2") high lettering. (Size #8 nameplate)

EXAMPLE:
MAIN BREAKER 800 AMPS

EXAMPLE:
MAIN SWITCH 200 AMPS

347/600V, 3PH, 4W **120/208V, 3PH, 4W**

9.13 Install an additional "Lamicoid" nameplate on all, or any piece of electrical equipment, or apparatus, i.e. Main Switchboard, CDP panels, Panelboards, Motor Control Centres, that may contain overcurrent devices, ie. circuit breakers and/or fuses, that have been designed for, and incorporate interrupting capacity sized "larger" than 10 kAIC.

EXAMPLE:

Minimum interrupting capacity of breakers installed in this MCCpanel is to be not less than 22 kAIC

EXAMPLE:

Minimum interrupting capacity of fuses installed in this is to be not less than 100 kAIC

9.14 Lamicoid nameplates are to be installed above all types of receptacles and abutted directly to tops of their respective device plates. Identification is to indicate respective panel source c/w associated circuit breaker number(s) as per the following:

9.14.1 1.6mm (1/16 ") thick x 12.7mm (1/2") high c/w 6mm (1/4") black letters on white face, directly above all flush receptacles (identical width as finish device plate for both single and double gang outlets):

EXAMPLE: **H – 20**

9.15 Receptacles intended for computer, electronic or other sensitive types of electronic equipment, are to be identified as per the following:

9.15.1 1.6mm (1/16") thick x 19mm (3/4") wide c/w 6mm (1/4") black letters on white face above all flush receptacles (identical width as finish device plate for both single and double gang outlets):

EXAMPLE:

FOR COMPUTER USE ONLY
PANEL M – 20

9.16 Lamicoid nameplates installed above 120 volt receptacles protected by GFCI circuit breakers, or GFCI type receptacles (where their use is permitted) are to be identified as per the following:

EXAMPLE: **GFCI PROTECTED PANEL M – 22**

9.17 Receptacles that are an integral part of systems furniture are not to be lamicoid identified. The power outlet feeding the systems furniture, however, is to be lamicoid identified similar to receptacles.

9.18 Provide lamicoid plates for all voice, data, microphone, and cable television outlets. Lamicoid nameplate(s) may be applied directly to face of finish plate where practical, c/w information as required.

9.19 All addressable fire alarm devices are to be lamicoid identified.

9.19.1 Lamicoid identification is to be chain hung as required on mechanical items (pressure switches, supervisory switches, etc.). A second lamicoid plate shall be installed for addressable interface modules provided for said mechanical items.

9.19.2 Manual pull station lamicoid plate to be installed similar to typical receptacle lamicoid plate.

9.19.3 Lamicoid wording to match physical location and annunciator display address.

EXAMPLE: **FLOW SWITCH - A - F - 2**

(MP = manual pull station) **EAST EXIT - MP – 15**

9.20 Allow for an “average” of 40 letters for each lamicoid nameplate.

9.20.1 Lamicoid 1/16 inch thick plastic engraving sheet, black core, white face, for all electrical systems except for the following:

9.20.2 Fire alarm and emergency power systems shall have red face with white core. (1/8" where secured to metals)

9.20.3 Power/voice/data/CATV/multimedia outlets shall have white face, black core.

9.20.4 1.6mm (1/16") thick nameplates located less than 2400mm AFF shall have top left and right corners rounded off. where not applied to metals); exception: service rooms. Lettering on lamicoid nameplates shall not “start,” nor “end” nearer than 12.7mm (1/2") from either, or both ends of said plates.

Size of lettering, including overall lengths of various plates shall be as indicated in following chart:

N A M E P L A T E S I Z E S

Size 1 -	**9.5mm x 50mm (3/8" x 2")**	**1 line - 4.8mm (3/16") high letters**
Size 2 -	**12.7mm x 76mm (1/2" x 3")**	**1 line - 6mm (1/4") high letters**
Size 3 -	**16mm x 75mm (5/8" x 3")**	**2 lines- 5mm (3/16") high letters**
Size 4 -	**19mm x 89mm (3/4" x 3.5")**	**1 line - 9.5mm (3/8") high letters**
Size 5 -	**38mm x 89mm (1.5" x 3.5")**	**2 lines - 12.7mm (1/2") high letters**
Size 6 -	**25mm x 100mm (1" x 4")**	**1 line - 12.7mm (1/2)" high letters**
Size 7 -	**25mm x 100mm (1" x 4")**	**2 lines - 6mm (1/4") high letters**
Size 8 -	**50mm x 100mm (2" x 6")**	**2 lines - 12.7mm (1/2") high letters**

9.21 Examples of "grouped" electrical equipment that could have identical types of removable covers, that will require their Lamicoid nameplates installed on wall(s) adjacent to control, rather than directly to their covers (this is to avoid the possibility of cover mix-up occurring): magnetic starters, magnetic contactors, manual T.O.L. switches, and relays.

9.22 Lamicoid nameplates for Time Clocks shall have the designated name(s) and location(s) of load(s) being fed, in addition to the following.

9.22.1 Voltages ..... Phases ..... Wires ..... Panel and circuit breaker number(s)

EXAMPLE: PANEL HV - 3 PH/4 W - 347 V - LPA - Cct No. 16

9.23 Lamicoid nameplates shall be provided and installed on, or adjacent to, all various systems' control panels and/or cabinets c/w information as indicated. Nameplates are to reflect individual system's assigned name, and where applicable, shall also indicate both, designated panel name and associated branch circuit breaker number(s).

9.23.1 Fire alarm panels

9.23.2 Security (intrusion) panels

9.23.3 Energy management panels

9.23.4 Public address panels

9.23.5 Television panels

9.23.6 Gymnasium sound panels

9.23.7 Communication panels

9.23.8 Low voltage lighting relay panels.

EXAMPLE: LIGHTING RELAY PANEL #1 - LPA – 36

9.24 Control Transformers:

9.24.1 Concealed control transformers located within ceiling spaces are to have Lamicoid nameplates installed adjacent to same indicating their identified system, primary power source including designated panel name, c/w associated branch circuit breaker number(s).

9.24.2 A second plate with identical information is to be installed on underside of room grid system or access opening frame directly below control transformer, so as to identify its concealed location directly above same.

9.24.3 All control transformers installed in either control cabinets or on walls adjacent to same, are to be identified with Lamicoid nameplates containing information as previously indicated.

9.25 All various pieces of mechanical equipment are to be identified with “identical” information as indicated on electrical equipment Lamicoid nameplate feeding aforesaid mechanical equipment. Both “Lamicoid” nameplates are to be supplied and installed by the electrical contractor in the absence of any mechanical trade identification.

9.26 Bonding conductors require labelling on both ends of runs where they are “dedicated” solely to the designated branch circuit they accompany. Identify with same number(s) as being used to identify accompanying branch circuit phase(s) and neutral conductor(s).

9.27 Labelling of all branch circuit phase and neutral conductors is to be done on both ends of all circuit conductors, plus in “all” junction and/or pull boxes located in between. Use write- on, self laminating labels sized as necessary. To be installed in a “flagged” manner around individual conductor(s).

9.28 Coverplates for junction and/or pull boxes located above or within finish ceilings containing branch circuits, are to have each branch circuit number neatly identified on coverplate. Felt marker-pen may be used for this purpose.

9.29 All of the following conductors are to have their “insulation” colours identified as indicated:

Phase	**(A)**	**Red**
Phase	**(B)**	**Black**
Phase	**(C)**	**Blue**
Neutral		**White / Grey**
Bond		**Green**
Ground		**Green**
Isolated Ground		**Green c/w Yellow Stripe**

9.29.1 Colour coded "conductor insulation" as per the following:
9.29.1.1 All sizes of phase conductors up to and including #2 AWG.
9.29.1.2 All sizes of neutral, bond and/or ground conductors, up to and including #3/0 AWG.

9.29.2 Approved coloured tapes in lieu of insulation colouring may be used to identify conductors that exceed sizes as previously indicated. To take place on "both ends," of all runs, a minimum of 300mm (12") from where terminations take place, in addition to within all or any boxes located in-between both ends of runs.

9.30 All junction and/or pull boxes, conduit fittings (and respective covers), complete with their respective cover plates are to be colour coded as per the following: Boxes are to be coloured both inside and outside, where "one" colour only is required. Boxes are to be coloured on inside only where "two" colours are required. Metal coverplates are to have both colours applied diagonally where "two" colours are required. Complete plate is to be painted where one colour only is required. All junction boxes are to be colour identified prior to installation.

9.31 All various systems concealed junction and/or pull boxes located "within" ceiling spaces are to have their locations identified on room side of T-Bar grid spline or access cover frames with appropriate colour coded, circular shaped, self adhering discs. Discs are to be both, ¾" and ¼" in diameter as indicated in the following legend, with ¼" discs always being centered in middle of ¾" discs:

VARIOUS SYSTEMS	19mm (3/4") DISCS	6mm (1/4") DISCS
0 to 50 Volts	**Violet**	
51 to 240 Volts	**Yellow**	
241 to 600 Volts	**Orange**	

Fire Alarm	**Red**	
Telephone (voice only)	**Black**	
P.A. and Intercom	**Blue**	
Security	**Brown**	
Ground or Bond	**Green**	
Cable Television	**Yellow**	**White**
Nurse Call	**Orange**	**White**
Energy Management	**Red**	**White**
Computer (data only)	**Black**	**White**
Voice & Data	**Blue**	**White**
Other	**Brown**	**White**
Other		**White**
Other		**White**

9.32 Where boxes are not concealed, such as in an open ceiling concept, discs are to be fastened directly to the outside of the boxes after architectural painting is complete. Coverplates for boxes containing branch circuits, are to have each branch circuit number neatly identified on the inside of the coverplate. Felt marker-pen may be used for this purpose.

9.33 A legend of colour coding is to be provided under plexiglass and located in the main electrical room (600mm x 600mm (24" x 24") minimum size frame).

9.34 Where appropriate, coloured conduit may be used in lieu of colour coded boxes/fittings.

Section 26 05 00 Common Work Results for Electrical

1. Outlet Boxes, Conduit Boxes & Fittings

1.1 Sectional type boxes are not to be used without special permission from the Minister’s Representative.

1.2 Cast type "FS" or "FD" boxes are to be utilized for all surface wiring of devices installed lower than 8' AFF, (regardless of systems type involved) c/w matching steel type "FS" metal device plates unless specifically indicated otherwise. Cover plates are to be specifically made for FS & FD boxes and are to utilize 4 point fastening.

1.3 Flush installed 100mm (4") square, or a 120mm (4-11/16") square box being used as a junction or pull box that requires a blank metal coverplate, is to have an appropriate sized, square welded one or two gang “tile ring” installed on same. This permits the use of a standard, one or two gang (blank) finish metal coverplate to be used, and avoids the necessity of acquiring an oversized, custom made coverplate.

1.4 When installing flush boxes in metal drywall partitions where the grouping of multiple device boxes is required, support the box between the studs with a box mounting bracket. Caddy RBS series box mounting brackets or Caddy SGB series box brackets or equal are approved for this application. Where a single flush box is installed, this box may be supported by the wall stud without any additional support required.

1.5 Condulet fittings (LB, LL, LR) and their respective covers/plates are to be painted, (coloured coded) and where concealed, have their locations identified with appropriate colour coded self adhering discs applied directly to T-Bar splines and/or access opening frames in same manner as required for identifying concealed junction and/or pull boxes.

1.6 The use of either, corner pulling “Ells” or corner pulling “Elbows” in lieu of acceptable “Condulet” fittings is strictly prohibited.

1.7 Tile type extension rings are not to be used on boxes that have not been “flush” installed. They are not intended, nor acceptable for “surface” type application.

1.8 Surface boxes intended to be used for housing 347 volt light switches are to be cast steel, type FS or FD, and “stamped” by manufacturer as being suitable for this particular voltage. Matching FS steel device plate is to also have 347 volts stamped into face of same. Where installed higher than 2440mm (8') AFF, metal type 1110-HV boxes c/w matching orange coloured metal switch plates may be used.

1.9 The use of floor boxes or PAC poles is to be approved by the Minister’s Representative.

1.10 Boxes connected to AC90 cables are to be specifically made for this purpose. Dual rated boxes (AC90/NMD90, etc.) are not acceptable.

1.11 Outlet boxes mounted in tilt-up construction are to be properly placed and secured so that they are not accidentally dislodged prior to concrete pour. This is to include for both “face- down” and “face-up” design.

1.12 Where devices are to be installed in t-bar ceilings, the devices shall be securely mounted by the following method: a 103mm (4") square box shall be supported by the grid system using a bar hanger, a single gang round or rectangular tile ring or other plate as required by the device, and sized accordingly, shall be mounted to the

box flush to the underside (room interior) of the ceiling; mount the device to the tile ring or plate.

