

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 Related Sections:**

- .1 26 05 01 Common Work Results - For Electrical
- .2 26 05 20 Wire and Box Connectors 0-1000 V
- .3 26 05 21 Wires and Cables (0-1000 V)
- .4 26 05 28 Grounding - Secondary
- .5 26 05 29 Hangers and Supports for Electrical Systems
- .6 26 05 31 Junction, Pull Boxes and Cabinets
- .7 26 05 32 Outlet Boxes, Conduit Boxes and Fittings
- .8 26 05 34 Conduits, Conduit Fastenings and Conduit Fittings
- .9 26 50 00 Lighting

### **1.3 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23<sup>rd</sup> Edition), Safety Standard for Electrical Installations.
  - .2 Abbreviations for electrical terms: to CSA Z85.
  - .3 CSA Electrical Bulletins in force at the time of tender submission, while not identified and specified by number in this division, are to be considered as forming part of the related CSA Part II standard and must be complied with.
- .2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

### **1.4 Contract Drawings**

- .1 No omissions in the drawings or specifications are intended and the Contractor shall give due consideration to this matter. Any work or material referred to in the drawings and not in the specifications, or vice versa, shall be furnished and performed as though fully covered in both. This shall apply particularly to the drawings where descriptions are sufficiently detailed so as to require little or no mention in the specifications. Items indicated on floor plans and not on riser diagrams, or vice versa, shall be considered fully covered by both.
- .2 Runs of conduit and outlet locations indicated on the drawings are diagrammatic and exact locations must be determined by the Contractor as the work proceeds, with due regard to the structure and the work of other trades. The Departmental Representative reserves the right to alter locations of conduit and outlets up to [3000 mm] without extra cost, provided that the Contractor is advised prior to roughing in. The Contractor shall make any changes dictated by structural requirements, or conflicts with other trades, without charge to the Departmental Representative.

- .3 Any error or omission shall be referred to the Departmental Representative whose decision shall be final.
- .4 Building dimensions shall not be scaled from the electrical drawings but shall be obtained from the Architectural and/or Structural drawings. Any discrepancy between the drawings and the building shall be questioned before proceeding with the installation.

## **1.5 Design Requirements**

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

## **1.6 Submittals**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings:
  - .1 The Contractor shall prepare shop drawings showing in detail the design and construction of all equipment, panels, cabinets, lighting fixtures, etc. high quality digital copies of all such drawings shall be submitted to the Departmental Representative for review, and the work shall not be executed until such review has been obtained.
  - .2 All shop drawings, other than standard manufacturers' dimensions and data sheets, shall bear the stamp of a registered professional Departmental Representative who shall be fully responsible for the Engineering content of such drawings.
  - .3 Prior to submission the Contractor shall carefully check all shop drawings to ensure that they comply with the drawings and specifications in both intent and detail. No consideration will be given to shop drawings submitted without this approval and review from the Contractor. Appendix A at the end of this section must be completed and signed and must accompany all shop drawing submissions. Submissions not accompanied by Appendix A will be returned for re-submission.
  - .4 The Departmental Representative's review of these drawings is general and is not intended to serve as a check and shall not release the Contractor from responsibility for errors or from the necessity of checking the drawings himself, or of furnishing the materials and performing the work as required by the plans and specifications.
  - .5 High quality electronic "PDF" copies of shop drawings are acceptable.
- .3 Quality Control:
  - .1 Provide CSA certified equipment and material.

- .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
- .3 Submit test results of installed electrical systems and instrumentation.
- .4 Permits and fees: in accordance with General Conditions of contract.
- .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .4 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

### **1.7 Quality Assurance**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

### **1.8 System Start-up**

- .1 At the conclusion of the job, the Contractor shall review and demonstrate to the Departmental Representative, all electrical equipment and their respective functions and operation. Such demonstration shall be provided for such reasonable periods of time as the complexity of the job warrants, and as approved by the Departmental Representative. Such review and demonstration shall be made by an authorized representative of the Contractor, who shall be fully knowledgeable of the project, its installation and operation. Three bound maintenance and operational manuals shall be reviewed and left with the Departmental Representative. These manuals shall be custom written for materials and systems supplied for this project. Generic information may accompany the manuals but must only be supplemental information. These manuals shall include, but not be limited to, approved copies of all shop drawings, guarantees, manufacturers maintenance instructions, diagrams, and parts lists, all packaging and installation instructions, and all operating instructions. Where manufacturers' literature is not available, or appropriate, the Contractor shall provide same in written form. This shall apply particularly to the general light, power and control system. Refer also to Section 01 78 00. Prior to final inspection, submit these manuals to the Departmental Representative for review.
- .2 Arrange and pay for services of manufacturer's factory service Departmental Representative to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

## **1.9 Commissioning**

- .1 Upon written verification from the Departmental Representative that all systems are complete and operational, that all documents, reports, and tests have been submitted, and that all demonstrations are complete, then the Departmental Representative's maintenance staff shall commence a commissioning period not to exceed 5 working days. During the period the contractor shall supply and pay for the services of an electrician familiar with the works and all manufacturers service technicians, as well as all necessary test equipment as required to assist the Client.
- .2 Deficiencies and/or discrepancies discovered during the commissioning are to be immediately rectified. Exceptional arrangements for labour and materials required to correct deficiencies which prevent the satisfactory completion of the commissioning process in the indicated time frame will be the responsibility and liability of the contractor.

## **1.10 Minimum Standards**

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

## **1.11 Permits, Fees and Inspection**

- .1 The Contractor shall obtain all inspections and permits required by all laws, ordinances, rules, and regulations by public authority having jurisdiction in this district, and shall obtain certificates of such inspections and shall pay all charges in connection therewith. The final certificate of inspection shall be obtained before final payment for work shall be considered due.
- .2 In no instance shall the standard established by the drawings and specification be reduced by any codes, etc..

## **1.12 Supervision**

- .1 The Contractor shall provide supervision and sufficiently qualified foreman to ensure that the job proceeds in a proper and efficient manner. If in the opinion of the Departmental Representative, such personnel are not competent to carry out their work, the Contractor shall replace these men immediately upon written request of the Departmental Representative.

## **1.13 Other Trades**

- .1 The Contractor shall co-operate and investigate with other trades to make maximum use of the spaces and avoid conflict with pipes, ducts, equipment radiation, etc. Shop drawings shall be prepared by the Contractor indicating the route of main conduits and ducts which shall be submitted to the Departmental Representative for review.
- .2 The Contractor shall co-operate with other Contractors on the site and carry out the work, in such a way, as not to hinder or hold-up the work of other trades.

- .3 The Contractor shall consult with other Contractors, where their respective installations conflict and shall re-route conduits, ducts, outlets, equipments, etc., as required, subject to the approval of the Departmental Representative.
- .4 The Contractor shall obtain from the mechanical and other trades complete detailed wiring diagrams of equipment requiring connections and shall be responsible for pointing out any discrepancies or the reason why they cannot be adhered to.

#### **1.14 Utility Co-ordination**

- .1 Co-ordination with the Utility is not a requirement for this project.

#### **1.15 Fire Penetrations**

- .1 Where conduits and cables pass through fire separations and sound rated separations, including floors, walls, membranes, etc., provide a metallic sleeve, or core drill to (25 mm) radius larger than the conduit or cable passing through the fire separation. Construct a ceramic fibre insulation dam, or dams as required, and fill the penetration with 3M PUTTY 303 or 3M CAULK CP25. A minimum depth of (50 mm) of putty or caulk is required. As an alternate system, pack the space with ceramic fibre insulation to within 1 inch of each face of the separation, and fill the remaining voids with (25 mm) of Electrovert AA 400 FLAMESEAL PUTTY, on each side. Either installation shall be in strict accordance with manufacturers recommendations and to suit UL and/or ULC requirements. All such work shall be performed by personnel familiar and experienced with this type of work.

#### **1.16 Guarantee**

- .1 The Contractor shall guarantee all work, under this Division, free from defects, for a period of one (1) year, after final acceptance of the entire project. The Contractor shall make good all defects, other than normal wear and tear, during the life of the guarantee. Notwithstanding the above, longer guarantees may be required for specific installations or equipments, as indicated in other sections of the specifications.
- .2 Guarantees shall be submitted in writing, bound where more than one is required, and submitted to the Departmental Representative for review. Each guarantee shall include:
  - .1 Project name and address.
  - .2 Guarantee time period (commencement date shall be the date as shown on the project final certificate of completion, unless otherwise indicated).
  - .3 Clear and concise definition of what is guaranteed.
  - .4 Signatures of company officers of the Contractor and/or manufacturers, as applicable.
- .3 The Contractor shall provide services for the inspection of the installation every 6 months, for the period of not less than 4 years.

#### **1.17 Record Drawings**

- .1 One (1) set of white prints will be provided for record drawing purposes. Maintain project "as-built" record drawings and accurately record significant deviations

from the Contract Documents, caused by site condition or Contract change. Mark changes on white prints in "RED".

- .2 Prior to start of testing, balancing and adjusting, finalize production of as-built drawings.
- .3 Testing, balancing and adjusting to be performed using as-built drawings.
- .4 Turn over the as built drawings to the Departmental Representative at the completion of the project.

## **PART 2 PRODUCTS**

### **2.1 Materials and Equipment**

- .1 Contract materials shall be new and C.S.A. approved for their specific use.
- .2 For the purposes of uniformity similar materials shall be of one manufacturer (i.e. all panels and switchgear; all motor control equipment; all light fixtures in as much as is possible; etc.).
- .3 To avoid the possibility of the work being delayed, the Contractor shall order all materials as soon as possible, and he shall report at once to the Departmental Representative any delays in the delivery of materials which would hold up the completion of the job.

### **2.2 Warning Signs**

- .1 Warning Signs: As specified and in accordance with requirements of Electrical Inspection Department and Departmental Representative.
- .2 Decal signs, minimum size [175 x 250 mm].

### **2.3 Wiring Terminations**

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

### **2.4 Equipment Identification**

- .1 All devices are to be provided with "Iamicoid" nameplates as further described herein. Care is to be taken to ensure that all plates are affixed true and level, and plumb in all instances.
- .2 Nameplates are to be affixed to all "metal" surfaces with steel type "pop-rivets".
- .3 Nameplates are to be affixed to other types of surfaces with contact type cement.
- .4 Nameplates are to be affixed to building "exterior" surfaces with nylon inserts and self tapping screws unless specifically indicated otherwise.
- .5 Contact type cement is to be applied (buttered) to complete rear side of plate, as opposed to several locations or areas on same.

