

**PART 1 - GENERAL****1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

**1.2 REFERENCE STANDARDS**

- .1 CSA Group
- .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
  - .2 CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
- .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.3 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
- .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
  - .3 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
  - .4 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
- .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 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.

<u>1.4 ACTION AND INFORMATIONAL SUBMITTALS</u> (Cont'd)	.4	(Cont'd)
	.5	Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
	.6	Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
	.5	Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.
<u>1.5 CLOSEOUT SUBMITTALS</u>	.1	Operation and Maintenance Data: submit operation and maintenance data for for incorporation into manual.
	.1	Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
	.2	Operating instructions to include following:
	.1	Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
	.2	Start up, proper adjustment, operating, lubrication, and shutdown procedures.
	.3	Safety precautions.
	.4	Procedures to be followed in event of equipment failure.
	.5	Other items of instruction as recommended by manufacturer of each system or item of equipment.
	.3	Print or engrave operating instructions and frame under glass or in approved laminated plastic.
	.4	Post instructions where directed.
	.5	For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
	.6	Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.
<u>1.6 DELIVERY, STORAGE AND HANDLING</u>	.1	Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
	.2	Storage and Handling Requirements:
	.1	Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
	.2	Store and protect from nicks, scratches, and blemishes.
	.3	Replace defective or damaged materials with new.
	.3	Packaging Waste Management: remove for reuse and return of pallets, crates, padding, and packaging materials.

**PART 2 - PRODUCTS****2.1 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 and French.
- .4 Use one nameplate or label for both languages.

**2.2 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

**2.3 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction.
- .2 Decal signs, minimum size 175 x 250 mm.

**2.4 WIRING TERMINATIONS**

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

**2.5 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicoid 3 mm melamine, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:
 

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

2.5 EQUIPMENT  
IDENTIFICATION  
(Cont'd)

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. \_\_\_\_\_" as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.6 WIRING  
IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.7 CONDUIT AND  
CABLE  
IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 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
Other	Green	Blue
Communication Systems		

2.8 FINISHES

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

**PART 3 - EXECUTION**

<b><u>3.1 INSTALLATION</u></b>	.1	Do complete installation in accordance with CSA C22.1 except where specified otherwise.
<b><u>3.2 NAMEPLATES AND LABELS</u></b>	.1	Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.
<b><u>3.3 CONDUIT AND CABLE INSTALLATION</u></b>	.1	If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
	.2	Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
<b><u>3.4 LOCATION OF OUTLETS</u></b>	.1	Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
	.2	Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
	.3	Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
	.4	Locate light switches on latch side of doors.
	.1	Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.
<b><u>3.5 MOUNTING HEIGHTS</u></b>	.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: 1100 mm.
	.2	Panelboards: as required by Code or as indicated.
<b><u>3.6 CO-ORDINATION OF PROTECTIVE DEVICES</u></b>	.1	Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.7 FIELD QUALITY CONTROL

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

3.8 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.

3.9 CLEANING  
(Cont'd)

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

**PART 1 - GENERAL**

<b><u>1.1 RELATED SECTIONS</u></b>	.1	This section shall be read in conjunction with specification Section 26 05 00 - Electrical General Requirements, all electrical sections, and all other disciplines related to the project.
<b><u>1.2 DEFINITIONS</u></b>	.1	SRS: acronym for Seismic Restraint System.
<b><u>1.3 GENERAL DESCRIPTION</u></b>	.1	This section covers design, supply and installation of complete SRS for all systems, equipment specified for installation on this project by Division 26. This includes, but is not limited to, electrical light fixtures, transformers, MCC's, UPS, diesel generators, fire protection, conduit, communications, electrical equipment and systems, both vibration isolated and statically supported.
	.2	Cable restraint systems, rod stiffener clamps and seismic isolator capacities to be verified by an independent test laboratory. Connection materials and site specific designs to be by the Seismic Engineer. The Seismic Engineer may specify material and anchors provided by the contractor where this is appropriate. It is the contractors' responsibility to ensure that the Seismic Engineers' requirements and specification have been met.
<b><u>1.4 REFERENCES</u></b>	.1	Canadian Standards Association (CSA)
	.1	CSA S832-14, Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings.
	.2	Ontario Regulation
	.1	ONTARIO OBC-2012, 2012 Ontario Building Code.
<b><u>1.5 SUBMITTALS</u></b>	.1	Submit shop drawings and product data in accordance with Section 26 05 00 - Electrical General Requirements.
	.2	Submit seismic restraint shop drawings, c/w seal of Professional Engineer registered in Province of Ontario, clearly identifying equipment/systems reviewed and the equipment/systems requiring restraint. Shop drawings must clearly show all forces transferred to structure.
	.3	Seismic Design Engineer shall provide a spreadsheet identifying all equipment and systems requiring or not requiring seismic restraints and include all circulations.
	.4	Submit additional copy of shop drawings and product data to project Structural Engineer for review of connection points to building structure.



1.6 MAINTENANCE DATA .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 26 05 00 - Electrical General Requirements.

1.7 SEISMIC FORCE .1 The Importance Factor for this project is:  
.1 I = 1.0 - All other buildings i.e.: Office & General Buildings.  
Note: As per OBC.

## **PART 2 - PRODUCTS**

2.1 SRS MANUFACTURER .1 SRS to be from one manufacturer regularly engaged in production of same, 5 years experience.  
.2 Acceptable materials: Korfund-Sampson, Mason Industries, Tecoustics, Vibra-Sonic Control, Vibron.

2.2 GENERAL .1 Design to be by Professional Engineer specializing in design of SRS and registered in Province of Ontario. Division 26 to include all costs associated with this work as it relates to Division 26 installations.  
.2 SRS to be fully integrated into, compatible with:  
.1 Noise and vibration controls specified elsewhere in this project specification, telecommunications.  
.2 Structural, mechanical, electrical design of project.  
.3 During seismic event, SRS to prevent systems and equipment from causing personal injury, interfering with other systems, and from moving from normal position.  
.4 Design and installation in accordance with OBC, CSA S832.  
.5 SRS to provide gentle and steady cushioning action and avoid high impact loads  
.6 SRS to restrain seismic forces in all directions.  
.7 Fasteners and attachment points to resist same load as seismic restraints.  
.8 SRS of conduit systems to be compatible with:  
.1 Expansion, anchoring and guiding requirements.  
.2 Equipment vibration isolation and equipment SRS.  
.9 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.  
.10 Attachments to structure:  
.1 Use high strength mechanical expansion anchors.  
.2 Drilled or power driven anchors not permitted.  
.11 Seismic control measures not to interfere with integrity of firestopping.

