

Section	Subsection	Title	Supplementary Specifications
26 56 01	1.0	General	.1 Any reference to Roadway Lighting shall include tunnel lighting and controls. .2 The work shall include the supply and installation of all materials and equipment as shown on drawings 5608-17-01 to 06 and 171-08048-00-S-001 to S-005.
26 56 01	1.10	Inspection and Testing	.2 The City and their representative will observe the Contractor's work at various stages. Specifically when first group of luminaires and mounting hardware is prepared and ready for installation and during installation, during installation of the first set of anchors, following installation of all luminaires and prior to system energization when all controls are programmed. The contractor shall provide a schedule and advise at least 2 days prior to inspections
26 56 01	1.11 (NEW)	Contractor Qualifications	.1 All work must be installed by a qualified electrical contractor, who is required to obtain a permit from the Provincial Electrical Inspector.
26 56 01	1.12 (NEW)	Materials Supplied by Others	.1 All material shall be supplied by the contractor.
26 56 01	1.13 (NEW)	Warranty	.1 The Contractor shall for a period of one (1) year after the total performance date, replace or repair all deficiencies or failures to the installation free of all charges. .2 Tunnel luminaires shall have 10 year warranty
26 56 01	2.1	General	.6 All products are indicated on Drawings, and shall conform to the approved product list. .7 Electrical cabinets shall be Valid Manufacturing Ltd. type or approved equal in accordance with Section 16470. .8 Luminaires shall be as defined in Section 16500. Alternates will not be reviewed prior to bid close. .9 Luminaire mounting structure shall be designed and fabricated in accordance with drawings 171-08048-00-S-001 to S-005. Mounting system shall be designed by structural engineer. Contractor shall undertake all require field measurements to ensure product suit the beams it is being attached to.



			<p>Contractor shall provide shop drawings along with letters of assurance prior to fabrications and installation.</p> <p>.10 Lighting Controls – Lighting controls shall be NYX - Hemera as noted on drawings. Echelon line carrier tunnel lighting controls can be used provided it meets or exceeds the NYX – Hemera system. The tunnel control system shall include design drawings and system configuration, on-site set-up, commissioning and testing and training for City staff. The Local Product Controller (LPC) shall be factory installed in the luminaires. Where the LPC’s don’t fit in the luminaire a box shall be supplied mounted on or beside the luminaire to accommodate the LPC.</p>
26 56 01	3.1	Execution	<p>.6 The contractor shall use suitable equipment to install the lights and mounting supports</p> <p>.7 The contractor shall provide a fully functioning system including lighting control set-up, testing and commissioning. The actual set-up of the controls and set points for L20 meter shall be reviewed by the engineer.</p> <p>.8 The contractor shall provide training for City staff as well as O&M manuals.</p>

END OF SECTION

16470 ELECTRICAL CABINETS

GENERAL

1.01 GENERAL

- A. This specification shall apply to the design and supply of electrical cabinets which shall include:
 - 1. Tunnel Lighting Kiosk and NYX-Hemera controls
- B. Cabinets shall include all required equipment, not limited to the main breaker, meter, pull box, distribution panel(s), transformer, contactors, lighting controls, etc as shown on the drawings. The final cabinet complete with all electrical components shall bear the label of the CSA.
- C. The supplier shall design and produce the lighting control cabinet to meet the criteria noted in this document and ***all specific City requirements***. The supplier shall be capable of producing a premium grade product, which meets the quality, fit and finish noted in this document. The use of CNC equipment is mandatory. The supplier's shop shall be approved to produce CSA listed products.
- D. The cabinet and internal components shall be designed to meet the approval of the local electrical utility and shall be designed for easy maintenance.
- E. The power distribution system (one-line diagram) shall be as noted on the contract electrical drawings.
- F. All equipment produced shall meet the requirements of the Canadian Electrical Code.

1.02 ALTERNATE SUBMITTALS

- A. Alternate power distribution cabinet suppliers must submit the following for review:
 - 1. Detailed cabinet and door shop drawings showing all fabrication and the layout of all internal components. Drawings shall be produced using computer drafting format.
 - 2. List of components (by manufacturer and number) and product sheets for each item
 - 3. Cabinet ventilation drawings (sealed by PEng)
- B. Approval of alternates shall be granted if the submittal information listed above is complete and meets the approval of the engineer. To be accepted an alternate submittal must meet or exceed the Valid Manufacturing product in quality, performance, durability, warranty and shall meet the requirements of this specification. Where an alternate submittal is not accepted it shall be returned with a list of deficiencies. Alternates will be reviewed up to two week after award. Where deficiencies are noted the supplier will have 3 days to resolve the deficiencies to the satisfaction of the engineer.
- C. Acceptance of an alternate does not negate the contractor and suppliers responsibility to meet the requirements of these specifications.

1.03 QUALITY CONTROL

- A. The supplier shall have and maintain a suitable quality control program throughout the contract. The purpose of the quality control program is to ensure that the product meets the quality requirements of these qualifications, is delivered on time, and is produced in a cost-effective manner. The supplier's quality control program shall apply to all stages of the design, procurement, manufacturing, testing and delivery of the product.

1.04 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
1. One year parts and labor on all materials from the date of substantial performance

PRODUCTS

2.02 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, that may be incorporated in the Work include the following products:
1. Valid Manufacturing Ltd. Power Distribution Cabinet (ph 1-250-832-6477), or Approved Equal
 2. Engineer approved alternate (see 1.02 above)

2.03 GENERAL MATERIAL REQUIREMENTS

- A. All materials shall be new.
- B. Unless otherwise noted, the cabinet shall be fabricated from 12 gauge stainless steel.
- C. All materials shall be corrosion resistant for extended life

2.04 FABRICATION PROCESS

- A. The cabinet and door shall be fabricated using CNC controlled equipment.
- B. The cabinet and doors shall be fabricated to plus or minus 10 thousandths of an inch tolerance for proper fit.
- C. All bending shall be done using a suitable break press.