- .6 Lamicoid nameplates installed on distribution panelboards, motor control centres, splitter troughs, transformers, etc. shall indicate the following:

- .1 Designated name of equipment.
- .2 Amperage of overcurrent protection device.
- .3 Voltages, number of phases and wires.
- .4 Designation of power source.
- .1 Example:

**PANEL 101 – 150AMPS  
120/208V–3PH–4W  
FED FROM MAIN SWITCHBOARD**

- .7 Lamicoid nameplates installed on combination starters, magnetic starters, manual starters, and all various system controls, control panels, disconnect switches, etc. shall contain the following information.

- .1 Designated name of equipment.
- .2 Designated name of power source.
- .3 Branch circuit breaker number(s) where possible.
- .4 Voltage(s).
- .1 Examples:

**EXHAUST FAN NO. 1  
PANEL H – 120V  
CCT. NO.17**

**SUPPLY FAN NO. 1  
M.C.C. NO.1  
600V–3PH**

- .8 Lamicoid nameplates installed on fusible type disconnect switches are to also indicate maximum designated/designed fuse size.

- .1 Lamicoid nameplates installed for renewable systems disconnects shall contain an additional nameplate with the following information.

**WARNING: ELECTRIC SHOCK  
HAZARD. DO NOT TOUCH  
TERMINALS. TERMINALS ON BOTH  
THE LINE AND LOAD SIDES MAY BE  
ENERGIZED IN THE OPEN POSITION.**

- .2

Lamicoid nameplates installed for ungrounded DC renewable systems disconnects shall contain an additional nameplate with the following information.

**WARNING: ELECTRIC SHOCK  
HAZARD. THE CONDUCTORS OF THIS  
RENEWABLE ENERGY POWER**

**SYSTEM ARE UNGROUNDED AND  
MAY BE ENERGIZED.**

.3

Lamicaid nameplates installed for Photovoltaic output circuit system disconnects shall contain an additional nameplate with the following information.

**PHOTOVOLTAIC SYSTEM EQUIPPED  
WITH RAPID SHUTDOWN.**

- .9 Lamicaid nameplates are to be installed on all junction and/or pull boxes sized (6" x 6") (150 mm x 150 mm) and larger indicating name of system, designated panel name and electrical characteristics where applicable.
- .10 Lamicaid nameplates are to be installed adjacent to each overcurrent devices located in switchboards, CDP panels, etc. They need only indicate designated name and/or number of equipment they feed. Unused O.C. devices are to be identified as spare(s).
- .1 Lamicaid nameplates installed adjacent to each overcurrent device located in switchboards, CDP panels, etc. for renewable power systems shall contain an additional nameplate with the following information.

**WARNING: INVERTER OUTPUT  
CONNECTION. DO NOT RELOCATE  
THIS OVERCURRENT DEVICE.**

- .11 Lamicaid nameplates are to be installed on DC to AC inverters and the point of interconnection to indicate the following information on minimum size (6" x 2")(150 mm x 50 mm) plate complete with two lines of (1/2")(13 mm) high lettering. (Size #8 nameplate.)
- .1 Example:

**MAIN BREAKER PV PLANT #1  
347/600V-100 AMPS-3PH-4W**

- .12 Lamicaid nameplates installed on "main" service entrance switches, or "main" entrance switchboards to indicate the following information on minimum size (6" x 2")(150 mm x 50 mm) plate complete with two lines of (1/2")(13 mm) high lettering. (Size #8 nameplate.)
- .1 Example:

**MAIN BREAKER 1000 AMPS  
347/600V-3PH-4W**

- .13 Install an additional "lamicaid" nameplate on all, or any piece of electrical equipment, or apparatus (i.e.: main switchboard, CDP panels, panelboards, motor control centres, etc.) that may contain overcurrent devices, i.e. circuit



breakers and/or fuses, that have been designed for, and incorporate interrupting capacity sized "larger" than 10 kAIC.

.1 Examples:

**Minimum interrupting capacity of  
breakers installed in this panel to be  
not less than 25 kAIC.**

**Minimum interrupting capacity of fuses  
installed in this MCC to be not  
less than 25 kAIC.**

.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 complete with associated circuit breaker number(s).

.1 (1.6 mm) thick x (13 mm) high complete with (6 mm) black letters on white face, directly above all flush receptacles. (Plate to be identical width as finish device plate)

.1 Example:

**PANEL 101-20**

.15 General purpose receptacles located in rooms or areas containing additional receptacles intended for computer, electronic or other sensitive types of electronic equipment, etc. are to be identified as per the following:

.1 (1.5 mm) thick x (18.5 mm) high complete with (6 mm) black letters on white face, directly above all flush receptacles. (Identical width as finish device plate).

.1 Example:

**General Purpose Only  
PANEL 101-24**

.16 Lamicoid nameplate(s) for Cable T.V. and voice/data outlets are to be installed above the outlets and abutted directly to tops of their respective coverplates.

.17 Allow for an "average" of forty letters for each lamicoid nameplate.

.1 Lamicoid (3 mm) thick plastic engraving sheet, black letters, white face, for all electrical systems except fire alarm systems which shall have white letters on red face.

.2 (1.5 mm) thick nameplates above receptacles as previously indicated, with top left and right corners to be rounded off.

.3 Lettering on lamicoid nameplates shall not "start" or "end" nearer than (8 mm) from either, or both ends of said plates. Size of lettering, including

overall lengths of various plates shall be as indicated in the following chart.

.4 Sizes as follows:

NAMEPLATE SIZES

Size 1	{10 mm x 50 mm}	1 line	{5 mm} high letters
Size 2	{13 mm x 75 mm}	1 line	{6 mm} high letters
Size 3	{16 mm x 75 mm}	2 lines	{5 mm} high letters
Size 4	{19 mm x 90 mm}	1 line	{10 mm} high letters
Size 5	{37½ mm x 90 mm}	2 lines	{13 mm} high letters
Size 6	{25 mm x 100 mm}	1 line	{13 mm} high letters
Size 7	{37½ mm x 100 mm}	2 lines	{6 mm} high letters
Size 8	{50 mm x 150 mm}	2 lines	{13 mm} high letters

.18 Labelling of all branch circuit phase and neutral conductors 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).

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

.20 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 Strip
DC Positive	Red
DC Negative	Black

.1 Colour code conductor insulation and others as per the following:

.1 All sizes of phase conductors up to and including #2 AWG.

.2 All sizes of neutral, bond and/or ground conductors, up to and including #3/0 AWG.

.2 Approved coloured tapes in lieu of insulation colouring may be used to identify conductors that exceed sizes as indicated in items .19.1.1 and .19.1.2 above, and is to take place on both ends of runs for a minimum of (300 mm) from where terminations take place.

- .21 Some examples of electrical apparatus that could have (identical types) of removable covers, and will require to have their lamicoid nameplates installed on wall(s) adjacent to control, rather than directly to their covers are the following.
  - .1 Magnetic starters.
  - .2 Manual TOL switches
  - .3 Magnetic contactors.
  - .4 Relays.
- .22 Lamicoid nameplates shall be provided and installed on, or adjacent to, all various systems' control panels and/or cabinets, etc. complete with information as indicated. Plates are to reflect system's assigned name, and where applicable, shall also indicate both, designated panel name and associated branch circuit breaker number(s).
  - .1 Fire alarm panels.
  - .2 Security (intrusion) panels.
  - .3 Energy management panels.
  - .4 Television cabinets.
  - .5 Communication panels.
- .23 Control Transformers:
  - .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, and associated branch circuit breaker number(s).
  - .2 A second plate with identical information is to be installed on underside of room grid system or access opening frame so as to identify concealed location of same control transformer.
  - .3 All control transformers installed in control cabinets, and/or on walls adjacent to same, are to be identified with lamicoid nameplates containing information as previously indicated.
- .24 All various pieces of mechanical equipment are to be identified with identical information as indicated on electrical equipment nameplate feeding same mechanical equipment.
- .25 Both plates are to be supplied and installed by the electrical contractor in the absence of any mechanical trade identification.
- .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) being used to identify accompanying branch circuit phase and neutral conductor.
- .27 All junction and/or pull boxes, conduit fittings (and covers), etc., complete with their respective coverplates 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.
- .28 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, (18 mm) and (6 mm) in diameter, as described in the following legend, with (6 mm) discs being centred in the middle of (18 mm) discs. Concealed junction, pull and/or outlet boxes, conduit fittings, etc., in ceiling spaces complete with their respective metal coverplates.

- .29 A legend of colour coding used is to be provided under plexiglass and located in the main electrical room, (600 mm x 600 mm) minimum size frame.
- .30 Schedules shall be installed on the back of each door for panels, neatly arranged and mounted in frame under transparent cover. Schedules shall show system voltage, which outlets are on each circuit and any special information necessary. Schedules shall be typewritten and of a permanent nature.

## 2.5 Wiring Identification

- .1 Identify wiring on both ends of phase conductors of feeders and branch circuit wiring by circuit number at all panelboards, pull and junction boxes, outlet and equipment connections, and all devices. Labels shall be Panduit PLD-1 or PLD-2 as required. Labels to be installed in such a manner as to present white area with information in "flagged" position. Wrap around conductor in "U" fashion and have it adhere to itself. Identify neutrals and bond wires indicating which circuits with which they are used.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 The individual conductors and conductor pairs used in the various communications cables shall be colour coded. Maintain the colour coding scheme for each system throughout.

## 2.6 Conduit and Cable Identification

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

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

## 2.7 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

- .1 Paint outdoor electrical equipment [equipment green finish to EEMAC Y1-1-1955.
- .2 Paint indoor switchgear and distribution enclosures [light grey to EEMAC 2Y-1-1958.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

## **2.8 Access Doors**

- .1 Supply access doors for furred ceilings or spaces for servicing equipment and accessories or for inspection of safety, operating or fire devices for installation under section erecting the walls or ceilings.
- .2 Access doors shall be flush mounted 610mm x 610mm for body entry and 610mm x 610mm for hand entry, unless otherwise noted. Doors shall open 180 degrees, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps. Doors shall be of approved manufacturer with published literature. Access doors shall be minimum 14 gauge thick.
  - .1 General: Prime coated steel.
  - .2 Special areas such as tiled or marble surfaces: stainless steel.

## **2.9 Sprinkler Protection**

- .1 All equipment such as panelboards, transformers, switchboard, relay cabinets, control cabinets, etc., installed in areas equipped with sprinkler protection, shall be fitted with sprinkler hoods and shall comply with the intent of C.E.C. Sections 26-008 and Appendix B-26-008.

## **2.10 Housekeeping Pads**

- .1 Supply and install concrete housekeeping pads for all switchboards, transformers and motor control centres. Housekeeping pads to be (102 mm) thick, complete with 10M dowels at (457 mm) c/c around the perimeter, drilled and grouted into the existing slab (minimum embedment (102 mm). Concrete to be (3000 psi) (20,612 kPa) in accordance with CAN3-A23.1-M90. Reinforce with one layer 150 x 150 102/102 WWF. Pads to be nominally (150 mm) larger in all dimensions than the equipment being supported, and have chamfered edges.