**2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS**

- .1 Floor-mounted equipment, systems:
  - .1 Anchor equipment to equipment supports.
  - .2 Anchor equipment supports to structure.
  - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Install tight to structure.
    - .2 Cross-brace in all directions.
    - .3 Brace back to structure.
    - .4 Slack cable restraint system.
  - .2 SRS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
  - .3 Hanger rods to withstand compressive loading and buckling.

**2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor mounted equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Vibration isolators with built-in snubbers.
    - .2 Vibration isolators and separate snubbers.
    - .3 Built-up snubber system approved by Engineer, consisting of structural elements and elastomeric layer.
  - .2 SRS to resist complete isolator unloading.
  - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
  - .4 Cushioning action to be gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Slack cable restraint system.
    - .2 Brace back to structure via vibration isolators and snubbers.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- .1 Install Seismic Restraint Systems in accordance with Seismic Engineer's and manufacturer's recommendations.
- .2 Install SRS at least 25 mm from all other equipment, systems, services.
- .3 Co-ordinate connections with all disciplines.

**3.2 INSPECTION AND CERTIFICATION**

- .1 SRS to be inspected and certified by Manufacturer upon completion of installation.
- .2 Seismic Design Engineer shall provide written report to Engineer certifying that SRS has been installed in accordance with the SRS drawings. The report shall bear the seal and signature of the SRS Design Engineer.

3.3 COMMISSIONING <u>DOCUMENTATION</u>	.1	Upon completion and acceptance of certification, hand over to Engineer complete set of construction documents, revised to show "as-built" conditions.
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- END OF SECTION -

**PART 1 - GENERAL**

<u>1.1 RELATED REQUIREMENTS</u>	.1	Section 26 05 00 - Common Work Results for Electrical.
	.2	Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
<u>1.2 PRODUCT DATA</u>	.1	Provide product data in accordance with Section 26 05 00 - Common Work Results for Electrical.

**PART 2 - PRODUCTS**

<u>2.1 BUILDING WIRES</u>	.1	Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
	.2	Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketted.
<u>2.2 ARMOURED CABLES</u>	.1	Conductors: insulated, copper, size as indicated.
	.2	Type: AC90.
	.3	Armour: interlocking type fabricated from galvanized steel strip.
	.4	Connectors: anti short connectors.
<u>2.3 CONTROL CABLES</u>	.1	Type: 600 V stranded copper conductors, sizes as indicated: .1 Insulation:RW90 (x-link).

**PART 3 - EXECUTION**

<u>3.1 FIELD QUALITY CONTROL</u>	.1	Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
	.2	Perform tests before energizing electrical system.
<u>3.2 GENERAL CABLE INSTALLATION</u>	.1	Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
	.2	Conductor length for parallel feeders to be identical.

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<u>3.2 GENERAL CABLE INSTALLATION (Cont'd)</u>	.3	Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
	.4	Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
	.5	Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.
<u>3.3 INSTALLATION OF BUILDING WIRES</u>	.1	Install wiring as follows:
	.1	In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
<u>3.4 INSTALLATION OF ARMOURED CABLES</u>	.1	Group cables wherever possible on channels.
<u>3.5 INSTALLATION OF CONTROL CABLES</u>	.1	Install control cables in conduit.
	.2	Ground control cable shield.

END OF SECTION

**PART 1 - GENERAL**

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| <b><u>1.1 RELATED REQUIREMENTS</u></b>           | .1 | Section 26 05 00 - Common Work Results for Electrical.  |
| <b><u>1.2 DELIVERY, STORAGE AND HANDLING</u></b> | .1 | Deliver, store and handle materials in accordance with Section 26 05 00 - Common Work Results for Electrical. Product and with manufacturer's written instructions.   |
|  | .2 | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.   |
|  | .3 | Storage and Handling Requirements: <ul style="list-style-type: none"><li>.1 Store materials and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.</li><li>.2 Store and protect from nicks, scratches, and blemishes.</li><li>.3 Replace defective or damaged materials with new.</li></ul> |

**PART 2 - PRODUCTS**

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|-----------------------------|----|---|
| <b><u>2.1 EQUIPMENT</u></b> | .1 | Grounding conductors: bare stranded copper, soft annealed, size as indicated.   |
|                             | .2 | Insulated grounding conductors: green, copper conductors, size as indicated.  |
|                             | .3 | Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to: <ul style="list-style-type: none"><li>.1 Grounding and bonding bushings.</li><li>.2 Protective type clamps.</li><li>.3 Bolted type conductor connectors.</li><li>.4 Thermit welded type conductor connectors.</li><li>.5 Bonding jumpers, straps.</li><li>.6 Pressure wire connectors.</li></ul> |

**PART 3 - EXECUTION**

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| <b><u>3.1 INSTALLATION GENERAL</u></b> | .1 | Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit. |
|  | .2 | Install connectors in accordance with manufacturer's instructions.   |
|  | .3 | Protect exposed grounding conductors from mechanical injury.   |
|  | .4 | Use mechanical connectors for grounding connections to equipment provided with lugs.   |

<u>3.1 INSTALLATION GENERAL (Cont'd)</u>	.5	Soldered joints not permitted.
	.6	Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
	.7	Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
	.8	Bond single conductor, metallic armoured cables to cabinet at supply end, and load end.
<u>3.2 EQUIPMENT GROUNDING</u>	.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, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.
<u>3.3 FIELD QUALITY CONTROL</u>	.1	Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
	.2	Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
	.3	Perform tests before energizing electrical system.
<u>3.4 CLEANING</u>	.1	Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment

END OF SECTION

**PART 1 - GENERAL****1.1 RELATED  
REQUIREMENTS**

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

**1.2 DELIVERY,  
STORAGE AND  
HANDLING**

- .1 Deliver, store and handle materials in accordance with Section Section 26 05 00 - Common Work Results for Electrical. Product Product and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
- .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hangers and supports from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**PART 2 - PRODUCTS****2.1 SUPPORT  
CHANNELS**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 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.
- .6 Suspended support systems.
- .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.



