METROLINX

Lighting and Controls Specification

Specification 26 50 00

Revision 01
Date: March 2023

Lighting and Controls Specification

Specification 26 50 00

Publication Date: August 2018
Revision Date: March 2023

an Agency of the Government of Ontario

Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Cover page	March 2023	Removed 'Capital Projects Group' to reflect organizational changes
1.2, 1.3.4, 2.1.3	March 2023	Updated design requirements and numbering on Electrical Identification and Nomenclature specification
2.1, Table 2-1	March 2023	Updated general functional requirements and lighting level requirements
2.10	March 2023	Added elevated guideways/bridges requirements
2.13, 4.7	March 2023	Added requirements for exit signs and updated field services and test requirements

LIST OF CONTENT

TABLES

1. GENERAL

1.1. SCOPE OF WORK

1.1.1. This section addresses interior and exterior illumination and lighting design strategy for Metrolinx site and building facilities. The intent is to provide good uniform natural and artificial light sources, with little to no glare, no viewing light sources, no light trespass, with the intent of illuminating spaces with health, hospitality, functionality and atmosphere in mind that makes the customer feel secure and enjoy being in the space.

1.1.2. The intent is to provide requirements for power sources, control, lighting levels and maintenance of lighting systems.

1.2. DESIGN REQUIREMENTS

1.2.1. The equipment furnished and the equipment installation, wiring methods and materials used shall conform to the latest edition of the Ontario Electrical Safety Code, Electrical Safety Authority (ESA) Bulletins and Supplements issued by the Electrical Safety Authority, and the applicable Metrolinx Standards. In case of any conflicts, the more stringent requirement shall apply.

1.2.2. Design equipment and systems to all applicable standards of CSA, ULC, IEEE, ESA.

1.2.3. Design equipment and systems to the latest version of the GO DRM.

1.2.4. Design equipment and systems to standards and codes to be latest editions adopted by and enforced by local authorities having jurisdiction (AHJ).

1.2.5. Design the lighting system to create a balance of both artistry and function, while being both energy and cost-effective.

1.2.6. The Lighting design strategy shall be applied as a sequential overlay of Guiding Principles; followed by lighting design considerations, lighting typology applications and selection criteria and application specific lighting design requirements.

1.2.7. The lighting design strategy shall not be based on a component selection and related elements but on a network system design approach systematically working down to the component level for the monitoring, powering and control of light.

1.2.8. Lighting design criteria shall include for the safety, security and comfort of passengers in conjunction with operations and maintenance requirements with consideration of:

a) Function and vandal resistance;

b) Luminaire selection and availability avoiding custom designed and built fixtures, or end of life fixtures. Fixtures must be available for at least 10 years after purchase for parts and replacements;

c) Luminance values in conjunction with cadence brightness and contrast;

d) Lighting control system (no visible light sources at 4m or less and not trespass lighting outdoors);

e) Aesthetics and economics of power usage;

f) Ease of component replacement, and on-going maintenance (use of lenses and reduction of custom designed and build fixtures); and

g) CCTV compatibility.

1.2.9. The lighting system will be divided into two classifications: normal and emergency/Life safety.

1.2.10. Luminaries shall supply the required quality and quantity of light for each area with minimum variations.

1.2.11. The lighting system shall be designed to:

a) Maintain safety and security requirements;

b) Assist passenger direction and comfort;

c) Utilize the most current technologies and industry accepted practices;

d) Co-ordinate with railway and station operations;

e) System shall be supervised and require minimal maintenance;

f) Not require specialized tools or equipment for repair and maintenance;

g) Minimize power requirements and maximize energy efficiency;

h) Light fixture design shall be simple, elegant and contemporary;

i) Suit egress and evacuation routes as designated by Architects and OBC;

j) Be monitored and controlled by the BAS (Building Automation System) as well as locally. Use of addressable lighting is permitted, and a control system that is suited to the local conditions ; and

k) To provide a look and atmosphere in the space that is meeting the usage of the space with the use of both natural and artificial light sources.

1.2.12. The lighting system shall be designed to include the following:

a) Utilization of the standard luminaire in all areas - Urban light fixtures for each station site shall be selected from one fixture family and matched to the uses and lighting types called for at each site element;

b) Ease of cleaning and maintenance - All fixtures must be accessible for lamp replacement or unit replacement without having to construct special means of approaching and working with the fixture;

c) Architectural integration - Building luminaries in public areas shall be integrated with the architecture. Luminaries shall be in locations designed by the architect, easily access without the need for large equipment or construction of access platforms and complementing daylight sources;

d) General lighting and system circuits shall be alternately circuited to maintain partial lighting in the event of circuit failure;

e) Uniformity of light distribution;

f) Accurate colour rendition, use of colour temperature to provide both task relevant and special effects required;

g) Minimum glare by fixture selection, fixture positioning and location;

h) Minimum light loss and pollution; and

i) Outdoor lighting to meet BUG dark sky requirements.

1.2.13. The lighting system shall be designed to incorporate features that allow for easy access to luminaires at all times for ease of maintenance. Placing luminaires in areas over track work and in areas of inaccessible high mounting elevations above floor levels (i.e. stairs and escalators) shall be avoided.

1.2.14. The purpose of the lighting controls is to command the operation of specific lighting and space conditioning systems. The means of accomplishing this is through the installation of individual room lighting occupancy sensors and vacancy sensors to control the operation of the lighting and space conditioning systems.

1.2.15. Site lighting controls, including sensors and timers, shall be provided for all site element lighting where appropriate, and shall be integrated into the station building automation system, refer to BAS performance specification 25 05 10 for detailed integration requirement.

1.2.16. Daylight harvesting shall be incorporated into the overall lighting design whenever available and possible.

1.2.17. Direct and indirect glare shall be controlled.

1.2.18. All light fixtures shall be LED with the following criteria:

a) CRI (Colour Rendering Index) to be a minimum of 80 unless otherwise noted;

b) Uniformity (average to minimum ratio: 3:1 or better, maximum to minimum: 4:1 or better) unless otherwise noted;

c) Minimum glare and minimum light trespass particularly to residential areas;

d) Colour temperature to be 4000K outside and 3000K inside, and 5000K inside maintenance facilities, unless otherwise noted;

e) Exterior luminaires to have CSA or CUL Wet Location labels, minimum IP66 rating;

f) All lighting fixtures and control systems should carry minimum 10 years' manufacturer warranty; and

g) The luminaires shall be selected and located to minimize glare to passengers and Closed-Circuit Television (CCTV) cameras in particular.

1.3. RELATED WORKS

1.3.1. Section 26 05 00 Electrical General Requirements.

1.3.2. Section 26 05 21 - Electrical Conductors and Cables.

1.3.3. Section 26 05 31 - Splitter Boxes, Junction Boxes and Pullboxes.

1.3.4. Section 26 05 53 – Identification and Nomenclature

1.3.5. Section 26 09 23 - Occupancy Sensors.

1.3.6. Section 26 24 13 - Switchboards and Panelboards.

1.3.7. Section 26 27 26 - Receptacles and Plugs.

1.3.8. Section 26 28 00 - Circuit Breakers and Fuses.

1.3.9. Section 26 33 33 - Inverter Rectifier and Charger.

1.3.10. Section 26 33 53 - Uninterruptible Power Supply.

1.4. REFERENCE STANDARDS

1.4.1. Ontario Electrical Safety Code (OESC).

1.4.2. Ontario Building Code (OBC).

1.4.3. Metrolinx Standards, Drawings and Specifications.

1.4.4. GO Design Requirement Manual (DRM).

1.4.5. Metrolinx Electrical Safety Document.

1.4.6. CSA Z462, Workplace Electrical Safety.

1.4.7. ANSI C136.37, Solid State Lighting Sources Used in Roadway and Area Lighting.

1.4.8. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4.9. ANSI/NEMA C78.379 - Classification of the Beam Patterns of Reflector Lamps.

1.4.10. ASHRA/IESNA 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.4.11. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

1.4.12. ASME MC85.1 - Terminology for Automatic Control.

1.4.13. ASTM C636-04 - Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay in Panels.

1.4.14. ASTM E580 -02e1 - Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay in Panels in Areas Requiring Moderate Seismic Restraint.

1.4.15. CAN/CSA-A14, Concrete Poles.

1.4.16. CAN/CSA-C22.2 No. 250.13-14, Lighting Emitting Diode (LED) Equipment for Lighting Applications.

1.4.17. CAN/CSA-C239-02 - Performance Standard for Dusk-to-Dawn Luminaires.

1.4.18. CAN/CSA-E61347-2-3 - Lamp Controlgear.

1.4.19. CAN/CSA-E61347-2-3-03 - Lamp Control gear - Part 2-3: Particular Requirements for A.C. Supplied Electronic Ballasts for Fluorescent Lamps (Adopted CEI/IEC 61347-2-3:2000, first edition, 2000-10, with Canadian deviations).

1.4.20. CAN/CSA-E922 - Ballasts for Discharge Lamps (Excluding Tubular Fluorescent Lamps) - General Safety Requirements (Adopted IEC 922:1989, first edition, including Amendment 1:1990 and Amendment 2:1992, with Canadian deviations).