2.05 CONNECTING HARDWARE

- A. All screws, bolts, washers, nuts, etc. shall be stainless steel.
- B. All screws shall be stainless steel pan-head machine screw type.
- C. Any bolts that are 1/4-20 or larger shall be stainless steel hex head type.

- D. No sheet metal or self tapping screws shall be used.

2.06 WELDING

- A. All exterior seams shall be of continuously welded construction. All welds shall be free of slag and spatter. All exterior welds shall be ground smooth.
- B. The supplier shall have suitable credentials to weld stainless steel and shall adhere to all applicable ANSI standards.
- C. The supplier shall use a suitable welding process and materials.

2.07 DOORS AND HINGES

- A. Doors shall be designed for maximum strength and snug fit. It is the supplier's responsibility to design and fabricate the doors to the fit and finish required in this specification. Doors shall be fabricated out of a single sheet of aluminum and have wrap around return for strength and fit.
- B. Doors shall be fabricated out of a single sheet of stainless steel and have wrap around return for strength and fit.
- C. Doors shall be fully gasketed against the cabinet.
- D. Doors shall also have an inner skin for additional strength. The bottom of each door shall have ventilation holes.
- E. Each door shall have a pneumatic return device to control the rate of door open and close and prevent opening beyond 90 degrees (Faucher Series 777). The door shall be bonded to the cabinet with a bare ribbon type conductor.
- F. Door handles shall be recessed and 3 point contact stainless steel construction. The handles shall be designed to be vandal proof and accommodate a City padlock and shall latch to the cabinet 16 gauge stainless steel rails and rollers which shall be fabricated to provide a secure and well-sealed attachment to the cabinet.
- G. The exterior of the doors shall have continuous welds.
- H. All exterior corners shall be rounded to a minimum radius of 1/8 of an inch. All sharp edges shall be de-burred to a minimum radius of 1/64 inch in order to reduce hazards to service personnel.



Figure 1 - Cabinet Door

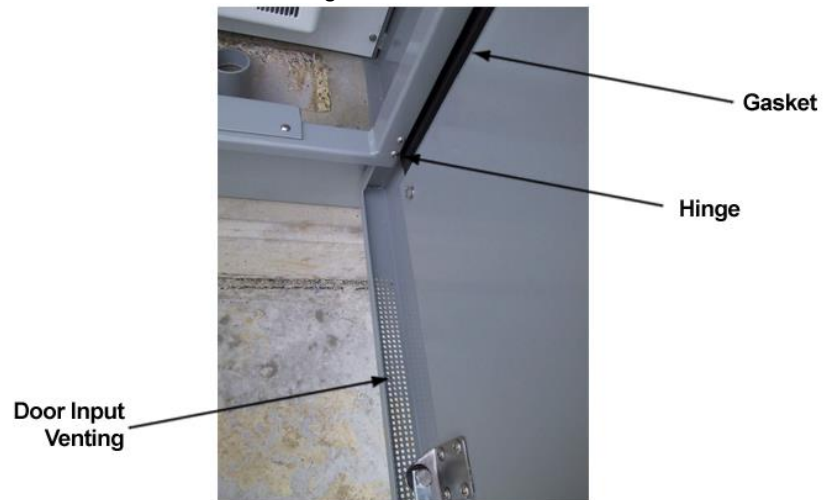


Figure 2 - Door Details

2.08 CABINET AND KIOSK

- A. The cabinet and door shall be constructed to meet NEMA 3R standards. The cabinet shall be made up of the main body, roof section and inner wall. These components shall be welded together. The cabinet shall be designed for maximum strength and proper fit to the door.
- B. The cabinet and kiosk shall have a peaked roof with a 20 degree slope.
- C. The cabinet and kiosk shall be designed to attach to concrete pad via Hilti style drop-in anchors, which shall be supplied with the cabinet. Supplier shall provide Hilti anchors.
- D. The exterior of the cabinet and kiosk shall have continuous welds.
- E. The cabinet and kiosk main body shall have a wrap around return to accept the door.
- F. The cabinet and kiosk shall contain two LED Strip Lights (RAB UC-LED300-NW or Approved Equal) controlled with door switch, 2 thermostatically controlled fans (EBM4600 or Approved Equal), a thermostatically controlled 500W heater (Oulette OVS0502BL or Approved Equal), and 120V spec grade ground fault duplex receptacle.
- G. The cabinet shall be equipped with lifting brackets, which shall be removed after the installation..
- H. All exterior corners of a cabinet and kiosk shall be rounded to a minimum radius of 1 inch. All sharp edges shall be de-burred to a minimum radius of 1/64 inch in order to reduce hazards to service personnel.
- I. The cabinet shall have peaked roof as per City standards.



Figure 3 - Cabinet

2.09 CABINET VENTILATION

- A. The cabinet and kiosk along with the doors shall be provided with an engineered ventilation system designed to move filtered air in through the bottom of the cabinet and out through the top. The internal air temperature shall be thermostatically controlled to allow the internal equipment to operate within their recommended operation temperatures and to reduce condensation. The supplier shall produce details of the ventilation system, how it works, and evidence that the system has been engineered.
- B. The cabinet shall have intake vents in the lower portion of each door and exhaust vents on the cabinet above the door that are protected with finger safe anti-vandalism protection when the door is closed.
- C. Ventilation holes shall not be larger than 1/8" diameter to prevent the entry of foreign particles into the cabinet.
- D. Both intake and exhaust vent shall be filtered.
- E. The cabinet shall be supplied with insulation and sun shielding.