3.1 INSTALLATION  
(Cont'd)

- .6 (Cont'd)
- .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 10 m on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.2 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

**PART 1 - GENERAL**

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

1.2 REFERENCE STANDARDS .1 Canadian Standards Association (CSA International)  
.1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.

**PART 2 - PRODUCTS**

2.1 JUNCTION AND PULL BOXES .1 Construction: welded steel enclosure.  
.2 Covers Flush Mounted: 25 mm minimum extension all around.  
.3 Covers Surface Mounted: screw-on flat covers.

**PART 3 - EXECUTION**

3.1 JUNCTION AND PULL BOXES INSTALLATION .1 Install pull boxes in inconspicuous but accessible locations.  
.2 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.2 IDENTIFICATION .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.  
.2 Identification Labels: size 2 indicating system name, voltage and phase or as indicated.

END OF SECTION

**PART 1 - GENERAL**

<u>1.1 RELATED REQUIREMENTS</u>	.1	Section 26 05 00 - Common Work Results for Electrical.
<u>1.2 REFERENCE STANDARDS</u>	.1	Canadian Standards Association (CSA International) .1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.
<u>1.3 DELIVERY, STORAGE AND HANDLING</u>	.1	Deliver, store and handle materials in accordance with Section 26 05 00 - Common Work Results for Electrical.

**PART 2 - PRODUCTS**

<u>2.1 OUTLET AND CONDUIT BOXES GENERAL</u>	.1	Size boxes in accordance with CSA C22.1.
	.2	102 mm square or larger outlet boxes as required.
	.3	Gang boxes where wiring devices are grouped.
	.4	Blank cover plates for boxes without wiring devices.
	.5	347 V outlet boxes for 347 V switching devices.
	.6	Combination boxes with barriers where outlets for more than one system are grouped.
<u>2.2 CONDUIT BOXES</u>	.1	Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of devices.
<u>2.3 FITTINGS - GENERAL</u>	.1	Bushing and connectors with nylon insulated throats.
	.2	Knock-out fillers to prevent entry of debris.
	.3	Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.

**PART 3 - EXECUTION**

<u>3.1 INSTALLATION</u>	.1	Support boxes independently of connecting conduits.
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3.1 INSTALLATION  
(Cont'd)

- .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. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

END OF SECTION

**PART 1 - GENERAL**

<u>1.1 REFERENCE STANDARDS</u>	.1	Canadian Standards Association (CSA International)
	.1	CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
	.2	CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.
	.3	CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
	.4	CSA C22.2 No. 83-M1985 (R2013), Electrical Metallic Tubing.
	.5	CSA C22.2 No. 211.2-06 (R2016), Rigid PVC (Unplasticized) Conduit.
<u>1.2 WASTE MANAGEMENT AND DISPOSAL</u>	.1	Separate waste materials for reuse and recycling.
	.2	Place materials defined as hazardous or toxic waste in designated containers.
	.3	Ensure emptied containers are sealed and stored safely for disposal away from children.

**PART 2 - PRODUCTS**

<u>2.1 CONDUITS</u>	.1	Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
	.2	Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
	.3	Rigid pvc conduit: to CSA C22.2 No. 211.2.
	.4	Flexible metal conduit: to CSA C22.2 No. 56, steel liquid-tight flexible metal.
<u>2.2 CONDUIT FASTENINGS</u>	.1	One hole steel straps to secure surface conduits 50 mm and smaller.
	.1	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 2 m on centre.
	.4	Threaded rods, 6 mm diameter, to support suspended channels.
<u>2.3 CONDUIT FITTINGS</u>	.1	Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
	.2	Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

2.4 EXPANSION  
FITTINGS FOR RIGID  
CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene.

**PART 3 - EXECUTION**3.1 MANUFACTURER'S  
INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in main hangar and helicopter hangar.
- .3 Surface mount conduits except within enclosed rooms, such as offices and meeting rooms.
- .4 Use rigid galvanized steel threaded conduit for all exterior applications and where specified otherwise.
- .5 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 21 mm.
- .8 Bend conduit cold:
  - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 21 mm diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Run 2-27 mm spare conduits up to ceiling space from each flush panel.
  - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.

3.2 INSTALLATION  
(Cont'd)

- .13 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.

3.3 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 or surface 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.

3.4 CONCEALED  
CONDUITS

- .1 Run parallel or perpendicular to building lines.

3.5 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

**PART 1 - GENERAL****1.1 REFERENCE STANDARDS**

- .1 CSA International
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
  - .2 CAN/CSA C22.2 No. 60950-00, Safety of Information Technology Equipment (Bi-national standard, with UL 60950).
- .2 California Energy Commission (CEC).
- .3 Federal Communications Commission (FCC) / Industry Canada (IC).
- .4 Local Building Codes.
- .5 National Fire Protection Association (NFPA).
  - .1 (NFPA (Fire) 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Space, 2015 Edition.
- .6 Electrical Safety Authority (ESA)
  - .1 ESA OESC-2012, Ontario Electrical Safety Code, 25th Edition.
- .7 Underwriters laboratories (UL)
  - .1 UL 916, Certified as Energy Management Equipment.
  - .2 UL 924, Certified as Emergency Lighting Equipment.
  - .3 UL 2043, Meet Heat and Smoke Release for Air-Handling Spaces.

**1.2 SYSTEM DESCRIPTION**

- .1 Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
  - .1 Wireless Manager
  - .2 System Server
  - .3 0-10V Dimming, Fixed Output Ballasts or 0-10V LED Drivers
  - .4 Wireless Control Modules
  - .5 Connected Lighting Modules - Provide integral Wireless Control for luminaires
  - .6 Wireless Sensors (Occupancy/Photo)
  - .7 Low-Voltage Sensors (PIR, Dual-Technology, Photo)
  - .8 Wallstations - Wireless/Low-Voltage
  - .9 Lighting Control System Software - Graphical User Interface based
  - .10 LCD Touch Screen Panel
  - .11 Communication Wire
  - .12 Wireless Area Lighting Controllers (to dim/switch a group of luminaires)
  - .13 AC Phase Cut Dimming Module (Forward & Reverse)
  - .14 Relay based Lighting Control Panels
  - .15 Interface to customizable Energy dashboard

**1.3 SUBMITTALS**

- .1 General: Provide submittals per below:
  - .1 Bill of Material: Complete list of all parts needed to fully install selected system components
  - .2 Product Data: For each type of product indicated.