1.4.21. CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

1.4.22. CAN/CSA-S157, Strength Design in Aluminum.

1.4.23. CAN/CSC22.2 No. 9.0-96 (R2001) A-E60598-2-3B-98 - Amendment 2:2002 to CAN/CSA-E60598-2-3-98, Luminaires - Part 2-3: Particular Requirements - Luminaires for Road and Street Lighting (Adopted Amendment 2:2000 to CEI/IEC 598-2-3:1993).

1.4.24. Canadian Aviation Regulations (CARs) 2017-3.

1.4.25. CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.4.26. CSA C22.2 No. 141, Emergency Lighting Equipment.

1.4.27. CSA C22.2 No. 206, Lighting Poles.

1.4.28. CSA C22.2 No. 250.0, Luminaires.

1.4.29. CSA C22.2 No. 250.4, Portable Luminaires.

1.4.30. CSA C22.2 No. 9.0, General Requirements for Luminaries.

1.4.31. CSA W59, Welded Steel Construction (Metal Arc Welding).

1.4.32. IES Handbook Latest Edition.

1.4.33. IES LM-79, Approved Method: Electrical and Photometric Testing of Solid-State Lighting Devices.

1.4.34. IES LM-80, Approved Method: Measuring Lumen Depreciation of LED Light Sources.

1.4.35. IES RP 20 Lighting for Parking Facilities.

1.4.36. IES RP 8 Recommended Practice for Roadway Lighting.

1.4.37. IES TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.

1.4.38. Metrolinx Standard for Poles.

1.4.39. MIL-S-29175 - Switch, Thermostatic, Low Voltage, Non- (Setback/Setup) and Setback/Setup), Limiting: Heating, Cooling and Heating-Cooling.

1.4.40. NEMA EMC1 Energy Management Systems Definitions.

1.4.41. NEMA ICS 1 Industrial Control and Systems: General Requirements.

1.4.42. NEMA ICS 2 Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

1.4.43. NEMA ICS 6 Industrial Control and Systems: Enclosures.

1.4.44. NEMA SH5, Standards for Tubular Steel, Aluminum and Prestressed Concrete Roadway Lighting Poles.

1.4.45. NEMA SSL-1, Electronic Drivers for LED Devices, Arrays, or Systems.

1.4.46. NEMA ST 1 Specialty Transformers (Except General Purpose Type).

1.4.47. NEMA WD 6 Wiring Devices Dimensional Requirements. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

1.4.48. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4.49. SA-E928 - Auxiliaries for Lamps -Adopted IEC 928:1995, second edition, with Canadian deviations).

1.4.50. Standard 621.19/TP32 Appendix B Obstruction Lighting Specifications.

1.4.51. Toronto Green Development Standards (for locations under City of Toronto Jurisdiction).

1.4.52. Transport Canada.

1.4.53. UL 508 Industrial Control Equipment.

1.4.54. UL 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.5. SPARE PARTS

1.5.1. Not applicable.

1.6. TRAINING

1.6.1. Provide training as noted below.

1.6.2. Operation Training

a) Allow for minimum of 2 hours of total on-site time to train in all aspects of equipment and system(s) operation(s), per group to be trained.

b) Schedule separate training sessions for each group on separate days.

1.6.3. Maintenance Training

a) Metrolinx Electricians: Allow for minimum of 8 hours of total in-class and on-Site time to train in all aspects of equipment and system(s) operation(s), repair and maintenance, per group to be trained.

b) Provide training for Metrolinx maintenance personnel to a depth that troubleshooting and maintenance can be carried out by Metrolinx.

c) Training to be specific to equipment, model number, and version installed. Provide material for each participant and include record drawings and comprehensive operating and maintenance manual for equipment installed.

1.7. WARRANTY

1.7.1. The contractor shall provide a manufacturer warranty for lighting including but not limited to LED units and poles with a minimum warranty period of ten years after acceptance by Metrolinx.

1.7.2. The contractor shall provide a manufacturer warranty for lighting control system with a minimum warranty period of five years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING

1.8.1. Care should be taken to prevent damage to materials and equipment during transporting, loading, and unloading. Packaged units shall be delivered in their original crates. Equipment and materials shall be stored inside and protected from the weather.

1.8.2. Deliver, store, and handle materials in accordance with manufacturer's written instructions.

1.8.3. Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.8.4. Storage and Handling Requirements

a) Store materials in accordance with manufacturer's recommendations and in a clean, dry, secure, and well-ventilated area.

b) Store and protect products from nicks, scratches, and blemishes.

c) Replace defective or damaged materials with new.

1.9. SUBMITTALS

1.9.1. Shop Drawings and Product Data

a) Submit Shop Drawings indicating location of occupancy sensor system components, wiring connections and diagrams, dimensions.

b) Submit manufacturer's Installation Instructions: Include for manufactured components.

c) Submittal of automatic control systems components which are not the product of the control system manufacturer shall bear evidence of its approval.

1.9.2. Project Record Documents

a) Accurately record actual locations of control components, including relays, power supplies, and sensors.

b) Revise Shop Drawings to reflect actual installation and operating sequences.

c) Provide as-built equipment location and wire routing diagrams, as-built termination and interconnection drawings as well as as-built elementary diagrams.

d) Provide detailed set-up information for furnished equipment, indicating required initial configuration switch settings, jumper positions, to facilitate equipment replacement.

e) Submit field reports indicating operating conditions after detailed check out of systems at commissioning.

1.9.3. Operation and Maintenance Data

a) Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.

b) Include operation and maintenance manuals for equipment and devices, including sensors, power supplies, and other equipment furnished.

c) Include recommended preventive maintenance procedures and materials.

d) Include systems descriptions, set points, and controls settings and adjustment.

e) Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.10. QUALITY ASSURANCE

1.10.1. Products shall be tested, approved and labeled/listed by CSA ,Underwriters Laboratories Canada, or by a nationally recognized testing laboratory (NRTL).

1.10.2. Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

1.10.3. Manufacturer's Qualifications: Company experienced in manufacturing the products specified in this Section with minimum five years documented experience.

1.10.4. Installer Qualifications: Company experienced in applying the work of this Section with minimum 5 (five) years documented experience approved by manufacturer.

1.10.5. The installer shall furnish labor and materials, install the necessary hardware, accomplish the necessary wiring, interfacing and panel work, and place into operation the system as specifically stated in the specifications and drawings.

1.10.6. The installer shall have experience with installation and service operation within the site area.

1.10.7. The electrical standards shall comply with NEMA standards pertaining to components and devices for electric-electronic Energy Management Control Systems (EMCS).

1.10.8. Where substitutions are proposed to the specified equipment, Contractor shall provide all necessary technical documentation, and if required, mock-ups, samples and/or demonstrations, to enable Metrolinx to evaluate the proposed equipment.

1.11. COORDINATION

1.11.1. Refer to Section 26 05 00.

1.11.2. Ensure installation of components is complementary to installation of similar components in other systems.

1.11.3. Coordinate installation of system components with mechanical systems equipment such as air handling units and air terminal units.

1.11.4. Ensure system is completed and commissioned prior to final acceptance inspection by Metrolinx.

1.12. MAINTENANCE SERVICE

1.12.1. Free maintenance services shall be provided by the control system supplier for 2 years after final system acceptance. These services shall consist of manufacturer's factory-trained representatives providing emergency repair service with on-site response within 24 hours of call, all test equipment and hardware necessary for maintenance and repair work and installation of hardware modifications designed to improve system performance or eliminate known problems or deficiencies.

1.12.2. Submit written reports on each inspection or maintenance service to Metrolinx.

1.12.3. Maintenance Data

a) Routine preventive maintenance schedule.

b) Lists of required tools, maintenance materials, and replacement parts.

c) Repair instructions for procedures to check, repair, and test equipment during typical malfunctions.

d) Recommended cleaning methods, frequency, and materials.

2. FUNCTIONAL REQUIREMENTS

2.1. GENERAL

2.1.1. Lighting shall be provided for all indoor and outdoor areas comprising but not limited to:

a) bus-infrastructure;

b) parking garage;

c) surface parking;

d) passenger pick-up drop-off area;

e) passenger station public areas and non-public areas;

f) associated surface facilities (e.g. station entrance/exit);

g) railway platform;

h) tunnels;

i) elevated guide ways/bridges;

j) substations;

k) maintenance facilities;

l) landscaped areas;

m) signage and advertising; and

n) maintenance Facilities.

2.1.2. Particular attention shall be given to areas where changes of elevation and/or environment occur such as:

a) escalators;

b) elevator landings;

c) ramps;

d) platform edges;

e) station entrances and exits;

f) bus loops;

g) maintenance pits;

h) parking garages; and

i) Daylight harvesting areas.

2.1.3. The lighting system design shall include the circulation patterns of pedestrians and vehicles, staff and with special emphasis at:

a) the interface points;

b) decision/transition points; and

c) recognized areas of potential problems.