## **PART 3 EXECUTION**

### **3.1 Installation**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

### **3.2 Nameplates and Labels**

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

### **3.3 Conduit and Cable Installation**

- .1 Install conduit and sleeves prior to the pouring of concrete, laying of concrete block, and the installation of drywall partitions.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

### **3.4 Location of Outlets**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum (305 mm) horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed (3000 mm), and information is given before installation.
- .4 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical rooms on latch side of door.

### **3.5 Mounting Heights**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: (1200mm).
  - .2 Wall receptacles:
    - .1 General: (457 mm).
    - .2 Above top of counters or counter splash backs: (150mm).
  - .3 Panelboards: (1829mm) to top as required by Code or as indicated.
  - .4 Telephone and interphone outlets: (457mm).
  - .5 Wall mounted telephone and interphone outlets: (1200 mm).
  - .6 Fire alarm stations: (1200 mm).
  - .7 Fire alarm bells: (2286 mm).
  - .8 Television outlets: (457 mm).
  - .9 Door bell pushbuttons: (1200 mm).

### **3.6 Motor and Equipment Connections**

- .1 Provide final connections to all motors, equipments, controls, etc. indicated on the drawing. These motors, equipment, controls, etc. shall include those supplied under other sections of this specification, as well as Departmental Representative supplied items. Ensure that equipment will operate properly (e.g. proper rotation)

and report any instance of defective equipment to the Departmental Representative.

### **3.7 Co-ordination of Protective Devices**

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

### **3.8 Cutting and Patching**

- .1 All cutting and patching shall be by the electrical contractor.
- .2 Make every effort to minimize cutting and patching by providing dimensions, locations and other data for bases, sleeves, boxes, etc., to be built in as construction proceeds. Set sleeves and mark openings in concrete forms and masonry before placing concrete and masonry.

### **3.9 Field Quality Control**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment. Such adjustments shall be made under normal load conditions.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests:
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems: fire alarm system, communications.
  - .6 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
- .3 Check resistance to ground before energizing.
- .4 Test all wiring included in the Contract, to ensure there are no shorts or grounded conductors and that insulation values are as required by the Canadian Electrical Code.

- .5 The Departmental Representative reserves the right to use any piece of electrical equipment, device, or material installed under this Contract for such reasonable lengths of time and at such times as he may require to make a complete and thorough test of the same, before the final completion and acceptance of the work.
- .6 The following wiring methods detailed below are designed to enhance the ability to perform capacitive leakage tests; these methods are to be strictly followed and tests performed under this Contract.
  - .1 All circuit conductors are to be individually tie wrapped to their corresponding labelled neutral conductor in all panelboards, pull boxes and junction boxes. Enough slack conductor length should be left to enable the ability to clamp the ground detector around the individually tie wrapped circuit conductor and its corresponding labelled neutral. This wiring method is to be neat and of good workmanship quality.
  - .2 The tie wrapping of the neutral with its respective phase conductors is to be made at the closest point of entry into panelboards, pull boxes and junction boxes.
  - .3 The main switchboard, CDP's, panelboards, MCC's, etc. are to have their respective feeder phase and neutral conductors tie wrapped together and enough slack conductor length to enable the ability to clamp the ground detector around each set of feeders. This wiring method is to be neat and of good workmanship quality.
  - .4 The main electrical switchboard is to have each of its sub-feeder phase conductors tie wrapped together with each respective neutral. This tie wrapping is to be located such that ease of clamping the ground detector can be accomplished without excessive exposure to live bus.
  - .5 After all electrical wiring has been completed by the Electrical Sub-Contractor, he is to test the grounded electrical distribution system to ensure there are not ground shorts, and capacitive leakage in the system is within acceptable limits.
  - .6 All feeders or branch circuits, which do not have neutral conductors, are to have their respective phase conductors tie wrapped together in accordance with the methods described previously.
- .7 Submit properly prepared and bound reports of all tests indicating:
  - .1 The date and time of the test.
  - .2 The name or names of those who conducted the test.
  - .3 The purpose of the test.
  - .4 The results of the test.
  - .5 Any applicable code limits or bounds.
- .8 Such tests shall not be construed as evidence of acceptance of any part of the Contract, and it is agreed and understood that no claim for damage will be made for any injury or breakage to any part or parts of the above, due to the aforementioned tests, where caused by weakness or inaccuracy of parts, or by defective materials or workmanship of any kind whatsoever.
- .9 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .10 Manufacturer's Field Services:



- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### **3.10 Cleaning**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .3 On completion of this project, the Contractor shall remove all debris and leave the site neat and tidy. Equipment shall be checked for proper fitting and alignment, adjusted, cleaned, repainted where necessary, and left in first class condition.

**END OF SECTION**

**APPENDIX A**

**ONSA Job Number: 17260**

**Shop Drawing Submittal Form**

General Contractor:

Phone Number:

Fax No:

Electrical Contractor:

Phone Number:

Fax No:

Electrical Contractor Project Representative:

Phone Number:

Fax No:

Shop Drawing Items:

Number of Shop Drawing Copies:

Supplier of Shop Drawings:

Manufacturer of Shop Drawings:

Specification Section and Items:

Drawing Reference:

***Specified Options Indicated***    ☐ ***Yes***    ☐ ***No***

***Items are in Conformance with Plans and Specifications Confirmed by Contractor.***

***(If No, explain):***

***Contractor's Signature:***

***Date:***

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 References**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-C22.2No. 18.2-06 (R2016), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2No.65-13, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

### **1.3 Waste Management and Disposal**

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.
- .3 Divert unused wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

## **PART 2 PRODUCTS**

### **2.1 Materials**

- .1 For branch circuit wiring #10 AWG and smaller, use spring type pressure wire connectors with current carrying parts of copper, or copper alloy, and insulating cap, all to fit copper conductors as required. Standard of acceptable quality: Ideal "wing nuts".
- .2 Joints for all other wiring shall be made using T & B colour keyed compression type connectors, 54000 series, and T & B series compression tools. Insulation shall consist of a first layer of compound type tape followed by a layer of Scotch #33 vinyl tape

## **PART 3 EXECUTION**

### **3.1 Installation**

- .1 Remove insulation carefully from ends of conductors and:

- .1 Install spring type wire connectors for branch circuit and control wiring #10 AWG and smaller. Plier tighten all wire nut joints and connections.
  - .2 Install pressure type wire connectors for branch circuit wiring larger than #10 AWG. Insulating tapes to overlap successive wraps by a minimum of 50%.
  - .3 The splicing of feeders conductors is not acceptable.
- .2 All connections shall be made electrically and mechanically secure. The sizes of connectors shall be according to manufacturer's recommendations for each wire size and combination of wires.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 Related Sections**

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

### **1.2 References**

- .1 CSA C22.2 No .0.3-09 (R2014), Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-2007, Type TECK 90 Cable.

### **1.3 Product Data**

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

### **1.4 Waste Management and Disposal**

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

## **PART 2 - PRODUCTS**

### **2.1 General**

- .1 Wire and cable shall conform fully to the latest specifications of the Canadian Standards Association (C.S.A.), Electrical and Electronic Manufacturers Association Of Canada (EEMAC), the Insulated Power Cable Engineers Association (IPCEA), and the American Society of Testing Materials (ASTM).

### **2.2 Building Wires**

- .1 Wiring on circuits exceeding 50 volts to ground shall be of soft drawn stranded copper of 98% conductivity and of full size and AWG gauge. Insulation shall be cross-linked polyethylene RW-90 rated 600 volts. Wiring shall be continuously colour coded as follows:
  - .1 Phase A Red
  - .2 Phase B Black
  - .3 Phase C Blue
  - .4 Neutral – White/Grey
  - .5 Ground Green
  - .6 Where extra colours are required for three way switches, etc., they shall be yellow.
- .2 Conductors pertaining to the wiring of thermostats, motorized valves, damper actuators, and electric pneumatic relays shall be stranded copper conductor of

95% conductivity and of full size and AWG gauge. Insulation shall be thermoplastic "TW" rated 600 volts. Colour code shall be orange and brown. Minimum size shall be No. 18 AWG.

- .3 Colour coding shall be by insulation colour as follows: Phase conductors on sizes up to and including No. 2 AWG. Neutral, ground and bond conductors on sizes up to and including No. 3/0 AWG. Approved coloured tape, in lieu of coloured insulation, may be used for phase conductors sized No. 1 AWG and larger, neutral, ground and bond conductors sized No. 4/0 AWG and larger.

## 2.3 **Teck Cable**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
  - .1 Grounding conductor: copper.
  - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
  - .1 Type: Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
  - .1 One hole steel straps to secure surface cables 50mm and smaller. Two hole steel straps for cables larger than 50mm.
  - .2 Channel type supports for two or more cables at 1828.8 centers.
  - .3 Threaded rods: 10mm diameter to support suspended channels.
- .8 Connectors:
  - .1 Watertight approved for TECK cable.

## 2.4 **Armoured Cables**

- .1 AC-90 cables shall be soft drawn solid copper of 98% conductivity and of full size and AWG. Insulation shall be cross-linked polyethylene rated 600 volts. Outer armour shall be of interlocking aluminium. Colour coding of AC-90 cable shall be as follows:
  - .1 Phase Conductors - Black or Red
  - .2 Neutral Conductor - White
  - .3 Ground Conductor – Bare
  - .4 Dedicated/Isolated Bond Conductor - Green

## 2.5 Control Cables

- .1 Type LVT: Soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.

## PART 3 - EXECUTION

### 3.1 General

- .1 The Contractor shall run all circuits so that the voltage drop, in no case exceeds 3% of the line volts. The neutral wire, wherever it is run shall be continuous with no fuses, switches, or breaks of any kind.
- .2 The installation of more than 3 conductors in a run of conduit is permissible provided C.E.C. Section 4-004(1) is adhered to with respect to the derating of the conductors.
- .3 The minimum conductor size for all 15-amp branch circuits is to be #12 AWG. For 15 amp 120 volt branch circuits, the following table shall be followed:

<b>Branch Circuit One-Way Length from Panel to Load (Including Vertical Drops)</b>	<b>Phase Wire Size</b>	<b>Dedicated Neutral Wire Size</b>	<b>Shared Neutral Wire Size</b>	<b>Bond Wire Size</b>
<b>Up to (24.38 m)</b>	<b>#12 AWG</b>	<b>#12 AWG</b>	<b>#10 AWG</b>	<b>#12 AWG</b>
<b>(24.68 m to 38.1 m)</b>	<b>#10 AWG</b>	<b>#10 AWG</b>	<b>#8 AWG</b>	<b>#12 AWG</b>
<b>(38.4 m to 56.38 m)</b>	<b>#8 AWG</b>	<b>#8 AWG</b>	<b>#6 AWG</b>	<b>#10 AWG</b>

- .4 Oversized #10 AWG branch circuit wiring conductors to be extended to outlet box of device they feed. Oversized #8 or #6 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. A #8 or #6 AWG wire can be reduced to #10 AWG for vertical portion of drop only.
- .5 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:
- .1 Receptacles.
  - .2 Light switches.
  - .3 Neutral terminal strips.
  - .4 Bonding terminal strips.
  - .5 Circuit breakers.
  - .6 Disconnect switches.
  - .7 Magnetic and manual starters.
  - .8 Magnetic contactors.
  - .9 Relays.