1.3 SUBMITTALS  
(Cont'd)

- .1 (Cont'd)
- .3 Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
- .4 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- .5 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
  - .1 Software operating and upgrade manuals
  - .2 Program Software Backup: On portable memory storage device, compact disc, or DVD, complete with data files.
  - .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
- .6 Installation Instructions: Manufacturer's installation instructions.
- .7 Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- .8 Warranty: Copy of applicable warranty.
- .9 Additional information as required on a project specific basis.
- .2 Wiring control schematics shown on project plans are intended to be conceptual only for illustrative purposes. They are not intended to indicate specific product or wiring requirements. Electrical contractor shall include all necessary parts, wiring and components etc. for a complete and fully operational installation. Contractor shall submit detailed wiring and component diagram with shop drawings.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- .2 Manufacturer Requirements: The manufacturer shall have a minimum of 5-10 years' experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
- .3 Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.
- .4 Performance Requirements: Shall provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

1.4 QUALITY  
ASSURANCE  
(Cont'd)

- .5 Performance Testing Requirements:
  - .1 Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.
- .6 Code Requirements:
  - .1 System Control Unit and System Field Devices shall be UL listed and certified.
  - .2 All system components shall be FCC /IC compliant.
  - .3 All system components shall be installed in compliance with Ontario Electrical Safety Code and Canadian Electrical Code.
  - .4 Building Codes: All units shall be installed in compliance with applicable, local building codes.
- .7 ISO Certification: System components shall be manufactured at ISO-9000 certified plants.
- .8 Coordination:
  - .1 Shall coordinate lighting control components to form an integrated interconnection of compatible components.
    - .1 Match components and interconnections for optimum performance of lighting control functions.
    - .2 Display graphics showing building areas controlled; include the status of lighting controls in each area.

1.5 PROJECT  
CONDITIONS

- .1 Operating Temperature Range: -40°C to +60°C 'applicable devices'.
- .2 Humidity:
  - .1 Wired field devices: 0% to 100% RH condensing rated for damp locations and 0% to 95% RH non-condensing rated for indoor locations.
  - .2 Wireless modules: 5% to 95% RH non-condensing rated for indoor locations.

1.6 DELIVERY,  
STORAGE & HANDLING

- .1 Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- .2 Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.
- .3 Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.7 WARRANTY

- .1 On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labour.
- .2 Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1.7 WARRANTY  
(Cont'd)

- .3 Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.
- .1 Warranty Period: All system hardware components, excluding third party components, shall have full warranty (non-prorated) for a minimum period of twenty-four (24) months and all software, excluding Open Source Software and third party operating systems, perform substantially in accordance with published specifications for a period of twelve (12) months from the date of System Start-up.

**PART 2 - PRODUCTS**2.1 SYSTEM  
PERFORMANCE  
REQUIREMENTS

- .1 This specification is intended to describe the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
- .2 The lighting control "system" shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system manufacturer or contractors certified by the manufacturer.
- .3 The basis of system design shall utilize non-proprietary industry standard 0-10V dimming or fixed output ballasts and/or 0-10V LED drivers, occupancy sensors, daylight sensors, etc.
- .4 UL 924 listed devices shall have the ability to control 120V/277V load.
- .5 System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
- .6 On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labour.
- .7 Lighting Control Software: The system shall offer two separate levels of lighting control: (1) personal lighting control for the average building occupant to override the control system during off-peak hours and return fixtures to full brightness for a pre-determined time, and (2) central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
- .1 Native central control software shall be utilized for energy performance monitoring and complete programming without the need for any third party hardware or software.
- .2 Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.

2.1 SYSTEM  
PERFORMANCE  
REQUIREMENTS  
(Cont'd)

- .7 (Cont'd)
- .3 Central Lighting Control:
- .1 Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
- .1 Interactive;
  - .2 Vector based;
  - .3 Zoom;
  - .4 Rotate;
  - .5 Pan;
  - .6 Tilt.
- .2 Shall allow system performance visualization across a portfolio of buildings via a single interface.
- .3 All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- .4 Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- .1 Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- .5 Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colourized gradient ("weather" map) type of graphical representation.
- .6 Energy Analysis data shall be exportable in CSV or image file formats.
- .7 Shall allow import of native AutoCAD files.
- .4 Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
- .1 Energy consumption broken down by energy management strategy.
  - .2 Energy demand broken down by energy management strategy.
  - .3 Occupancy data by zone.
  - .4 Building wide occupancy status
  - .5 Time Schedule status
  - .6 Lighting energy consumption in a colour gradient ("weather map" type) view
  - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.

2.1 SYSTEM  
PERFORMANCE  
REQUIREMENTS  
(Cont'd)

- .7 (Cont'd)
  - .4 (Cont'd)
    - .8 Battery status report indicating device name, location on the floor plan and battery voltage shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
    - .9 Colour gradient ("weather map" type) view for the following:
      - .1 Robustness of the mesh network (hop count)
      - .2 Route of the signal
      - .3 Wireless signal strength
      - .4 Battery status for wireless components
  - .5 Personal Lighting Control: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual luminaire or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments. This software shall have the capability of acting as a "virtual occupancy sensor" for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.
    - .1 Fade Time: The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- .8 Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where 0-10V dimming ballasts and/or drivers exist. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.
- .9 Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.
  - .1 Programming: User friendly, Outlook style interface shall be available for programming schedules.
  - .2 Override: Manual adjustments via wallstations or personal control software shall temporarily override off status imposed by time clock schedule.
  - .3 Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
  - .4 Flick Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flick warning time shall have the ability to be programmed via software between 1 and 5 minutes.
  - .5 Option to automatically turn on or wait for an input: Using this option, a group of luminaires can be made to turn on automatically in response to a scheduled event or wait for a signal from a wallstation to turn the same group of luminaires on (and stay on) for the reminder of the scheduled event.
- .10 Shall support BMS Schedules/Calendars.