2. Conduits, Conduit Fastenings & Conduit Fittings

2.1 Flexible Conduit:

2.1.1 Liquid seal flexible conduit, not smaller than 12mm (3/8") inside diameter shall be used for final connections to "all" vibrating and/or mechanical equipment, including various systems' controls and related devices, sprinkler system devices, etc. only. The use of liquid seal flexible conduit as a general purpose raceway is not permitted.

2.1.2 Steel type connectors are to be used on flexible type conduits. Malleable type connectors are not permitted.

2.2 EMT Conduit:

2.2.1 Unless noted otherwise, steel set screw type fittings shall be used on EMT. Rigid condulet fitting bodies made of alloys or malleable types of metals are not to be used.

2.2.2 Screw-on metal (malleable) type bushings are to be installed on all EMT connectors sized 35mm (1-1/4") and larger. (To be installed prior to drawing-in conductors)

2.2.3 EMT connectors sized 27mm (1") and smaller do not require insulated throats nor any types of "screw-on" type bushings.

2.2.4 Rain-tight EMT connectors and couplings (complete with o-rings) are to be used on "vertical" portion of conduit runs, where terminating into tops of electrical equipment incorporating drip shields or hoods. This is a precaution or safeguard against possible infiltration of water into pieces of electrical equipment located in rooms containing sprinkler heads.

2.2.5 Vertically installed EMT conduit stubs from flush installed device boxes are to be provided in all block or concrete block walls.

2.2.6 EMT conduit stub is to be off-set out of wall into accessible ceiling space of room containing flush installed device box, and have steel EMT connector complete with plastic or grounding type bushings "screwed" on same. EMT plastic end cap bushings that are CSA approved may also be used.

2.2.7 All EMT conduit "wall stubs" and associated boxes are to be adequately bonded to ground as per the latest edition CEC requirements.

2.2.8 The use of EMT in wet and exterior locations is not permitted.

2.3 PVC Conduit:

2.3.1 Unless specifically indicated otherwise, all switchboards, distribution panelboards, motor control centres, splitter troughs, various systems control panels/cabinets, may be fed underground utilizing code approved, rigid type, thick wall PVC conduit.

2.3.2 Conduits are only permitted to be installed below floors and are not permitted to be installed “in” concrete floor slabs unless specifically indicated otherwise. This is especially important when in-floor radiant heating is being utilized.

2.3.3 PVC conduits sized 35mm (1-1/4") in diameter and larger are to be installed in trenches not less than 300mm (12") in depth from underside of concrete floor slab to bottom of trench. Conduits are to be placed on a 75mm (3") bed of freshwater sand and are to have a second 75mm (3") of freshwater sand placed on top. Conduits are to be “completely surrounded” by freshwater sand prior to backfilling taking place. This freshwater sand shall conform to either Medium or Fine grade particles as defined under ASTM D-2487 and D-2488.

2.3.4 Conduit installation is not to influence the thickness of the floor slab.

2.3.5 Conduits are not to be run along concrete wells installed to reinforce wall installations.

2.3.6 Wiring for all various systems devices and/or outlets installed below ground floor concrete floor slabs may be performed utilizing code approved, minimum 21mm (3/4") PVC rigid type conduit. Transition from PVC rigid thick wall conduit to rigid steel threaded conduit to take place “below” floor slab. Transition from rigid steel threaded conduit to EMT type conduit to take place "above" concrete floor slab.

2.3.7 PVC conduits of all sizes prior to turning-up through floor slabs, unless specifically indicated otherwise, are to have transition to rigid steel threaded conduit take place as previously indicated.

2.3.8 The installation of PVC type conduits above ground is prohibited.

2.3.9 All conduits used in underground and tilt-up installations are to be up-sized at least one trade size above the minimum code requirement for ease of pulling.

2.3.10 In tilt-up construction, utilize minimum 21mm (3/4") PVC conduit.

2.3.11 Rigid Types EB1 and DB2/ES2 PVC (thinwall) Conduit (CSA C22.2 211.1) shall only be used where embedded in concrete.

2.3.12 Rigid PVC (thickwall) Conduit (CSA C22.2 211.2) shall be permitted to be direct buried.

2.4 All various types of systems, including lighting and power, whose wiring is to be installed on any exposed types of surfaces are to always be completely installed in raceway as per the following guidelines:

2.4.1 Use EMT conduit in unfinished areas.

2.4.2 Use aesthetic type surface raceway in finished areas where it is impossible to conceal conduits.

2.4.3 Ceiling mounted conduit/raceway is to be secured directly to overhead structure and/or related structural steel as high as possible in the ceiling space, and as close as practicable to the underside of the deck.

2.4.4 Wall mounted conduit/raceway is to be secured directly to, or directly on, exposed walls.

2.4.5 AC-90 and/or other types of systems pliable cables are not to be installed on exposed walls and/or ceilings without the benefit of conduit/raceway. This applies to all systems, including control wiring.

2.5 The use of ENT shall not be permitted.

2.6 Control Circuit Raceway:

2.6.1 Mechanical controls raceway is to be similar to the voice/data structured cabling system.

3. Wire and Box Connectors - 0 - 1000 Volts

3.1 Use spring type pressure wire connectors for all branch circuit wiring sized #10 AWG and smaller. Current carrying parts are to be made of copper or copper alloy and be c/w an appropriate size insulating cap. Cap is to completely fit, or cover all enclosed conductors as required.

3.2 All wire connectors are to be “plier-tightened” (finger-tight is not acceptable).

3.3 Bushing stud connectors are not acceptable.

4. Service Equipment

4.1 Discuss well in advance with the Power Authority, the size and type of service required. Obtain from the Power Authority the three phase symmetrical short circuit fault level at their electrical service entrance transformer(s) to determine the interrupting capacity and coordination of protective devices required for the service equipment.

4.2 Primary Service Equipment: Include overcurrent protective devices, instrument transformers, metering equipment and other requirements of the Power Authority.

4.3 Allow for 100% lighting load plus an appropriate demand factor on the remaining load, based on operating characteristics.

4.4 The main service shall provide for minimum 25% load growth plus an allowance for future expansion if anticipated.

4.5 Submit a study of load requirements and obtain the Minister's Representatives approval before proceeding.

4.6 A 120/240 volt, single phase, three wire power source may be required to service specific items of equipment. Obtain the Minister's Representatives approval before proceeding.

4.7 A 120/208 volt, three-phase, four-wire system for lighting, receptacles and power is usually satisfactory for smaller buildings. For larger buildings, a 347/600 volt, three-phase, four-wire system or higher may be warranted. Obtain the Minister's Representatives approval before proceeding.

4.8 Incorporate H.R.C. Form I current limiting fuses into circuits requiring high short circuit protection.

Section 26 05 19 Low Voltage Electrical Power Conductor and Cables

1. Wiring for circuits exceeding 50 volts to ground shall be minimum size #12 AWG, soft drawn stranded copper, of 98% conductivity rated at (600 volts) unless specifically indicated otherwise.

2. Feeders fed from an overcurrent device rated up to and including 100A are to utilize copper conductors. Feeders fed from an overcurrent device rated above 100A may utilize aluminum conductor material (ACM). Ensure the use of a wire brush, joint compound, and proper torque wrench.

3. Bonding and grounding conductors shall always be copper.

4. Current carrying and neutral conductors for all systems rated 600 volts and less, shall have RW90 - XLPE type insulation rated accordingly.

   4.1 The supply and installation of 1000 volt rated conductors shall be considered only where equipment manufacturer or other applications warrants same.

   4.2 The neutral conductor on the secondary side of dry type transformers shall be upsized to 200%.

   4.3 The feeder neutral for all branch circuit panels which feed computerized equipment shall be upsized to 200%. Grounding and bonding conductors sized up to and including #10 AWG, are to have green coloured RW90 X-link insulation. Type TW75 c/w green coloured insulation is acceptable for all sizes #8 AWG and larger.

5. The tye-wrapping of the neutral conductor with its respective phase conductors is to be made at the closest point of entry "within" all panelboards, pull boxes, junction boxes, outlet boxes, etc

6. All branch circuits which do not have neutral conductors, are to have their respective phase conductors tye-wrapped together in accordance with previously described methods.

7. Wiring methods related to the installation of main feeders:

   7.1 Where feasible, all feeder conductors to Main Switchboards, CDP panels, branch circuit panelboards, dry type transformers, MCCs, are to be fed under concrete floor slabs utilizing rigid (thick wall type only) PVC conduits.

   7.2 Unless specifically indicated otherwise, surface installed "feeder" conductors are to always be installed in EMT type conduits, run parallel and perpendicular to building lines.

8. The use of NMD-90 cable in new construction is prohibited; the use of NMD-90 in renovations must be pre-approved by the Minister's Representative. The Minister's Representative will not consider the use of NMD-90 in new construction, the use of NMD-90 will only be considered if it exists in the building being renovated with prior approval, contact the Minister's Representative for this approval and details on the restricted use of this wiring.

9. Limited use of copper Teck, AC-90 or other types of armoured copper cables will be considered upon request:

   9.1 to be pre-approved by the Minister's Representative.

   9.2 In particular instances where the use of various types of rigid conduit might be considered impractical.

   9.3 Where environmental issues/conditions could dictate the use of other than rigid type of conduit installation use.

   9.4 All Teck cable is to be terminated with proper Teck connectors.

   9.5 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 5 2 5 m m (60") intervals or as otherwise indicated, in such manner as to ensure they are protected from potential types of mechanical damage occurring. Install independent supports for cabling in ceiling spaces, and do not use those of other trades. Do not secure cables to mechanical systems piping, ducts, or suspended ceiling support wires. The laying of "un- supported" cables directly atop the ceiling grid system is strictly prohibited.

9.6 Always install and secure surface cables directly to underside of metal decking and/or ceiling slabs where located in concealed ceiling spaces.

9.7 AC-90 cable is to be installed as per the following guidelines:

9.7.1 AC-90 shall only be permitted for branch circuit wiring drops from ceiling junction boxes to light fixtures, receptacles and other equipment in the same room requiring electrical power. The installation of AC-90 cable for branch circuit wiring home runs or runs between rooms is not acceptable. Conduit/wire shall be used for this purpose unless otherwise noted.

9.7.1.1 All branch circuits are to utilize conduit pathways for home runs to each room or area, including rooms in which the panel is located. A home run is defined as that portion of the branch circuit wiring that runs between the applicable panelboard and the area or room in which it either terminates at the applicable branch circuit device, or makes a splice for final connection to the applicable branch circuit device.

9.7.1.2 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 splice or drop off is reached.

9.7.2 The grouping together of AC-90 cables to form a “bundle” for securing purposes is acceptable providing the following procedures are adhered to:

9.7.2.1 In addition to securing type AC-90 cables at 60" intervals to structure, multiple or bundled groups of armoured cables shall be tye-wrapped together at mid-point between each structure support, or every 762mm (30") and are to be secured to structure at 1525mm (60") intervals, and also secured together (between each structure support) at 1525mm (60") intervals.

9.7.2.2 In addition to the requirements of the Canadian Electrical Code, 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.

9.7.3 The following examples incorporate uses of both, common and dedicated (separate) branch circuit neutral conductors:

9.7.3.1 Maximum of two runs of #12/4 conductor cables, including common (oversized) branch circuit neutral in each.

9.7.3.2 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.

9.7.3.3 Maximum of four runs of #12/2 conductor cables, each including a separate, dedicated branch circuit neutral conductor.

9.7.4 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.

9.7.5 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 120mm (4-11/16") square.

9.7.6 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.

9.7.6.1 Fixture drops are not to exceed 4570mm (15') in total length unless specifically indicated otherwise.

9.7.6.2 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 300mm (12") of the junction box. Each light fixture is to be complete with its own separate fixture drop originating from junction box located within same ceiling of room as fixture. An exception shall be recessed down lights which may be wired from one fixture to another if they have integral junction boxes and the luminaire access opening is 150mm (6") or greater in diameter.

9.7.6.3 With the exception of where "modular" type wiring has been "approved" for a particular application, within a T-Bar ceiling space, each light fixture shall be wired with a separate "whip" emanating from an overhead junction box.

9.7.6.4 Both, #12 AWG and #14 AWG type AC-90 armoured cables may be used where total fixture drop "loads" do not exceed the following:

9.7.6.4.1 Maximum of 5000 watts @ 347 volts using #12 AWG drop.

9.7.6.4.2 Maximum of 3500 watts @ 347 volts using #14 AWG drop.

9.7.6.4.3 Maximum of 1800 watts @ 120 volts using #12 AWG drop.

9.7.6.4.4 Maximum of 1300 watts @ 120 volts using #14 AWG drop

9.7.7 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.