.10 Terminating lugs, etc.

### **3.2 Installation of Building Wires**

- .1 Where pulling wires and cables, the use of an approved lubricant only will be permitted. No wires or cables shall be pulled in conduits until such conduits are free from moisture and in no case shall wires be pulled until approval of the Departmental Representative is obtained.
- .2 All various types of cables are to be installed parallel or perpendicular to building lines and shall be adequately secured to the building structure at not more than 1524mm intervals or as otherwise indicated, in such a 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 or ducts, suspended ceiling support wires, etc.. The laying of "unsupported" cables of any types whatsoever directly atop ceiling grid system is strictly prohibited.
- .3 Install and secure surface cables directly to underside of metal decking and/or ceiling slab where installed in any concealed ceiling spaces.
- .4 Cables are "always" to be installed as high as possible to underside of structure.
  - .1 Where cables 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 structure. Do not install cables in the upper portions of any Q-Decking.
- .5 The grouping together of cables to form a "bundle" for securing purposes, is acceptable provided that the following procedures are adhered to.
  - .1 In addition to securing cables at 1524mm intervals to structure, multiple or bundled groups of cables (including low voltage types), shall be tie-wrapped together at mid-point between each structure support, or every 762mm. Secure to structure at 1524mm intervals, and secure together (between structure supports) at 1524mm intervals.
- .6 After all wiring devices have been installed, the Contractor shall test all systems to make sure there are no grounds, leaks, or shorts. Such tests shall be performed to the satisfaction of both the inspection authority having jurisdiction and the Departmental Representative.

### **3.3 Installation of Teck Cables 0 -1000V**

- .1 Install cables.
  - .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

### **3.4 Installation of Armoured Cables**

- .1 AC-90 is permitted for use as indicated in paragraphs 3.4.6 and 3.4.7 below. All AC-90 cable shall be run parallel to building lines, secured in accordance with C.E.C. 12-618 and shall be adequately clamped and "ty-rapped" to the building structure in such a manner



- that they are protected from mechanical damage. This contractor shall install his own supports for cabling in ceiling spaces and he shall not use those of other trades or secure cabling to pipes, ducts, suspended ceiling support wires, etc.. The laying of cables directly atop ceiling grids is strictly prohibited. The incoming (Panel Side) grounding conductor shall be secured to the grounding screw of each outlet box, before connecting to the other grounding conductors. Twist all grounding conductors to the back of the outlet box, such that the grounding conductors obstruct as little room as possible.
- .2 All flexible conduit or AC-90 fixture feeds shall originate from the side of the outlet box and not from the box cover. Where 3 or 4 drops extend from one outlet box, the box shall be a minimum 121mm square. There shall be no more than 4 drops from any one box. All flex or AC-90 cables used for fixture drops are to be secured within 305mm of the junction box.
  - .3 Grouping of AC-90 cables shall be limited to a maximum of eight current carrying conductors, including associated oversized neutral conductors where phase sharing occurs.
  - .4 The following examples incorporate uses of both common and dedicated (separate) branch circuit neutral conductors:
    - .1 Maximum of two runs of #12/4 conductor cables, including common (oversized) branch circuit neutral in each.
    - .2 Maximum of two runs of #12/3 conductor cables, including (oversized) branch circuit neutrals (if not 3 phase, 3 wire), plus one run of #12/2 cable.
    - .3 Maximum of four runs of #12/2 conductor cables, each including a separate, dedicated branch circuit neutral conductor.
  - .5 Where dedicated or separate branch circuit neutral conductors are non phase sharing, they need not be sized larger than phase conductors they accompany unless specifically indicated otherwise.
  - .6 AC90 may be utilized as a fixture drop. A 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) and its respective light fixture.
  - .7 AC90 may be utilized as a wiring device drop. A wiring device drop (drop to receptacle and light switches) is defined as that portion of AC-90 cable being used to make final connection between "accessible" type junction or outlet box located in ceiling space (above T-bar ceiling) and its respective wiring device.
    - .1 There shall be not more than four drops from any one box regardless of size. All AC-90 cables used for fixture drops are to be secured within 305mm of the junction box. Each fixture is to be complete with its own separate fixture drop originating from junction box located within same room.
    - .2 Provide 20 amp O.C. protection for "all" lighting branch circuits, unless specifically indicated otherwise.
    - .3 No. 12 AWG and No. 14 AWG Type AC-90 cables may be used where total fixture drop "loads" do not exceed the following:
      - .1 Maximum of 1800 watts at 120 volts using #12 AWG drop.
      - .2 Maximum of 1300 watts at 120 volts using #14 AWG drop.
  - .8 Separate pig-tail type leads shall be provided in each light fixture junction/outlet box for "final" connections to fixture drops. These pig-tail leads are to be "only" connected to light fixture "returns" and associated "neutral" conductors.

- .9 AC90 may be not be utilized as a home run to any panel board.

### **3.5 Installation of Control Cables**

- .1 The installation of "surface" wiring on walls or in open (non-enclosed) type ceilings, shall be Type EMT conduit complete with associated steel type connectors and couplings.
- .2 EMT conduit is to be extended to within 610mm of "all" various control devices associated with the operation of any given piece of mechanical equipment.
- .3 Unless specifically indicated otherwise, liquid tight, flexible metal type conduit complete with steel type connector and steel locknut may be used for the "final" 610mm connection between the end of the EMT conduit and the applicable control device.
- .4 EMT or PVC type conduit "wall stubs" complete with flush installed device box shall be installed in all masonry or concrete partitions where, and as may be required, where plenum rated cabling is used.
- .5 EMT connectors complete with nylon insulated throat or threaded type bushing shall be installed on end of EMT stub above "finish" type ceilings, etc., where plenum rated cabling is used.
- .6 All EMT conduit stubs are to be "bonded" to ground as per CEC.
- .7 Ground control cable shield.

### **3.6 Stranded Conductors**

- .1 All stranded conductors prior to terminating under device bolts such as circuit breakers, switches, receptacles, etc., are to be twisted together so as to form a single conductor to ensure a reliable mechanical connection.

### **3.7 Capacitive Leakage Wiring Methods**

- .1 The following wiring methods detailed below are designed to enhance the ability of the Departmental Representative to perform capacitive leakage tests in the future:
- .1 All circuit conductors are to be individually ty-wrapped to their corresponding labelled neutral conductor in all panelboards, pull boxes and junction boxes. Enough slack conductor length should be left to enable the ability to clamp the ground detector around the individually ty-wrapped circuit conductor and its corresponding labelled neutral. This wiring method is to be neat and of good workmanship quality.
- .2 The ty-wrapping of the neutral with its respective phase conductors is to be made at the closest point of entry into panelboards, pull boxes and junction boxes.
- .3 The main switchboard, CDP's, panelboards, etc. are have their respective feeder phase and neutral conductors ty-wrapped together with enough

slack conductor length to enable the ability to clamp the ground detector around each set of feeders. This wiring method is to be neat and of good workmanship quality. This ty-wrapping is to be located such that ease of clamping the ground detector can be accomplished without excessive exposure to live bussing.

- .4 After all electrical wiring has been completed by the Electrical Sub-Contractor, he is to test the grounded electrical distribution system to ensure there are no ground shorts or grounds.
- .5 All feeders or branch circuits which do not have neutral conductors are to have their respective phase conductors ty-wrapped together in accordance to the methods described previously.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 Related Sections**

- .1 Section 26 05 01 - Common Work Results - Electrical.

### **1.3 References**

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
  - .1 ANSI/BICSI 007-2017, Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)

### **1.4 Waste Management and Disposal**

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

## **PART 2 PRODUCTS**

### **2.1 Equipment**

- .1 Grounding equipment shall be to CSA C22.2 No.41.
- .2 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .3 All ground plate clamps and fittings to be bronze or brass.
- .4 Ground conductors to be to ASA-G7.1.
- .5 Insulated ground conductors are to be RW90, green, for sizes up to and including #2. Insulated ground conductors #1 and larger to be TWH, green. All ground conductors to be copper without exception.
- .6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1 Grounding and bonding bushings.
  - .2 Protective type clamps.
  - .3 Bolted type conductor connectors.
  - .4 Bonding jumpers, straps.
  - .5 Pressure wire connectors.

## **PART 3 EXECUTION**

### **3.1 Installation General**

- .1 All equipment and exposed non-current-carrying metal, conduits and parts shall be permanently and effectually grounded to meet minimum requirements of the C.E.C., and as indicated on the drawings and further specified. Standards set either by drawings or specifications which are above those covered by C.E.C. shall not be reduced under any circumstances.
- .2 A complete grounding system shall be installed as indicated, which shall include but not be limited to the following:
  - .1 The wall mounted ground busses in all communications rooms.
  - .2 The metallic piping in storm and sanitary waste systems.
  - .3 The metallic piping in sprinkler systems.
  - .4 Structural steel.
- .3 Generally, minimum grounding shall be provided by the metallic conduit/outlet box system and by the bond wire in cables. Additional insulated ground wires, sized as per the drawings, shall be provided as follows:
  - .1 In all EMT conduit feeders that supply panelboards, CDP panels, FDP panels, MCC's, and transformers - all sized as per C.E.C. Table 16.
  - .2 All non-metallic conduit systems (i.e.- PVC conduit).
  - .3 A separate green bond conductor sized as per Table 16 of the C.E.C. shall be installed in each EMT conduit run for branch circuit wiring.
  - .4 Ground plates shall be buried in the locations as indicated on the drawings. The maximum resistance to ground, of the entire system shall not exceed 10 OHMS, and additional ground plates shall be buried, as required, to attain this value.
  - .5 A Number 6 AWG insulated copper cable shall be run from the main distribution ground bus to the main water pipe and connected to the upstream side of the water meter. Water pipes shall be scraped and sanded to remove all scale, rust or paint at location where ground is to be made, and ground connectors shall be tightened securely. Where water mains are not available, provide grounding electrode.
  - .6 A number 6 AWG insulated copper cable shall be run from the main electrical room ground bus to all main metallic drainage, water and sprinkler piping.
  - .7 Where ground conductors terminate at ground buses in switchboards or panelboards, the connection shall be made with a compression lug, which shall be secured to the bus with nut, bolt and two Belleville washers. Size of bolts shall be to suit lug and shall be properly torqued and marked.
  - .8 A ground bus shall be supplied and installed in the main electrical room and the main communications room, all as indicated on the drawings. Connections to these busses shall be via two hole, compression lugs and thermit weld as indicated.
- .4 Install connectors in accordance with manufacturer's instructions.
- .5 Protect exposed grounding conductors from mechanical injury.

- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install separate ground conductor to outdoor lighting standards.
- .9 Connect building structural steel and metal siding to ground by welding copper to steel.
- .10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .11 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

### **3.2 System and Circuit Grounding**

- .1 Install system and circuit grounding connections.

### **3.3 Equipment Grounding**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, elevators and escalators, distribution panels, outdoor lighting.

### **3.4 Communication Systems**

- .1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:
  - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
  - .2 Sound, fire alarm, intercommunication systems as indicated.

### **3.5 Field Quality Control**

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 Related Sections**

- .1 Section 26 05 01 Common Work Results - For Electrical.

### **1.3 Waste Management and Disposal**

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

## **PART 2 PRODUCTS**

### **2.1 Support Channels**

- .1 U shape, size [41 x 41] mm, [2.5] mm thick, surface mounted, suspended, set in poured concrete walls and ceilings.
- .2 All strut to be galvanized.
- .3 All threaded hanger rods to be minimum (10 mm) diameter, larger if required, made from mild steel.
- .4 In concrete use cast in threaded inserts wherever possible. Should additional inserts be required use a "red head" type of insert capable of carrying at least (227 kg).
- .5 Supports for all conduit work shall be one hole steel pipe straps; unistrut, or equal, with necessary fittings, approved for their respective use.
- .6 All pull and junction boxes, wireways, and multiple conduits shall be supported by a steel channel support system with all components, hangers, wall supports, cable clamps, etc., specifically manufactured and approved for their application.
- .7 Fastening devices for cabinets, boxes, supports etc., shall be nut and bolt, expansion shields, wedge anchors, or toggle bolts, size and number to suit the application or as detailed on the drawings. Toggle bolts may not be used in plasterboard construction.
- .8 Fastening devices for outlet boxes shall be nut and bolt, expansion shields, wedge anchors or caddy clips, size and number to suit the application or as detailed on the drawings.

- .9 Where outlet boxes are set in drywall construction, a piece of steel stud shall be secured to either side of the outlet box or use caddy quick-mount box supports, or caddy J-1-A for side box supports

### **PART 3 EXECUTION**

#### **3.1 Installation**

- .1 Secure all equipment in a manner so as not to distort or cause undue stress on any components.
- .2 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts. Toggle bolts shall not be used to secure equipment to plasterboard, drywall, or acoustic tile surfaces.
- .5 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .6 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .7 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole steel straps to secure surface conduits and cables (50 mm) and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than (50 mm).
  - .3 Beam clamps to secure conduit to exposed steel work.
- .8 Suspended support systems.
  - .1 Support individual cable or conduit runs with (10 mm) dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by (10 mm) dia threaded rod hangers where direct fastening to building construction is impractical.
- .9 For surface mounting of two or more conduits use channels at (1.5 m) on centre spacing.
- .10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .12 Do not use wire lashing or perforated strap to support or secure raceways or cables.



- .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Departmental Representative.
- .14 Do not support any electrical conduits, wire or equipment from ceiling system support cables. Ceiling systems support cables may be utilized to marshal AC90 drops to fixtures.
- .15 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .16 In addition to the C.E.C. conduit support requirements, all suspended conduit runs containing horizontal or vertical elbows shall have one additional support installed not greater than (305 mm) from the midpoint of the 90° bend.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 Shop Drawings and Product Data**

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

### **1.3 Waste Management and Disposal**

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

## **PART 2 PRODUCTS**

### **2.1 Junction and Pull Boxes**

- .1 Pull and junction boxes, where larger than standard boxes shall be Type "C" or "D" boxes sized according to C.E.C. Sections 12 3000 to 12 3036. Use Type "D" for boxes up to (300mm) x (300mm) and Type "C" for boxes (300mm) x (300mm) or larger.
- .2 Pull boxes shall be of sheet metal construction with all welded steel corners and screw on flat covers for surface mounting.
- .3 All flush installed boxes shall be Type "D". Covers for flush mounted pull boxes shall extend a minimum of (25 mm) all around.
- .4 Concealed junction boxes (within ceiling space) shall not be smaller than (100 mm) square.
- .5 Pull and junction boxes, where installed exterior to the building shall be the equivalent of C.S.A. 4x.

### **2.2 Cabinets**

- .1 Cabinets shall be steel, fabricated to C.S.A. & EEMAC Standards with baked enamel finish. Cabinet shall be EEMAC Standard Types "C", "D", or "T" as indicated on the drawings. Type "T" cabinets shall be complete with hinged door, lock, two keys, and handle, and be lined with [19 mm] plywood.

## **PART 3 EXECUTION**

### **3.1 Junction, Pull Boxes and Cabinets Installation**

- .1 Install pull boxes in inconspicuous but accessible locations and secure them adequately to the building structure. Pull boxes installed in the middle of conduit runs without backing are not acceptable.
- .2 The location of junction and/or pull boxes in suspended ceiling spaces, i.e. - dry wall, T-Bar, etc., is not to be greater than (762 mm) above the finished ceiling and must be easily accessible.
- .3 All suspended junction, pull and outlet boxes shall be supported with minimum size (9.5 mm) threaded rods, nuts and flat washers. Threaded rods shall be secured to boxes with one flat washer and nut installed on both sides of box. One rod required for all boxes sized up to and including (119 mm) square. Two rods required for boxes larger than (119 mm) square, up to and including (203 mm) square. A minimum of four rods required for all boxes larger than (203 mm) square.
- .4 Mount cabinets with top not higher than (2000 mm) above finished floor.
- .5 Install terminal block as indicated in Type T cabinets.
- .6 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed (30 m) of conduit run between pull boxes.

### **3.2 Identification**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 References**

- .1 Canadian Electrical Code, Part 1.

### **1.3 Waste Management and Disposal**

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

## **PART 2 PRODUCTS**

### **2.1 Outlet and Conduit Boxes General**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

### **2.2 Sheet Steel Outlet Boxes**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. (102 mm) square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size [102 x 54 x 48 mm].
- .3 (102 mm) square or octagonal outlet boxes for lighting fixture outlets.
- .4 (102 mm) square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.
- .5 Surface outlet boxes installed below (2500 mm) shall be hot dipped galvanized cast "FS", or "FD" series boxes with metal coverplates.

## **2.3    Conduit Boxes**

- .1     Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

## **2.4    Fittings - General**

- .1     Bushing and connectors with nylon insulated throats.
- .2     Knock-out fillers to prevent entry of debris.
- .3     Conduit outlet bodies for conduit up to (32 mm) and pull boxes for larger conduits.
- .4     Double locknuts and insulated bushings on sheet metal boxes.

# **PART 3   EXECUTION**

## **3.1    Installation**

- .1     Support boxes independently of connecting conduits.
- .2     Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3     For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4     Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5     At each local switch, convenience outlet, receptacle, ceiling or wall fixture, continuous row of fixtures, or system unit (i.e. fire alarm, etc.) provide and install a standard pressed steel outlet box unless specifically noted otherwise. All outlet boxes shall be galvanized inside and out and set flush with finished surfaces. They shall be rigidly and securely set. Boxes shall not be mounted back to back, but separated by a minimum of (305 mm), to prevent noise transmission.
- .6     In centering outlets, the Contractor is cautioned to allow for radiation, pipes, ducts, etc., and for the variation in arrangement and thickness of finishes, etc.. His failure to comply with this will not relieve him from the cost of necessary alterations.
- .7     The Contractor shall allow for the relocation of an outlet up to (3048 mm) from where shown, provided he has been notified so prior to rough-in of the same.
- .8     No outlet or junction box may be installed more than (762 mm) above a finished ceiling.
- .9     All suspended boxes are to be supported with minimum size (9 mm) threaded rod(s).
- .10    All flexible conduit fixture feeds shall originate from the side of the outlet box and not from the box cover.

- .11 Flush installed (100 mm) square or a (119 mm) square box being used as a junction or pull box that requires a blank metal coverplate, is to have an appropriate sized, one or two gang "plaster 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.
- .12 When installing flush boxes in metal drywall partitions, always screw a short piece of metal stud (same width as partition) to non-supported side of box.
- .13 Concealed boxes installed above drywall ceilings or behind walls, are to have their locations identified on room sides of access opening frames with properly colour coded identification discs.
- .14 Condulet fittings (LB, LL, LR, etc.) and their respective covers/plates are to be painted, and where concealed, have their locations identified with appropriate colour coded, (19 mm), self adhering discs, applied to T-bar splines and/or access opening frames, in similar manner as for concealed junction and/or pull boxes, etc..
- .15 Tile type extension rings are not to be used on boxes that have not been "flush" installed. They are not intended, not acceptable for "surface" type application.
- .16 Install floor boxes in concrete form work, prior to concrete pour, securely set to ensure finished collar is flush with the finished floor.

### **3.2 Identification**

- .1 All outlet boxes shall be colour coded as per the colour coding legend for conduits and cables. Refer to Specification Section 26 05 01. Outlet boxes are to be coloured only on the inside.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 General Requirements**

- .1 Division 1 and the General Conditions of the Contract between the Departmental Representative and the Contractor shall deem to apply and be part of this section.

### **1.2 References**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No. 18.2-06 (R2016), Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
  - .2 CSA C22.2 No. 45.1-07 (R2017), Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56-17, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 83-M1985 (R2017), Electrical Metallic Tubing.
  - .5 CSA C22.2 No. 211.2-06 (R2016), Rigid PVC (Unplasticized) Conduit.
  - .6 CAN/CSA C22.2 No. 227.3-15, Flexible Nonmetallic Tubing.

### **1.3 Waste Management And Disposal**

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

## **PART 2 PRODUCTS**

### **2.1 Conduits**

- .1 Rigid steel threaded conduit shall conform to C.S.A. C22.2 No. 45.1-07 (R2017) galvanized, sized as indicated.
- .2 Thinwall Type "EMT" conduit shall conform to C.S.A. C22.2 No. 83-M1985 (R2017), galvanized, sized as indicated.
- .3 Flexible galvanized steel liquid tight conduit shall conform to C.S.A. C22.2 No. 56-17, sized as indicated.
- .4 Rigid P.V.C. conduit shall conform to C.S.A. C22.2 No. 211.2-06 (R2016), sized as indicated.

### **2.2 Conduit Fastenings**

- .1 One hole steel straps to secure surface conduits (50 mm) and smaller. Two hole steel straps for conduits larger than (50 mm).
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at [1500mm] on centers.

- .4 Threaded rods, (10 mm) diameter, to support suspended channels.