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**2.1 SYSTEM  
PERFORMANCE  
REQUIREMENTS**  
(Cont'd)

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- .11 Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- .12 Addressing: All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- .13 Programmable Task Tuning: The light output level of an individual or group of luminaires shall be programmed via system software.
- .14 Continuous Dimming: Individual or group of luminaires dimming in response to user initiated action and/or system generated signal shall be over continuous range.
- .15 Overlapping Zones: System shall be capable of creating "overlapping" zones to ensure continuous lighting and safety of the occupants as they move from one lighting zone to another (for example, hallways) while minimizing the energy use.
- .16 Participation in Intelligent Building Framework: The system shall have the ability to be a component of Intelligent Building framework. Wireless Managers and System server communication shall be based on TCP/IP over Ethernet backbone.
- .17 LAN Operations: System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.
- .18 Network Security: Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- .19 Lighting Maintenance:
  - .1 System software shall notify wireless low battery, lamp or ballast failure events via system & email messages.
  - .2 Wireless devices hop count, route of the signal, signal strength & battery voltage levels shall be available via GUI.
  - .3 Percentage left in Lamp & Ballast Life Time shall be programmed to display in different colours for easier visual representation and quicker maintenance turnaround time.
  - .4 0-10V Dimming and/or Fixed Output Ballast/LED Driver replacements shall not require re-programming of the system or re-addressing of the said components.
- .20 Group (zone) Configuration: The assignment of individual or group of system components to zones shall be performed via Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- .21 Sensor Control Parameters: Light level sensor parameters shall be configurable through software.

2.1 SYSTEM  
PERFORMANCE  
REQUIREMENTS  
(Cont'd)

- .22 Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.
- .23 The system software shall have the capability of providing an optional web based energy dashboard to show real time energy savings data and carbon footprint reductions.
- .24 Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.
- .25 The system shall have the ability to control (dim/switch) a group of luminaires with loads up to 20A.
- .26 Astronomical Clock feature: Luminaires switch ON/OFF with the sunset and sunrise (with an option to select offset, depending on the geographic location (latitude & longitude) of the building. An offset option shall be available to turn the schedule ON/OFF up to 12 hours before or after dusk or dawn.
- .27 Migration plan to control LED luminaire: System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers utilizing the same control hardware.
- .28 AC Phase Cut Dimming circuit Integration: System shall have the ability to control Incandescent, Fluorescent or LED lighting load that are otherwise controlled by manual AC Phase Cut Dimmers.
- .29 Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
- .30 Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
- .31 System design shall ensure seamless communication among devices when hybrid wired/wireless control systems are implemented. Hybrid control system refers to devices that communicate over a DALI/0-10V field bus and/or wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication. Devices in the hybrid control system shall communicate with all the devices in the system regardless of their native protocol they are designed to work with.
  - .1 Luminaires enable wireless communication either via add-on or integrated modules

2.2 WIRELESS  
WALLSTATIONS

- .1 General: The system shall connect with the wallstations via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication.
  - .1 Software configurable wall station shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
  - .2 Shall allow manual dimming of light levels and override of the time schedule.
  - .3 Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.
  - .4 Addressing: All wallstations shall be individually addressable & reconfigurable via system Control Software.
  - .5 LED's: All wall stations shall feature status LED's.

2.2 WIRELESS  
WALLSTATIONS  
(Cont'd)

- .1 (Cont'd)
  - .6 Lighting scenes shall automatically reconfigure based on scene changes from personal control software.
- .2 Electrical:
  - .1 Class 2 Low Voltage device.
  - .2 Power source: 2-AA/4-AAA 10-year life Alkaline batteries.
- .3 Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication:
  - .1 Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
  - .2 Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
- .4 Performance:
  - .1 Wallstation configuration shall be via GUI in a drag and drop format:
    - .1 Custom button cap configuration shall allow combination of scene & zone in one wallstation.
    - .2 Custom commands shall be applied to individual wallstation buttons.
    - .3 Status LED: Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation.
  - .2 The following User Interface and custom labelling options shall be available:
    - .1 Up to five (5) scene switching & dimming.
    - .2 Up to six (6) zone switching.
    - .3 One (1) zone switching.
  - .3 Shall have icons that will illuminate when Loss of communication with the system control unit, Fire Alarm & Wallstation Lock statuses are detected.
  - .4 Shall allow vacancy sensor configuration.
  - .5 The battery life statuses of wireless wallstations shall be monitored via GUI.
- .5 Mechanical:
  - .1 Dimensions: Shall meet NEMA WD-6 spec.
  - .2 Colour: Shall meet NEMA WD1 colour specifications.
    - .1 Surface mount.
    - .2 Mount in standard size wall box.
    - .3 On mounting brackets for low v
  - .3 Shall provide support for "Decorator" style wall plate installation.
- .6 Reliability:
  - .1 Operating temperature range: -10°C to 40°C.
  - .2 Humidity: 5% to 95% RH non-condensing rated for indoor locations.
- .7 Regulatory:
  - .1 Safety: UL 916 listed.
  - .2 Environmental protection: Rated for dry location; RoHS compliant.
  - .3 Radio Interference: FCC Part 15/ICES-003.
  - .4 Shall comply or exceed the following electromagnetic requirements:
    - .1 EN 61000-4-2
    - .2 EN 61000-4-4
    - .3 EN 61000-4-5