Figure 4 - Heater and Intake Holes

2.10 EQUIPMENT MOUNTING INNER WALL

- A. Equipment shall be mounted on an inner panel.
- B. Equipment mounting panels shall be constructed from minimum 14 ga. galvanized steel.

2.11 FINISH

- A. Upon completion of fabrication the cabinet, door and inner wall shall be finished as follows:
 - 1. The surface shall be thoroughly cleaned and degreased using alkaline cleaner and then rinsed.
 - 2. The surfaces shall be brush blasted to a 1.5 to 2 mil profile.

3. The surfaces shall then be pre-baked and a prime coat shall be electrostatically applied (DuraCoat zinc epoxy powder primer E-2024-2Z) 2 to 3 mils in thickness.
4. After the prime coat has set, the top coat shall be electrostatically applied (polyester urethane anti-graffiti type resin for cabinet and doors) 3 to 5 mils in thickness. Color shall be as defined by RAL # listed on the contract drawings for the cabinet and door and white for the internal back plane.
5. An independent testing agency shall test and verify the final powder adhesion and finish is suitable for a long life in an outdoor environment.
6. The final product shall be free of dents, scratches, weld burns and abrasions harmful to its strength and general appearance.

2.12 GENERAL ELECTRICAL

- A. The supplier shall provide equipment layout details with the shop drawings.
- B. An inner mask shall be installed to protect personnel from electrical hazard. The mask shall have cut-outs for circuit breaker toggle mechanisms. Knock outs in the mask shall be provided for all spare breaker spaces.
- C. All equipment shall be mounted on stand-off back panels and shall be secured using 8-32 inserts.
- D. All equipment shall be labeled using Lamicoid or vinyl adhesive labels with ½-inch high black characters on a white background.
- E. All panels shall be supplied with the breakers installed.

2.13 METERING

- A. Metering shall meet the approval of the local utility. All metering shall be mounted to the exterior of the lighting control cabinet. The metering shall be located for easy reading by the local utility.
- B. CT's shall be to local utility standards. CT's and metering cabinets shall be sized and laid out to meet utility standards.

2.14 PANELBOARDS

- A. The main panel boards shall have a copper bus and shall be supplied based on the panel schedule on the contract drawings.
- B. A load center shall also be supplied to feed internal lighting, heater, fan, receptacle, etc in the lighting control cabinet. This panel may also feed some external devices noted on the contract drawings.
- C. The panel boards and load centers shall be Schneider Square D, or Approved Equal.
- D. Panel boards and load centers shall be securely attached to the cabinet back plane and shall be located for easy access and servicing.

E. Panels shall have breaker covers over signal breakers where signals and lighting are in the kiosk. This is to protect accidental turn off of traffic signal breakers. See Figure 5 below.

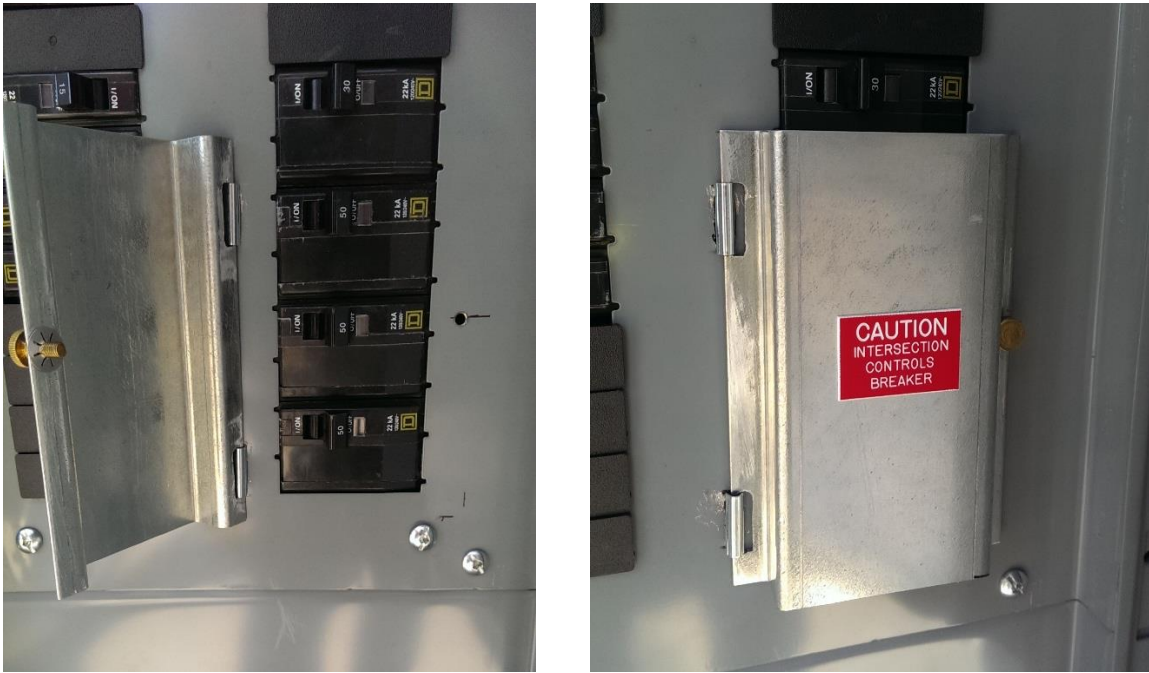


Figure 5 - Breaker Covers

2.15 CIRCUIT BREAKERS

- A. The main breaker (reverse breaker not allowed) shall be thermal magnetic trip, molded-case, and bolt-on type (Schneider Square D, or approved Equal).
- B. Branch circuit breakers shall be thermal magnetic trip, molded-case, bolt-on type (Schneider Square D, or Approved Equal) to suit the main panel board.
- C. The minimum fault current shall be as noted on the contract drawings. Series rating is allowed if acceptable panel supplier shall provide calculations.
- D. Breaker terminals shall be rated for a minimum of 75 degrees C.