## **2.3 Conduit Fittings**

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90 degree bends are required for (25 mm) and larger conduits.
- .3 Couplings for thinwall Type "EMT" shall be permitted to use set screw type, galvanized steel above TBAR in ceiling space. Locknuts shall be case hardened steel.
- .4 Connectors for thinwall Type "EMT" shall be permitted to use set screw type, galvanized steel above TBAR in ceiling space. Locknuts shall be case hardened steel. Connectors (32 mm) and larger shall be complete with threaded plastic bushings. Connectors less than (32 mm) shall be complete with insulated throats.
- .5 Couplings and connectors for P.V.C. rigid conduit shall be C.S.A. Approved for their respective use. All P.V.C. fittings shall be solvent weld type. Push-fit type fittings are not acceptable.
- .6 Connectors for flexible conduit, armoured cable shall be permitted to use set screw type, galvanized steel above TBAR in ceiling space. Units shall be T&B #3110 series, steel, and be complete with case hardened locknuts.
- .7 Connectors for liquid tight flexible conduit shall be watertight, compression type galvanized steel or aluminum. Locknuts shall be case hardened. Dry type connectors may be used in dry indoor areas not exposed to liquids or moisture, if approved for use.
- .8 For exposed installations of horizontal and vertical runs of EMT conduit use raintight connectors and couplings. Set-screws are not acceptable.

## **2.4 Fish Cord**

- .1 Polypropylene.

## **PART 3 EXECUTION**

### **3.1 Installation**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Rigid PVC or Galvanized rigid steel threaded conduit shall be used in all poured concrete construction. Thinwall Type "EMT" shall be used for all branch circuit wiring and all systems installed exposed on ceilings and walls unless noted otherwise. Bends, offsets, or elbows made on the job for steel conduits shall be made so that the conduit is not injured or flattened.



- .4 All branch circuit wiring run in thinwall Type EMT conduit shall be complete with a No. 12 AWG minimum green insulated bonding conductor, increasing as required by Table 16 of the C.E.C..
- .5 P.V.C. conduits sized (25 mm) in diameter and larger shall be installed in trenches not less than (305 mm) in depth from underside of concrete floor slab to bottom of trench. Conduits shall be placed on a (50 mm) bed of sand and have a second (50 mm) of sand placed on top (completely around) of conduits prior to backfilling.
- .6 All concealed and exposed conduit shall be kept parallel to building lines and run "on the square". All conduits shall be installed to avoid proximity to steam and hot water pipes by (152 mm). Conduits shall run through ceiling spaces and down in walls. No conduit shall run in or under floor slabs unless specifically indicated.
- .7 All conduits shall be securely held in place by means of approved supports and in accordance with C.E.C. Sections 12-1010, 12-1114 and 12-1406. All EMT conduit straps shall be steel. Cast straps are not acceptable. EMT conduit shall be installed as a complete system and shall be securely fastened in place within one meter of each outlet box, junction box, cabinet, couplings or fittings and the spacing between supports as follows:
  - .1 Less than (1524 mm) for (13 mm) and (19 mm) EMT;
  - .2 Less than (2286 mm) for (25 mm) and (32 mm) EMT;
  - .3 Less than (3048 mm) for (38 mm) EMT or larger.
- .8 Code approved P.V.C. rigid conduit shall be used for underground circuits and where otherwise specifically noted. Conduit shall be joined with approved connectors and P.V.C. solvent cement. The proper size bonding conductor, as per the C.E.C., shall installed in all P.V.C. conduits.
- .9 No Branch circuit wiring shall run in concrete slabs. Conduit stubs in concrete shall be protected from damage during construction. Conduit openings shall be sealed with plugs or caps to prevent entrance of foreign materials. Where conduits pass through a waterproof membrane an oversize sleeve shall be installed and caulking applied to maintain the waterproof properties of the membrane. A cold cure mastic shall then be applied between sleeve and conduit.
- .10 Flexible conduit, not smaller than (10 mm) I.D., or flexible armoured cable with separate grounding conductor, and complete with insulating anti shorts, shall be used between lighting fixtures and their respective junction boxes, and where rigid or "EMT" conduit cannot be used, such as in cabinet work.
- .11 Liquid tight flexible conduit, not smaller than (10 mm) I.D., shall be used for connections to all transformers, motors and equipments, in both wet and dry areas.
- .12 Upon installation of all conduits, terminate in boxes, cabinets, and fittings, or install suitable plugs or caps, to prevent the entrance of foreign materials. Conduits shall be swabbed out using a drag, consisting of tight fitting rubber washers and shall be dry before conductors are pulled in.

- .13 All conduit subject to corrosive elements shall be treated with corrosion resistant compounds.
- .14 Conduit shall not pass through structural members without the permission of the Departmental Representative.
- .15 A sufficient number of fittings shall be used to permit easy pulling of wires. Conduits shall be continuous, and shall be made electrically and mechanically secure throughout.
- .16 Conduits shall not run directly between outlets on the opposite sides of a common partition, in order to prevent sound transmission.
- .17 It is strictly prohibited to install or otherwise "conceal" any types of rigid or flexible conduits, cables, etc. "within" the uppermost, or top portions of metal type Q-Deck "flutes", regardless of their intended use(s).
  - .1 All or any types of wiring associated with metal type decking is to be "surface" installed on underside, or room side of same.
- .18 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .19 Minimum conduit size for lighting and power circuits: [13 mm].
- .20 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .21 Mechanically bend steel conduit over (19 mm) diameter.
- .22 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .23 Install fish cord in empty conduits.
- .24 Run 2-[25 mm] spare conduits up to ceiling space and 2- [25 mm] spare conduits down to ceiling space from each flush panel. Terminate these conduits in [152 x 152 x 102 mm] junction boxes in ceiling space.
- .25 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .26 Dry conduits out before installing wire.

### 3.2 **Surface Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended channels.
- .5 Do not pass conduits through structural members except as indicated.

- .6 Do not locate conduits less than (75 mm) parallel to steam or hot water lines with minimum of (25 mm) at crossovers.

### **3.3 Concealed Conduits**

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

### **3.4 Couplings and Connectors**

- .1 Threaded couplings shall be used for all rigid steel threaded conduit joints. All joints in or below concrete slabs shall be thoroughly red leaded and screwed tight. No exposed threads shall be left, i.e., running thread couplings are not approved. Ericson couplings are approved.
- .2 Rigid steel threaded conduit shall connect to boxes and cabinets with the use of two case hardened steel locknuts and insulated bushing. Painted area at locknut connections shall be scraped clean, and locknuts screwed tight to ensure ground continuity.
- .3 Thinwall Type "EMT" couplings shall be securely tightened.
- .4 Connectors for thinwall Type "EMT", liquid tight and flexible conduit or cable shall terminate at boxes and cabinets with one case hardened locknut. Painted area shall be scraped clean, and locknut screwed tight to ensure ground continuity.
- .5 Couplings and connectors for rigid P.V.C. shall be cleaned with solvent and joined with cement C.S.A. approved for the purpose.

### **3.5 Conduit Fittings**

- .1 Install conduit fittings where required. Secure conduit in fittings and secure conduit to structure within (300 mm) of fitting.
- .2 Colour code coverplates, ceiling splines and access covers in accordance with Section 26 05 01.

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 Related Requirements**

- .1 Section 01 33 00 Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 26 05 01 - Common Work Results - Electrical.

### **1.2 Reference Standards**

- .1 CSA C22.2 No.42.1 00, Cover Plates for Flush Mounted Wiring Devices (Bi national standard, with UL 514D).
- .2 CSA C22.2 No. 223 – Power Supplies with Extra-low-voltage Class 2 Outputs; **2015**.

### **1.3 Administrative Requirements**

- .1 Coordination:
  - .1 Coordinate the placement of sensors and wall controls with existing millwork, furniture, equipment, etc..
  - .2 Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
  - .3 Coordinate the work to provide luminaires compatible with the lighting controls to be installed.

### **1.4 Shop Drawings and Product Data**

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

### **1.5 Waste Management and Disposal**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

## **1.6 Delivery, Storage, and Handling**

- .1 Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

## **1.7 Technical Support and Service**

- .1 Manufacturer's field service representatives shall be available for immediate Dispatch 7 days a week, 365 days a year. All field service personnel shall be factory trained, by the manufacturer, and certified in the maintenance and repair of the specified equipment. Manufacturer's field service representatives shall have a local permanent office in the province of Nova Scotia.

## **1.8 Warranty**

- .1 For wireless sensors, the 12 month warranty period is extended to 60 months.
- .2 Warranty:
  - .1 Lighting Control System Components, Except Wireless Sensors, Ballasts/Drivers and Ballast Modules: One year 100 percent parts coverage, no manufacturer labor coverage.
  - .2 Wireless Sensors: Five years 100 percent parts coverage, no manufacturer labor coverage.

## **PART 2 PRODUCTS**

### **2.1 Acceptable Manufacturer**

- .1 Lutron Electronics Company, Inc; Vive wireless control system.

### **2.2 Lighting Controls - General Requirements**

- .1 Use the following paragraph to specify optional manufacturer Sensor Layout and Tuning (requires On-Site Full-Scope Start-Up Service to be specified under "FIELD QUALITY CONTROL" in Part 3 and Pre-Wire Meeting to be specified under "ADMINISTRATIVE REQUIREMENTS" in Part 1). Edit the choice to have this additional value included as an alternate or as part of the base bid.
- .2 Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.
- .3 Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, programming, etc. as necessary for a complete operating system that provides the control intent indicated.

- .4 Typical dimming equipment is rated for 40 degrees C (104 degrees F). This is the maximum ambient temperature that can exist while the dimming equipment is operating at full load conditions. Include the following paragraph to ensure that the operating equipment is designed to operate at worst case environmental conditions without affecting product life.
- .5 Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.
- .6 Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
- .7 Power dropouts occur frequently. The momentary interruption of power should not cause extended periods without lighting or require some manual intervention to reset the lighting system. Some manufacturers may define power failure memory as a feature that handles momentary power outages on the order of 20 seconds. This does not account for power outages that occur for a longer period of time.
- .8 Power Failure Recovery: When power is interrupted and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
- .9 Wireless Devices:
  - .1 Wireless device family includes area or fixture level sensors, area or fixture level load controls for dimming or switching, and load controls that can be mounted in a wallbox, on a junction box, or at the fixture.
  - .2 Wireless devices including sensors, load controls, and wireless remotes or wall stations, can be set up using simple button press programming without needing any other equipment (e.g. central hub, processor, computer, or other smart device).
  - .3 Wireless hub adds the ability to set up the system using any smart device with a web browser (e.g. smartphone, tablet, PC, or laptop).
  - .4 System does not require a factory technician to set up or program the system.
  - .5 Capable of diagnosing system communications.
  - .6 Capable of having addresses automatically assigned to them.
  - .7 Receives signals from other wireless devices and provides feedback to user.
  - .8 Capable of determining which devices have been addressed.
  - .9 RF Range: 60 feet (18 m) line-of-sight or 30 feet (9 m) through typical construction materials between RF transmitting devices and compatible RF receiving devices.
  - .10 Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.