2.1.4. Luminaire selection and placement shall consider:

a) light pollution and light trespass;

b) traffic and/or pedestrian hazards;

c) vandalism;

d) dark spots, shadows for personnel security and effective operation of security devices;

e) glare;

f) CPTED (Crime Prevention Through Environmental Design)

g) BUG (Backlight, Uplight, and Glare) Dark Sky;

h) ease of maintenance by fixture selection (tool-less maintenance and repair);

i) minimum light loss due to occasional lamp burnout;

j) maintenance accessibility;

k) lens for uniformity of light colour and maintenance;

l) no flood lighting without special approval of the owner;

m) light source not visible;

n) lighting to provide corporate look and feel using natural lighting and artificial lighting sources. For the definition of corporate look and feel, refer to Metrolinx Architecture and Urban Design Standards; andsite clearances as per GO-DRM.

2.1.5. Emergency lighting shall meet the perceived and real requirements of safety and security, to define and to provide a path of egress to assist in safe and orderly evacuation in event of normal power failure and to permit security devices to maintain effective operation. Except for the electrical rooms and communication rooms where in addition to the backup generator lighting there shall be battery pack lighting.

2.1.6. Factory assembled, dead front, metal enclosed and self-supporting switchboard. Complete with line and load side terminations.

2.1.7. Energy Management System/ monitored electronically controlled breakers and metered Panels or IP addressable fixtures and controls shall provide the most flexible control system available: multi-level lighting, occupancy lighting changes, light harvesting, zoning, programmable circuit control, dimming, IP addressable, open architecture (BACnet / Modbus compliant).

2.1.8. Maximize the use of natural light coupled with photocells, motion sensors and controls to activate or dim lighting when necessary to reduce energy consumption and emissions at all facilities.

2.1.9. Areas having more than one light fixture must be serviced by a minimum of two power sources. The design principle is no area is to be in the dark if a circuit fails or maintenance work is being performed on the panel or circuit. Electrical and communication room require in addition to the two or more circuits must have battery pack lighting that would allow safe working conditions with the power off. The loss of the one circuit will be designed so that the space is uniformly lit with no dark areas and will support the use of security cameras.

2.1.10. For areas that are publicly accessible, the power shall be 208/120 VAC (such as but not limited to: platforms, waiting areas, shelters, tunnels, bridges etc.…) For parking lots using high mast lighting, the power shall be 347VAC

2.2. STATIONS

2.2.1. Lighting levels shall produce a natural lead-in, guiding both the driver and the pedestrian to the station facilities.

2.2.2. Lighting of access roads to station property shall integrate with local roadway/area lighting.

2.2.3. The lighting system shall provide sufficient quality and values at all times to provide security and assistance in minimizing potential problems in the vehicle passenger interface areas adjacent to the station, in particular:

a) bus loading/unloading;

b) passenger pick-up and drop-off areas;

c) park and ride facilities;

d) rail platform loading/unloading; and

e) support buildings and paths.

2.2.4. Pedestrian access lighting shall clearly define walkways, cross-walks, ramps, stairs and bridges to facilitate movement at night and for security.

2.2.5. Station entrances shall have the highest brightness within the station facilities, creating an easily recognizable destination focus.

2.2.6. Entrances located either off-street or in conjunction with non-transit facilities shall be illuminated to emphasize the station entrance or portal in conjunction with the signage.

2.2.7. Station entrance stairways and escalators shall be illuminated to give prominence to the stair, escalator head and run areas.

2.2.8. Portal lighting shall be designed to account for the distinct transitions between ambient (outdoor) light levels, transitional light levels, then the lighting levels of the interior of the facility.

2.2.9. Lighting in the station interior shall be appealing to the passengers, and provide awareness of position and orientation. Due consideration shall be given to colours and materials used in construction regarding reflection of light from ceilings and walls, i.e., additional fixtures shall be provided as required to maintain the necessary lighting levels.

2.2.10. Finish ceiling height shall be between 3600 to 4000 mm maximum do not combine a circulation path within a seating zone.

2.2.11. Defined spaces are as follows:

a) Public Washrooms:

1) Entrances into multi-use washrooms (i.e. female/male) shall be door-less with a light ascent wall. Use linear LED lighting in the ceiling cove at back wall of washroom stalls to create a soft uniform glow in the space;

2) Use recessed LED fixtures for the rest of the washroom area; and

3) Provide a perimeter ceiling cove and linear lighting along the wall within the washroom stalls.

b) Service Counter Service Counter:

1) Semi-recessed slot lighting system around the perimeter of the finish ceiling system to be used to create a soft front illumination on the fascia and customer side of the counter, and lengthwise along the walls of the adjacent spaces;

2) Adjustable recessed pot lights to be provided on the customer side in the bulkhead of the Service Counter;

3) Task eyeball lights provided at ceiling level on either side of the station attendant work area, with light direction concentrated at the centre of the attendant work surface, minimizing glare off desk surface;

4) Puck light at underside of station attendant counter for servicing with built in on/off controls;

5) 200mm cube pendant light above each station attendant service position to be individually programmed to indicate whether service position is open (ON), or closed (OFF); and

6) . Consider placement of CCTV cameras to avoid conflict with pendant lights.

c) Retail/Concession:

1) Base building fit-out as per retail strategy guidelines;

2) Lighting of the space must be compliant with Metrolinx lighting requirements and fit in with the design and atmosphere of the station lighting; and

3) The lighting design and layout is the responsibility of the retail tenant.

d) Ancillary Spaces:

1) Ancillary area includes Maintenance Room, Mechanical Room, Electrical Room, and Communications Room.

2.3. LIGHTING DESIGN CONSIDERATIONS

2.3.1. A cohesive and adaptable hierarchy of lighting

a) Provide a consistent and flexible lighting approach across all sites that will promote intuitive wayfinding.

2.3.2. The hierarchy of lighting is identified as:

a) Areas of transition and boarding of Metrolinx services that are highlighted to enhance the experience of movement and safety;

b) Illuminated built structures that serve as lanterns and aid wayfinding throughout the site;

c) Pedestrian scaled illumination for areas of rest and waiting that promote comfort; and

d) Areas of vehicular movement and parking.

2.3.3. Durable and adaptable design with sustainable maintenance and operational efficiencies:

a) Use LED technology for its low energy consumption and long lifecycle; and

b) Integrate control systems and sensors to assist with energy management and contribute to sustainable practices.

2.3.4. Shall guide customers through the sequence of unique customer journey touchpoints at a site:

a) Use lighting to articulate each site element's sense of place;

b) Highlight areas of transition to heighten the experience of movement; and

c) Reinforce site order and hierarchy by emphasizing important zones with light.

2.3.5. Deliver an engaging, comfortable, and safe experience for the customer:

a) Use a variety of lighting types to create ambiance and provide comfort;

b) Highlight significant edges of site elements–thresholds–to create a dynamic and engaging experience;

c) Provide lighting levels that ensure visual and physical comfort of customers;

d) Use a design that keeps the light source out of view or site (indirect lighting) wherever possible;

e) Use light sources with good colour rendering and colour temperature to support comfort and well-being; and

f) Highlight edges of train platforms and curbs to provide a high level of safety and visibility.

2.3.6. The levels and quality of lighting for the various types of areas shall be as outlined in the latest edition of the Illuminating Engineering Society of North America (IES) Lighting Library, as modified here and as required to accommodate the OBC and OESC. They shall take into consideration the aging population and the needs for accessibility of all groups (e.g. CNIB recommendations).

2.3.7. Illumination systems shall require minimal maintenance, and shall be energy efficient and readily accessible, designed for passenger safety and security:

a) Illumination shall be designed to provide visual comfort and minimum glare for Metrolinx staff and passengers; and

b) The illumination systems shall be compatible with CCTV systems.

2.3.8. Building luminaries in public areas shall be integrated with the architecture:

a) Luminaries shall be in locations designed by the architect, complementing daylight sources; and

b) All luminaries must be accessible for maintenance and lamp/unit replacement without having to use specialized tools or construct special means of approaching the fixture.

2.3.9. Urban light fixtures for each station site shall be selected from one fixture family and matched to the uses and lighting types called for at each site element.

2.3.10. Wayfinding through each station site shall be supported by using fixtures that are common to the scale of the user wherever possible:

a) For example, for pedestrian areas, a common lamppost design and scale shall be used throughout the site to identify pedestrian areas.

2.3.11. Light fixture design shall be simple, elegant and contemporary.

2.3.12. Site lighting controls, including sensors and timers, shall be provided for all site element lighting where appropriate, and shall be integrated into the station building automation system:

a) Lighting controls shall support daylight harvesting where applicable;

b) Timers shall be used for lighting zones as defined in the contract drawings;

c) Timers shall be capable of remote access via the BAS or a local controller. Timers must be able to be modified and overridden for maintenance purposes. Refer to section 3.7 Override Switches for more details; and

d) Timers shall be able to revert to original programming automatically after a pre-defined time period set by Metrolinx.

2.3.13. Photosensors are to be located so there is a direct view of the sun and that no shadows or obstructions will interfere with readings. Photosensors shall not be placed in areas where the sensor could get dirty or in a position to give inaccurate light levels

2.3.14. Occupancy sensors are to be provided in the following areas with not less than 90% coverage of space:

a) Parking garage lobbies;

b) Service rooms ;

c) Tunnel bridges ; and

d) Washrooms

2.3.15. Photosensors shall be provided for site lighting in the following areas:

a) Bus platforms, including shelters;

b) Surface parking lots;

c) Station plaza;

d) Rail platforms;

e) Open bridges, including stairways; and

f) Closed bridges.