2.16 TRANSFORMERS

- A. Transformers shall be dry type (Delta ET series, or Approved Equal). Transformer size and voltage shall be as noted on the contract drawings.
- B. Transformer shall be mounted and attached in a suitable location for easy access.

2.17 GROUNDING

- A. Transformers shall be dry type (Hammond epoxy type, or Approved Equal).
- B. Transformer size and voltage shall be as noted on the contract drawings.
- C. Transformer shall be mounted and attached in a suitable location for easy access.
- D. All transformer windings shall be copper.

2.18 GROUNDING AND SURGE PROTECTION

- A. The grounding system shall be designed to meet all CSA standards and any codes and local utility standards.
- B. The grounding system shall be designed as part of the power distribution system.
- C. Surge protection shall be provided. For cabinets on the main panel bus and for kiosks on the secondary side of the transformer surge protection shall be Advanced Protection Technology or approved equal.

2.19 PULL BOXES AND WIREWAYS

- A. Pull boxes and wire ways shall be provided for easy field wiring and trouble shooting. Pull box size and locations shall meet utility standards.
- B. All wire ways and pull boxes shall have removable covers.



Figure 6 - Wireway

2.20 CONTROLS

- A. Lighting controls shall be as noted on the Contract Drawings.
- B. Contactors shall be rated for lighting.

2.21 WIRING

- A. All wiring shall be neatly grouped bundled and ty-rapped as shown below.
- B. All conductors shall be stranded copper RW90 insulation.
- C. Provide 8-32 inserts and ty-rap mounts for the attachment of wiring.
- D. Wiring and terminal blocks shall be labeled.
- E. All wiring shall meet CEC standards.

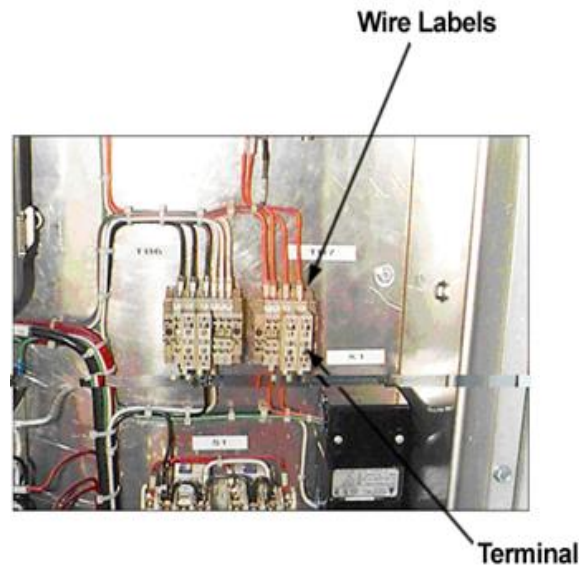


Figure 7 - Wiring

2.22 TERMINAL BLOCKS

- A. Terminal blocks in the contactor cabinet shall be din rail mounted for stranded copper wiring.
- B. Output wiring shall be connected via terminal blocks to accept field wiring from #10 AWG to #14 AWG.
- C. Terminals for bonding conductors will also be required.

2.23 LABELING

- A. All products shall be labeled (inside) with the supplier's company name, model number, panel rating and the date of manufacture. Kiosk and cabinets shall be waterproof label on the outside of the cabinet which defined the weight of the cabinet. A waterproof decal (with kiosk or cabinet #) shall be supplied with kiosk or cabinet and installed by the City.

- B. The supplier shall also provide adhesive Lamicoid or vinyl labels on the inside of each cabinet for each component. Each contactor and output circuit shall also be labeled in accordance with the suppliers lighting design.
- C. All ID labels shall have ¼” to ½” high white characters on a red background as shown in Figure 8.
- D. All wiring shall be labeled with computer generated sleeve type wire markers.
- E. The inner mask shall be supplied with a panel directory and holder for the single line diagram and manuals.



Figure 8 - Label

2.24 TESTING AND INSPECTION

- A. The supplier shall test all equipment circuits and lighting controls prior to shipment. Test results shall be provided upon request.
- B. The owner reserves the right to inspect the completed product prior to packaging and shipping. The supplier shall advise the engineer a minimum of 5 working days prior to shipping for inspection.

2.25 PACKAGING

- A. Each cabinet shall each be lag bolted to two 4” x 4” posts along the shorter sides of the cabinet to be used for support when kiosk is being lifted or moved.
- B. Any product damaged in shipping shall be repaired or replaced at no extra cost to the City.

EXECUTION

3.02 INSTALLATION

- A. Set units on concrete foundation and attach with drop-in anchors supplied with cabinet. The cabinet supplier shall supply a bolt layout template with the cabinet
- B. Seal cabinet to concrete with suitable sealant.
- C. Conduits shall be located as shown on the supplier's conduit layout drawing.
- D. Concrete Foundations:
 - 1. Size as noted on the contract drawings
 - 2. Concrete shall have a minimum compressive strength of 28Mpa at 28 days.
 - 3. Comply with details on the contract drawings for reinforcing, attachment, etc.
 - 4. Trowel finish and rub smooth parts exposed to view. Top of concrete shall be level. Chamfer all exposed edges.
 - 5. Conduits shall be as noted on the contract drawings. Supplier to provide template locating conduits to suit the cabinet

3.03 GROUNDING

- A. Install all grounding and bonding in accordance with CEC and the contract drawings. Install a minimum of two (2) ground plates per cabinet or kiosk and place a minimum of 1.5m apart.