2.3 LOW VOLTAGE  
WALLSTATIONS

- .1 General: The system shall connect with the wallstations via field bus that carry 0-10V control signals.
  - .1 Software configurable wall station shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
  - .2 Shall allow manual dimming of light levels and override of the time schedule.
  - .3 Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.
  - .4 Addressing: All wallstations shall be individually addressable & reconfigurable via System Control Software.
  - .5 LED's: All wall stations shall feature status LED's .
  - .6 Lighting scenes shall automatically reconfigure based on scene changes from personal control software.
- .2 Electrical:
  - .1 Class 2 Low Voltage device.
  - .2 Power source: Communication bus.
- .3 Communication: Shall be via NEC/CEC Class 2 communication wire.
- .4 Performance:
  - .1 Wallstation configuration shall be via GUI in a drag and drop format:
    - .1 Custom button cap configuration shall allow combination of scene & zone in one wallstation.
    - .2 Custom commands shall be applied to individual wallstation buttons.
    - .3 Status LED: Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation.
  - .2 The following User Interface and custom labelling options shall be available:
    - .1 Up to five (5) scene switching & dimming.
    - .2 Up to six (6) zone switching.
    - .3 One (1) zone switching.
  - .3 Shall have icons that will illuminate when Loss of communication with the system control unit, Fire Alarm & Wallstation Lock statuses are detected.
  - .4 Shall allow vacancy sensor configuration.
- .5 Mechanical:
  - .1 Dimensions: Shall meet NEMA WD-6 spec.
  - .2 Colour: Shall meet NEMA WD1 colour specifications.
  - .3 The following mounting options shall be supported:
    - .1 Surface mount.
    - .2 Mount in standard size wall box.
    - .3 On mounting brackets for low voltage devices.
  - .4 Shall provide support for "Decorator" style wall plate installation.
- .6 Reliability:
  - .1 Operating temperature range: -10°C to 60°C.
  - .2 Humidity: 5% to 95% RH non-condensing rated for indoor locations.
- .7 Regulatory:
  - .1 Safety: UL 916 listed.
  - .2 Environmental protection: Rated for dry location; RoHS compliant.
  - .3 Radio Interference: FCC Part 15/ICES-003.

2.3 LOW VOLTAGE  
WALLSTATIONS  
(Cont'd)

- .7 (Cont'd)
- .4 Shall comply or exceed the following electromagnetic requirements:
- .1 EN 61000-4-2
  - .2 EN 61000-4-4
  - .3 EN 61000-4-5

2.4 WIRELESS AREA  
LIGHTING  
CONTROLLER (WALC)

- .1 General: Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers over wireless medium that uses non-proprietary open protocol for communication.
- .1 Addressing: Area Lighting Controllers shall be addressable via Control Software.
  - .2 System shall automatically address individual wireless area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- .2 Electrical:
- .1 Maximum Load Ratings:
    - .1 20A 120-347 Vac Ballast
    - .2 20A 120-347 Vac Resistive
    - .3 20A 120-347 Vac Tungsten
    - .4 20A 120-347 Vac General Purpose
    - .5 1.5 HP 120-277 Vac Motor
- .3 Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication:
- .1 Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
  - .2 Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
  - .3 Shall connect to NEC/CEC Class 2 communication wire.
- .4 Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee).
- .5 Performance:
- .1 Control Options:
    - .1 ON/OFF Switching .
    - .2 Continuous 0-10V dimming.
    - .3 Shall be able to communicate with 0-10V ballasts/drivers.
  - .2 Shall be used for general purpose plug load control.
  - .3 Group Control: Shall control up to 50 ballast/LED Drivers.
  - .4 Shall enable direct 0-10V sensor connection.
  - .5 Shall enable wireless connection to low-voltage infrared, ultrasonic, and multi-technology sensors, Relay based Lighting Control Panels and AC Phase Cut Dimming Modules.
  - .6 Air Gap Off: Shall enforce physical disconnection of AC power to the ballast or driver when "OFF" is selected either automatically or manually.
  - .7 Memory: Shall retain all system settings in non-volatile memory.
- .6 Mechanical:
- .1 Mounting: Standard 1/2" electrical box knockout.

2.4 WIRELESS AREA LIGHTING CONTROLLER (WALC) <u>(Cont'd)</u>	.6	(Cont'd)
	.2	Material: Plenum rated black plastic (UL 2043).
	.7	Reliability:
	.1	Operating temperature range (wireless): -40°C 65°C.
	.2	Humidity: 5% to 95% RH non-condensing rated for indoor locations.
	.8	Regulatory:
	.1	Safety: UL 916, UL 924 & UL 2043 listed.
	.2	Environmental protection: Rated for damp location; RoHS compliant.
	.3	Radio Interference: FCC Part 15/ICES-003.
	.4	Shall comply or exceed the following electromagnetic requirements:
2.5 COMMUNICATION WIRE <u>WIRE</u>	.1	General: The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, wireless sensors and wallstations into a complete, networked programmable lighting control system.
	.2	Electrical: NEC/CEC Class 2 Communication bus.
	.3	Mechanical:
	.1	Multi-conductor cable with stranded-copper conductors.
	.4	Performance:
	.1	Shall power photo sensors, PIR and dual-technology occupancy sensors.
	.2	Shall allow random devices connection without the need for special network channel termination.
	.3	Minimize system down time by self-diagnosing the field bus for any shorts and open loops.
	.5	Regulatory:
	.1	Flame rated jacket for plenum use NFPA (Fire) 262 (UL: FT6, CSA: CMP).
2.6 LOW VOLTAGE PHOTO SENSOR <u>PHOTO SENSOR</u>	.1	General: Photo sensor connectivity shall be via field bus that carry 0-10V control signals.
	.2	Electrical:
	.1	Class 2 Low Voltage device.
	.2	Power source: Communication bus.
	.3	Communication:
	.1	Shall be via Class 2 communication bus.
	.2	Wireless communication shall be enabled via Wireless Control Module/Wireless Area Lighting Controller.

2.6 LOW VOLTAGE  
PHOTO SENSOR  
(Cont'd)

- .4 Performance:
  - .1 Accuracy: +/-1% at 21°C, derated to +/-5% at 49°C or at -18°C.
  - .2 The indoor sensor range shall be between 0 and 750 FC.
  - .3 The Outdoor sensor range shall be between 0 and 750 FC.
- .5 Mechanical:
  - .1 Mounting options shall include the following:
    - .1 Junction Box mounting.
    - .2 Knock-out mounting.
- .6 Reliability:
  - .1 Operating temperature range: -11°C to +60°C.
  - .2 Humidity: 5% to 95% RH (non-condensing).