9.7.8 Termination of AC90 cable is to utilize steel connections with accompanying lock nuts similar to or equal to T&B 3301 series.

9.7.9 Vertically installed drops for all device boxes flush mounted in walls. Routing AC-90 cable horizontally through walls in not permitted except for short portions of the run where obstructions impede this method of installation, the remainder of the installation AC-90 cable shall be vertically installed. Each device box requires its own dedicated vertical drop.

10. All cables are to be secured to concrete, concrete block, brick, metal decking/siding, with nylon type inserts c/w self tapping metal screws.

10.1 Pliable type cables are to be secured to building structure at 4' intervals, and tye-wrapped together at mid-point between each structure support.

10.1.1 Cables are to have insulation qualities as indicated.

11. Voltage drop in no instance shall exceed 3% of the line voltage. The following table is intended for all 120 volt, 15 amp branch circuits and 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 not be less than #12 AWG.

Branch Circuit Length of Run	Phase Wire Size	Separate Neutral	COMMON NEUTRAL	Bond Wire Size
1' to 80'	#12	#12	#10	#14
81' to 125'	#10	#10	#8	#12
126' to 185'	#8	#8	#6	#10

12. The requirements for accommodating larger common or "shared" branch circuit neutral conductors where the application might warrant such, could restrict the use of some types of AC-90 cables. In certain instances, however, the installation of AC-90 cable" (where permissible), and the use of "oversized" neutral conductors where required, is more than acceptable.

13. Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed. Oversized #8 AWG branch circuit wiring conductors to be extended from panelboard to junction box located on wall or in ceiling space directly above outlet or device they feed. No. 8 AWG wire is to be reduced to #10 AWG for vertical portion of drop only.

14. All "stranded" conductors are to be "twisted together" prior to any types of terminations taking place, but not necessarily limited to, some of the following areas:

    14.1 Receptacles ..... Light switches ..... Neutral terminal strips ..... Bonding terminal strips .....Circuit breakers ..... Disconnect switches ..... Magnetic and Manual starters ..... Magnetic contactors ..... Relays .....All types of termination lugs ..... Panelboards .....

15. Control Circuit Wiring 50 Volts and Less:

    15.1 Unless otherwise noted, mechanical controls wiring methods are to be similar to the voice/data structured cabling system, with the exception that cabling shall be run as high as possible.

15.2 The installation of "surface" wiring on walls or in open (non-enclosed) type ceilings, shall always be in EMT type conduit c/w associated "steel" type connectors and couplings.

15.3 EMT conduits are to be extended to within 762mm (30") of all various control devices associated with the operation of any given piece of mechanical equipment or device they might feed.

15.4 Unless specifically indicated otherwise, liquid tight flexible metal conduit c/w matching liquid tight type connectors are to be used for "final" connection between end of EMT conduit and applicable control device. A junction or pull box may also be utilized to make the transition.

15.5 EMT type conduit "wall-stub" turned out into the room where the device is located c/w flush installed device box shall be located in all partitions to accommodate wiring between the device and the underside of the metal decking in the accessible ceiling space.

15.6 EMT connectors c/w nylon insulated throat or threaded type bushing shall be installed on end of EMT stub where it protrudes through wall "above," and within finish accessible type ceilings. EMT plastic end cap bushings that are CSA approved may also be used.

15.7 All EMT conduit stubs are to be "bonded" to ground as required by the latest edition CEC.

16. Receptacles for computer use are to be wired as per the following:

16.1 Quadraplex type receptacle, or two (ganged together) 120V U-Ground duplex receptacles n grouped together in common (2) gang device box, are to be on the "same" branch circuit, maximum 3 workstations per circuit.

16.2 Provide "same size" branch circuit neutral conductor as accompanying phase conductor where neutral is separate, or dedicated to same circuit.

16.3 Provide an "oversized" branch circuit neutral conductor where phase sharing with two or three other computer related branch circuits occurs.

16.4 Not more than 2 servers are to be fed from same branch circuit.

16.5 Each printer is to be fed from a dedicated branch circuit.

16.6 The location of receptacles and related communications outlets shall be co-ordinated with equipment layout, and indicated accordingly on drawings.

17. Housekeeping receptacles located in corridors shall be grouped on separate dedicated 20A circuits, maximum 10m spacing.

18. All branch circuit phase and/or neutral conductors are to be “Megger” tested for insulation resistance utilizing the following type meter:

    18.1 500 volt meter for conductor insulations rated up to 500 volts.

    18.2 1000 volt meter for conductor insulations rated above 500 volts.

19. Conductor insulation rating

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

    19.2 The minimum size of any branch circuit conductor used shall be based on the 75 degree C allowable ampacity in the CEC, with all relevant correction factors being applied as required. Transitions in conductor size due to the equipment’s lower termination temperature rating and a higher insulation temperature rating used in the circuit shall not be permitted in the branch circuit wiring.

Section 26 05 26 Grounding and Bonding for Electrical Systems

1. Determine well in advance the type of grounding system (solid, high resistance, low resistance, ungrounded) to be used.

2. Determine well in advance with the equipment supplier as to any special grounding requirements. Keep a record of all correspondence with the suppliers, and forward same to the Minister’s Representative upon request.

3. Indicate grounding details on drawings, especially for the incoming service and distribution transformers.

4. All grounding and bonding requirements shall be in accordance with all applicable C.E.C. codes and the DC350 standards, whichever is the most stringent.

5. All conduit for all electrical (including communications) systems is to contain a minimum # 14 AWG copper bond wire. Bonding jumpers are permitted for conduit stubbed into a T-bar ceiling. All metallic conduit stubs shall be bonded regardless of length.

6. For electrical services sized 200A and larger, install one predrilled minimum size 6mm x 100mm x 600mm (1/4" x 4" x 24") copper grounding bus bar, (either vertical or horizontal) on main electrical room wall unless specifically indicated otherwise, c/w approved cone shaped insulators for securing bus directly to same.

7. The main “incoming ground” conductor is to run unbroken to the main electrical service entrance overcurrent device ground bus and then to the wall mounted ground bus.

8. All other various systems' electrical ground connections (excluding transformer grounds) are to take place on the ground bus with "compression" type lugs. Lugs are to be as follows.

    8.1 Copper, one hole, short barrel (single crimp) type lugs are to be used for all wire sizes up to, but not including #6 AWG.

    8.2 Copper, two holes, long barrel (dual crimp) type lugs are to be used for all wire sizes #6 AWG and larger.

    8.3 To be bolted to bus bar utilizing concave, or combination of flat and locking type washers c/w accompanying hardware as may be required.

9. All cables and feeder and branch circuit conductors installed in conduit are to be c/w a separate minimum size #14 (solid) AWG copper bond/ground wire as follows:

    9.1 Where bond wire sizes larger than #14 AWG are required, they are to be increased as required by C.E.C. table 16, or as otherwise noted.

    9.2 No.14 AWG and larger size ground or bond conductors shall be of soft drawn stranded copper of 98% conductivity, and of full size and AWG gauge.

    9.3 Size of bond conductor is to be based upon the latest edition CEC.

    9.4 Size of ground conductor is to be based upon the latest edition CEC.

    9.5 Minimum size #14 AWG (solid) green insulated conductors are to be provided for bonding purposes associated with various other systems rated at 50 volts or less.

10. The contemplated use of any isolated ground systems and/or isolated ground type receptacles is to be approved by the Minister's Representative.

11. The "feed" bonding conductor shall be secured (wrapped around unbroken) to the grounding screw of each outlet/device box, before connecting to the other grounding conductors, and/or providing a "pig-tail" lead for device terminations.

12. All bond wire joints are to be twisted together with a screw-on type wire connector, and then placed in rear of outlet box in such manner as to minimize obstructions.

13. Information transport systems bonding

    13.1 Provide an information transport system bonding riser on the drawings.

    13.2 Provide and install an information transport system bonding system to meet or exceed the requirements identified in the latest edition of the TIA 607 standard for Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

13.3 Provide and install one predrilled minimum size 6mm x 100mm x 600mm (1/4" x 4" x 24") Primary Bonding Busbar (PBB) copper bonding bus bar in the main Telecommunications Entrance Facility, either vertically or horizontally wall mounted 450mm (18”) A.F.F. c/w approved cone shaped insulators for securing bus directly to wall.

13.4 Provide and install one predrilled minimum size 6mm x 100mm x 600mm (1/4" x 4" x 24") Secondary Bonding Busbar (SBB) copper bonding bus bar in each telecommunications room, either vertically or horizontally wall mounted 450mm (18”) A.F.F. c/w approved cone shaped insulators for securing bus directly to wall.

13.5 Bond each copper bonding bus bar to the building metallic structural framing where available.

13.6 In each telecommunications room, bond all conductive equipment enclosures (including power panels) to the copper bonding bus bar.

13.7 Bond each equipment rack individually to the room’s copper bonding bus bar.

13.8 The minimum size information transport systems bonding conductor shall be #6 AWG.

13.9 All Telecommunications Bonding Backbone (TBB) and Telecommunications Bonding Conductor (TBC) conductors shall be sized in accordance with the latest TIA 607 standard for Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises recommendations.

13.10 All Information transport systems bonding conductors are to be complete with green coloured insulation, the use of bare, stranded bonding conductors in cable tray is not permitted.

13.11 Information transport systems bonding conductors are to be run as directly as possible following building lines; minimizing the number of bends in the conductor and secured to meet the latest edition CEC requirements. The minimum bend radius of any information transport systems bonding conductor not run in conduit shall be 230mm (9”).

13.12 All bonding conductors exiting the telecommunications room, with the sole exception of the conductor used to bond the cable trays, shall be run in conduit. Ensure these conduits are bonded at both ends.

13.13 All conductor to conductor connections to the Telecommunications Bonding Backbone (TBB) and all other bonding conductors are to be made using irreversible, listed, compression connection; or by using an exothermic welded connection.

13.14 Bonding / Grounding conductor identification

13.14.1 All bonding / grounding conductors shall be identified at both ends to indicate the bonded equipment (bond bar end) and the originating bond bus (equipment end of the bond conductor) using size 1 lamicoid nameplates secured to the conductor with two metal straps.

13.15 Ensure ALL antennae cables are routed through properly bonded RF protection device(s) at the antenna cable entry point to the building for lightning protection.

Section 26 05 29 Hangers and Supports for Electrical System

1. Supporting of electrical systems raceway shall be independent of any non-electrical systems supports such as T-bar ceiling supports, mechanical systems supports, etc.

2. Various suspended types of outlet, pull and/or junction boxes including conduits, are to be supported with minimum size 9.5mm threaded rod, nuts and flat washers. Threaded rods are to be secured to boxes with one flat washer and nut installed on both sides of box.

   2.1 One rod required for all types of boxes sized 152.4mm x 152.4mm (6” x 6”) or 23226 sq. millimeters and smaller.

   2.2 Two rods required for all types of boxes sized larger than 23226 sq. millimeters, up to, and including those sized 304.8mm x 304.8mm (12” x 12”) or 92903 sq. millimeters equivalent.

   2.3 Minimum of four rods required for all boxes sized larger than 92903 sq. millimeters.

3. EMT shall be securely fastened in place within 1m (39”) of each outlet box, junction box, pull box, cabinet or condulet fitting, with spacing between supports as per the C.E.C. Securing of surface and concealed conduits to structure for sizes up to and including 35mm (1-1/4”) diameter may be done utilizing one hole steel straps. Two-hole steel straps for all sizes 41mm (1-1/2”) and larger. Grouped or singularly suspended conduits of all sizes to be supported with minimum sized 9.5mm (3/8”) threaded rods and concrete shields. Where possible, two or more suspended type conduits shall be secured to a common steel support channel system and are to be suspended utilizing minimum size 9.5mm (3/8”) threaded rods, washers and nuts. Channel is to be sandwiched between nuts and washers located on both upper and underside portions of channels.

4. All excess rod is to be cut off within 12.7mm (1/2”) of channel bottom. 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 (12”) from the midpoint of “all” 90 degree bends. Maximum spacings between conduit support channels shall be as dictated by smallest size conduit(s) being supported and/or secured to same.

5. The use of tye-wraps for “supporting” purposes, is strictly prohibited and will be strictly enforced. They may “only” be utilized to secure various systems wiring “in-place,” for cable

marshalling but in no instance are they to be used as a substitute for approved type metal straps, clamps, etc.

Section 26 05 33 Raceways and Boxes for Electrical Systems

1. All "surface" type boxes larger in size than 120mm (4") square where installed on, or within ceiling spaces, are to be type "E" c/w hinged type cover plates. Hinged covers are not required for pull boxes.

2. All "flush" installed boxes are to be type "D" and have their finish cover plates sized a minimum of 25.4mm (1") larger than actual box dimensions.

3. Concealed junction or outlet box (within ceiling space) feeding a "maximum" of (2) fixture drops, shall not be sized smaller than 100mm (4") square.