2.3.16. Lighting in enclosed stairways and parking garages shall remain on at all times but may be dimmed when not occupied, unless otherwise noted.

a) Lighting fixtures and ballasts shall be selected and installed to ensure ease of access for servicing and ease of maintenance

2.3.17. All light fixtures shall be LED with the following criteria:

a) CRI (Colour Rendering Index) to be a minimum of 80 unless otherwise noted;

b) Colour temperature to be 4000 K unless otherwise noted; and

c) Exterior luminaires to have CSA or ULC Wet Location labels.

2.3.18. Use light fixtures equipped with industry standard LED light engines.

2.3.19. Specify light fixtures that limit glare, uplight, and support dark sky policy.

2.3.20. Specify light fixtures that are locally distributed and serviced.

2.3.21. Where accessible by the public, light fixtures are to have vandal resistant features.

2.3.22. Glare: Adjacent properties shall be shielded from glare or light trespass. There shall be no interference with railroad signal or operations systems due to glare. The discomfort Glare Rating shall have a Visual Comfort Probability (VCP) of 65% or greater for interior lighting. Station attendants and passengers at service counters shall be able to see each other 100% when the sliding glass panel is in the closed position. Luminaries in this location shall have parabolic egg crate lenses, with all illumination directed vertically down to the task. Passengers and station attendants shall be capable of seeing out to the exterior at night. All glass shall be clear and not tinted, for maximum visibility of the interior. Luminaries' placement shall take into account viewing angles and fields of view of close circuit television cameras. Luminaries shall not present a source of glare to surveillance cameras.

2.3.23. Exit lights shall be of the fully self-contained and low energy LED type.

2.3.24. Emergency lighting shall be in accordance with the OBC, OESC and the latest CSA standards.

2.3.25. Daylight: particular attention shall be directed to parking structure, rail station and bus terminal entrance/ exit areas, especially on large projects. Illumination shall provide for a visually comfortable transition from outdoors to facility entry areas during all hours of system operation. Illumination levels will likely have to be graduated in stages during the daylight hours to minimize otherwise abrupt changes from outdoors to indoors, and vice versa. Photoelectric cells for the automatic operation of additional lighting fixtures may be utilized.

2.3.26. Sundry: All rail platform poles shall be hinged to avoid flagman services. Hinged poles shall be installed in such a manner to avoid obstructions when lowered. Hinging shall be always parallel to the track. CCTV and digital display monitors and camera(s) shall have dedicated split pole(s). PA speakers can be installed on existing lighting poles only if they are split. High-mast lighting poles shall have no objects attached onto it (e.g. parking identification, PA speakers, etc.) to avoid obstruction of the lowering device.

2.3.27. Standard Light Pole Drawings: Digital drawing files (AutoCAD) are available for 3 m and 6 m hinged pole, 6 m, 12 m and 30 m (high mast) pole under Metrolinx Standard Drawings.

2.3.28. Uniformity Ratio

a) Maximum to minimum: 4:1 or better.

b) Average to minimum: 3:1 or better.

2.3.29. Where lighting is of a complex or unique nature or if required by Metrolinx, the Consultant shall engage the services of a qualified Illumination Designer.

2.3.30. Design photometric digital file in PDF or DWG format, complete with printouts using recognized computer lighting design software, shall be provided for Metrolinx review of design illumination levels for both normal and emergency/life safety lighting at all key design milestones. These photometric files shall be included in the As-built drawings.

a) Integrate control systems and sensors to assist energy management and contribute to sustainable practices.

2.3.31. Guide customers through the sequence of unique customer journey touchpoints at a site:

a) Use lighting to articulate each site element’s sense of place;

b) Highlight areas of transition to heighten the experience of movement; and

c) Reinforce site order and hierarchy by emphasizing important zones with light.

2.3.32. Deliver an engaging, comfortable, and safe experience for the customer:

a) Use a variety of lighting types to create ambiance and provide comfort;

b) Highlight significant edges of site elements–thresholds–to create a dynamic and engaging experience;

c) Provide lighting levels that ensure visual and physical comfort of customers;

d) Use light sources with good colour rendering and colour temperature to support comfort and well-being; and

e) Highlight edges of train platforms and curbs to provide a high level of safety and visibility.

2.3.33. Bus Loops

a) General illumination for bus platform shall be provided by a line of full cut-off single-headed downlights on lampposts and bus shelters.

b) Lamppost height shall be kept to a minimum, based on site layout and design intent.

c) General illumination for bus platforms with pedestrian walkways behind shelters shall be provided by a line of full cut-off double-headed downlights on lampposts aligned with the back of bus shelters.

d) One head will provide platform lighting; the other head will provide pedestrian scale lighting on the pedestrian walkway behind the shelter.

e) Pole height shall be kept to a minimum, based on site layout and context.

f) Pedestrian scale fixture head shall be between 3 and 6 meters above the plaza surface.

g) Lighting of the bus shelter, while not within the scope of site lighting, shall be taken into consideration in calculations and overall balance of lighting design.

h) Minimum average maintained illumination levels shall be:

1) Bus Platform Boarding Area: 100 LUX horizontal and 50 LUX vertical;

2) Bus Platform: 50 LUX horizontal, 25 LUX vertical; and

3) Colour temperature shall be 4000K and shall be confirmed through testing with site materials.

2.3.34. Parking Garage

a) The lighting in the parking area of the garage shall be provided by direct/indirect fixtures positioned above the bottom edge of structural beams.

b) The lighting in the elevator lobby shall be provided by graphic direct LED fixtures positioned parallel to the elevator doors.

c) In cases where the design and layout of the garage permit, use graphic direct LED fixtures to highlight key pedestrian areas and promote wayfinding within the garage.

d) Minimum average maintained illumination levels shall be:

1) General Parking and Pedestrian Areas: 55 LUX horizontal;

2) Ramps and Corners: 110 LUX horizontal;

3) Elevator Lobbies: 200 LUX horizontal;

4) Parking Garage Entrance Areas – Nighttime: 110 LUX horizontal, 55 LUX vertical;

5) Parking Garage Entrance Areas – Daytime: 550 LUX horizontal, 275 LUX vertical;

6) Colour temperature – 4000 K minimum; and

7) CRI–80 preferred, 70 minimum.

2.3.35. Surface Parking

a) The lighting in the parking and drive aisle areas shall be provided by full cut-off single and double-headed downlights on lampposts.

b) Lamppost height shall be kept to a minimum, based on site layout and context.

c) The lighting in the pedestrian walkways shall be provided by full cut-off single-headed lighting fixtures on lampposts.

d) Fixture head shall be between 3 and 6 metres above the walkway surface.

e) Minimum average maintained illumination levels shall be:

1) Parking Lot: Refer to the latest version of GO DRM;

2) Pedestrian Walkways: 20 LUX horizontal;

3) Colour temperature–4000K minimum; and

4) CRI–80 preferred, 70 minimum.

2.3.36. Station Plaza

a) Lighting along the Plaza Edge/Drop Off and Pick-up Area shall be provided by full cut-off double-headed downlights on lampposts aligned parallel to edge of plaza:

1) One head will provide roadway lighting, the other head will provide pedestrian scale lighting on the plaza;

2) Lamppost height shall be kept to a minimum, based on site layout and context;

3) Pedestrian scale fixture head shall be between 3and 6 metres above the plaza surface; and

4) Lighting within the plaza shall be provided by indirect light lampposts aligned parallel to the station building and integrated with the planting zone if one exists:

i) Pedestrian scale fixture head shall be between 3 and 6 metres above the plaza surface;

ii) Lighting of the station building shall be taken into consideration in calculations and overall balance of lighting design;

iii) Minimum average maintained illumination levels shall be:

.1 Plaza Edge/Drop Off and Pick-up Area: 50 LUX horizontal, 25 LUX vertical; and

.2 Plaza: 50 LUX horizontal.

iv) Colour temperature shall be:

.1 Plaza Edge/Drop Off and Pick-up Area: 4000 K minimum Plaza: 4000 K.

2.3.37. Rail Platforms

a) The lighting of the platform area and its stair and elevator access points shall be provided by direct/indirect lighting fixtures that produce a graphic effect, aligned parallel to the platform edge.

b) At platforms without roof soffits, lighting is to be provided by direct full cut-off lighting on poles:

1) illuminate the platform; and

2) poles shall be kept to a minimum, based on site layout and context.

c) Stairwells and their handrails shall have integrated lighting:

1) Avoid placing lights in the ceiling above stairs or in other not easily accessible places;

2) Minimum average maintained illumination levels shall be:

i) Platform Boarding Area: 100 LUX horizontal, 50 LUX vertical;

ii) Platform: 50 LUX horizontal, 25 LUX vertical ; and

iii) Stairwells: 200 LUX horizontal.

3) Colour temperature shall be 4000K.