3.04 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged components.
- B. Give advance notice of dates and times for field tests.
- C. Provide instruments to make and record test results.
- D. Tests and Observations: Supplier shall test all circuits and controls prior to shipping.
- E. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until all units operate properly.

END OF SECTION

16500 TUNNEL LUMINAIRES

GENERAL

1.05 GENERAL

- A. This specification shall apply to the design and supply of electrical installation which shall include:
1. Tunnel Lighting Fixtures
 2. Installation of the Tunnel Lighting Equipment

1.06 SCOPE OF WORK

- A. Description: This special provision is for the tunnel lighting fixtures to be provided for use in the tunnels.
- B. The work also consists of installing and testing of the tunnel lighting system complete with fixtures, mounting brackets, including all miscellaneous hardware, and all other equipment and materials required to install the tunnel lighting system completely and operable as specified herein and as shown on the drawings.
- C. Performance Requirements: The roadway lighting levels for the design are based on the following minimum values shown on the drawings including any degradation occurring over 88,000 hours of service.
- D. Durability: The tunnel lighting and mounting system will be subject to a wet, corrosive environment with periodic direct spray washing for the entire life. Equipment shall meet or exceed the product ratings as implied by having obtained NEMA 4x, IP67 ratings, and UL 1598 "Suitable for Wet Location and Direct Spray" listing.
- E. Physical Characteristics: The tunnel lighting fixtures and mounting system will be as described herein and as shown on the Drawings.
- F. Light Source Life: The tunnel lighting to be provided by an LED source having a minimal longevity of at least 88,000 hours at 80% of initial lumen output.

1.07 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of these special provisions to the extent referenced. The publications are referenced in the text by basic designation only. Materials and workmanship and system performance shall be in accordance with the following standards and codes to the extent specified herein. Unless otherwise indicated, the issuance or date of applicable standards and codes at the time the request for proposal is issued shall govern.
- B. American National Standards Institute (ANSI) Publications:
1. C2 National Electrical Safety Code
 2. C37 Seismic Testing of Relays
 3. C78.377 Specifications for the Chromaticity of Solid State Lighting Products

4. C82.SSL-1 Operational Characteristics and Electrical Safety of SSL Power Supplies and Drivers
 5. C83.77 Harmonic Emission Limits – Related Power Quality Requirements for Lighting
 6. C136.2 Roadway and Area Lighting Equipment-Fixture Voltage Classifications
 7. C136-22 Standard for Roadway Lighting, Internal Labeling of Fixtures
 8. C136-31 Standard for Roadway Lighting Equipment Fixture Vibration
- C. ASTM International, Inc. (ASTM) Publications:
1. B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
 2. D522 Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
 3. D714 Standard Test Method for Evaluating Degree of Blistering of Paints
 4. D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 5. D3359 Standard Test Methods for Measuring Adhesion by Tape Test
 6. G7-05 Standard Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials: Testing for UV resistance
- D. International Electrotechnical Commission (IEC):
1. IEC 60598 Degrees of Protection provided by Enclosures (IP Code)
 2. Institute for Electrical and Electronic Engineers (IEEE) Publication
- E. Canadian Electrical Code
- F. Canadian Standards Association
- G. Illuminating Engineering Society of North America (IESNA) Publications:
1. HB-10 IESNA Lighting Handbook, 10th Edition
 2. RP-8 Roadway Lighting
 3. RP-16 Nomenclature and Definition
 4. RP-22 Practice for Tunnel Lighting
 5. LM-63 Standard file format for Electronic Transfer of Photometric Data
 6. LM-69 Approved Guide for the Interpretation of Roadway Fixture Photometric Reports
 7. LM-71 Photometric Measurements of Tunnel Lighting Installations
 8. LM-79 Photometric Measurement of Solid State Lighting Products
 9. LM-80 Measuring Lumen Maintenance of LED Sources
 10. LM-82 Approved Method for Characterization of LED Light Engines and Integrated LED Lamps for electrical and Photometric Properties as a Function of Temperature
 11. TM-15 Lighting Classification
 12. TM-15 BUG Ratings Addendum
 13. TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources
- H. National Fire Protection Association (NFPA) Publication:
1. 502 Standards for Road Tunnels, Bridges, and Other Limited Access Highways
- I. National Electrical Manufacturers Association (NEMA):

1. 250 Enclosures for Electrical Equipment

J. Military Specification:

1. MIL-A-8625F Anodic Coatings for Aluminum and Aluminum Alloys.

1.08 SUBMITTALS

- A. General: Submittals shall consist of a package received in hard copy (unless otherwise noted) that incorporates the necessary information illustrating compliance with this special provision. All submitted information shall employ the terminology, classifications, and methods prescribed in the above Applicable Publications. Failure to provide the following information with the submittal will give cause to reject the submission in its entirety and be returned incomplete without supporting comments. Until all submittals have been returned in hard copy form with a status of "Approved" or "Approved as Noted", no production of any product defined in this section shall be completed. Any production shall be at the manufacturers own risk. Where alternate luminaires are proposed manufacturer shall provide computerized calculation(s) detailing the area(s) to be illuminated by the submitted luminaires and detail a statistical summary of maintained illumination levels using a light loss factor (LLF) of 0.51 per the spacing(s), mounting height(s), and details as defined in the drawings, and in the performance requirements tabulated above. The calculations shall show that the submitted luminaires will meet the criteria roadway luminance levels. The calculations shall adhere to the guidelines for performing tunnel calculations as defined in IESNA RP-22-14. The submitted information shall be provided to the Engineer of Record, in electronic form, for all calculations. All calculations shall be provided using the latest version of the AGI32 program and submitted in the format from which the calculations are derived.
- B. Shop Drawings Shop drawings with the following information, shall be submitted for each type of fixtures inclusive of the mounting system:
1. Manufacturer's catalog information.
 2. Complete fabrication and assembly drawings.
 3. Bill of materials and components.
 4. Complete mounting diagrams, with suggested mounting procedures. Manufacturer's data shall be submitted for the mounting channels, hardware, anchors, and brackets proposed to mount the tunnel lighting fixtures as shown on the Plans.
 5. Manufacturer's installation and operating instructions.
 6. Electronic and printed Photometric files in .IES format.
 7. Shop Drawings/Manufacturer's data shall be submitted for the following components of the Tunnel Lighting Control System:
 8. Photocells
 9. Mounting Brackets
 10. Lighting Contactors
 11. Cabinet and Component Assembly Details
 12. Wiring Diagrams
 13. Bill of Materials
 14. Installation Diagrams
- C. Component Data: Manufacturer's data shall be submitted for the individual components for each fixture and wireway type; including housing components, lens and frame, latches, LED