4. Single gang type device boxes being utilized in steel stud walls for the installation of both, metallic and (where approved) non metallic type cables, shall not be sized smaller than 246 cubic millilitres (15 cu in).

5. Two or more flush installed boxes ganged together, or boxes sized 100mm (4") square and larger (intended for devices), are to have an additional support bracket installed on opposite side of box not presently secured to metal stud.

6. Where larger sized devices or other types of "flush" outlet or junction boxes may be required, suitably sized 100mm (4"), 100mm (4") deep or 120mm (4-11/16") square boxes c/w appropriate sized extension tile rings are to be utilized. The use of "plaster" type extension rings in lieu of "tile" type extension rings is not acceptable.

7. Concealed boxes located in ceiling spaces above suspended type ceilings are not to be installed at greater than 762mm (30") above finished ceiling elevations. Where radiant heating panels are installed, junction boxes are to be "in-board" of same for easy access.

8. Junction boxes larger than 120mm (4-11/16") used in branch circuit wiring are to be c/w bonding terminal strips.

9. Pull boxes are to be bonded to ground utilizing a bonding conductor.

Section 26 08 00 Commissioning of Electrical Systems

1. Purpose

   1.1 The basic purpose of electrical commissioning is to provide documented confirmation that electrical systems function in compliance with the criteria set forth in the contract documents to satisfy the operational needs of the owner.

1.2 Electrical commissioning provides, throughout the many phases of design and construction, a means for the owner to continuously communicate electrical systems criteria to the consultant/contractor and to rigorously verify compliance with these.

2. Scope

2.1 Prior to design, the owner will evaluate the facility's requirements regarding such issues as energy conservation, indoor environment, staff training, and operation and maintenance.

2.2 The owner/owner's consultant will review all phases of design and construction documents for:

2.2.1 Compliance with design criteria,
2.2.2 Commissioning requirements,
2.2.3 Bidding issues,
2.2.4 Construction coordination and installation concerns,
2.2.5 Performance aspects, and
2.2.6 Facilitation of operations and maintenance, including training and documentation.

2.3 The owner/owner's consultant will review the equipment submittals for compliance with commissioning issues.

2.4 The owner/owner's consultant will verify or manage the scheduling and procedures used for system start-up.

2.5 The owner/owner's consultant will verify that the training for the owner's operating staff is conducted in accordance with the project documents.

2.6 The owner/owner's consultant will verify that the operations & maintenance manuals comply with the contract documents.

2.7 Prior to expiration of the construction contract warranty, the owner will carry out functional performance testing (FPT).

2.8 The consultant/contractor will cooperate fully with the owner's commissioning initiatives and pay for all associated costs.

3. Equipment and Materials

3.1 The owner will provide the following equipment and materials for FPT:

3.1.1 Light meter.
3.1.2 Receptacle tester.
3.1.3 Clip-on ammeter.
3.1.4 2-way radios.

3.1.5 Flashlights.
3.1.6 Cameras.
3.1.7 Documentation sheets.

3.2 The contractor will provide all equipment not provided by the owner as required to perform all commissioning including FPT.

3.2.1 Where a transfer switch and connection point for a portable generator have been provided for a building designated as an EMO site, the contractor shall provide a suitable portable generator, all associated wiring, equipment, materials and labor required to connect the generator to the transfer switch. The contractor shall provide all personnel and equipment required to test the functional operation of the emergency power system. This equipment shall remain the property of the contractor.

4. Submittals - The Contractor shall submit the following documentation prior to FPT:

4.1 Record drawings, or a copy of the Contractors "Red Line" marked-up As-Built drawing shall be made available for use.

4.2 Operations and maintenance manuals.

4.3 A letter of acceptance from the inspection authority. A copy is to be included in the operations and maintenance manuals.

4.4 A letter of guarantee. A copy is to be included in the operations and maintenance manuals.

4.5 Copies of the following test results (A copy is to be included in the operations and maintenance manuals):

4.5.1 Insulation/megger tests.
4.5.2 Load balance tests on all transformers, the main switchboard, and distribution panels.
4.5.3 Voltage regulation/tap tests on all transformers.
4.5.4 Load tests on all electric motors.
4.5.5 Generator / UPS tests.
4.5.6 Structured cabling system link tests.
4.5.7 Fire alarm system verification.

4.6 A Commissioning and/or Certification Report from the manufacturer for the following systems (A copy is to be included in the operations and maintenance manuals):

4.6.1 Security system.
4.6.2 Multimedia system.
4.6.3 Public Address system.
4.6.4 Intercom system.

4.6.5 CATV system.
4.6.6 Dimming system.
4.6.7 Assistive listening system.

4.7 Written verification from the end user that staff training has been performed according to the manufacturer's recommendation for the following (A copy is to be included in the operations and maintenance manuals):

4.7.1 Dimming system.
4.7.2 Main switchboard including digital meter.
4.7.3 Generator and transfer switch.
4.7.4 Motor Control Centres (MCC's).
4.7.5 Fire alarm system.
4.7.6 Security system(s).
4.7.7 Multimedia system.
4.7.8 Public address/intercom system.
4.7.9 CATV system.
4.7.10 Assistive listening system.

5. Functional Performance Testing (FPT)

5.1 The Department of Transportation and Infrastructure Renewal will commence a Functional Performance Testing (FPT) Program independent of other processes, upon receipt of written verification from the General Contractor that:

5.1.1 All systems are complete and operational in all respects.
5.1.2 All specified reports and documents have been submitted and approved.
5.1.3 All tests, commissioning and start-up processes are complete.
5.1.4 All demonstrations have been completed and documented.
5.1.5 All defects and deficiencies identified during the construction process and during the commissioning of all electrical systems have been corrected.

5.2 Allow for 1 day for every 10,000 square feet or portion thereof.

5.3 Provide an electrician and all manufacturer's technical representatives as required by the owner. Make all arrangements and pay for all associated costs.

5.4 FPT shall be performed on all electrical systems referenced in the contract documents which may include, but not be limited to, the following:

5.4.1 Life Safety Systems:
5.4.1.1 Emergency Lighting.
5.4.1.2 Exit Signs.
5.4.1.3 Fire Alarm System.
5.4.2 Lighting System.
5.4.3 Power Distribution System.
5.4.4 Electric Heating System.
5.4.5 Structured Cabling System.

5.4.6 CATV System.
5.4.7 Multi-Media System.
5.4.8 Security System(s).
5.4.9 Public Address System.
5.4.10 Assistive Listening Systems.
5.4.11 Intercom System.
5.4.12 UPS System

5.5 Deficiencies or defects discovered during the FPT process are to be immediately rectified by the Electrical Contractor.

Section 26 09 24 Instrumentation and Control for Electrical Systems

1. Lighting Control Equipment - Low Voltage

1.1 Provide a complete low voltage lighting control system as required. Provide a riser diagram on the drawings.

1.2 Lighting systems shall be controlled by means of low voltage switches for all applications unless noted otherwise.

1.2.1 Utilize occupancy sensors in combination with low voltage switching to control lighting in individual common use rooms. Where occupancy sensors are utilized in buildings to control lighting, they shall not control lighting in stairwells or rooms where the primary source of illumination is slow to produce full lumen output.
1.2.2 In large, open office areas, separate floor areas into zones based on their usage and provide automatic on/off control and a centralized master switch station with manual on/off control for each zone.

1.3 Low voltage lighting control systems.

1.3.1 In all multi-storey buildings or buildings with complex interior layouts, provide a centralized, programmable lighting control system capable of interfacing with the building automation system. The system shall combine integrated control, supervision, data logging, alarms, scheduling, and programming/system management functions.
1.3.1.1 The lighting control system shall be capable of time of day scheduling, weekend, and holiday scheduling.
1.3.1.2 The system shall Provide means for manual and automatic control of each and every lighting circuit or relay leg. Input from automatic time of day clocks, occupancy sensors, and photo sensors to control lighting or other electrical loads shall be available for each relay while allowing individual override capability from as many local and remote areas as desired via switches.
1.3.1.3 Blink Warn - the system shall automatically blink the lighting channel minutes prior to a scheduled shut-down. System shall be capable of

interfacing with the Building Automation System (BAS) to turn on/off the lighting based on the building's normal operating schedule. System shall be capable of interfacing with the Building Security needs.

1.3.1.4 In the event of power loss, the lighting control system shall retain system status information for up to 72 hours in non-volatile memory.

1.3.1.5 Programming of the lighting control system shall be via desktop or laptop computer. This computer shall not be necessary for running the system only for programming or operator override. The operations available from the remote computer shall have upload/download (for system alteration and backup) and diagnostic capability. The connected desktop or laptop computer shall be able to display the status of any relay or relay group and shall be able to switch any relay or relay group.

1.3.1.6 Where the lighting control system configuration permits, the intrusion alarm system is to activate general area lighting as part of the annunciation of an intrusion alarm.

1.4 Switches:

1.4.1 Single pole, double throw, momentary contact, centre pivot rocker type action, with or without LED pilot lights as indicated.

1.4.2 Switches containing LED pilot lights are to be wired in such manner as to indicate "red" status (pilot light) symbol as being in the "on" position, and "green" status symbol indicating switch as being in the "off" position. Red LED pilot light is to be oriented to be on top or upper side of switch.

1.4.3 Light switches located in rooms containing light fixtures that they in turn control need not incorporate LED type pilot light function.

1.4.4 Low voltage light switches controlling lighting fixtures installed in remote areas or rooms other than where actual light fixtures are located are to incorporate LED pilot light function.

1.4.5 Where switches cannot be installed on latch side of door due to windows, provide mullion mounting where appropriate, ensure mounting straps are bonded.

1.5 Relay Panels:

1.5.1 Panels are to include a maximum of 12 relays, electrically operated by momentary pulse, mechanically latched, rated for 20A @ 347 volts, control transformer and suitable voltage barriers, c/w factory installed bonding and neutral termination strips.

1.5.2 Lighting relay panels shall contain both, 10% spare relays and 10% free space for the addition of future relays, with "minimum" of (2) spare relays.

Section 26 20 00 Low Voltage Electrical Distribution

1. Dry Type Transformers up to 600 Volts Primary

1.1 All transformers 600V and below are to be dry type.

1.2 Transformers are to be minimum K13 rated and contain only "copper" windings.

1.3 Transformers are to accommodate 200% upsized neutrals.

1.4 Transformers are to be bolted securely to concrete housekeeping pads.

1.5 Vibration isolation:

1.5.1 For transformers smaller than 112.5 KVA, rubber vibration isolating pads are to be placed below transformer support channels at each of four exterior corners, in locations where transformer has been secured (bolted) to concrete housekeeping pad.

1.5.2 For transformers 112.5 KVA and larger, provide vibration isolation with double deflection neoprene vibration isolation mounts at the corners of the transformer. The mounts shall have a minimum static deflection of 0.35" (9mm). All metal surfaces shall be Neoprene covered to prevent corrosion and shall also have friction pads, both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole with cap screw and washer on top. Bolt isolation mounts to both the transformer and housekeeping pad.

1.6 Transformers containing electrical termination points located on both front and rear sides of same, are not to be considered for use unless a "minimum" of not less than 1 metre of unobstructed clearance is provided completely around each of four sides.

1.7 All dry type transformers are to be c/w a Dual Rated Spade Type Transformer Lug, sized as required to facilitate both, grounding and bonding conductor requirements.

1.7.1 Lugs to be bolted directly to transformer enclosure (chassis) with a minimum of two 12.7mm bolts, flat and lock washers and accompanying nuts.

1.7.2 Lugs to contain number of termination openings as necessary to ensure individual terminations of "each" ground and "each" bond conductor(s) is achieved.

1.8 Transformers may be bottom or side fed with both primary and secondary conduits and associated conductors as follows:

1.8.1 Each "primary" raceway is to contain a "grounding" conductor sized to suit minimum the latest edition CEC requirements of transformer "XO" point where applicable, unless specifically indicated as being oversized. Where separately run grounding conductors are utilized they are to be run in suitably sized conduit.

1.8.2 Each “secondary” raceway is to contain a “bonding” conductor sized as per the latest edition CEC unless specifically indicated otherwise.

1.8.3 Bottom fed transformers located on slab-on-grade type ground floors only, may be fed utilizing rigid, thickwall type PVC conduit, for both primary and secondary feeders.

1.9 All connections are to be made utilizing flexible metal conduit. If “liquid tight” flexible metal conduit is used, then the associated “liquid tight” connectors shall also be used.

Section 26 24 00 Switchboards and Panelboards

1. Service Entrance Boards

1.1 Use metal enclosed assemblies c/w circuit breakers as required. Air circuit breakers are to be the draw-out type. Insulated case and moulded case circuit breakers are to be of the fixed type. Ensure voltage, current, and short circuit ratings of breakers meet code requirements for their particular application.