2.3.38. Bridges

a) Enclosed bridges shall have ceiling integrated direct/indirect lighting that produces a graphic effect.

b) Open bridges shall have lighting integrated on the interior, into side elements such as structure, handrails and guards.

c) Bridges shall be connected to daylight harvesting photocells to save on energy when there is sufficient daylight entering the bridge.

d) Light sources shall not to be visible from the point of view of train conductors.

e) Enclosed stairs to bridges shall have lighting integrated into side walls above head height, and lighting integrated into handrails.

f) Open stairs to bridges shall have lighting integrated into handrails.

g) Minimum average maintained illumination levels shall be:

1) Enclosed and Open Bridges: 150 LUX horizontal, 75 LUX horizontal;

2) Enclosed and Open Stairs: 200 LUX horizontal; and

3) Colour temperature shall be 4000 K.

2.3.39. Pedestrian Tunnels

a) Enclosed tunnels shall have ceiling integrated direct/indirect lighting that produces a graphic effect.

b) Entrances stairs and elevator and lobbies shall have lighting integrated on the interior, into side elements such as structure, handrails and guards.

c) Light sources shall not to be visible from the point of the occupant.

d) Tunnel lighting shall be on occupancy sensors. When no motion is detected, the lights shall dim to maximum 50% output (not less). Once motion is detected, lighting shall turn on to 100%.

e) Enclosed stairs to bridges shall have lighting integrated into side walls above head height, and lighting integrated into handrails.

f) Open stairs to tunnels shall have lighting integrated into handrails or step stairway walls.

g) Minimum average maintained illumination levels shall be:

1) Enclosed tunnel: 200 LUX horizontal, 100 LUX vertical ;

2) Enclosed and Open Stairs: 200 LUX horizontal; and

h) Colour temperature shall be 4000 K.

2.4. RAILWAY PLATFORMS

2.4.1. The platform area shall be clearly lighted to produce an environment that will enhance the passenger's ability to detect, recognize, and identify objects and events. The colour and areas of contrast are particularly important.

2.4.2. The platform edge shall be illuminated to a higher intensity than the waiting area to indicate the transition between station and train. Lighting of the actual track area shall be minimized to highlight the contrast with the platform edge. This is a specific deviation permitted in lieu of evenness.

2.4.3. The shelters shall be illuminated to a higher level than the general waiting area, to delineate the emphasized area.

2.5. PARKING GARAGE AND SURFACE PARKING

2.5.1. Parking areas shall have luminaires located to minimize shadows between rows of automobiles. Lighting levels shall be even, not striped, and shall be of sufficient value to provide visibility into the back seat of an automobile.

2.5.2. In covered parking areas the vertical and horizontal illuminance shall be such that columns, walls and curbs etc. are clearly emphasized for avoidance.

2.5.3. Focal points in parking areas, such as entrances, exits, handicap parking, toll plazas and pedestrian cross-walks, shall have an average illuminance of 200% to 500% of general parking area.

2.5.4. Parking structure lights to turn fully off with the aid of photocells where light levels are high enough from daylight harvesting.

2.6. LANDSCAPING

2.6.1. Landscape lighting shall be integrated and coordinated with feature planting.

2.6.2. Luminaires used for landscaping shall be shielded and generally beamed downwards, where upward lighting is required, luminaires shall be aimed into the planted materials allowing little or no light to trespass beyond.

2.6.3. Seasonal effects of plant foliage shall be considered in the landscape lighting design and control system.

2.7. ILLUMINATED SIGNAGE

2.7.1. Lighting shall emphasize directional and informational signage.

2.7.2. Signage and graphics may be illuminated either internally or externally, using an internal source, an external source and/or area ambient light.

2.7.3. Areas designated for advertising signs shall be provided with electrical receptacles.

2.7.4. Station directional and information signage and graphics shall be supplied from the normal power supply system.

2.7.5. Exit and exterior station identification signage at grade signs shall be supplied by the emergency power system.

2.8. RIGHTS-OF-WAY

2.8.1. Rights-of-way lighting shall be implemented using weather sealed luminaires.

2.8.2. The lighting shall be circuited from the nearest lighting distribution panel(s) such that adjacent luminaires are not on the same phase, phases shall be balanced. Blue light fixtures shall be on emergency power system.

2.8.3. Luminaires shall be selected, located, aimed and shielded to eliminate interference with signals.

2.8.4. Sufficient Illumination shall be provided along the main-line right-of-way to provide safety and security for:

a) passenger emergency egress path; and

b) maintenance access areas (stairs and ladders, switch machine locations).

2.9. UNDERGROUND TUNNEL SECTIONS

2.9.1. Transit Vehicle Underground tunnel sections shall have luminaires mounted to reduce the amount of glare and to eliminate stroboscopic effects, to the driver of the transit vehicle. Luminaires generally shall be mounted to beam down from the horizontal and away from the direction of normal train travel

2.9.2. Daytime tunnel portal luminance at the threshold zone, where a transition is made from the high lighting level of the exterior portion to the lower lighting level of the interior portion, shall have a relatively high illuminance level to maintain visibility during eye adaptation period and vice versa.

2.9.3. Underground sections of lighting shall be located above the walkway for each direction of travel. Luminaires shall be mounted at a minimum nominal height above the designated walkway.

2.9.4. Underground sections of lighting shall be on the emergency power system.

2.10. ELEVATED GUIDEWAYS/BRIDGES

2.10.1. Luminaires shall be selected and mounted along the guide way to minimize the amount of light trespass,pollution and in a position to be easily maintainable.

2.10.2. Illumination shall be provided under elevated guide ways where publicly accessible pedestrian or vehicular ways are provided, to facilitate movement and recognition at night. Placement of luminaires shall minimize shadows in areas which are accessible to the public.

2.10.3. All Lighting on the elevated guideways shall be supplied by emergency power system utilizing multiple circuits. When possible, use different emergency powered lighting panels to minimize disruption if one panel is out of service or being maintained.

2.10.4. All lighting on the elevated guideways shall be circuited with multiple circuits to ensure a minimum of 50% coverage in case of a circuit failure(s).

2.10.5. Emergency access/exit stairs that lead to/from the elevated guide way shall be illuminated and supplied by emergency power system.

Table 2-1 Illumination Level Requirements

Locations	Color temperature	Illumination Level Horizontal [1]	Illumination Level Vertical [2]
General or Common Building [3]			
Kitchen / Counter/Lunch Rooms	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Public Washroom	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Electrical Room	3000K	75 Fc (750 LUX)	75 Fc (750 LUX)

[1] As shown is a minimum level at working / walking task heights.
[2] If it is not noted otherwise the horizontal to vertical ratio is to be 2:1.
[3] Local override switches on site (service center, electrical room and outside station building or convenient location), remote control (BAS) monitoring and dimming, photocell. Night levels at site operating and site in security mode.

Locations	Color temperature	Illumination Level Horizontal [1]	Illumination Level Vertical [2]
Communication rooms	3000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Janitor and Storage Rooms	3000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Electrical rooms	3000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Mechanical/Boiler rooms	3000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Office	3000K	As per IES or CIBC or as directed by GO or CNIB	As per IES or CIBC or as directed by GO or CNIB
Meeting rooms [4]	3000K	As per IES or CIBC or as directed by GO or CNIB	As per IES or CIBC or as directed by GO or CNIB
Building entrances and exits	4000 K	10 Fc (100 LUX)	10 Fc (100 LUX)
Utility areas	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Office areas	3000K	40 Fc (400 LUX)	40 Fc (400 LUX)
Emergency and night time lighting	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Stairs	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Closets (Door Switch Control)	3000 K	20 Fc (200 LUX)	20 Fc (200 LUX)
Service Rooms	3000 K	50 Fc (540 LUX)	50 Fc (540 LUX)
Emergency lighting	match area lighting	2 Fc (20 LUX)	2 Fc (20 LUX)
Exit Signs	match area lighting	2 Fc (20 LUX)	2 Fc (20 LUX)
Hallway/Corridor	3000 K	20 Fc (200 LUX)	20 Fc (200 LUX)
Mechanical Room	3000 K	75 Fc (750 LUX)	75 Fc (750 LUX)
Station / Terminal or Transportation HUB			
Waiting Room [5]	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Staff Washroom	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Station Attendant Room	3000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Service Counter task lighting	3000K	40 Fc (400 LUX)	40 Fc (400 LUX)
Kiosk Information Area	3000K	30 Fc (300 LUX)	30 Fc (300 LUX)
Station Plaza	3500K	5 Fc (50 LUX)	5 Fc (50 LUX)

[4] Meeting rooms require multiple methods of controlling light: dimming, occupancy sensors, desk /table lighting control, projection or monitor light control, perimeter lighting controls.
[5] Minimum of 2 circuits and working level battery pack lighting good for a minimum of 8 hrs