modules, printed circuit board(s), LED driver(s), fuses and fuse holders, pin and socket (quick-disconnect) connectors, cord and cord connectors (male and female).

- D. **Warranty Compliance:** The manufacturer shall provide in written form as part of the submittal process the willingness to comply with the Warranty section defined within.
- E. **CSA Listing:** Manufacturer will provide documentation (on CSA letterhead) that the components being submitted meet the CSA Listing requirements stated throughout this document.
- F. **Test Data:** Manufacturer will provide all test data defined under Testing. For the initial submittal, preliminary (pre-production) in-house testing will be allowed; however, the Engineer of Record reserves the right to request additional water-spray and vibration tests, up to 2 per tunnel, on post-production product to ensure compliance with these special provisions. The Engineer of Record reserves the right to reject an entire production lot and request additional testing if fixtures fail these additional tests.
- G. **Samples:** With the shop drawings, submit a working sample for each type of fixture configuration specified. Fixture samples shall be equipped with a cord and plug for operation at 347V. All samples will be used to confirm quality conformance to the prescribed requirements herein and will not be returned for use on the project.
- H. **Quality Assurance:** Manufacturer shall provide documentation of quality assurance procedures and allow the Quality Assurance Manager to audit that quality procedures are being followed.

1.09 QUALIFICATIONS

- A. **Manufacturer:** Company specializing in manufacturing products specified in this section with a minimum four (4) years documented experience in meeting performance requirements as described in this section. Company shall be willing to extend their standard warranty period as outlined in this specification, as well as provide the testing as outlined in this specification.

1.10 WARRANTY

- A. Manufacturer(s) agrees to repair or replace fixtures and/or components there-of as well as LEDs and Drivers that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather, vibration or solar radiation.
- B. Warranty period shall be a minimum of 10 years from date of Installation. The manufacturer is to provide a statement to the Quality Assurance Manager that installation of their equipment meets their installation guidelines as outlined in this specification.
- C. Claims against the warranty will be valid regardless of who performs the installation. The manufacturer will be allowed to inspect, at no cost to the project, with the Engineer of Record, the initial installation of the product and after the time a repair has been made. The manufacturer has the right to waive these inspections prior to the final issuance of the warranty specified.
- D. Where this is failure rate of over 5% in the first two years of operation year the supplier shall also pay the labour to replace the failed luminaires.

1.11 TESTING

- A. Photometric Test(s): A hard copy photometric report, completed in accordance with the appropriate IESNA testing procedure, shall be accompanied with a CD/DVD or flash media that includes the data in IESNA format for each fixture type submitted. All tests submitted must have been completed within the past 3 years. Provide photometric files in IESNA format.
- B. Paint Adhesion and Finish Test(s): The manufacturer shall submit a sample piece of each cast or fabricated part(s) for testing. The manufacturer shall use the same preparation treatment, the same paint, and the same method of application the submitted fixture shall receive. All test samples shall be submitted to the Quality Assurance Manager for review and acceptance after testing has been completed.
- C. Tests shall include the following (if applicable):
1. Cast Aluminum Parts: All exposed cast aluminum parts shall be subjected to the following tests (Tests shall be performed in 4 locations on the sample):
 2. ASTM3359 - Test Method B, Rating shall be 5B. This includes the housing, door frame, and latch(s). Test shall be performed in 4 locations on the sample.
 3. ASTM D2247, ASTM D714, ASTM B117, ASTM D1654 – Corrosion Resistance tests in accordance with the noted ASTM documents. The procedure to follow shall be similar to that illustrated in AAMA 2604 – 7.8. Note, test shall be conducted on 4 pieces of the cast parts that have been finished using the production paint method.
 4. AAMA 2604 – 7.7 Chemical Resistance
 5. AAMA 2604 – 7.8 Corrosion Resistance
 6. Extruded Parts: All exposed extruded parts shall be subjected to the following tests (Tests shall be performed in 4 locations on the sample):
 7. AAMA 2604 – 7.4 Film Adhesion
 8. AAMA 2604 – 7.5 Impact Resistance
 9. AAMA 2604 – 7.7 Chemical Resistance
 10. AAMA 2604 – 7.8 Corrosion Resistance
 11. Fabricated Aluminum and Steel Parts: All exposed fabricated parts shall be subjected to the following tests regardless of material. (Tests shall be performed in 4 locations on the sample):
 12. AAMA 2605 – 7.4 Film Adhesion
 13. AAMA 2605 – 7.5 Impact Resistance
 14. AAMA 2605 – 7.7 Chemical Resistance
 15. AAMA 2605 – 7.8 Corrosion Resistance
 16. ASTM D 522 - The flexibility of the finish shall withstand a 180 degree bend over a ¼ inch mandrel diameter without loss of adhesion or cracking.
- D. Dust and Water Intrusion Test(s): The manufacturer shall provide written documentation that the fixture(s) and wireway(s) have been tested in accordance with EN 60598 and have successfully passed the requirements to obtain an IP66 certification.
- E. High Pressure Water Spray Test(s). The test data and results shall be completed in writing and shall be submitted to the Quality Assurance Manager for review and concurrence.
- F. The test shall conform to the following procedure:

1. The fixture assemblies shall be completely operable. The fixture assembly shall be mounted to an adjustable mounting surface with the longitudinal side (worst case, as determined by the reviewing engineer) of the fixture parallel to the spray nozzles.
2. The manufacturer has the option to make the nozzle positions adjustable or to have the fixture assembly adjustable. The range of adjustment shall be such that all exposed surfaces of the fixture assembly when mounted in the apparatus shall be able to be exposed to direct contact with the water spray.
3. The spray apparatus shall consist of four spraying nozzles, spaced 30 inches apart attached to a 2-inch pipe, each providing a minimum of 12 gallons per minute at 100 pounds per square inch at the nozzle, in a 90-degree cone. The water pressure gauge used to track water pressure shall be installed at the spray nozzle furthest from the source.
4. Repeat steps 1 through 4 of the test procedure below for each assembly until all assemblies (fixture(s)) have been tested or unless the Quality Assurance Manager warrants otherwise. A successful overall test, is defined as a complete 4 position test on each of the assemblies, and shall illustrate that no water has entered the fixture(s).
5. The test procedure, as defined below in steps 1 through 4, shall be as follows (approximate time to complete one test is one uninterrupted 8 hour period):
 - (i) Step 1: With the center of the fixture assembly positioned between the center two nozzles at a distance of 18 inches, adjust the apparatus so that the spray is directly aimed at the fixtures' photometric nadir (Position #1) of the fixture.
 - (ii) Step 2: Energize the fixture for a minimum of 30 minutes, and then turn on the water. After 15 minutes of water application, de-energize the fixture, leaving the water spray on for 15 more minutes.
 - (iii) Step 3: Within 30 minutes of turning off the water spray, rotate the assembly to directly apply spray at electrical entry or access, (Position #2) and repeat Step 2.
 - (iv) Step 4: Immediately after turning off the water spray, dry the exterior surfaces of the assembly(s) using a dry cloth, then open the entry points to investigate whether the fixture shows any evidence of water entry under the conditions specified (maximum time between turning off the water and opening the assembly(s) to be 15 minutes). Water leakage (water entry) signifies failure for the position and test. Additionally, if any latch releases during the procedure, shall be cause for failure for that position and test.
6. Vibration Test. While attached to its mounting plate in the orientation for which it will be installed, the complete fixture (same fixture), with LED lamps and drivers installed, and shall successfully pass a vibration test at 2 g loading for 100,000 cycles in two of the three major axes and a 4 g test for 5000 cycles in one axis chosen by the Quality Assurance Manager. At the end of the test, the fixture shall then be energized to illustrate that no failure to the electrical components has been experienced. Note: As an alternative test, the manufacturer shall submit the results of the fixture submitted to the ANSI 136.31. However, the same fixture and mounting plate shall be used in all planes of test for all planes.

1.12 HANDLING AND DELIVERY

- A. Ship fixtures, components and accessories securely packaged and labeled for safe handling in shipment and to avoid damage or distortion. Store all fixtures and accessories in a secure, dry

facility and in original packaging in a manner to prevent soiling, physical damage, wetting, or corrosion prior to installation. All cartons shall be clearly marked with the proper identification of manufacturer, catalogue number, fixture designation, and proper storage/handling instructions.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Fixtures shall be furnished complete, of the type specified herein, and shall conform to fixture dimensions shown on the drawings.
- B. All materials, equipment, and devices shall, as a minimum, meet the requirements of CSA where CSA standards are established for those items and the requirements of CSA and NFPA-502-7. All tunnel lighting fixtures and provided shall be new and shall bear CSA Listing "SUITABLE FOR WET LOCATIONS" label.
- C. All fixture surfaces shall be finished on all sides of each product. All finishes shall be applied such that the entire assembly is rendered completely corrosion resistant for the service intended. Once the finish is applied, no additional holes will be acceptable.
- D. Anodized Finish: Shall be a Type 3, Class 1 Hard Anodic Coating. Anodic coating shall applied in accordance with MIL_8625F.
- E. Paint Finish: Shall be cleaned and treated utilizing the Alodine 5200 product procedures. The base coat shall be a PPG 590-534 Cathodic Epoxy E-coat applied 0.08 to 1.20 mil (2.03 to 30.48 microns) in a single coat application, followed with a TGIC Powder coat applied to 2.0 to 4.0 mil (50.8 to 101.6 microns) of the approved RAL color in a single coat application.
- F. Electrical Components. Manufacturer is responsible for all compatibility testing between components. Driver(s). LED driver efficiency shall be 90% or higher with power factor greater than 90% at any drive current. LED drivers designed for multi-voltage input (120-347) shall automatically select for the connected voltage or shall be clearly marked at the point of connection for the particular voltage. The Wiring inside the driver shall comply with 600V/105 degrees C rating or higher. LED drivers shall comply with UL1012, have a Class A sound rating, have a minimum ambient operating temperature of minus 40 degrees C (max. +50 deg C), a life expectancy of 100,000 hours at a case temperature of less than or equal to 65 degrees C, the drivers shall comply with the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR Part 15 Non-Consumer (Class A). Drivers shall be 10kV overload/overcurrent protected on the AC line side connection preferably with an electronic resettable device or a fuse; fuses shall be protected in tool-less, finger-safe holders and shall be replaceable without removing incoming power. A shielded and replaceable surge protective device (rated ANSI C62.41 Category C) shall be provided integral with the fixture/driver package to dissipate transient voltages appearing on the AC input. The driver current for operating the LED light engines shall be as noted for each fixture.
- G. Light Emitting Diodes (LEDs) Manufacturer of LEDs shall have been in the business for more than 15 years. Qualified manufacturers of LEDs include: NICHIA, CREE, OSRAM. LEDs used by the fixture manufacturer shall be identified and direct-sourced from the manufacturer of the LED and shall be certified by the manufacturer of the fixture as being the LED type and

rating used in the manufacture and design of the photometric and thermal characteristics of the particular fixture.