- .10 Wireless Network:
  - .1 RF Frequency: 434 MHz or 900 MHz; operate in Industry Canada governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
  - .2 Wireless sensors, wireless wall stations and wireless load control devices do not operate in the noisy 2.4 GHz frequency band where high potential for RF interference exists.
  - .3 Wireless devices operate in an uncongested frequency band providing reliable operation.
  - .4 Fixed network architecture ensures all associated lights and load controls respond in a simultaneous and coordinated fashion from a button press, sensor signal, or command from the wireless hub (i.e. no popcorning).
  - .5 Distributed Architecture: Local room devices communicate directly with each other. If the wireless hub is removed or damaged, local control, sensing, and operation continues to function without interruption.
  - .6 Local room devices communicate directly with each other (and not through a central hub or processor) to ensure:
    - .1 Reliability of system performance.
    - .2 Fast response time to events in the space (e.g. button presses or sensor signals).
    - .3 Independent operation in the event of the wireless hub being removed or damaged.
- .11 Device Finishes:
  - .1 Wall Controls: Ivory
  - .2 Color Variation in Same Product Family: Maximum delta E of 1, CIE L\*a\*b color units.
  - .3 Daylight or fluorescent lighting generate ultraviolet light which can cause parts that do not meet ASTM D4674 to discolor/yellow over time.
  - .4 Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

## 2.3 **Wireless Sensors**

- .1 General Requirements:
  - .1 Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.
  - .2 Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
  - .3 Does not require external power packs, power wiring, or communication wiring.
  - .4 Capable of being placed in test mode to verify correct operation from the face of the unit.
- .2 Lutron's occupancy/vacancy sensors are wireless, battery-powered passive infrared (PIR) sensors that automatically control lights via RF communication to compatible dimming and switching devices. These sensors detect the heat from people moving within an area to determine when the space is occupied. The sensors then wirelessly transmit the appropriate commands to the associated

dimming and switching devices to turn the lights on or off automatically. They combine both convenience and exceptional energy savings along with ease of installation.

.3 Wireless Occupancy/Vacancy Sensors:

.1 General Requirements:

- .1 Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
- .2 Include the following paragraph to ensure that the line-of-sight is not obstructed due to dust and other contaminants.
- .3 Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
- .4 Lutron's XCT signal processing technology greatly enhances the performance of PIR sensors, enabling them to "see" fine motions that other sensors couldn't previously detect. Plus, the user-replaceable batteries are designed to last up to 10 years.
- .5 Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions; Lutron XCT Technology. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
- .6 Provide optional, readily accessible, user-adjustable controls for timeout, automatic/manual-on, and sensitivity.
- .7 Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
- .8 Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
- .9 Color: White.
- .10 Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
- .11 Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
- .12 Sensor lens to illuminate during test mode when motion is detected to allow installer to place sensor in ideal location and to verify coverage prior to permanent mounting.
- .13 Ceiling-Mounted Sensors:
  - .1 Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
  - .2 Provide recessed mounting bracket compatible with drywall and compressed fiber ceilings.

.2 Wall-Mounted Sensors: Provide wall or corner mounting brackets compatible with drywall and plaster walls.

.4 Wireless Combination Occupancy/Vacancy Sensors:

- .1 Ceiling-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), an occupancy sensor with low



- light feature (automatic-on when less than one lux of ambient light available and automatic-off), or a vacancy sensor (manual-on and automatic-off).
- .2 Wall-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), or a vacancy sensor (manual-on and automatic-off).
  - .3 Product(s):
    - .1 Ceiling-Mounted Occupancy/Vacancy Sensor; **Lutron Radio Powr Savr Series, Model LFR2-OCR2B-P-WH**: Coverage from 324 square feet (30.2 sq m) to 676 square feet (62.4 sq m) depending on ceiling height from 8 to 12 feet (2.4 to 3.7 m); 360 degree field of view.
    - .2 Wall-Mounted Occupancy/Vacancy Sensor; **Lutron Radio Powr Savr Series, Model LFR2-OWLB-P-WH**: Minor motion coverage of 1500 square feet (139.4 sq m) and major motion coverage of 3000 square feet (278.7 sq m) with mounting height of 6 to 8 feet (1.8 to 2.4 m); 180 degree field of view.
    - .3 Corner-Mounted Occupancy/Vacancy Sensor; **Lutron Radio Powr Savr Series, Model LFR2-OKLB-P-WH**: Minor motion coverage of 1225 square feet (113.8 sq m) and major motion coverage of 2500 square feet (232.3 sq m) with mounting height of 6 to 8 feet (1.8 to 2.4 m); 90 degree field of view.
    - .4 Hallway Occupancy/Vacancy Sensor; **Lutron Radio Powr Savr Series, Model LFR2-OHLB-P-WH**: Major motion coverage of up to 150 feet (45.7 m) with mounting height of 6 to 8 feet (1.8 to 2.4 m); narrow field of view.
  - .5 Wireless Daylight Sensors:
    - .1 Product: Lutron Radio Powr Savr Series, Model LFR2-DCRB-WH.
    - .2 Open-loop basis for daylight sensor control scheme.
    - .3 Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
    - .4 Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
    - .5 Provide linear response from 2 to 150 footcandles.
    - .6 Color: White.
    - .7 Mounting:
      - .1 Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
      - .2 Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
      - .3 Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

## 2.4 Load Control Modules

- .1 Provide wireless load control modules as indicated or as required to control the loads as indicated.
- .2 Junction Box-Mounted Modules:
  - .1 Plenum rated.
  - .2 Dimming Modules:
    - .1 Product(s):
      - .1 8 A dimming module with 0-10V control; **Lutron PowPak Dimming Module Model RMJS-8T-DV-B.**
    - .2 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
    - .3 IEC 60929 is a standard for electronic fluorescent ballasts, and is used by other lighting equipment controlled by low voltage signals including LED drivers and low voltage controlled neon. It defines specific methods for 0-10V, pulse width modulation (PWM), and Digitally Addressable Lighting Interface (DALI).
    - .4 Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
    - .5 Certain applications, such as hallways, may require that the lights never turn off. For these areas, select the minimum light level option and the load will lower to programmed low-end level. Default operation lowers to OFF.
    - .6 Selectable minimum light level.
    - .7 Configurable high- and low-end trim.
    - .8 Relay: Rated for 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.
- .3 0-10 V Dimming Fixture Control Modules:
  - 1. Product(s):
    - .1 Lutron's PowPak® wireless fixture control is a radio frequency (RF) device that controls either the Lutron EcoSystem® or 0-10 V ballasts/drivers (depending on model) based on RF input from Pico® wireless controls and Radio Powr Savr™ wireless occupancy/vacancy sensors or wired inputs from the PowPak® fixture sensor. The control module mounts to a fixture or junction box. Communication with RF input devices is accomplished using Lutron Clear Connect® RF Technology, which ensures smooth, consistent performance.
      - .1 Product: Lutron PowPak Wireless Fixture Control for 0-10 V ballasts/drivers; Model FCJS-010.
    - .2 Supports reporting of energy measurement to wireless hub at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
    - .3 IEC 60929 is a standard for electronic fluorescent ballasts, and is used by other lighting equipment controlled by low voltage signals including LED drivers and low voltage controlled neon. It defines specific methods for 0-10V, pulse width modulation (PWM), and Digitally Addressable Lighting Interface (DALI).

- .4 Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
  - .5 Provides 0-10 V control for up to 3 ballasts/LED drivers (1 A load at 120-277 V, 6 mA max control current).
  - .6 Rated for switching 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.
3. Relay Modules:
- .1 Product(s):
    - .1 16 A relay module, without contact closure output; **Lutron PowPak Relay Module Model RMJS-16R-DV-B.**
  - .2 Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
  - .3 Relay:
    - .1 Lutron Softswitch circuitry prevents arcing at the relay contacts for all three load types, and extends the relay life in excess of one million cycles. Switching high inrush loads can damage relay controls over time. The arcing of these relays, depending on load, typically will limit relay life to 10,000 or 50,000 cycles.
    - .2 Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
    - .3 Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
    - .4 Fully rated output continuous duty for inductive, capacitive, and resistive loads.
  - .4 Contact Closure Output:
    - .1 Single contact closure output with normally open and normally closed dry maintained contacts suitable for connection to third party equipment (e.g. building management system, HVAC system, etc.).
    - .2 Contact Ratings: Resistive load; 1 A at 0-24 VDC, 0.5 A at 0-24 VAC.
    - .3 Controlled by associated occupancy/vacancy sensors and wall controls.

## 2.5 Wireless Control Stations

- .1 The Pico Wireless Control is a flexible and easy to use device that allows the user to control dimmers and switches. The Pico wireless control can function as a tabletop control on a pedestal, a lightweight handheld remote, or it can be wall-mounted with or without a Lutron Claro faceplate, to mimic a traditional keypad. The battery-operated control requires no external power or communication wiring. Models are available with integral night light. Visit [www.lutron.com](http://www.lutron.com) for data sheets and other information.
- .2 Product(s):
  - .1 2-Button Control; **Lutron Pico Wireless Control Model PJ2-2B.**

- .1 Button Marking: **Light (icons).**
- .2 2-Button with Raise/Lower Control; **Lutron Pico Wireless Control Model PJ2-2BRL.**
  - .1 Button Marking: Light (icons).
- .3 Screw Mounting Kit; **Lutron Model PICO-SM-KIT.**
- .4 Wallbox Adapter; **Lutron Model PICO-WBX-ADAPT.**
- .5 Wallplates;
  - .1 Single Gang; Lutron Model CW-1-IV.
  - .2 Two Gang; Lutron Model CW-2-IV.
  - .3 Three Gang; Lutron Model CW-3-IV.
  - .4 Four Gang; Lutron Model CW-4-IV.
- .3 Quantity: **As indicated on the drawings.**
- .4 Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
- .5 Does not require external power packs, power or communication wiring.
- .6 Controls can be programmed with different functionality through system software without any hardware changes.
- .7 Allows for easy reprogramming without replacing unit.
- .8 Button Programming:
  - .9 Single action.
  - .10 Toggle action.
  - .11 Includes LED to indicate button press or programming mode status.
- .12 Mounting:
  - .13 Capable of being mounted with a table stand or directly to a wall under a faceplate.
- .14 Faceplates: Provide concealed mounting hardware.
- .15 Power: Battery-operated with minimum ten-year battery life.
- .16 Finish: Ivory.

## **2.6 Wireless Hubs**

- .1 Product(s):
  - .1 Wireless hub without BACnet; Lutron Vive Hub.
    - .1 Flush-mount wireless hub; Model HJS-1-FM.
- .2 Integrated multicolor LED provides feedback on what mode the hub is in for simple identification and diagnosis.