2.7 WIRELESS  
MANAGER (WM)

- .1 General:
  - .1 The wireless manager shall be the central intelligence point for the area that it controls, collecting signal information from sensors, wallstations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. Each wireless manager shall control large quantity of wireless devices. The wireless manager shall automatically detect and during start-up addresses the compatible sensors, wallstations & system field devices it is connected to and establishes two-way communication.
  - .2 The wireless manager shall communicate with the server over Ethernet connection that employs TCP/IP protocol. The wireless manager shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet connection to enable desktop personal control.
- .2 Electrical:
  - .1 Input voltage: Via Power over Ethernet.
- .3 Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication:
  - .1 Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
  - .2 Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
  - .3 Server communication shall be via TCP/IP over Ethernet.
- .4 Mechanical:
  - .1 Plastic material.
  - .2 Mounting: Ceiling or wall mount via j-box.
- .5 Visualization & Performance:
  - .1 Manages large number of nodes.
  - .2 Shall appear in system software.
  - .3 Shall be configured via system software.
  - .4 Shall display transmit/receive signal strength with the nodes on the floor plan.
  - .5 Shall display hop count information with the nodes on the floor plan.
- .6 Reliability:
  - .1 Safety: UL 916 listed.

2.7 WIRELESS  
MANAGER (WM)  
(Cont'd)

- .6 (Cont'd)
  - .2 Environmental protection: Rated for dry location; RoHS compliant.
  - .3 Radio Interference: FCC Part 15/ICES-003.
  - .4 Complies with the following electromagnetic requirements:
    - .1 EN 61000-4-2
    - .2 EN 61000-4-4
    - .3 EN 61000-4-5

2.8 SYSTEM SERVER  
(SSU)

- .1 General:
  - .1 System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.
  - .2 Server shall have the ability to:
    - .1 Analyze system performance or energy data or generate system report;
    - .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
    - .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
    - .4 Reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware if desired;
    - .5 Interconnect with Wireless Managers over standard Ethernet connection that employs TCP/IP protocol;
  - .3 Hardware based servers shall at minimum meet the specifications listed below:
- .2 Electrical:
  - .1 Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.
- .3 Communication:
  - .1 Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.
- .4 Mechanical:
  - .1 Shall mount in a standard 483 mm rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
  - .2 Provide a standard 19" rack (1" width) for system server and ethernet switch. Rack shall be provided complete with a 120V power bar to power equipment in rack.
- .5 Reliability:
  - .1 Operating temperature range: 10°C to 35°C.
  - .2 Operating Relative Humidity: 10% to 90% (non-condensing).
- .6 Regulatory:
  - .1 FCC (US only) Class A.
  - .2 DOC (Canada) Class A.
  - .3 UL 60950.
  - .4 CAN/CSA-C22.2 No. 60950.

2.9 LIGHTING  
CONTROL SYSTEM  
SOFTWARE

- .1 Technical Information: Adobe Flash based user interface.
  - .1 System shall require:
    - .1 Internet web browser with Flash® Player 8 or later.
    - .2 Internet/Intranet connection.
    - .3 SSU enabled and configured to host dynamic website.
    - .4 Network connection with access to a network-enabled WM.
- .2 Web based Central Control Software:
  - .1 Central control software application shall be used to start-up, configure and manage the system. Every system parameter in a building (or campus of buildings) shall be configured for each individual user or space and baseline settings shall be established for each of the following (depending on the basis of design) system features:
    - .1 Daylight harvesting.
    - .2 Occupancy control.
    - .3 Smart time scheduling.
    - .4 Task tuning.
    - .5 Personal control.
    - .6 Load shedding.
  - .2 Software shall utilize a web based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and two-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application integral to the system shall be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light luminaire, wallstations, sensors, switches, etc. A central system server shall be provided to support system data base and enterprise control management.
    - .1 System shall require:
      - .1 Software that can run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).
      - .2 Ability to support all common browsers, i.e.,
        - .1 Internet Explorer 6.0 or later
        - .2 Mozilla Firefox 3.0 or later
        - .3 Safari
        - .4 Google Chrome
      - .3 Network connection/access to all network-enabled CUs.
      - .4 Native Energy Performance Monitoring capability.
      - .5 Colour gradient ("weather map" type) data view (see below for an example) to display the following criteria:
        - .1 Lamp & ballast life time
        - .2 Current energy consumption
        - .3 Current energy savings
        - .4 Current luminaire brightness
        - .5 Current luminaire status
        - .6 Current occupancy data
        - .7 Current load shedding status
        - .8 Hop count
        - .9 Route of the signal
        - .10 Signal Strength

2.9 LIGHTING  
CONTROL SYSTEM  
SOFTWARE  
(Cont'd)

- .2 (Cont'd)  
.2 (Cont'd)
- .11 Battery Voltage Status  
.12 Other custom modes that may be specified elsewhere

**PART 3 - EXECUTION**3.1 EXAMINATION

- .1 Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
- .2 Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

- .1 The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
- .2 Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
- .3 Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

3.3 SENSOR  
INSTALLATION

- .1 Adjust sensitivity to cover area installed
- .2 Set time delay on occupancy sensors that are connect to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
- .3 Vacancy sensor configurations shall be via Central Control Software.
- .4 Sensors shall be powered through Input Module, Wireless Control Module, Kinetic energy or batteries.
- .5 Install occupancy sensors on vibration free stable surface.
- .6 Install atrium and skylight light sensor facing toward window or skylight.
- .7 Install interior light sensor in ceiling facing the floor.

3.4 WIRING  
INSTALLATION

- .1 Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- .2 Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
- .3 Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- .4 Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 SOFTWARE  
INSTALLATION

- .1 Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

3.6 FIELD QUALITY  
CONTROL

- .1 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- .2 Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
  - .1 Operational Test: After installing wallstations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- .3 Lighting control devices will be considered defective if they do not pass tests and inspections.
- .4 Prepare test and inspection reports.

3.7 SYSTEM START-UP  
REQUIREMENTS &  
SUPPORT SERVICES

- .1 System Start-up: The manufacturer shall supply factory trained representatives to start-up the lighting control system.
- .2 Training: As part of the system start-up service, the provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building in the operation of the system. The start-up service provider shall also provide owner's representatives with system operating manuals.
- .3 Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.
- .4 Requests for start-up or technical services shall be at least fifteen (15) business days prior to date desired for service.
- .5 Electrical contractor shall perform functional testing under the guidance of technical service agent and in accordance with factory specified guidelines.



3.7 SYSTEM START-UP  
REQUIREMENTS &  
SUPPORT SERVICES  
(Cont'd)

- .6 Technical service provider shall provide technical services for the lighting control system.
- .1 Verify proper communication over control wires.
  - .2 Map addresses of all devices.
  - .3 Verify communication to wireless managers and system server.
  - .4 Software configuration of occupancy sensors, light level sensors, wallstations and other contacts to suit design specifications.
  - .5 Configure and program lighting control sequences as described on contract documents.
  - .6 Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

3.8 TESTING

- .1 Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
- .2 At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.9 DEMONSTRATION

- .1 The provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems.