- H. The LED module, comprised of multiple LEDs shall be connected such that individual LED failures may occur without affecting any other LEDs on the PCB.
- I. The overall design of the thermal package shall provide a temperature margin when operating at the maximum rated driver current in a 50 degrees C ambient temperature not to exceed the maximum allowable LED junction temperature.
- J. Wiring within the fixtures shall conform to the requirements of CSA and CEC. Conductor size, temperature rating, voltage rating and manufacturer clearly marked on the insulation of each conductor. Unless otherwise specified, the housing of each lighting fixture shall be provided with a separate, factory-installed, grounding device.
- K. Fixture Hardware: Manufacturer is responsible for all compatibility testing between components. Latch and release mechanism, hinges, pins and other retaining parts of fixtures: screws, bolts or other assembly and mounting parts shall all be stainless steel.
- L. All nuts shall have captive externally-footed lock washers.
- M. Neoprene pads, isolation washers or gaskets shall be used to separate any dissimilar metals subjected to corrosion by galvanic action. This includes any and all locations where the Stainless Steel hardware may come into contact with the aluminum fixture housing.

2.02 LUMINAIRES

- A. Approved LED Tunnel Fixture: The Holophane Tunnel Pass (TNLEDMED-PK9-40K-HVOLT-CLN-DGRA-S) and Kenall Luxtran (LTSI-A2-C-CM-2A-8-295L-40k7-DCC-CV) have been pre-approved photometrically and no information is required however it must meet all requirements listed. Alternate fixtures must meet or exceed the requirements listed and all information requested shall be submitted to the Engineer of Record.
- B. The Local Product Controller (LPC) shall be factory installed in the luminaires. Where the LPC's don't fit in the luminaire a box shall be supplied mounted on or beside the luminaire to accommodate the LPC.
- C. The LED light engines or refractor/reflector assemblies shall be fully protected against outside contaminants.
- D. Rated life greater than 100,000 hours.
- E. Fixture shall have three integral driver(s) with a maximum output of 150 watts and a maximum input power of 160 watts. Input voltage shall be 347V.
- F. The Correlated Color Temperature (CCT) shall be 4000K maximum with a CRI of 70 minimum.
- G. Fixtures shall have integral time delay fusing in addition to any circuit over-current protection.

- H. The finish shall be painted gray and applied as specified above in the finishes section.
- I. The fixture shall include an alloy type 316 stainless steel mounting plate, as shown with the attached product information, and shall be pre-mounted at the factory by means of alloy 316 stainless steel bolts.

EXECUTION

3.02 PERFORMANCE REQUIREMENTS

- A. Perform all Work in accordance with the requirements of the Canadian Electrical Code and NFPA 502-17, and those authorities having jurisdiction. Verify that other construction work is complete to the extent that Fixtures may be installed. Install Fixtures of the type required in the locations shown and make all final electrical connections. Provide accessories as required to properly install the material defined in this section even though these accessories may not be specifically indicated on the Plans. Provide appropriate support(s) for each lighting fixture.
- B. Fixtures and support elements shall not be mounted on or in contact with ducts or pipes.

3.03 INSTALLATION

- A. Install rows of fixtures accurately on straight lines unless otherwise indicated on the Plans. Install all necessary hangers, channels, bars, supports, and rods required to align Fixtures.
- B. Fixture Adjustment: Provide labor and materials for final adjustment of all fixtures to the Quality Assurance Manager's satisfaction. Adjustment shall take place immediately before the work is accepted by the Engineer of Record.
- C. Anchors/Fastening System for Lighting and Conduits. Alloy 316 Stainless steel mechanical anchors/fasteners shall be used to attach/mount new lighting fixture mounting system to concrete tunnel walls, ceilings, or floor.
- D. Cleaning. Follow the cleaning procedures recommended by the fixture manufacturer. Clean the fixtures during installation, so as to render them free of foreign material, substances, or film on the fixture.
- E. Fixture Operation. Ascertain and make sure that the LED fixtures installed are exactly as specified for each fixture type fixture with regards to the number of LED and distribution required for the given location. Replace without cost to the project inoperative LED panels, which fail to operate prior to final acceptance of the work.

3.04 FIELD QUALITY CONTROL:

- A. Operating Tests: Upon completion of the installation, conduct an operating test to demonstrate that the lighting systems and associated equipment operates in accordance with the performance requirements of the Tunnel Lighting System. The following tests shall be successfully performed, and the results submitted to the Engineer of Record prior to project acceptance:

- B. Verification of Tunnel Lighting levels in Accordance with requirements via accepted IES procedures. Verification that Tunnel Lighting Levels are maintained through the control sequence outlined in this section, at the switching levels, and within the time delays set.
- C. Operator Interface Panel Test to insure that manual control of the tunnel lighting system operates per manufacturer's requirements.
- D. Inspections: Inspect fixture for material defects, improper closures, and damage that may have occurred during installation. Report and replace damaged equipment. Inspect cables for physical damage and proper connection.
- E. For Warranty Purposes, the manufacturer, or their representative has the right to perform periodic reviews of the installation to insure that the supplied products have been installed in accordance to their installation guidelines. Deviations from the installation guidelines shall be reported to the Engineer of Record.

END SECTION