1.2 Main switchboards rated 600 amps and larger are to be "free-standing" c/w minimum working space of not less than 1270mm between any portion of the board and all walls surrounding same. This will accommodate future wall mounted electrical installations up to 270mm deep while maintaining the CEC required 1m clearance.

1.3 Free-standing switchboards are to be a minimum of 610mm in depth.

1.4 All free-standing switchboards are to be rigidly secured (bolted) to concrete housekeeping pads.

1.5 Free-standing switchboards rated 1000 Amps and larger are to include a bussed wireway enclosure for terminating “in-coming” feeder conductors. Bussed wireway section is to be not less than 610mm (24") in width.

1.6 Service entrance boards rated 250A and larger are to be complete with integral digital meter which displays volts, amps, power factor, frequency, kW, kVAR, kVA, THD, demand kW, demand kVAR, demand kVA, etc.

1.7 Switchboards readily identified and approved by the manufacturer as being suitable for a specific use, shall not under any circumstances be “field modified” to suit any other applications.

1.8 If not specifically designed for, and designated as such by manufacturer as suitable for “free standing” application, electrical equipment shall be raised “off” floors, secured directly to walls and/or channel supports, and have their bottom entry raceways connected or terminated (directly to) the enclosures with appropriate steel type connectors Additional supports as may be required, are to be installed between floor and underside, or bottom of enclosure.

1.9 Non-connected PVC or steel raceways protruding up through open bottoms of "free standing" switchboards require PVC bell ends and steel type "grounding bushings" installed on ends of respective types of conduits.

1.10 Extension handles are to be provided for all breakers sized 225 Amps and larger.

1.11 Provide TVSS protection in all service entrance boards as per Section 26 43 00

2. Panelboards - Breaker Type

2.1 Panelboards are to be c/w factory installed bonding terminal strips. Where more than one bonding terminal strip is present in any one panel, both shall be hard-wired together using identical size bonding conductor as one accompanying the panel feeder conductors.

2.2 Detail each new and/or existing panel on the drawings as per the following:

2.2.1 Location, Voltage and phase(s), Mounting options, Bus capacity, Total load, Individual load of branch circuit breaker(s), Size of main breaker where applicable.

2.2.2 Typewritten or computer generated panel schedules are to indicate locations and types of "loads" each branch circuit breaker(s) feeds.

2.3 Kitchen panels shall incorporate shunt trip breaker(s) for the shutting down of ranges, deep fat fryers, grills, etc.

2.4 Panelboards for machine shops, carpentry shops, and/or other specifically defined areas, shall contain shunt trip "Main Breakers" c/w remote maintained red (emergency off) push buttons placed at all exits to the shops/areas. Lighting circuits are not to be fed from these types of panels.

2.4.1 Dust producing equipment ducted to the central dust collector must be interlocked with the dust collector control to prevent the operation of this equipment if the dust collector is not running.

2.5 The use of panelboards is "always" the required method of distribution. The use of splitter troughs combined with fused disconnect switches is not acceptable unless prior approval is obtained from the Minister's Representative.

2.6 Branch Circuit Panelboards (225A and smaller)

2.6.1 Each branch circuit shall be clearly identified on a typewritten directory, with directory being protected by a clear plastic cover.

2.6.2 Panelboard enclosures are not to be less than 508mm (20") in total width.

2.6.3 Branch circuit panelboards are to be fitted with lock type doors.

2.6.4 Panelboards are to be complete with the following:

2.6.4.1 Minimum of 10% spare 15 amp 1 pole circuit breakers.

2.6.4.2 Minimum of 10% spare spaces for 1 pole circuit breakers.

2.6.4.3 Minimum of 10% of breaker locking devices, based upon total number of circuit breakers that panel can accept.

2.6.5 Panelboards shall be centrally located within the servicing area to "minimize" excessive lengths of branch circuit wiring runs.

2.6.6 Branch circuit panelboards shall not be fed from other branch circuit panelboards.

2.6.7 All recessed panelboards shall have two 27mm (1") empty EMT conduits stubbed up and out into the accessible ceiling space above the panel for future use. Each conduit shall be terminated in a 152 mm x 152 mm x 102 mm (6" x 6" x 4") type 'D' box.

2.6.8 Branch circuit panel boards feeding electronic equipment shall be protected with TVSS protection as per Section 26 43 00.

2.7 Distribution Panelboards (above 225A)

2.7.1 Distribution panelboards are to have their enclosures sized not less than 914mm (36") wide x 279mm (11") deep. Provide a minimum of 20% additional bussed space.

2.7.2 Distribution panels readily identified and approved by the manufacturer as being suitable for a specific use, shall not under any circumstances be "field modified" to suit any other applications.

2.7.3 If not specifically designed for, and designated as such by manufacturer as suitable for "free standing" application, panelboards shall be raised "off" floors, secured directly to walls and/or channel supports, and have their bottom entry raceways connected or terminated (directly to) the enclosures with appropriate steel type connectors Additional supports as may be required, are to be installed between floor and underside, or bottom of enclosure.

2.7.4 Non-connected PVC or steel raceways protruding up through open bottoms of "free standing" panelboards require PVC bell ends, and steel type "grounding bushings" installed on "ends" of respective types of conduits.

2.7.5 The use of single enclosure, combined distribution panelboard and branch circuit panelboards is strictly prohibited.

3. Motor Control Centers or Low Voltage Controllers

3.1 Wall mounted "grouped motor control" type MCC's may be used for groups of up to four starters.

3.2 Use standard motor control centres where more than four (4) motor starters are required in the same location. Centres should be enclosed, dead front, free-standing structures. Use combination starters. Mount centres on continuous mounting channels on raised concrete housekeeping pads. Specify control centres as per NEMA Standard for class and type. Cells shall be "minimum" 20" wide and 20" deep. Wiring shall be EEMAC 1 type B. Provide wireways at the top, bottom or side for proper installation of all wires.

3.3 Free standing MCC's are to be bolted to concrete housekeeping pads.

3.4 Provide minimum 20% bussed space in all MCC's.

3.5 Motor Control Centres readily identified and approved by the manufacturer as being suitable for a specific use, shall not under any circumstances be "field modified" to suit any other applications.

3.6 Non-connected PVC or steel raceways protruding up through open bottoms of free standing MCC's require PVC bell ends and steel type "grounding bushings" installed on ends of respective types of conduits.

3.7 Single-phase and Three-phase motor control centres mains shall be provided with a neutral conductor such that the control transformers located in motor starters can be connected Line-to-Neutral.

Section 26 27 00 Low Voltage Distribution Equipment

1. Receptacles:

1.1 All receptacles are to be of "one" manufacturer throughout the project.

1.2 Receptacles to be specification grade.

1.3 All vertically installed 120 volt,15A U-ground receptacles are to be installed with the U- ground connection oriented to the upper, or top side.

1.4 Horizontally installed 120 volt U-ground receptacles are to be installed with their neutral termination bolts located on the top side.

1.5 "Pig-tail" type leads are to be installed on conductors in all device or outlet boxes where feeding through to other receptacles. "Daisy-chain" or looping through of conductors from one device to another is not acceptable. Provide separate pig-tail conductor leads for final termination to each receptacle for phase, neutral and bond conductors. All conductors are to be terminated on external, side wiring clamps suitable for #10 AWG conductors, "push in" type back wiring termination is not permitted.

1.6 Each 120 volt U-Ground receptacle installed on the "exterior" of a building is to be mounted in a weatherproof enclosure incorporating a recessed box, heavy cast aluminum cover plate and enclosure keys.

1.7 Provide "housekeeping" receptacles throughout buildings at a maximum 10m spacing. All rooms shall contain at least one "housekeeping" receptacle. These receptacles are to be rated 120V, 20A, T-slot type.

1.8 In addition to normal quantity of 120 volt U-Ground receptacles indicated to be installed in "Mechanical" rooms, there shall be an additional quadraplex receptacle installed in common two gang "FS" box on "separate" 15 amp branch circuit c/w separate neutral and fed from nearest panelboard containing TVSS protection. Location of receptacle(s) will be as dictated by location of "controls" panel in same room.

1.9 There shall be at least one exterior U-Ground receptacle installed on wall adjacent to every entry into a building, with each being fed from a "separate" 20A, single pole GFCI circuit breaker or faceless GFCI. These receptacles are to be rated 120V, 20A, T-slot type. Where there are multiple entries within 6m (or less) of each other, provide a single exterior receptacle adjacent to one of the entries only.

1.10 All receptacles are to be "polarity" tested.

1.11 Ceiling receptacles for overhead projectors are to be mounted with the face in the vertical position to prevent plug-in type transformers from falling.

1.12 Unless otherwise noted, provide a 15A, 120V duplex receptacle adjacent all washroom sinks. Feed from a 15A, 1P GFCI breaker or faceless GFCI.

1.13 Receptacles for exercise equipment such as treadmills, step machines, bicycles, elliptical machines, etc. are to be rated 120V, 20A, T-slot type.

1.14 Receptacles requiring GFCI protection are to be fed from a GFCI circuit breaker or faceless GFCI.

1.15 Receptacles for computer use are to be provided as per the following:

1.15.1 Quadraplex type receptacle, or two (ganged together) 120V U-Ground duplex receptacles grouped together in common (2) gang device box mounted behind a common coverplate, are to be on the "same" branch circuit and provided for each work station within 3 feet of the data outlet.

1.16 Electric Vehicle Charging Stations

1.16.1 NEMA 3R exterior free-standing pedestal mounted housing. Housing to be mounted on concrete base.

1.16.2 Level 2 electric vehicle charging stations,

1.16.3 AC charging 120/208 VAC or 120/240 VAC by industry standard SAE J1772E power connector mounted on an 5490mm (18') cord.

1.16.4 Capable of being integrated into the building access control system for on/off control. The access control system (or other control system) is to provide the initial on input signal and the charging system is to automatically turn off when power is disconnected from the vehicle.

1.16.5 Equipment shall meet the requirements of UL 2231 personnel protection systems for EV charging circuits.

1.16.6 Protect the charging stations from damage with bollards.

2. Switches:

2.1 All light switches are to be of one manufacturer throughout project.

2.2 Switches are to be ivory colour, specification grade c/w stainless steel cover plates unless otherwise noted.

2.3 Device “leveller and retainer” shall be used for securing devices to flush installed device boxes. This is particularly practicable where an enlarged opening around a box has been made, preventing device “ears” from coming into direct contact with finish wall as is intended.

2.4 Single gang adjustable “box extension” shall be used for extending single gang box openings a maximum of 22mm (7/8”). Their use is acceptable in non-combustible type walls where front edges of boxes have not been installed greater than 29mm (1-1/8”), or 6mm (1/4”) from finish wall surface.

2.5 Control of 347 Volt indoor lighting shall be by low voltage switching. 347V line voltage switching shall be acceptable only in the following locations:

2.5.1 Service rooms.
2.5.2 Storage rooms.
2.5.3 Electrical rooms.
2.5.4 Mechanical rooms.
2.5.5 Boiler rooms.

2.6 Where switches cannot be installed on latch side of door due to windows, provide mullion mounting where appropriate.

3. Heavy duty retractable electric extension cord reels:

3.1 Portable grounded cord reel with locking ratchet.

3.2 15m (50’) of 14/3 yellow SJOW-A cord rated 13A, 125V.

3.3 Power outlet box c/w two (2) 15A, 120V duplex receptacles and strain relief, fed from separate 120V, 15A circuit.

4. All kitchens are to be wired similar to residential kitchens except that each split circuit shall be dedicated to one duplex receptacle only.

Section 26 28 00 Low Voltage Circuit Protective Devices

1. Fuses

1.1 Provide three (3) spare fuses of each type and size installed above 600A.

1.2 Provide six (6) spare fuses of each type and size installed up to and including 600A.

2. Disconnect Switches - Fused and Non-Fused Up To 1000 Volts

2.1 Both fusible and non-fusible types of disconnect switches are to be type "A" - quick make- quick break, c/w types of enclosure(s) as required.

2.2 Provisions for padlocking switch in either on or off positions.

2.3 Door is to be mechanically interlocked so as to prevent opening of same when handle is in "on" position.

2.4 Fuse holders to be suitable to accept size and type of fuses as specified.

2.5 On - off position of switch is to be indicated on enclosure.

2.6 Provide local non-fusible type disconnect switches for the following:

2.6.1 Humidifiers and de-humidifiers.
2.6.2 Duct Heaters.
2.6.3 Domestic hot water heaters.
2.6.4 Other types of equipment containing resistive type loads.26 28 16 Enclosed Switch and Circuit Breakers

3. Breakers are to have sufficient interrupting capacity to withstand the available fault current. Series rating of breakers is not acceptable.

4. Circuit breakers shall be bolt-on type only. Multi-pole breakers are to have single handle. Tie-bars are not permitted

4.1 The use of 'plug on, screwed in place' type circuit breakers are accepted under the following conditions:

4.1.1 Installed in distribution panels which are rated 250A and above, and at least one breaker in a panel is larger than 100 A.
4.1.2 Breaker's operation, performance, and characteristics comparable to that of a bolt-on circuit breaker.
4.1.3 Plug-on connection shall be factory installed, integral to the circuit breaker, and paired with integral mounting bracket at the load side to secure circuit breaker to panel board. Circuit breaker connection must provide a secure and reliable means of connection to the panel board.
4.1.4 The plug-on breakers must connect to a front-to-back busbar assembly.
4.1.5 The breaker and busbar assembly must feature slots and keys that interlock to prevent breaker movement in conjunction with an integral breaker mounting bracket that features retaining screws.
4.1.6 The load side terminals of the plug-on breakers must indicate the corresponding phases of the terminals.

4.1.7 The manufacturer's conductive compound must be used on all plug-on connections where recommended; an unopened tube of the manufacturer's conductive compound (if recommended) must be turned over to the building's maintenance staff along with the respective instruction manual.

4.1.8 Install a Lamicoid label to the front of the panel which states "Notice: phasing of breaker terminals may vary between breakers. Refer to the phase marking next to each terminal."

4.1.9 Multi-pole breakers are to have single handle. Tie-bars are not permitted.

4.1.10 Thermal imaging of the breaker shall be able to show hotspots within the breaker's internal components, not only at connection points. The respective manufacturer shall agree to perform an annual preventative maintenance infrared scanning and thermal imaging of panel interiors under normal operating conditions upon occupancy of the building and at the end of the warranty period with both reviews witnessed by the Minister's Representative and submit all associated official documents and reports accordingly.

4.1.11 Panels that accept plug on breakers shall indicate a warning that breakers shall not be installed while panel is live, with no exceptions.

5. Under no circumstances are the use of "mini" type circuit breakers acceptable.

6. Both 120V and 347V lighting circuits are to be fed from 20 Amp, single pole circuit breakers unless indicated otherwise.

Section 26 29 00 Low-Voltage Controllers

1. Contactors

1.1 Provide two (2) normally open and two (2) normally closed auxiliary contacts.

2. Motor Starters to 600 Volts

2.1 Coordinate control sequences to provide starters, and other auxiliary control equipment with the proper characteristics and features to obtain the performance intended.

2.2 Provide disconnect switches, starters and auxiliary control equipment which are not an integral part of packaged units described in equipment specifications, but which are required for performance and sequence of operation of equipment specified under other Divisions.

2.3 Motors sized one HP and larger are to be three-phase, where three phase power source is available.

2.4 Check that the voltage drop due to motor starting is within acceptable limits. If required, use a reduced-voltage type starter.

2.5 When a manual-automatic operation is required, use a "Hand-Off-Automatic" (HOA) selector switch. Connect the selector switch so that only the normal automatic regulating control devices will be bypassed when the switch is in the hand (manual) position. Connect “all” safety control devices, such as low or high pressure cutouts, high temperature cutouts, motor overload, in the control circuit in “both” the Hand and Automatic positions of the selector switch.

2.6 All items (current sensors, etc.) affecting starter CSA certification (or equivalent) are to be factory installed. Field certification is to be avoided.

2.7 Provide the following for all three-phase type motor starters:

- 2.7.1 Magnetically operated MCP type motor starter.
- 2.7.2 Fused 120V control transformer (confirm control voltage with mechanical discipline); the control transformer shall be fed line to neutral from one phase of the motor supply and an associated neutral conductor.
- 2.7.3 Do not use a (3) position Hand/Off/Automatic (HOA) selector switch where only a (2) position On/Off selector switch is required.
- 2.7.4 Solid state single phasing protection for all three phase motors.
- 2.7.5 All pilot lights are to be of the LED type.
- 2.7.6 Thermal overload protection to be provided on all three phases.
- 2.7.7 Short circuit protection in the form of a motor circuit protector (MCP).

2.8 Where manual motor starters are utilized, they are to be installed in a recessed backbox unless the starter is installed in a mechanical or an electrical room. Locate manual motor starters in limited access areas adjacent to the utilization equipment a maximum of 1220mm (48") AFF. Group manual motor starters where practicable. Do not mount starters in the accessible ceiling space.

- 2.8.1 All single phase manual motor starters are to meet the following requirements:
  - 2.8.1.1 Switching mechanism, quick make and break.
  - 2.8.1.2 One overload heater, manual reset, trip indicating handle.
  - 2.8.1.3 Accessories:
    - 2.8.1.3.1 Toggle switch: standard labeled as indicated.
    - 2.8.1.3.2 Indicating light: LED type and red in colour.
    - 2.8.1.3.3 Locking tab to permit padlocking in "ON" or "OFF" position.
    - 2.8.1.3.4 Recessed backbox to allow for flush mounting, unless noted otherwise.

3. Variable Frequency Motor Controllers

3.1 Ensure that the VFD, load side wiring, and motor combination are completely compatible.

3.2 Wiring on the load side of variable speed drives shall be specifically rated for this application. Regular wiring is not acceptable.

3.3 Output waveform tests shall be performed on all VFD's. Submit test results to the engineer.

3.4 Ensure all VFD's are properly ventilated.

3.5 Provide circuitry to limit the total harmonic distortion (THD) on the line side of the VFD.

3.6 Ensure that the VFD is rated for constant torque or variable torque loads as applicable.

Section 26 32 00 Packaged Generator Assemblies

1. Where required, provide a complete operational diesel emergency power generating system including all architectural, structural, mechanical, and electrical components.

2. The generator set is to be c/w the following:

2.1 Engine.

2.2 Generator.

2.3 Controller.

2.4 Instrument Panel.

2.5 Accessories:

2.5.1 Over voltage protection.
2.5.2 Line circuit breaker.
2.5.3 Exhaust silencer.
2.5.4 Flexible exhaust connector.
2.5.5 Radiator duct flange.
2.5.6 Flexible fuel lines.
2.5.7 Battery charger.
2.5.8 Battery rack and cables.
2.5.9 Run relay kit.

2.6 Vibration isolation.

2.7 CSA certification.

2.8 Alarms: provide the following alarms

2.8.1 Overcrank
2.8.2 Low engine temperatures (i.e., too low for reliable start)
2.8.3 High engine temperature pre-alarm
2.8.4 High engine temperature
2.8.5 Low lube oil pressure pre-alarm
2.8.6 Low lube oil pressure
2.8.7 Overspeed
2.8.8 Low fuel (signals less than 2 h of fuel remaining)
2.8.9 Emergency electrical power supply system supplying load
2.8.10 Control switch not in automatic position
2.8.11 Low voltage in battery
2.8.12 Lamp test
2.8.13 Contacts for local and remote common alarm
2.8.14 Audible alarm silencing switch
2.8.15 Low starting air pressure (if applicable)
2.8.16 Low starting hydraulic pressure (ii applicable)
2.8.17 Air shutdown damper (if applicable)
2.8.18 Remote emergency stop station (if provided)
2.8.19 Low coolant level (if applicable)
2.8.20 Ventilation dampers not open
2.8.21 Auxiliary supply tank containment leak sensing
2.8.22 Automatic transfer switch in non-auto mode or bypass mode (if applicable)
2.8.23 Underfrequency/underspeed
2.8.24 Overcurrent
2.8.25 Undervoltage
2.8.26 Overvoltage

3. The generator is to be located within the building so as to minimize sound transfer to occupied spaces. Ensure generator rooms are remote from occupied areas that are either adjacent to, above, or below same. Provide buffer rooms, such as storage rooms, between generator rooms and other occupancies.

4. Provide a minimum 5 year/2000 hour warranty.

5. Provide a standard 5 year service contract, the cost of this contract is to be included with the supply and installation of this equipment. The service contract shall include (but not be limited to) the semi-annual, annual and five year inspection test and maintenance requirements of the CSA C282 (if applicable).

6. When a generator is permanently installed in such a way that the generator will carry all or any part of the distribution system for the building, the generator will be treated as service

equipment under this Design Requirements Manual. Generator loading requirements will meet all service equipment requirements.

Section 26 36 23 Automatic Transfer Switches

1. The automatic transfer switch shall be c/w the following:
   1.1 Power transfer module.
   1.2 Separately mounted control module.
   1.3 Continuous duty contactors.
   1.4 Silver AC contacts.
   1.5 Rated to withstand the available fault current.
   1.6 Bypass and isolation.
   1.7 NEMA 1 enclosure.
   1.8 Accessories:
      1.8.1 Readily adjustable/programmable time delay for momentary outages, transfer, and engine cool down.
      1.8.2 Voltage and frequency sensing.
      1.8.3 Gold plated DC contacts.
      1.8.4 Auxiliary contacts.
      1.8.5 Pilot lights.
2. Provide a minimum 5 year/2000 hour warranty.
3. Provide a standard 5 year service contract, the cost of this contract is to be included with the supply and installation of this equipment. The service contract shall include (but not be limited to) the semi-annual, annual and five year inspection test and maintenance requirements of the CSA C282 (if applicable).
4. Where a transfer switch has been provided for a portable generator; a suitable weatherproof exterior building mounted connection point shall be provided.

Section 26 43 00 Transient Voltage Suppression (TVSS)

1. Provide integral TVSS protection at the electrical power service entrance for all buildings where computerized or other electronic related equipment is in use as per the following:
   1.1 Operation and Environment:
      1.1.1 Voltage. The TVSS devices shall be suitable for the voltage and system configuration as indicated on the single line diagram(s).

1.1.2 Maximum Continuous Operating Voltage (MCOV). The maximum continuous operating voltage of the suppressor unit shall be greater than 125% for 208Y/120V systems and 115% for 480V and 600V systems.

1.1.3 Protection Modes. Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line, and each line and neutral).

1.2 Suppression:

1.2.1 The maximum peak surge current capacity per phase of the specified units, based on the standard 8 x 20 microsecond current waveform (described in ANSI/IEEE C62.41-1991), is not less than 240,000 Amps for main entrance panel applications and 120,000 Amps for branch panel applications.

1.2.2 Let-Through Voltage. The TVSS unit for main panel applications shall demonstrate peak voltage Let Through characteristics as listed below. Voltage is measured L-N for WYE configurations. Testing shall be performed in accordance with Category A3, B3 and C1 test wave forms as described in ANSI/IEEE C62.41 – 1991 (Guide for Surge Voltages in Low Voltage AC Power Circuits). Other aspects of the test shall be in accordance with ANSI/IEEE C62.45 - 1987 (Guide on Surge Testing for Equipment Connected to Low Voltage AC Power).

6000 Vpk L - N	**CAT A3 Ring Wave, 200 Amp**	**CAT B3 Ring Wave, 500 Amp**	**CAT C1 Impulse, 3000 Amp**
208 V Units	400 V	400 V	400 V
600 V Units	400 V	400 V	1200V

1.2.3 Each model shall be able to withstand 1,000 sequential impulses using the category C1, 6kV/3kA, 8 x 20 ìs waveform as described in ANSI/IEEE C62.42-1991 (IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits). The interval between impulses shall not exceed 30 seconds. The resultant peak let-through voltage of the last impulse shall not vary from the first impulse by more than + or - 10%.

1.2.4 Suppression System. The TVSS unit shall include an engineered solid-state high-performance suppression system, utilizing non-linear voltage dependant metal oxide varistors or selenium cells. The suppression system’s components shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow or cause system upset of connected loads.

1.2.5 The TVSS clamping components shall have a response time rated less than 1 nanosecond. Filter components shall respond instantaneously.

1.3 Filtering:

1.3.1 Noise Attenuation. The TVSS unit shall be listed under UL 1283 and contain

a high- frequency extended range tracking filter. The filter shall reduce fast rise-time, high- frequency, error-producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system upset. Noise attenuation shall be a minimum of 45dB at 100 kHz based on standardized insertion loss data obtained utilizing the MIL-STD-220A, 50 ohm insertion loss methodology. Only manufacturers providing a documented attenuation value at 100 kHz will be considered. Spectrum analysis data may be required for support.

1.3.2 Bandwidth. The TVSS unit(s) for main entrance panel application shall have an effective filtering bandwidth of 180 Hz to 50 MHZ.

1.4 General Features:

1.4.1 Connectors. Terminals shall be provided for all of the necessary input and output power and ground connections on the TVSS.

1.4.2 Internal Connections. All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low impedance connections. No printed circuit boards shall be used for surge suppression paths.

1.4.3 Enclosure. The specified system shall be provided in a heavy duty NEMA 12 dust tight, enclosure with no ventilation openings. Indication of surge current module status shall be visible without opening the door.