- .3 Integrated processor and web server allows hub to set up and operate the system without any external connections to outside processors, servers, or the internet.
- .4 A single hub or network of hubs can operate on either a dedicated lighting control only network or can be integrated with an existing building network as a VLAN.
- .5 Communicates directly to compatible Lutron Vive RF devices through use Lutron Clear Connect radio frequency communications link; does not require communication wiring; RF range of 71 feet (23 m) through walls to cover an area of 15836 square feet (1471 sq m) (device and hub must be on the same floor).
- .6 Communicates directly to mobile device (smartphone or tablet) or computer using built-in Wi-Fi, 2.4 GHz 802.11b/g; wireless range of 71 feet (23 m) through walls (device and hub must be on the same floor).
- .7 Does not require external Wi-Fi router for connecting to the hub.
- .8 Allows for system setup, control, and monitoring from mobile device or computer using Vive web-based software:
- .9 Any given load device can be controlled by 10 occupancy sensors, 10 Pico remote controls or 1 daylight sensor (Pico remote controls and sensors must be located within 30 ft (9 m) of the load device they are controlling).
- .10 Supports up to 700 total paired devices including compatible wireless sensors, wireless control stations, and wireless load devices.
  - .1 Allows for timeclock scheduling of events, both time of day and astronomic (sunrise and sunset).
    - .1 Timeclock is integrated into the unit and does not require a constant internet connection.
    - .2 Retains time and programming information after a power loss.
    - .3 Utilizes weekly calendar view for monitoring and adjustment of scheduled events.
    - .4 Time clock events can be scheduled to:
      - .1 Send lights to a desired level.
      - .2 Adjust level lights go to when occupied.
      - .3 Adjust level lights go to when unoccupied.
      - .4 Enable/disable occupancy.
      - .5 Adjust timeout of sensors (requires **Model DFCSJ-OEM-OCC** wireless fixture control dongle with integral sensing capabilities).
  - .2 Daylighting:
    - .1 Daylighting can be enabled/disabled. Can be used to override the control currently taking place in the space.
    - .2 The following is particularly useful when new departments move into a space.
    - .3 Daylight set point can be adjusted with the software to increase or decrease the electric light level in the room based on the same amount of natural light.

- .3 Uses RF signal strength detection to find nearby devices for quick association and programming without having to climb ladders.
  - .1 Association and setup does not require a factory technician to perform.
- .4 System using Lutron Vive wireless hub(s) can operate with or without connection to the internet.
- .5 Supports energy reporting.
  - .1 Reports measured energy data for PowPak fixture control modules at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
  - .2 Reports calculated energy data for PowPak junction box mounted modules at accuracy of 10 percent.
- .6 Wireless hub can be firmware upgraded to provide new software features and system updates.
  - .1 Firmware update can be done either locally using a wired Ethernet connection or Wi-Fi connection.
- .11 ***Lutron Vive*** Web-Based Application:
  - .1 Accessibility and Platform Support:
    - .1 Web-based; runs on most HTML5 compatible browsers (including Safari and Chrome).
    - .2 Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone.
    - .3 User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
    - .4 Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
    - .5 Multi-level Password Protected Access: Individual password protection on both the integrated Wi-Fi network and web-based software.
    - .6 WPA2 security for Wi-Fi communication with wireless hub.
  - .2 System Navigation and Status Reporting:
    - .1 Area Tree View: Easy navigation by area name to view status and make programming adjustments through the software.
    - .2 Area and device names can be changed in real time.
  - .3 Setup app available for iOS and Android that allows for:
    - .1 Job registration to extend product warranty.
    - .2 Management of setup for multiple projects in different locations.
    - .3 Creation of handoff documents that are sent directly to a facility manager via email once setup is complete.
    - .4 Access to native help and instructions to assist user with Vive system setup.

## 2.7 **Spare Parts**

- .1 Provide 5 spare components for each type of lighting control piece of equipment.
- .2 Programming software (software and/or mobile app) to be provided to Facility Personal.

## 2.8 **Source Quality Control**

- .3 See Section **01 45 00 - Quality Requirements**, for additional requirements.
- .4 Factory Testing; ***Lutron Standard Factory Testing***:
  - 1. To ensure that 100 percent of the lighting control products work at installation, the manufacturer should test 100 percent of all assemblies at full rated load in the factory. This testing will assure that every product has been tested and guaranteed to work. Sampling would only prove that the samples work and should not be acceptable.
  - 2. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
  - 3. To ensure that 100 percent of the lighting control products work at installation, the manufacturer should test 100 percent of all ballasts at the factory.
  - 4. Perform full-function factory testing on 100 percent of all ballasts and LED drivers.
  - 5. Sample burn-in is used to verify the consistency of quality for the supplied devices and manufacturing processes so that they meet the design intent.
  - 6. Perform factory burn-in of 100 percent of all ballasts at 104 degrees F (40 degrees C).

### **PART 3 EXECUTION**

#### **3.1 Examination**

- .1 Verify that field measurements are as shown on the drawings.
- .2 Verify that ratings and configurations of system components are consistent with the indicated requirements.
- .3 Verify that mounting surfaces are ready to receive system components.
- .4 Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 Installation**

- .1 An internet connection to setup or operate the Lighting Control system shall not be required. Install products in accordance with manufacturer's instructions.
- .2 Sensor Locations:
  - 1. Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.
- .3 Interior sensors work mainly with diffused light, as such, they have a much higher lighting gain than exterior sensors. Electric light sources can affect these sensors unless the sensors are shielded from the light given off by electric light sources.
- .4 Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted daylight sensors to avoid direct view of luminaires.

- .5 The control system shall be fully programmed as per the sequence of operations (with modifications as directed by the Departmental Representative to meet their needs).
- .6 The lighting control system shall be fully programmed, setup and commissioned using a manufacturer trained representative. The system shall be complete with all necessary hardware, equipment, control interface, software, and accessories required to make a complete system. Setup and commissioning shall include Departmental representative training.

### **3.3 Cleaning**

- .1 Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### **3.4 Commissioning**

- .1 See Section **01 9113** for commissioning requirements.

### **3.5 Closeout Activities**

- .1 See Section **01 7800 - *Closeout Submittals***, for closeout submittals.
- .2 See Section **01 7900 - *Demonstration and Training***, for additional requirements.
- .3 Demonstration:
  - .1 Demonstrate proper operation of lighting control devices to Departmental Representative, and correct deficiencies or make adjustments as directed.
- .4 Training:
  - 1. Include services of manufacturer's certified service representative to perform on-site training of Departmental Representative's personnel on operation, adjustment, and maintenance of lighting control system.

### **3.6 Protection**

- .1 Protect installed products from subsequent construction operations.

**END OF SECTION**



## **PART 1 GENERAL**

### **1.1 Related Requirements**

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

### **1.2 References**

- .1 Illuminating Engineering Society of North America (IESNA):
  - .1 IES-LM-79-08, Electrical and Photometric Measurements of Solid-State Lighting Products.
  - .2 IES-LM-80-15, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
  - .3 IES-TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):
  - .1 ANSI/IEEE C62.41-1991 (R1995), Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .3 ASTM International Inc.:
  - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA International).
- .5 ICES-005-07, Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC).

### **1.3 Action and Informational Submittals**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide complete photometric data prepared by independent testing laboratory for the manufacturer's standard production model luminaire, for review by Departmental Representative. The report shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES-LM-79.
  - .3 LEDs shall be tested per IES-LM-79, IES-LM-80, and IES-TM-21 parameters.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.

- .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, cleaning procedures and maintenance.

#### **1.4 Delivery, Storage and Handling**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Divert unused metal materials from landfill to metal recycling facility.
- .5 Disposal and recycling of fluorescent lamps as per local regulations.

### **PART 2 PRODUCTS**

#### **2.1 Drivers**

- .1 Rated life: 50,000 hours (minimum) at Tcase of  $\leq 70^{\circ}$  C.
- .2 Flicker free dimming range.
- .3 Power factor 90% minimum.
- .4 Class "A" sound rating.
- .5 Thermally protected.
- .6 Dynamic end of life protection circuit.
- .7 Rated for 60 Hz and voltage as indicated by the circuit on the drawings.
- .8 0-10V dimming to 1%, standard in laboratory areas. 0-10V dimming to 10% otherwise.
- .9 LEDs of the same luminaire supplied from the same batch during manufacturing.

#### **2.2 Finishes**

- .1 Baked enamel finish:
  - .1 Conditioning of metal before painting:
    - .1 For corrosion resistance conversion coating to ASTM F1137.
    - .2 For paint base, conversion coating to ASTM F1137.
  - .2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel or polyester powdercoat to give smooth, uniform appearance, free from pinholes or defects.

- .3 Reflector and other inside surfaces finished as follows:
  - .1 White, minimum reflection factor 85%.
  - .2 Colour fastness: yellowness factor not above 0.02 and after 250 hours exposure in Atlas fade-ometer not to exceed 0.05.
  - .3 Film thickness, not less than 0.03mm average and in no areas less than 0.025mm.
  - .4 Gloss not less than 80 units as measured with Gardner 60E gloss meter.
  - .5 Flexibility: withstand bending over 13mm mandrel without showing signs of cracking or flaking under 10 times magnification.
  - .6 Adhesion: 25mm square lattice made of 3mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.
- .2 Alzak finish:
  - .1 Aluminium sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:
    - .1 Finish for mild commercial service, minimum density of coating 7.8 g/m<sup>2</sup>, minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.
    - .2 Finish for regular industrial service, minimum density of coating 14.8 g/m<sup>2</sup>, minimum reflectivity 82% for specular and 73% for diffuse.
    - .3 Finish for heavy duty service, minimum density of coating 21.8 g/m<sup>2</sup>, minimum reflectivity 85% for specular, 65% for diffuse.

## **2.3 Luminaires**

- .1 As indicated in luminaire schedule.

## **PART 3 EXECUTION**

### **3.1 Installation**

- .1 Supply, store and install all luminaires in such a manner that their attachment to the ceiling shall be secure in all respects. In order to avoid any danger that the weight of the fixtures might distort hung ceilings (where such occur), provide approved type independent supports to the satisfaction of the Departmental Representative.
- .2 Luminaires shall not be hung directly from plasterboard ceilings, but shall derive their support from channels independently mounted in the ceiling space.
- .3 Provide any supporting angles, channels, unistrut, caddy clips, etc., required to adequately secure and support the luminaires. Exposed supporting system shall be painted white and blended in with the background colours.

### **3.2 Wiring**

- .1 Connect luminaires to lighting circuits:
  - .1 Install flexible or rigid conduit for luminaires as indicated.

### **3.3 Luminaire Alignment**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

### **3.4 Cleaning**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**