Locations	Color temperature	Illumination Level Horizontal [1]	Illumination Level Vertical [2]
Dispatch Room	3000K	15 Fc (150 LUX)	15 Fc (150 LUX)
Maintenance Facility (Rail or Bus)			
Maintenance pit	5000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Pedestrian gates	4000K	10 Fc (100 LUX)	10 Fc (100 LUX)
Interior repair garage, general	5000K	50 Fc (500 LUX)	50 Fc (500 LUX)
Interior repair garage, workbenches	5000K	75 Fc (750 LUX)	75 Fc (750 LUX)
Bus garage areas	5000K	30 Fc (300 LUX)	30 Fc (300 LUX)
Shop	5000K	30 Fc (300 LUX)	30 Fc (300 LUX)
Crew Building /locker Changeroom and exercise areas	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Layover General Lighting (Yard)	4000K	2 Fc (20 LUX)	2 Fc (20 LUX)
Wayside cabinet and Switch Area	4000K	10 Fc (100 LUX)	10 Fc (100 LUX)
Out Buildings / Crew Quarters	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Shop/Workbenches	4000K	30 Fc (300 LUX)	30 Fc (300 LUX)
Electronic Shop Workbenches (task lights)	4000K	As per IES	As per IES
Parking Garage			
General Parking and Pedestrian Areas Occupied	4000K minimum	5 Fc (55 LUX)	5 Fc (55 LUX)
Unoccupied Areas	4000K minimum	2.5 Fc (28 LUX)	2.5 Fc (28 LUX)
Ramps and Corners	4000K minimum	10 Fc (110 LUX)	10 Fc (110 LUX)
Entrance Areas	4000K minimum	50 Fc (540 LUX)	50 Fc (540 LUX)
Passenger Drop-off and Pick-up Areas	4000K minimum	5 Fc (50 LUX)	5 Fc (50 LUX)
Stairways and Elevator Lobbies	4000K minimum	20 Fc (200 LUX)	20 Fc (200 LUX)
Common Buildings spaces	4000K minimum	To match surrounding lighting level	To match surrounding lighting level

Locations	Color temperature	Illumination Level Horizontal [1]	Illumination Level Vertical [2]
Exterior circulation areas	4000K minimum	3 Fc (30 LUX)	3 Fc (30 LUX)
Exterior parking areas	4000K minimum	3 Fc (30 LUX)	3 Fc (30 LUX)
Pedestrian Bridges	4000K minimum	20 Fc (200 LUX)	20 Fc (200 LUX)
Service Rooms	4000K minimum	50 Fc (540 LUX)	50 Fc (540 LUX)
Ramps and Corners	4000K minimum	10 Fc (110 LUX)	10 Fc (110 LUX)
Surface parking / Parking Lot [6]			
Canopy Separate from Buildings	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Canopy Walkways at Buildings	4000K	10 Fc (100 LUX)	10 Fc (100 LUX)
Canopy at Platform	4000K	5 Fc (50 LUX)	5 Fc (50 LUX)
Canopy at Mini Platform	4000K	15 Fc (150 LUX)	15 Fc (150 LUX)
Canopy at Station	4000K	10 Fc (100 LUX)	10 Fc (100 LUX)
Railway Platform	4000K	5 Fc (50 LUX)	5 Fc (50 LUX)
Platform Union Station and UP Express	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Canopy at Boarding Edge	4000K minimum	10 Fc (100 LUX)	10 Fc (100 LUX)
Bus Loop	4000K	2 Fc (20 LUX)	2 Fc (20 LUX)
Platform Boarding Area (bus and train)	4000K	10 Fc (100 LUX)	10 Fc (100 LUX)
Train Platform	4000K	5 Fc (50 LUX)	5 Fc (50 LUX)
Mini-Platform/Designated Waiting Area	4000K	15 Fc (150 LUX)	15 Fc (150 LUX)
Bus Platform	4000K	5 Fc (50 LUX)	5 Fc (50 LUX)
Illuminated Signage	6000k	Levels to suite application	Levels to suite application
Landscaping	4000K	Levels to suite application	Levels to suite application
Access Road	4000K	2 Fc (20 LUX)	2 Fc (20 LUX)
Elevated Guideways / Bridges, Pedestrian Tunnel or Overpass and Open Stairwell	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)

[6] Local override switches on site (service center, electrical room and outside station building or convenient location), remote control (BAS) monitoring and dimming, photocell. Night levels at site operating and site in security mode. Control exterior lighting by means of a photocell and contactor with a manual override; provide a computer based low voltage lighting control system to switch various lighting circuits through the building. Control interior lighting by local switches, occupancy sensors and the low voltage lighting control system.

Locations	Color temperature	Illumination Level Horizontal [1]	Illumination Level Vertical [2]
Exterior Stairs and Walkways Separate from Buildings	4000K	20 Fc (200 LUX)	20 Fc (200 LUX)
Pedestrian Paths and Bike Ways	4000K	2 Fc (20 LUX)	2 Fc (20 LUX)
Underground Vehicle Tunnel	4000K	2 Fc (20 LUX)	2 Fc (20 LUX)
Shelter	4000K unless otherwise noted	5 Fc (50 LUX)	5 Fc (50 LUX)
BRT Building (Bus Rapid Transit)	4000K unless otherwise noted	15 Fc (150 LUX)	15 Fc (150 LUX)
Substation Yard [7]			
Other	4000K	10 Fc (100 LUX) or as per IES or as directed by Metrolinx	10 Fc (100 LUX) or as per IES or as directed by Metrolinx

General Notes:

- The lighting control system shall be flexible i.e. programmable to be controlled per circuit complete with IP addressable and remote access and control.
- Outdoor lighting shall have a publicly inaccessible master switch to disable for maintenance
- Methods of reducing energy usage and maintenance shall be considered in design.
- LED Lighting shall be continuous dimmable (0 to 10 V DC).
- The design shall consider occupied spaces and provide 50 % reduction in light levels when unoccupied.
- Light harvesting systems shall also be considered.
- Control interior lighting by local switches, occupancy sensors and the low voltage lighting control system and BAS.
- Control exterior lighting by means of a photocell, dimming by mesh or cell network and/or contactor with a manual override; remote control, BAS monitoring provides a computer based low voltage lighting control system to switch various lighting circuits throughout.
- POE, 24 VDC, 0 to 10 V dimming, 120VAC are all acceptable power sources and control for public access areas. POE, 24 VDC, 0 to 10 V dimming, 120 or 347 VAC are all acceptable power sources and controls for all other areas.
- Life safety lighting shall be on a generator and approved for use with separate life safety UPS or inverter.
- All areas required to keep the location operational shall have the lighting additionally fed from backup power generators where available.

[7] Lighting should be kept outside of areas of high and medium voltages. The light sources shall be accessible without having to enter the yard.

2.11. EMERGENCY LIGHTING

2.11.1. Emergency lighting levels have been established for the egress when normal AC power supply has failed.

2.11.2. All station public areas and non-public areas shall be provided with uniform minimum average levels of not less than 10 LUX as per the Ontario Building Code.

2.11.3. All station stairways and stair landings shall be provided with minimum average level of 50 LUX.

2.11.4. Exit lights shall be supplied with and connected to the emergency power system.

2.12. RADIO TOWER OBSTRUCTION LIGHTS

2.12.1. Flashing Red Beacon Lights: Type to be determined (TBD), weatherproof duplex style.

2.12.2. Red Obstruction Lights: Type TBD, single or double fitting as required by the application.

2.12.3. High Intensity White Obstruction Lights: Type TBD.

2.12.4. Medium Intensity White Obstruction Lights: Type TBD.

2.12.5. Provide all necessary support including power, control, and mounting equipment.

2.12.6. Installation

a) Install to CSA C22.1, Safety Standard for Electrical Installations and Transport Canada Canadian Aviation Regulations.

b) Install obstruction lighting units on 35mm GRC threaded conduit ends to project at least 305 mm above highest point of building. or at require intervals on the tower and at the top of the tower.

c) Install photocell unit on receptacle base.

2.12.7. Field Quality Control

a) Section Field Inspection, testing, adjusting.

b) Inspect and test obstruction lighting equipment to CSA C22.1, Safety Standard for Electrical Installations.

2.12.8. Adjusting

a) Section on Adjusting installed work.

b) Adjust flash rate and photocell level set points to meet requirements of Transport Canada Canadian Aviation Regulations.

2.13. EXIT SIGNS

2.13.1. Use CSA and/or ULC listed green Running Man type exit sign with LED powered lighting

2.13.2. Signs shall be able to operate using 120V and require connection to emergency power.

2.13.3. For Combo Emergency Light signs use minimum 2 heads with battery backup for 90 minutes to allow workers in those spaces to work safely.

2.13.4. All exit signs shall have universal mounting capabilities for wall/side/ceiling mounting and require no specialized tools for installation or maintenance.

Battery Charger: Dual rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.

2.14. MOCK-UP

2.14.1. Requirements for mock up for sensitive first time design, or custom-made fixtures and use of new systems for review, comment and possible improvements.

2.14.2. Provide mock-up of luminous system, or fixture, minimum size to effectively display the lighting, control and fixtures including at least one of each component, located where directed, to Section Mock up.

2.14.3. Analyze mock-up to determine if the electrical requirements, effect, ease of maintenance, illumination level and comfort achieved meet Metrolinx requirements.

2.14.4. Mock-up may [not] remain as part of Work.

2.14.5. TEST switch: Transfers unit from external power supply to integral battery supply.

2.14.6. Electrical Connection: 1800 mm cord with plug cap, NEMA WD 6, Type 5 20 configuration. Conduit connection.

2.14.7. Input Voltage: 120 or 208 volts AC for public access areas. 120, 208 or 347 volts AC for all other areas

3. LIGHTING CONTROL SYSTEM

3.1. DESIGN OF LIGHTING CONTROL SYSTEM

3.1.1. This section applies for LEED, which requires compliance with ASHRAE/IESNA 90.1. ASHRA/IESNA 90.1, section on "Lighting" sets minimum interior and exterior lighting power densities and minimum requirements for lighting controls. Refer to the newest version of LEED certification published by the Canada Green Building Council (CaGBC) for a full list of requirements. In the event of conflicts between ASHARE 90.1 and Metrolinx requirements, the Metrolinx Standards shall govern.

3.1.2. Controls include: Local switches, occupancy sensors, and daylight-harvesting controls can be used to meet the requirements of LEED. However, the use of task lighting may also be required, depending on the type of lighting system used on the project. Occupancy sensors and daylight-harvesting controls can be combined with other energy-conserving measures to meet the requirements of LEED Occupancy sensors.

3.1.3. Power supply components

a) Relays.

b) Supply wiring.

c) Control wiring.

d) Control panels.

e) Hubs and Electronic network switches.

f) Addressable devices, wired, wireless and POE where permitted by Code.

3.1.4. Extra Materials

a) Provide as spare parts two (2) of each type and model of sensor, power pack, slave relay.

3.1.5. External power supply shall be 120 or 208 Vac, 60 Hz, with the following characteristics:

a) Secondary output 24 VDC, 100 mA minimum ; and

b) Transformer and contact closure relay in single unit.

3.1.6. Relays

a) Contacts: NEMA ICS 2; Form C

b) Contact Ratings: NEMA ICS 2; Class A150.

c) Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts for each detection zone to provide accessory functions specified.

3.1.7. Occupancy/Motion Sensors

a) See section on occupancy sensors, 26 09 23.

b) If both infrared and ultrasonic sensors are utilized, they shall be of like manufacturer, with interchangeable heads, so that an ultrasonic head may be substituted for an infrared head and vice versa, without necessity for replacement of other devices (i.e. Slave relays, power supplies, et. al.), and shall be interchangeable in mounting, utilizing the same size cut-outs, connectors, etc.

c) Wall mounted switch occupancy sensors are not to be used.

d) It is acceptable to use double or triple (infrared, audio and ultrasonic) methods in one sensor.

e) POE and wireless switches and sensors are acceptable. Sensors should be addressable if possible.

f) Sensing system shall incorporate a time-delay-before-off relay, adjustable as a minimum from 5 to 20 minutes.

g) Occupancy sensors shall include a manual override to energize the lighting system upon failure of the occupancy sensor, or occupancy sensor design/installation shall provide for the lighting system to automatically remain in operation upon a failure of the occupancy sensor.

h) Outdoor motion sensors shall be rated and labeled for outdoor conditions and operations and impervious to the effects of ultraviolet rays and wet conditions.

3.2. INTERIOR CONTROLS: MORNING PERIOD

3.2.1. Morning controls One half (1/2) hour before the first AM train and/or bus for the full rush hour period of about 4 hrs:

a) Station Building and/or Bus Terminal lighting to be 100% ON excluding ancillary area;

b) Tunnel and Bridge lighting shall be 100% ON when occupied;

c) Parking structure lights to be 100% ON when occupied; and

d) Outside of rush hours the timer and photocells will be over ridden by override switches, BAS system, daylight harvesting sensors, motion sensors to allow dimming of lighting to 50 % or as directed by Metrolinx. When the space is occupied by staff or public the lighting is to be 100% on.

3.2.2. Occupancy sensors shall be provided in driver washrooms, maintenance rooms, mechanical, electrical, and communications rooms, staff service and back-of-house area.

3.3. EXTERIOR CONTROLS: MORNING PERIOD

3.3.1. One half (1/2) hour before the first AM train and/or bus:

a) Platform, platform canopy, platform shelter, information signs and shelters, and building canopy lighting to be 100% ON;

b) Bus loop and bus loop shelter lighting to be 100% ON; and

c) Parking lot lighting shall be 100% ON.

3.4. EVENING PERIOD: INTERIOR CONTROLS

3.4.1. One (1) hour after the last PM train and/or bus:

a) Station Building and/or Bus Terminal lighting to drop to 30% illumination;

b) Tunnel lighting to drop to 50% illumination;

c) Parking structure lighting to drop to security lighting (i.e. 30% or better);

d) Occupancy sensors shall be provided on Station Building and/or Bus Terminal lighting controls;

e) Tunnel lighting shall be on occupancy sensors. When no motion is detected, the lights shall drop 50% output, as noted above. Once motion is detected, lighting shall turn on to 100%;

f) Occupancy sensors shall be provided on Parking Structure lighting controls; and

g) Can be disabled as part of a master shut off noted in section 3.7

3.5. EVENING PERIOD EXTERIOR CONTROLS

3.5.1. The lighting controls shall be designed to provide the following functions:

a) The lighting controller (i.e. timer) shall be programmable controlled, complete with automatic daylight savings adjustment;

b) Provide a photocell control on all control designs where the default is "dusk to dawn";

c) The exterior lighting levels are to dim to 30% 1 hour for security lighting and CCTV cameras after the last scheduled transit vehicle has left and the site is closed;

d) Sites that are being rehabilitated shall have their lighting controls modified to meet these requirements; and

e) Can be disabled as part of a master shut off noted in section 3.7.

3.6. DIMMABLE ILLUMINATION

3.6.1. Photocells, motion and occupancy sensors are to be used within multi-level parking structures, tunnels and pedestrian bridges.

3.6.2. Occupancy sensors are to be placed to allow no blind spots.

3.6.3. Refer to Illumination Levels table for minimum lighting levels within multi-level parking structures, tunnels and pedestrian bridges as recommended by IESNA.

3.6.4. The lighting control shall be flexible i.e. programmable controlled per circuit complete with IP addressable and remote access and control.

3.6.5. Methods of reducing energy usage and maintenance shall be considered in design. LED lighting shall be continuous dimmable (0 to 10 V DC). The design shall consider occupied and a 50 % reduction in light levels when unoccupied. Light harvesting systems shall also be considered.

3.7. OVERRIDE SWITCHES

3.7.1. Station lighting is to be wired into separate zones listed in the table and controlled independently by one of three master override switches.

3.7.2. Switches shall be strategically located at the following 3 locations within:

a) Employee side of Service Counter area;

b) Main Electrical Room; and

c) Exterior of the station.

3.7.3. Switches shall be labeled and housed in a weather tight, PVC lockable box accessible to Metrolinx staff, and Metrolinx approved contractors/agents.

3.7.4. Remote parking shall have its own override switches following the same guidelines as above.

a) The locations shall be inside the local power cabinet and outside the cabinet housed in a weather tight, PVC lockable box.

3.7.5. Overall Master Shut Off overrides programmed lighting controls for a prescribed timeframe. When prescribed time frame elapses, programmed lighting resumes.

a) Zones for Override Switches;

b) Station building;

c) Surface parking;

d) Multi-level parking;

e) Bus loop;

f) Rail Platform;

g) Kiss & Ride;

h) Access Road; and

i) Overall Master Shut Off.

4. EXECUTION

4.1. INSTALLATION

4.1.1. Qualifications

a) Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.

b) Most authorities having jurisdiction with respect to electrical code enforcement accept Underwriters Laboratories' listing and classification as evidence that a product meets adequate safety standards and, in the case of classification, is suitable for the classified environment or application. Many authorities also accept similar listing and classification from other testing agencies. The second choice in the paragraph below permits other testing agencies, including Underwriters Laboratories, to provide such a determination.

c) Use this Article when more than one luminaire type is specified in this section and include the second paragraph if product substitution is allowed. Use the second set of requirements to specify one luminaire type.

d) For products such as High Mast, Epoxy and PVC coated steel conduit, and other equipment must be supplied and installed by manufacturer approve and certified installers with a minimum of 5 years experience.

e) Verify that systems are ready to receive work by methods such as but not limited to: reviewing recent condition assessments and performing inspections.

f) Beginning of installation means installer accepts existing conditions.

g) Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

h) Support luminaires larger than 600 x 1200 mm size independent of ceiling framing.

i) Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

j) Install surface mounted luminaires and exit signs to make even contact with the installing surface throughout and adjust to align with building lines and with each other. Secure to prevent movement.

k) Select one of the following requirements if luminaires are surface mounted on a suspended ceiling surface. The last option is applicable only for exposed grid ceilings.

l) Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.

m) Install recessed luminaires to permit removal from below.

n) Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.

o) Install clips to secure recessed grid supported luminaires in place.

p) Install wall mounted luminaires, emergency lighting units and exit signs at height as indicated on Contract Documents.

q) Install accessories provided with each luminaire.

r) Connect luminaires, emergency lighting units and exit signs to branch circuit outlets provided under Section 26 05 34 using flexible conduit as indicated.

s) Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

t) Bond products and metal accessories to branch circuit equipment grounding conductor.

u) Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

4.2. INTERFACE WITH OTHER PRODUCTS

4.2.1. Use the following paragraph when air handling luminaires are specified.

4.2.2. Interface with air handling accessories provided and installed under Section on Air Handling.

4.3. FIELD QUALITY CONTROL

4.3.1. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

4.4. CONTROLS

4.4.1. Install system in accordance with manufacturer's instructions.

4.4.2. Install to CSA C22.1, Safety Standard for Electrical Installations and Transport Canada Canadian Regulations.

4.4.3. Locate luminaires to achieve even luminance of the ceiling luminous elements.

4.4.4. Install suspension system to manufacturer's written instructions and as supplemented.

4.4.5. The following paragraph is required for ceiling systems subject to seismic loading.

4.4.6. Install suspension system to ASTM E580 to meet seismic loading requirements.

4.4.7. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

4.4.8. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

4.4.9. Do not eccentrically load system or produce rotation of runners.

4.4.10. Coordinate installation of ceiling elements and supports with other Work in the area.

4.4.11. Install edge moulding at intersection of ceiling and vertical surfaces, using longest practical lengths. Mitre corners. Provide edge mouldings at junctions with other interruptions.

4.5. CONTROL COMPONENTS

4.5.1. Sensor installations shall be subject to the Metrolinx's approval as to location, mounting, insertion length, and wiring.

4.5.2. Occupancy Sensors

a) Occupancy sensors will be furnished for each of the rooms specified in the input/output points list, or as proposed and approved by Metrolinx. Occupancy sensors shall be provided for each room to provide 100% coverage of the room. In large areas requiring multiple sensors, occupancy sensors shall be installed in sufficient numbers and in such locations as to provide overlap between zones of coverage of individual sensors, thereby insuring positive and accurate indication of occupancy in portions of each lighting area.

b) Occupancy sensors shall be ceiling-mounted and shall incorporate selective aperture attenuation and adjustments as required to prevent spurious lighting initiations e.g. due to passing personnel in adjacent area, such as corridors; HVAC operated.

c) Connect the occupancy detector output control relay to the building automation system (BAS), field processing unit (FPU), the space conditioning system, as well as to the local area lighting circuits, so that the occupancy detectors will turn off area lighting and reset the space conditioning system, set points during unoccupied periods. Where multiple rooms comprise a single HVAC zone (create an Input/output Points List), connect occupancy sensors in parallel, so that sensor may indicate the zone is occupied.

4.5.3. Relays

a) Slave relays or other components related to the occupancy detectors shall be mounted in proximity to the occupancy sensors, in NEMA 1 enclosures, and locations shall be indicated on Shop Drawings to be approved by Metrolinx, and on "as-built" documentation furnished by Contractor.

b) In addition, Contractor shall identify locations of relays or other devices above ceilings by a standardized method of conspicuous visual indication on the ceiling at the time of installation of such devices by Contractor, the method of indication to be directed by Metrolinx.

c) Under no circumstances shall emergency or egress lighting be controlled by the occupancy-sensing controls.

d) One or more relay contacts shall be wired to control the lighting in such a way that the local light switch can turn off the lights, but when the switch is turned on, the occupancy detector contact can still turn the lights off.

4.5.4. Field Wiring

a) Contractor shall furnish and install necessary wire, conduit, tubing, pull boxes, connection boxes, fittings, and other materials as required to provide an automatic lighting control system in accordance with [the Specifications and Drawings and] the equipment suppliers' specific and general installation instructions and recommendations.

b) For purposes of fire safety and wiring integrity. The wire/cable specification calls for the installation of "plenum" rated cable and must be in a raceway (conduit).

4.5.5. Refer to Section 25 50 00 – BAS for requirements involving connecting to the BAS.

4.6. SEQUENCE OF OPERATIONS

4.6.1. Occupancy sensors shall initiate lighting level change operation in an area upon entry of one or more persons and shall maintain uninterrupted lighting operation throughout the period that the area is occupied plus a short period of time after occupancy 5 min to an hour. While the space is occupied the lighting level shall be 100%. In open areas, or areas with less than full height partitions, occupancy of portion of the area shall initiate operation of the lighting throughout the area, except where the Metrolinx specifically directs otherwise.

4.6.2. When an area is vacated the lighting shall remain in operation for the adjustable time delay period.

4.6.3. The occupancy sensor coverage and sensitivity shall be adjusted so that an occupant in a portion of a controlled room moving a hand in plane at approximately one (1) foot per second will trigger at least one occupancy sensor.

4.7. FIELD SERVICES AND TEST

4.7.1. Start-up commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operations.

4.7.2. Assist in a comprehensive acceptance inspection and test of installation details and system operational validity, including but not limited to; inspection and verification of input/out sensor locations, control device location and connection, input/output point terminations, point-by-point proof of function for each occupancy sensor and input/output device. Test results shall be submitted to Metrolinx as proof of verification

4.7.3. The controls and BAS interconnect are to be tested and proven to operate as designed and specified before acceptance. There shall be at least a one-year period of aiming and adjusting for seasonal and traffic changes.

a) Tests:

1) It shall be the Contractor's responsibility to ensure the proper operation of the lighting control system.

b) Demonstration:

1) Demonstrate a complete and operating system to the designated Metrolinx representative(s) and/or authorized representative(s);

2) The lighting system shall be documented with pictures and/or video taken of the working lighting system for verification and record keeping purposes;

3) The different functions of the lighting control system as defined within this specification such as programmable controls may be subjected to modification to ensure proper operation; and

4) Consider controlling artificial lighting automatically where practical by selecting from among various arrangements. Lighting controls are devices for turning lights on and off or for dimming them. The most useful controls for increasing lighting energy-efficiency are timers, dimmers, photocells, and occupancy sensors.

4.7.4. Select control strategies based upon the following types of security lighting:

a) Continuous Lighting: lighting designed to continuously illuminate an area during a combination of hours of darkness and hours of operation. Examples of continuous lighting could be at-grade stops, platforms, vehicle approaches, and parking lots. Suitable controls for continuous lighting are timers and photo sensors; and

b) Standby Lighting: similar in design to continuous lighting, except not continuously operated. Instead, standby lighting is turned on automatically when activity is detected in the area or manually as necessary to occupy a space. Standby lighting is suitable only for “instant on” lamps. Examples of standby lighting could be utility closets, offices, or restrooms. Suitable controls for standby lighting include discrete “on/off” switches, occupancy sensors, and dimmers.

4.7.5. Lighting Control system shall be compatible with the Building Automation System , capable to be controlled and monitored by BAS, also capable to work stand alone in case the connection is lost. The equipment shall be compatible with the BAS includes interior luminaires, emergency lighting units, exit signs, lighting control equipment, and luminaire accessories. Refer to Metrolinx Specification 25 05 10 BAS for requirements related to performance, proprietary and integration with lighting systems.

4.7.6. Adjusting

a) Aim and adjust luminaires as directed.

b) Position exit sign directional arrows as indicated.

c) Adjust flash rate and photocell level set points to meet requirements of Metrolinx and Transport Canada Canadian Regulations.

4.7.7. Adjust Dimming and Dimmers

a) Include integral circuit breaker in each dimmer.

b) Provide adequate forced air ventilation.

c) Test and verify that the dimmers or dimmed areas are operating to the specified levels. Make the necessary adjustment at no cost.

4.7.8. Cleaning

a) Clean finishes and touch up damage.

b) Follow all manufacturer’s instructions or recommendations on cleaning and maintaining lighting equipment

c) Clean luminous ceiling elements to manufacturer's written instructions.

d) this section applies to all newly installed work and any existing fixtures in the area.

e) Clean electrical parts to remove conductive and deleterious materials.

f) Remove dirt and debris from enclosure.

g) Clean photometric control surfaces as recommended by manufacturer.

4.7.9. Demonstration and Instructions

a) Arrange a site visit with all identified stakeholders to demonstrate luminaire operation for a minimum of 2 hours.

b) Document and submit the procedure for testing the lighting system to Metrolinx for review and approval at least 2 weeks prior to the indicated date of demonstration.

4.7.10. Protection of Finished Work

a) Re-lamp luminaires or replace those that have failed lamps and at Substantial Completion.

4.7.11. Preparation

a) Apply finish paint to surfaces and mechanical installations in cavity above luminous elements. Use 90% reflectance white paint.

b) Lay out system on room axis as indicated to a balanced grid design with edge units no less than 50%of acoustical unit size.

c) Provide common channel strut support system for luminaires and ceiling suspension system.

4.7.12. Protection of Finished Work

a) Re-lamp luminaires which have failed lamps at Substantial Completion.

b) Install to CSA C22.1, Safety Standard for Electrical Installations and Transport Canada Canadian Regulations.

4.7.13. Field Quality Control

a) Inspect and test obstruction lighting equipment to CSA C22.1, Safety Standard for Electrical Installations.

4.7.14. Training

a) Training on the lighting, components and control systems are to be provided. The training shall take place over no less than 3 days and shall be no less than 4 hours. All relevant training materials and information will be provided to the attendants in the training.

END OF SECTION