1.4.4 Unit Status Indicators. Red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.

1.4.5 Fuses. The unit shall utilize internal fuses rated 600 VAC or greater and with a minimum interrupting capability of 200,000A or greater.

1.4.6 Identification. The unit shall include manufacturer’s nameplate, UL rating, and a CSA approval on the exterior of the enclosure.

1.4.7 Warranty. The manufacturer shall provide a Five-Year Warranty from date of shipment.

1.4.8 Quality. Testing of each unit shall include but shall not be limited to quality assurance checks, a “Hi-Pot” test at two times rated voltage plus 1000 volts per UL requirements, and operational and calibration tests. Test results will be made available to the Engineer upon request.

2. Provide integral TVSS protection within all branch circuit panels which feed computerized equipment as per the following:

2.1 Operation And Environment:

2.1.1 Voltage. The TVSS devices shall be suitable for the voltage and systems configuration as indicated on the single line diagram(s)

2.1.2 Maximum Continuous Operating Voltage (MCOV). The maximum continuous operating voltage of the suppressor unit shall be greater than 125% for 208Y/120V systems and 115% for 480V and 600V systems.

2.1.3 Protection Modes. Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line, and each line and neutral).

2.2 Suppression Component:

2.2.1 Surge Current. The unit's maximum peak surge current capacity per phase based on the standard 8 x 20µs waveform (described in ANSI/IEEE C62.41-1991), shall be not less than 120,000 Amps. Total device peak surge current rating shall be not less than 300,000 Amps.

2.2.2 Let-Through Voltage. The Integrated Filtering Panelboard shall demonstrate the following peak Let Through Voltage when measured at the panelboard bus bar. Test points at the panelboard bus bar demonstrate actual distribution system transient let- through voltages. UL1449 ratings established at test points other than the bus bar, shall not be considered. Testing shall be performed utilizing Category B3 and C1 test wave forms as described in ANSI/IEEE C62.41 – 1991. The test procedure shall be in accordance with ANSI/IEEE C62.45 – 1987 and shall be conducted on the device as a finished product complete with integral fusing.

IEEE C62.41 (1991) Let Through Voltages (208Y/120V Units)
Category B3/C1 Impulse
(Combination Waveform)

L-L 680 Volts

L-N 430 Volts

L-G 430 Volts

N-G 380 Volts
(For Delta configurations, IEEE Let Through is measured L-L and L-G).

2.2.3 Each unit shall be capable of withstanding 3,000 sequential, Category C1, 8 x 20 ìs impulses as described and conducted in ANSI/IEEE C62.42-1991 and C62.45 –1987. The interval between impulses shall not exceed 30 seconds. The resultant Let Through Voltage of the last impulse shall not vary from the first impulse by more than +5%.

2.2.4 Suppression System. The TVSS filtering unit shall include an engineered solid-state high- performance suppression system, utilizing non-linear voltage dependent metal oxide varistors or selenium cells. The suppression system's components shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow or cause system upset of connected loads.

2.2.5 The TVSS clamping components shall have a response time rated less than 1

nanosecond. Filter components shall respond instantaneously.

2.3 Filtering:

Noise Attenuation. The TVSS unit shall be listed under UL1283 and contain a high- frequency extended range tracking filter. The filter shall reduce fast rise-time, high- frequency, error-producing transients and electrical line noise to harmless levels thus eliminating disturbances which may lead to system up-set. Noise attenuation shall be a minimum of -45db at 100 kHz based on standardized insertion loss data obtained utilizing the MIL-STD-220A, 50 ohm insertion loss methodology. Only manufacturers providing a documented value at 100 kHz will be considered. Spectrum analysis may be required for support.

Bandwidth. The TVSS filter shall have an effective filtering bandwidth of 10 kHz to 50 MHZ.

2.4 General Features:

2.5 The Integrated TVSS Panel shall be fully integrated. The TVSS unit shall be factory installed and connected to the bus bar. Field installed TVSS component products will not be considered. The integrated panelboard is to be factory tested as a complete unit to ensure completed product integrity.

2.6 Suppression/Filter System Connections. No plug-in component modules, quick-disconnect terminals or printed circuit boards shall be used in surge current-carrying paths.

2.7 The unit will have visual indicator lights for each phase of operation. The system will continuously monitor the operating status of each phase of suppression protection. If the unit is in proper working order, the indicator lights will be illuminated. If unit performance is degraded, the lamps will no longer be illuminated. These indicators must be visible without removal of the panel trim.

2.8 Fuses. The TVSS/filter system shall utilize internal fuses rated with a minimum interrupting rating of 200,000 AIC.

2.9 Identification. The unit shall include manufacturer's nameplate and CSA approval on the exterior of the enclosure.

2.10 Warranty. Provide a Limited Five-Year Warranty on the TVSS filter. This warranty shall commence from date of shipment.

2.11 Testing. Testing of each unit shall include quality assurance checks, "Hi-Pot" test at two times rated voltage plus 1000 volts per UL requirements, and operational and calibration tests.

3. All AC power receptacles feeding main communications equipment shall be integral TVSS type, in addition to being fed from a branch circuit panel protected by an integral TVSS.

4. All neutral conductors between the distribution transformer and the TVSS equipped branch circuit panel shall be sized @ 200% of code.

Section 26 50 00 Lighting

1. For each room or area determine the task performed and provide maintained, uniform lighting levels per IES standards unless otherwise specified herein.

2. The application of ANSI/ASHRAE/IESNA Standard 90.1 shall be on a project by project basis. Coordinate with the Minister's Representative.

3. Where a 347/600 volt electrical system is available, the lighting system shall be 347 V.

4. All lighting fixtures shall be "specification grade" and shall be specified with a unique fixture designation, detailed description which includes voltage, driver/ ballast, mounting, lamp wattage etc.

5. Interior lighting

5.1 Generally interior lighting systems shall utilize 4', recessed fluorescent LED fixtures (troffers) unless otherwise noted. Troffers shall incorporate the following:

5.1.1 Lenses shall be pattern 12 low brightness UV stabilized, 100% virgin acrylic lenses (0.125"). A minimum thickness of 0.125" shall be used regardless of manufacturers pattern 12 designation.
5.1.2 In order to reduce source image, a minimum distance between light source bottom to lens bottom of 50mm (2") must be maintained.
5.1.3 Hinged, latched, steel door frame c/w mechanical light leak seals or gaskets.
5.1.4 The fixture output shall not exceed 5400 lumens for ceiling / mounting heights 3m (10') or less.
5.1.5 Suitable for both T-bar and drywall installation c/w frame-in kits as required.
5.1.6 Driver and LED boards are to be accessible from the room side of the fixture. LED boards are to be individually replaceable.
5.1.7 LED fixture drivers shall have a Total Harmonic Distortion (THD) less than 20%.
5.1.8 Design lumen output shall be the average output of the fixture based on the IES LM-80 standard and TM-21.
5.1.9 CSA approved.
5.1.10 LED's shall have a colour temperature of 3500K and a minimum CRI of 80 for typical office and support spaces. Provide fixtures with different CRI values or different colour temperature where the use of the space or application requires it - obtain approval from the Minister's Representative before proceeding.

5.2 The use of fluorescent fixtures is to be pre-approved by the Minister's Representative. Where the use of fluorescent fixtures has been approved, interior

lighting shall utilize 4', recessed fluorescent fixtures (troffers) unless otherwise noted. Troffers shall incorporate the following:

5.2.1 Able to accommodate T8 lamps. Sockets are to be snap/push in, pressure lock type.
5.2.2 Lenses shall be pattern 12 low brightness UV stabilized, 100% virgin acrylic lenses (0.125"). A minimum thickness of 0.125" shall be used regardless of manufacturers pattern 12 designation.
5.2.3 In order to reduce lamp image, a low profile ballast cover and a minimum lamp bottom to lens bottom of 2 inches must be maintained.
5.2.4 Hinged, latched, steel door frame c/w mechanical light leak seals or gaskets.
5.2.5 Ballast cover shall be connected to the fixture housing at minimum 6 points.
5.2.6 Suitable for both T-bar and drywall installation c/w frame-in kits as required.
5.2.7 Interior fluorescent fixture ballasts shall be electronic, “small can” type, CSA & CBM certified, energy efficient, complete with minimum 0.88 ballast factor and THD less than 20%, sound rating “A” and 95% minimum power factor.
5.2.8 Fluorescent lamps shall be reduced mercury type, long life, T8, 2,950 initial lumens, 2,800 design lumens, 24,000 hour rated life, and CRI minimum of 86. Lamps shall be designed to pass the Federal TCLP test. Colour temperature to suit application -obtain approval from the Minister’s Representative before proceeding.
5.2.9 Use "High Performance/Super" T8 fluorescent lamps/ballasts. Ensure lamps and ballasts are compatible.
5.2.10 Three (3) lamp fixtures are to be used for office areas. 3-lamp fixtures are to be similar to 2- lamp fixtures. The two outer lamps shall be switched together, and the inner lamp switched separately.
5.2.11 Where 2' X 2' fluorescent fixtures are required, utilize 2', T8 lamps.
5.2.12 Provide 10% spare of each type of lamp installed.
5.2.13 CSA approved.

5.3 Provide local switching for enclosed rooms, i.e. conference/board rooms, private offices, training rooms, etc. For large areas provide some centralized control to adequately cover appropriate areas at each entrance. Refer to 26 09 24 Instrumentation and Control for Electrical Systems for detailed requirements.

5.4 Offices shall have a minimum average maintained illuminance level of 50 foot-candles (500 lux).

5.5 Every washroom toilet stall shall have direct illumination from a light fixture or portion thereof.

5.6 General lighting within stairwells and associated landings:

5.6.1 Recessed Lighting fixtures are to be only located in ceiling spaces immediately “prior to” ascending or descending stairs, and are not to extend

beyond same.

5.6.2 Lighting fixtures installed on end or side walls directly above “landings,” are not to be greater than 3.35m (11') AFF to bottom of same.

5.6.3 Lighting fixtures are not to be installed in, or on, ceilings or walls directly above intermediate stairs located between landings.

5.7 Provide task lighting above all sinks.

5.8 Valence lighting shall be provided under all cupboards installed above counters. Utilize strip lights in an architectural valence. The lack of an architectural valence shall not be permitted.

5.9 Every shower stall shall have direct illumination from a light fixture or portion thereof.

5.10 Light fixture locations are to be coordinated with mechanical ductwork so as to avoid conflicts. Allow a buffer zone to avoid light fixtures burning ductwork.

5.11 All interior surface mounted lighting fixtures are to be provided with a flush mounted outlet box.

5.12 Recessed Down Light

5.12.1 Non Accessible Ceilings:

5.12.1.1 If the luminaire opening is less than 150mm (6") in diameter, a separate fixture drop shall be provided.

5.12.1.2 Fixture drops shall be run to an accessible junction box above an accessible ceiling or an access panel.

5.12.1.3 Fixture drops shall not exceed 5m (15’) in length.

5.12.2 Accessible T-bar Ceilings:

5.12.2.1 Fixtures are to be securely fastened to the T-bar ceiling. No part of the fixture is to derive support from the T-bar ceiling tiles.

5.13 The use of interior HID fixtures is not recommended, provide LED High / Low bay fixtures to suit mounting height.

5.14 Recessed and/or surface type light fixtures, unless installed end-to-end are not to be wired in a “daisy-chain” manner, or have their power sources looped between fixtures.

5.15 The following wiring methods are related to the installation of lay-in type lighting fixtures installed within T-Bar or other removable types grid ceilings:

5.15.1 Additional T-Bar grid supports that may be required for light fixtures installed in, or secured to, T-Bar type ceilings, are to be identified accordingly to the applicable ceiling contractor, who in turn will be responsible for supplying and installing additional hangers as may be

required.

5.15.2 The installation of any “additional” T-Bar grid ceiling support wires is the sole responsibility of the ceiling installation contractor.

5.15.3 Independent supporting of light fixtures in T-Bar grid ceilings utilizing materials other than tie-wires, i.e. threaded rods, metal channels, etc., are the sole responsibility of the electrical contractor.

5.15.4 Each light fixture is to have a separate “fixture drop” installed and connected to hard wired junction or outlet box located in ceiling space.

5.15.5 A maximum of four drops is permitted from any single box, regardless of box size.

5.15.6 AC-90 fixture drops may only be supported from T-Bar ceiling grid support wires with “metal” type clips, approved for this particular application. The use of tye-wraps is prohibited.

5.15.7 Modular Wiring:

5.15.7.1 Fixtures recessed in, or secured to, T-Bar type ceilings incorporating C.S.A. approved type (modular) wiring harness system intended for interconnecting fixtures, is an acceptable alternative to supplying individual “hard wired” fixture (power) drops.

5.15.7.2 Modular type harness wiring, may only be supported from T-Bar ceiling grid support wires with “metal” type clips, approved for this particular application. The use of tye-wraps is prohibited.

5.15.7.3 Combined uses of both “Master” and “Slave” lighting fixtures shall be restricted to one “master” fixture with one accompanying “slave” unit.

5.15.7.4 Each “lay-in” type fixture shall be capable of being raised upwards and moved laterally in any direction a minimum of not less than 24".

5.15.7.5 Total length of “modular” wiring harness and accompanying conductors installed between “master” fixture and accompanying “slave” fixture, (including 1m (3') of wire within each fixture) is not under any circumstances to exceed 5.3m (17') in total length. Maximum of 3.3m (11') of flex, including associated conductors permitted to be used between “Master” and “Slave” fixtures (3.3m + 1m + 1m = 5.3m) (11' + 3' + 3' = 17').

6. Garage Bay Lighting

6.1 Utilize LED fixtures with a CRI in excess of 75 and a colour temperature of below 5000K for garage bay lighting.

6.2 Where motorized vehicles can be parked inside of a building, light fixtures shall not be located in the bays above the vehicles. The fixtures shall be installed between the bays so as to minimize shadowing caused by the vehicles.

6.3 Provide 50 foot-candles, average, maintained and 35 foot-candles vertical, average maintained on the vehicle sides.

6.4 Provide minimum 10% un-switched night light fixtures.

6.5 Fixtures shall have a maximum 15,000 lumen output and ensure diffusers and / or lenses are provided for LED fixtures to minimize glare for workers lying on the floor.

6.6 The fixture shall have an injection molded, 100% virgin UV stabilized acrylic, gasketed refractor/lens. All fixtures shall be vapor tight with a vapor tight optical assembly. Refractor /lens is to be hinged and latched so that no tools are required for access.

6.7 Fixtures shall be vapor tight, suitable for cold temperatures and damp locations.

7. Salt Dome Lighting

7.1 Provide 15 foot-candles horizontal, average, maintained.

7.2 Fixtures are to be LED High / Low bay fixtures. LEDs are to have a CRI in excess of 75 and a colour temperature of below 5000K. These fixtures shall be suitable for highly corrosive atmospheres, cold temperatures and wet locations. The fixtures shall be vapor tight with a vapor tight optical assembly (IP65, IP66 and IP67 rated) with a borosilicate glass or Injection molded, 100% virgin UV stabilized acrylic, gasketed refractor/lens c/w stainless steel latching hardware.

7.3 Fixtures shall be mounted to a support structure using stainless steel hardware in such a manner to prevent movement of the fixture. Provide bird guards on all exposed equipment.

7.4 Fixture to meets IESNA LM-80.

8. Exterior Lighting:

8.1 Provide exterior lighting where required for driveways, walks, parking areas, and building perimeters using LED fixtures with a CRI in excess of 75 and a colour temperature below 5000K.

8.2 All exterior building entrance doors shall be provided with a dedicated lighting fixture for security purposes.

8.3 Exterior lighting shall be controlled using a photocell in conjunction with a programmable time clock complete with battery back-up and a manual bypass. If the time clock has an astronomic feature, then a photocell is not required. Exterior lighting to be “dark skies” compliant.

8.4 Provide the following average, maintained illumination levels:

8.4.1 Landscaped areas: 1 fc, extended 20' away from the building
8.4.2 Parking lots: 1 fc

9. Existing PCB type ballasts are to be disposed of according to Government legislation concerning the removal and disposal of hazardous waste.

10. The use of HID fixtures is not recommended, provide LED High / Low bay fixtures to suit mounting heights.

11. LED High / Low bay fixtures are to have a CRI in excess of 75 and a colour temperature below 4000K.

12. Ensure diffusers and / or lenses are provided for LED High / Low bay fixtures to minimize direct glare.

13. Provide exterior lighting where required for driveways, walks, parking areas, and building perimeters using LED fixtures with a CRI in excess of 75 and a colour temperature below 5000K. Exterior lighting shall be controlled using a photocell in conjunction with a programmable time clock complete with battery back-up and a manual by pass. If the time clock has an astronomic feature, then a photocell is not required. Exterior lighting to be ”dark skies” compliant.

13.1 Provide the following average, maintained illumination levels:

13.1.1 Landscaped areas: 1 fc, extended 20' away from the building
13.1.2 Parking lots: 1 fc
13.1.3 Sidewalks: 1 fc
13.1.4 Driveways / Roadways:1 fc

14. Interior HID ballasts shall be high power factor type, encased and potted, and meet or exceed ANSI C8204.

15. HID lamps shall be as follows:

15.1 High quality, long life type.

15.2 High Pressure Sodium lamps are to utilize non-cycling, end of life indicator, lead free, reduced mercury with a minimum average life of 30,000 hours. Lamps shall be designed to pass the TCLP test in effect at time of manufacture.

15.3 Metal Halide lamps are to utilize reduced mercury technology. Published mean lumen rating is to be incorporated when doing lighting design.

16. Ensure lamps and ballasts are compatible.

17. Existing PCB type ballasts are to be disposed of according to Government legislation concerning the removal and disposal of hazardous waste.

18. The following wiring methods are related to the installation of lay-in type lighting fixtures installed within T-Bar or other removable types grid ceilings:

    18.1 Additional T-Bar grid supports that may be required for light fixtures installed in, or secured to, T-Bar type ceilings, are to be identified accordingly to the applicable ceiling contractor, who in turn will be responsible for supplying and installing additional hangers as may be required.

    18.2 The installation of any “additional” T-Bar grid ceiling support wires is the sole responsibility of the ceiling installation contractor.

    18.3 Independent supporting of light fixtures in T-Bar grid ceilings utilizing materials other than tie-wires, i.e. threaded rods, metal channels, etc., are the sole responsibility of the electrical contractor.

    18.4 Each light fixture is to have a separate “fixture drop” installed and connected to hard wired junction or outlet box located in ceiling space.

    18.5 A maximum of four drops is permitted from any single box, regardless of box size.

    18.6 Recessed and/or surface type fluorescent light fixtures, unless installed end-to-end are not to be wired in a “daisy-chain” manner, or have their power sources looped between fixtures.

    18.7 AC-90 fixture drops may only be supported from T-Bar ceiling grid support wires with “metal” type clips, approved for this particular application. The use of tye-wraps is prohibited.

    18.8 Modular Wiring:

        18.8.1 Fluorescent fixtures recessed in, or secured to, T-Bar type ceilings incorporating C.S.A. approved type (modular) wiring harness system intended for interconnecting fixtures, is an acceptable alternative to supplying individual “hard wired” fixture (power) drops.
        18.8.2 Modular type harness wiring, may only be supported from T-Bar ceiling grid support wires with “metal” type clips, approved for this particular application. The use of tye-wraps is prohibited.
        18.8.3 Combined uses of both “Master” and “Slave” lighting fixtures shall be restricted to one “master” fixture with one accompanying “slave” unit.
        18.8.4 Each “lay-in” type fixture shall be capable of being raised upwards and moved laterally in any direction a minimum of not less than 24".
        18.8.5 Total length of “modular” wiring harness and accompanying conductors

installed between “master” fixture and accompanying “slave” fixture, (including 3' of wire within each fixture) is not under any circumstances to exceed 5.3m (17') in total length. Maximum of 3.5m (11') of flex, including associated conductors permitted to be used between “Master” and “Slave” fixtures (3.3m + 1m + 1m = 5.3m) (11' + 3' + 3' = 17').

19. General lighting within stairwells and associated landings:

    19.1 Recessed fluorescent fixtures are to be only located in ceiling spaces immediately “prior to” ascending or descending stairs, and are not to extend beyond same.

    19.2 Fluorescent fixtures installed on end or side walls directly above “landings,” are not to be greater than 3.5m (11') AFF to bottom of same.

    19.3 Lighting fixtures are not to be installed in, or on, ceilings or walls directly above intermediate stairs located between landings.

20. Provide fluorescent task lighting above all sinks.

21. Valence lighting shall be provided under all cupboards installed above counters. Utilize side- mount strip lights in an architectural valence. The lack of an architectural valence shall not be permitted.

22. Provide 10% spare of each type of lamp installed.

23. Garage Bay Lighting:

    23.1 Where motorized vehicles can be parked inside of a building, light fixtures shall not be located in the bays above the vehicles. The fixtures shall be installed between the bays so as to minimize shadowing caused by the vehicles.

    23.2 Provide 50 foot-candles, average, maintained.

    23.3 Provide minimum 10% unswitched night light fixtures. Unswitched night light fixtures are to be c/w quartz restrike.

    23.4 Low Bay type HID metal halide fixtures shall be utilized as follows:

        23.4.1 Maximum 250W coated lamps shall be utilized to minimize glare for workers lying on the floor.
        23.4.2 Spun aluminum housing/reflector with a polyester powder coat, 90% minimum reflectance for reflector.
        23.4.3 Injection molded, 100% virgin UV stabilized acrylic, gasketed refractor/lens. Refractor is to be hinged and latched so that no tools are required for lamp change.
        23.4.4 High power factor ballast.
        23.4.5 Suitable for cold temperatures and damp locations.

24. Every shower stall shall have direct illumination from a light fixture or portion thereof. 25 All exterior entrance doors shall be provided with a dedicated lighting fixture for security purposes.

25. All interior surface mounted lighting fixtures are to be provided with a flush mounted outlet box.

26. Recessed Down Light

    26.1 Non Accessible Ceilings:

        26.1.1 If the luminaire opening is less than 6" (150mm) in diameter, a separate fixture drop shall be provided.
        26.1.2 Fixture drops shall be run to an accessible junction box above an accessible ceiling or an access panel.
        26.1.3 Fixture drops shall not exceed 15' (5m) in length.

    26.2 Accessible T-bar Ceilings:

        26.2.1 Fixtures are to be securely fastened to the T-bar ceiling. No part of the fixture is to derive support from the T-bar ceiling tiles.

27. Light fixture locations are to be coordinated with mechanical ductwork so as to avoid conflicts. Allow a buffer zone to avoid light fixtures burning ductwork.

Section 26 52 00 Emergency Lighting

1. Provide emergency lighting as required by the National and Provincial Building Code as a minimum.

2. Units shall be connected to the same circuit as the general lighting fixtures for that area. Remote heads shall cover only those areas on the same branch circuit as the emergency battery unit is fed from.

3. Units shall be installed in critical areas even if emergency power (i.e. diesel generator, UPS) is provided. Critical areas include:

    3.1 Electrical rooms, unit equipment in electrical rooms shall provide illumination for four (4) hours as a minimum.

    3.2 Mechanical rooms (including but not limited to Boiler rooms, sprinkler rooms etc.).

    3.3 Kitchens with stoves.

4. Units shall incorporate sealed maintenance free batteries complete with solid state charger, automatic self-diagnostic circuitry, test switch, and LED indicators for “on” and “charge”.

5. Batteries are to “each” have a (10) year life warranty.

6. Emergency light units containing “batteries,” are to be flush installed in both, T-Bar and dry- wall type ceilings as per the following:

   6.1 Flush installed units installed in “dry-wall” type ceilings incorporating batteries, shall contain a “frame-in” kit intended for this particular application.

   6.2 Flush installed units installed in T-Bar type ceilings shall be suitable for this particular application.

7. Where installed in the following areas, emergency lighting shall be located:

   7.1 In the middle (between corridor walls) or center of all corridor ceilings.

   7.2 On ceilings or walls prior to ascending or descending stairs.

   7.3 On rear, and/or “landing” side walls as may be required. Where installed on rear wall of landing, approximately 300mm (12") of space shall be provided between top of wall mounted lighting fluorescent fixture and bottom of remote emergency head.

8. The line supply voltage is to match the voltage of the local lighting system. If there are two voltages present in the same area, the higher voltage shall be utilized.

9. Utilize LED lamps to minimize maintenance requirements.

10. Remote heads shall be fed from unit equipment using conduit and wire. A transition from conduit and wire to AC90 cable as the drop to the equipment is permitted above accessible ceilings where the length of the AC90 cable is less than 4.5m (15'), and where the transition to AC90 is located in the same room as the remote head.

Section 26 53 00 Exit Signs

1. Provide exit lighting as required by the National and Provincial Building Code as a minimum.

2. Exit lights shall be die cast, soft designer look, LED type complete with DC backup. Specification grade. Faceplate to be fastened with appropriate screws.

3. Exit lighting fixtures shall be wall mounted 2286 mm (7’-6”) A.F.F. Where this equipment is located above or over doors, it shall be wall mounted 152 mm (6”) above the door frame. Hang from ceilings only where wall mounting is not feasible to a maximum height of 3350 (11'-0"), stem hang where necessary.

4. Provide a (10) year life warranty.

END