**PART 1 - GENERAL**

1.1 RELATED REQUIREMENTS	.1	Section 26 05 00 - Common Work Results for Electrical.
1.2 REFERENCE STANDARDS	.1	CSA International
	.1	CSA C22.2 No. 5-16, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2016).
1.3 ACTION AND INFORMATIONAL SUBMITTALS	.1	Submit in accordance with Section 26 05 00 - Common Work Results for Electrical.
	.2	Product Data:
	.1	Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.
	.3	Include time-current characteristic curves for breakers.
	.4	Certificates:
	.1	Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
	.1	Production certificate of origin must be submitted to Departmental Representative for approval.
	.2	Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
	.3	Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin by Departmental Representative. Unless complying with this requirement, Departmental Representative reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
	.4	Production certificate of origin must contain:
	.1	Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.
	.2	Licensed dealer's name and address and person of distributor responsible for Contractor's account.
	.3	Contractor's name and address and person responsible for project.
	.4	Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.
	.5	Name and address of building where circuit breakers will be installed:
	.1	Project title: _____.
	.2	End user's reference number: _____.
	.3	List of circuit breakers: _____.

**1.4 DELIVERY,  
STORAGE AND  
HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 26 05 00 - Common Work Results for Electrical and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store circuit breakers off ground indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, and packaging materials.

**PART 2 - PRODUCTS****2.1 BREAKERS  
GENERAL**

- .1 Circuit breakers: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers to have minimum 10 kA symmetrical rms interrupting capacity rating.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.

**3.2 CLEANING**

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning

END OF SECTION

**PART 1 - GENERAL**

- |   |   |
|---|---|
| <p>1.1 RELATED<br/>Section 26 05 00 -<br/>Common Work Results<br/>for Electrical.<br/><u>REQUIREMENTS</u></p>   | <p>.1<br/>Section 26 05 05 - Seismic Restraint Systems (SRS).</p>   |
| <p>1.2 REFERENCE<br/>Canadian Standards<br/>Association (CSA<br/>International)<br/><u>STANDARDS</u></p>  | <p>.1 Ontario Regulation<br/>.1 ONTARIO OBC-2012, 2012 Ontario Building Code Compendium.<br/>.3 Underwriters' Laboratories of Canada (ULC)</p>  |
| <p>1.3 ACTION AND<br/>Provide submittals in<br/>accordance with Section<br/>26 05 00 - Common<br/>Work Results for<br/><u>INFORMATIONAL</u><br/>Electrical.</p>                                   | <p>.1 Product Data:<br/>.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.<br/>.2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative.<br/>.3 Photometric data to include: VCP Table where applicable.<br/>.3 Quality assurance submittals: provide following in accordance with Section 26 05 00 - Common Work Results for Electrical<br/>.1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, cleaning procedures.</p> |
| <p>1.4 DELIVERY,<br/>Deliver, store and<br/>handle materials in<br/>accordance with Section<br/>26 05 00 - Common<br/><u>STORAGE AND</u><br/>Work Results for<br/><u>Electrical. HANDLING</u></p> | <p>.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.<br/>.3 Packaging Waste Management: remove for reuse and return of pallets crates padding and packaging materials.<br/>.4 Divert unused metal materials from landfill to metal recycling facility.<br/>.5 Disposal and recycling of fluorescent lamps as per local regulations.<br/>.6 Disposal of old PCB filled ballasts.</p>   |

**PART 2 - PRODUCTS****2.1 DRIVERS FOR LED**

.1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry FIXTURES

and damp locations. Include the following features unless otherwise indicated:

- .1 Rated for 50,000 hours of life, unless otherwise noted.
- .2 Sound Rating: Class A.
- .3 Total Harmonic Distortion Rating: 20 percent or less.
- .4 Current Crest Factor: 1.5 or less.
- .5 0-10V Dimming Standard.

on fixture schedules.

luminaires, of types and sizes indicated

- .2 Include the following features unless otherwise indicated:
- .2 Include the following features unless otherwise indicated:
  - .1 Each Luminaire shall consist of an assembly that utilizes edge-lit LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - .2 Luminaire optics shall consist of precision formed optical assembly with positively retained high grade acrylic lenses using laser precise micro-prism patterns to provide directional distribution (where indicated).
  - .3 Each luminaire shall be rated for a minimum operational life of 60,000 hours utilizing a maximum ambient temperature of (25°C).
  - .4 Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
  - .5 Colour Rendering Index (CRI) of 75 at a minimum.
  - .6 Colour temperature 4500 K, unless otherwise indicated.
  - .7 Rated lumen maintenance at 78% lumen output for 60,000 hours, unless otherwise indicated.
  - .8 Fixture efficacy of 95 Lumens/Watt, minimum.
  - .9 5 year luminaire warranty, minimum.
  - .10 Photometry must comply with IESNA LM-79.
  - .11 Luminaries shall be Design Lights Consortium Qualified
  - .12 he individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
  - .13 Luminaire shall be constructed such that driver may be replaced or repaired without the replacement of the whole fixture.
- .3 Technical Requirements:
  - .1 The luminaire shall not consume power in the off state.
  - .2 Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
  - .3 Power Factor: The luminaire shall have a power factor of 0.9 or greater.
  - .4 THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
  - .5 Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

**2.2 LED FIXTURES .1**

Except as otherwise indicated, provide LED luminaires, of types and sizes indicated

(Cont'd)

.4

**Thermal Management:**

- .1 The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
  - .2 The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
  - .3 Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
  - .4 The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
- to intended installation.

certifications related

**PART 3 - EXECUTION****3.1 INSTALLATION .1**

Locate and install luminaires as indicated.

.2

Provide adequate support to suit ceiling system.

**3.2 WIRING .1**

Connect luminaires to lighting circuits:

- .1 Install flexible or rigid conduit for luminaires as indicated.

**3.4 LUMINAIRE .1**

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

.2

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

**ALIGNMENT****3.5 CLEANING .1**

Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION