

Amendment Notice: Electrical Updates

This bulletin applies to and amends the following document:

GO Design Requirements Manual (GO DRM)

- Section 5.1 updated regarding requirements for existing facilities to follow latest standards and requirements.
- Section 5.2.2.6 updated to back up systems to be sized with 50% spare capacity to align with latest requirements.
- Section 5.2.2.8, Backup Power Systems Design Requirements Table updated to further distinguish loads and backup power. Provides different scenarios of load back up power with generator, UPS and without generator.
- Section 5.2.3 updated for generators to be prime rated. Generator load summary requirements are also added.
- Section 5.2.3.1 generator noise levels table updated to leave no gaps for generator sizes.
- Section 5.2.3.2.1 updated to indicate Tier 4 E.P.A requirements to align with latest requirements.
- Section 5.2.3.5.2 updated to provide platforms for outdoor generators with subbase fuel tanks.
- Section 5.2.4.1 updated to be size with 50% spare capacity to align with latest requirements.
- Section 5.2.8 Electrical Requirements at Stations and Facilities Table updated to include load flow, protection coordination and grounding study to align with rest of the DRM and requirements.
- Section 5.2.10 updated to provide 30% spare conduits. Added requirement of not bundling cables with different operating voltages. Section is also updated to provide 9 power and 9 communication spare backbone raceways across the platform.
- Section 5.2.11 updated to further provide clarification on meters and BAS connections.
- Section 5.2.13.3 updated to provide ground fault protection on downstream breakers and not main breaker.
- Section 5.2.14 updated to provide 25% spare breakers and 25% spare spaces in panelboard for future use.
- Section 5.2.18.1 updates requirement for using spare breakers on site.
- Section 5.2.23.1 adds the term electrical closet to meet design requirements. The section also adds definition for term electrical closet. The section also limits the maximum height of the electrical and communications rooms.
- Section 5.2.25.13 updated to clarify that all communications equipment shall be powered from panels located in communication or hub rooms.
- Section 5.2.26.3 updated to meet IES library rather than the handbook. Section also updated to support dark sky policy except for colour temperature.
- Section 5.2.31 updated to provide quick connect or receptacle connection to lighting fixtures rather than direct connection for ease of replacement.
- Section 5.2.32.4 provides further clarification on transformer grounding for high resistance grounding.
- Section 5.2.32.11 updated to provide monitoring capabilities for high resistance grounding.
- Section 5.3.4.17 updated to clarify different types of raceways to be used for CCTV system.
- Section 5.3.8.18 updated to indicate smoke detector bypass mode is only required when connected to Chubb System.

Amendments to the GO DRM are provided in the following attachment:

- Revisions to GO DRM March 2023 - Electrical Updates

The Bulletin is available for staff and external users to download via the Metrolinx public download site (http://www.gosite.ca/engineering_public/).

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UPE	Union Pearson Express
UPS	Uninterruptible Power Systems
U/S	Underside
USB	Universal Serial Bus
VCP	Visual Comfort Probability
VOC	Volatile Organic Compound
VT	Voltage Transformer
WAP	Wireless Access Points
WC	Water Closet
WMA	Wheeled Mobility Aids

2.2 How to use the DRM

- 2.2.1 The DRM is the starting point of infrastructure technical requirements for GO Stations, Terminals, and Facilities.
- 2.2.2 It has requirements that are performance based and may exceed industry regulations and codes.
- 2.2.3 The DRM does not absolve the designer of record from current regulations and codes or professional duty of care.
- 2.2.4 Information is in the order of design development, starting with identification of program elements, site planning, and then to technical details such as electrical, mechanical, communications, etc.
- 2.2.5 Technical requirements are performance-based and expected to be used as the starting point for design development. The DRM is part of a suite of products that shall be used to inform the design. The suite of products also includes:
 - a) GO Standard Drawings and Specifications;
 - b) All applicable Metrolinx standards.

2.3 Codes and Regulations

- 2.3.1 It is required that consultants design in accordance with [the latest current](#) version of all applicable standards, regulations, and codes to the approval of all authorities having jurisdiction.

Staff Parking	<ul style="list-style-type: none"> Exterior, parking spots with gated personnel entrance to the secure facilities compound +16 parking spots for GO Transit support Motorcycle Pad EV plug in locations as advised
Bus Storage Parking Expansion space	As advised
Co-generation / Tri-generation	If provided, minimum area needed = 15m X 8m

5 Technical Requirements

5.1 General Technical Requirements

5.1.1 Apart from compliance with good Engineering practice, the design shall meet the requirement as per the relative regulations, codes and standards, and address energy use to reduce consumption.

5.1.2 All equipment shall be provided from a recognized manufacturer with proven product testing. Any alterations or changes to equipment shall be approved for use prior to installation.

5.1.3 All systems and equipment provided shall be easily accessible for maintenance & operation purposes. Equipment shall not be located and installed in such a manner that the maintenance, removal, and replacement of the equipment is not physically possible or requires removal of other equipment and/or obstructions in the way or the use of specialized equipment.

5.1.4 The maintenance, removal or replacement of equipment shall not hinder the flow of pedestrian movement and the operation of vertical circulation elements. Avoid locating equipment that requires maintenance higher than 10ft in elevation where possible. Where it is not possible, fixed ladders and or catwalks shall be provided for access and shall be reviewed with Metrolinx Station Operations for approval.

5.1.2

5.1.35.1.5 For additional information, refer to GO Standard Specifications and Drawings.

5.1.45.1.6 For existing facilities projects, existing electrical and communication systems are to be upgraded to meet the latest DRM, Electrical Specifications, Electrical Safety Code and other CSA requirements.

5.2 Electrical

5.2.1 Electrical systems for GO Transit facilities shall comprise the following, including all relevant supply, protection, distribution, and control of alternating and direct current systems:

- a) Primary and secondary power services;
- b) Illumination;
- c) Grounding;
- d) Equipment labeling and identification.

5.2.2 Supply of Primary and Secondary Power Sources.

5.2.2.1 Incoming Utility Services

5.2.2.1.1 The local Supply Authority (PUC) will supply utility services to a site or building.

5.2.2.1.2 Services to an electrical room or kiosk shall be underground.

5.2.2.2 Service Requirements:

- a) The service ~~shall be~~ be sized to accommodate current and future known loads plus 50%, 400 amp min, 347/600 volt or 120/208 Volt service. Maintenance, Repair, Shop and Garage facilities and facilities with elevators: 347/600 Volt service. Refer to Table 38 for Utilization Voltages.
- b) Incoming services, utility metering, dedicated Metrolinx metering complete with remote monitoring, disconnected switches, distribution breakers shall be in one switchboard/distribution panel;
- c) Where GO Transit has tenants, check meters shall be required. One for each tenant;
- d) Service size shall be based on the application of conservative engineering design principles consistent with cost effective provisions for future station/terminal or other facility expansion;
- e) Temporary facilities shall have underground services;
- f) Disconnect switches shall come equipped with visual means to ensure power disconnection ~~such as an~~ (LED indicator or viewing window) ~~Utilization Voltages~~. For additional information, see Disconnect Switches Specification 26 28 23.

Table 38: Utilization Voltages

5.2.2.3 Balancing of Phases

5.2.2.3.1 Where single-phase power is taken from a 3-phase source, the loads shall be balanced among the three distribution phases.

5.2.2.3.2 Sites that have a single-phase source are to maintain ~~the a balanced~~ load ~~within~~ the distribution panels ~~balanced~~.

5.2.2.4 Voltage Drop

5.2.2.4.1 The maximum allowable voltage drop is 2%.

5.2.2.5 Power Factor

5.2.2.5.1 The overall system power factor shall be greater than 90% or .9 PF.

5.2.2.5.2 Power factor design calculations ~~shall~~ ~~are to~~ be done using an 80% or .8 PF.

5.2.2.6 Backup Power Systems

5.2.2.6.1 This subject describes the functional requirements for Metrolinx facilities backup power system.

~~5.2.2.6.2~~ The power generated by the backup system shall be either true sinusoidal 60 Hz or DC, depending on the requirements. The backup power system shall be sized to accommodate current and future emergency/critical/life safety loads plus 50% additional capacity.

~~5.2.2.6.2~~ ~~5.2.2.6.3~~ The intent of the backup power system is to ensure the continuing operation of essential equipment and services, and to effectively move passengers from station buildings and train platforms to outside parking areas in the event of a sustained power failure.

~~5.2.2.6.3~~ ~~5.2.2.6.4~~ The final design of the backup power system must include an as-built schematic drawing of the system distribution. It shall also include a checklist for commissioning, operation, and maintenance, respectively.

~~5.2.2.6.4~~ ~~5.2.2.6.5~~ Back-up power generators shall be installed in accordance with the Electrical Safety Authority (ESA), Technical Standards and Safety Authority (TSSA) and the regulations of the electrical inspection agency having jurisdiction. The back-up power generator shall be protected from surface deterioration caused by exposure to conditions (i.e: condensation, weather, winter maintenance and de-icing chemicals) producing corrosion. Flat surfaces which may retain water are not permitted. Provide safe access (min 1m).

5.2.2.7 Backup Required Time

5.2.2.7.1 Back-up power generators are a mandatory requirement, for providing the majority of our operational elements/ systems for 48 hours system operational duration for the following:

- a) GO Rail Line Stations (including Parking Structures);
- b) GO Bus Terminals (facilities with a station building only);
- c) GO Rail Layover Facilities;
- d) GO Operational Support Facilities (i.e. Wofldale, GTCC, Middlefield);

- e) GO Bus Maintenance Facilities;
- f) GO Rail Maintenance Facilities.

5.2.2.7.2 Backup Power System's design can include components such as Generator, UPS, Inverter, Rectifier, etc. As a minimum, the backup Power System shall include diesel or natural gas generator complete with UPS systems having a minimum of 30-minute duration or UPS systems with 90-minute minimum duration if there is no diesel/natural gas generator set.

5.2.2.7.3 In each case, the UPS shall be double conversion continuous duty type to provide the electronic communications systems with clean sine wave power. The UPS/Inverter shall be rated for life safety applications and be provided with signals for indication of general alarms and with dial in remote monitoring control, plus a remote alarm to the station alarm system and Network/ BAS.

5.2.2.7.4 There shall be one UPS for the site for operations critical equipment and one UPS/ Inverter dedicated to Life Safety equipment support as per the OESC. For further information on UPS inverters, rectifiers etc., refer to Metrolinx Standard Inverter Rectifier and Charger Specification 26 33 33.

5.2.2.7.5 Diesel is the preferred fuel for backup generators. Where site and operational conditions do not allow for the use of diesel fuel, natural gas fuel powered generators are acceptable with Metrolinx approval.

5.2.2.7.6 Rectifiers shall be used for backup DC power in maintenance and layover facilities where required.

5.2.2.8 Design Requirements

5.2.2.8.1 The following Table ~~39-40~~ shows a list of items that are considered essential. The table shows both backup power system conditions (i.e. Generator + UPS or UPS only).

—————The actual power draws shall be provided in the detail design.

Table ~~4039~~: Backup Power Systems - Design Requirements

Backup Power Systems–Design Requirements					
Essential and Life Safety Load	With TH Generator			No Generator Without Generator (Existing Facility Only)	
Life Safety	Diesel Generator Generator Backed Panel	UPS System Generator Backed UPS Panel	Generator Backed Life Safety Inverter/ UPS Panel	UPS System Panel	Life Safety Inverter/UPS Panel
Exit signs–buildings, tunnels and similar structures (LED type)	*	*	x	* + Life Safety	x

Public Address System	*	x		xx	
CCTV System	*	x		x	
Any additional rack in the Comms. Room	*	x		x + Life Safety	
GO Transit telephone system	*	x		x	
All Passenger Elevators and shafts	xx			x	
Elevator controls	xx			x	
Alarm Monitoring Systems	*	x		x + Life Safety	
<u>Fire Alarm System, if required</u>			<u>x</u>		<u>x</u>
Lighting					
Tunnels, bridges and stairwell illumination (at least 1 fixture on normal power)	x	*		x + Life Safety <u>x</u>	
Electrical Room Illumination (at least 1 fixture on normal power)	x	x		x	
Communications Room Illumination (at least 1 fixture on normal power)	x	x		x	
Service Area Illumination	x	x		x	
Waiting Area Illumination—minimal	x			x + Life Safety <u>x</u>	
Platform Lighting (Train and Bus)	x				
Main Parking Lots (Surface Parking)	x				
Parking Structures	x				
Pick-Up and Drop-Off (PUDO) (Passenger Pick up and Drop off)	x				
Bus Loop Lighting	x				
<u>Life Safety or Egress Lighting (Station, Service Rooms, Tunnel, Bridge, Stairs, etc.)</u>			<u>x</u>		<u>x</u>
Systems					
Ticket Sales Equipment	*	x		x	
Communications Equipment (White board, Pins etc.)	*	x		x	
Presto		x			
Door Operators (Building, Vestibules, Shelters)	x			x	
Mechanical					
Sump/Sanitary Pump	x			x	

5.2.3 Generators

5.2.3.1 Generators shall be placed within an enclosed area (a space with closed walls and ceiling) to ensure long term operation. Open generator rooms (not enclosed) will not be permitted within a building.

5.2.3.2 Generators shall be built with load banks and shall be tested on an ongoing schedule to ensure operation when required. Access shall be provided without interereng with customers at stations. Stations without load banks shall have easily accessbile connection points and sufficient space to bring in a trailer.

5.2.3.3 For generators, provide catwalks/platforms to completely encircle the unit(s) for safety and ease of maintenance.

5.2.3.4 Due to operational noise, the location of the generator shall consider neighbouring communitres. Efforts including careful location placement, screening, installing a sound attenuating enclosure consisting of 4 walls and a roof, landscaping, etc. shall be employed to minimize effects of noise.

5.2.3.5 Fuel filling shall be located within easy access of a drive aisle to facilitate delivery vehicle. Ramp approaches will not be acceptable. Access shall be provided on ground level (adjacent to delivery route) of storage areas.

5.2.3.6 Oil separator shall be placed within diesel generator fueling area and as directed by other Metrolinx requirements.

5.2.3.15.2.3.7 The prime rated generator shall be provided as a factory tested single unit and rated kW, 120/208 or 347/600 Volts, 3-phase, 4-wire, 60Hz, 1800 rpm. The generator shall be certified to CSA C22.2 No. 100, EEMAC MG1-22.40, NEMA MG1, and meet the requirements of Ontario Electrical Safety Code, ESA, EPA, MOE, TSSA, along with all applicable local codes and regulations. Generator load summary shall be provided with an itemized breakdown. The load summary at minimum should provide connected load, demand factor and demand load for each item. The generator is not be loaded more than 80% of its overall capacity. For additional information on generators refer to Metrolinx Standard Backup Power Supply Generator Specification 26 32 00. Refer to Table 40 for generators noise levels.

Table 401: Generators Noise Levels

kW	dB(A)	Metre <u>Meters</u>
≤ 150	65	7.0
≥150 75 to ≤500	75	7.0
>5600 to 1200	80	7.0

5.2.3.25.2.3.8 Diesel Engine

5.2.3.2.45.2.3.8.1 The engine shall ~~be EPA compliant with maximum NOx plus HC of 3.87g/(kw/hr)~~ comply with E.P.A. Tier 4 final standards for emissions.

~~5.2.3.2.25.2.3.8.2~~ ULC/CSA labelled double wall construction sub-base mounted steel fuel tank with an enough storage capacity to run the generator set at full load for 48 hours without refueling. The tanks and fueling system ~~has to~~shall be accepted by TSSA and equipped with fuel paddling system.

~~5.2.3.35.2.3.9~~ Natural or Propane Gas Engine

~~5.2.3.3.45.2.3.9.1~~ (For Prime Generators ≤ 150 kVA). Include liquid cooled, spark ignition engine.

~~5.2.3.45.2.3.10~~ Minimum Required Accessories

~~5.2.3.4.45.2.3.10.1~~ The minimum required accessories are the following:

- a) Line circuit breakers;
- b) Dedicated load bank of ~~110~~100% capacity for each generator (On Site).

~~5.2.3.4.25.2.3.10.2~~ There shall be a load bank for testing available on site rather than bringing a load bank onto site and connecting and disconnecting it.

~~5.2.3.4.35.2.3.10.3~~ This load bank shall be able to be added in steps for testing up to ~~110~~110% of the generators capacity.

~~5.2.3.10.4~~ Load bank shall be located on a concrete pad with a clearance to vegetation/combustibles on intake and discharge side as per manufacturers recommendation.

~~5.2.3.4.45.2.3.10.5~~ The controller shall have provisions for disconnecting a load bank (during exercise) if there is a loss of normal power by an Electrical and Mechanical interlock through ATS.

~~5.2.3.55.2.3.11~~ Generator Enclosures

~~5.2.3.5.45.2.3.11.1~~ Prime Generator Room Criteria are as follows:

- a) A Prime Generator room is a separate dedicated room for a Prime Generator that can be a standalone building or an integrated room in a Metrolinx Facilities Building. The Prime Generator Room shall be a self-contained room, complete with roof. If there are instances where a facility cannot accommodate a self-contained room, a request shall be submitted following the Procedure for Requesting Deviations to Metrolinx Standard Requirements (refer to CKH-ENG-PRC-001 for more details) for consideration by Metrolinx;
- b) A Prime Generator room shall house the fuel storage unit and all generator accessories including the Generator Electrical Switchboard and Automatic Transfer Switch. Generator room design criteria shall be in accordance with Generator's Manufacturer's operating requirements and good engineering experience;
- c) The room shall be separated from the rest of the building by construction with a 2-hour fire resistance rating;
- d) The room must meet all of the Generator's Manufacturer's operating requirements for ambient outdoor temperatures between -40°C to +40°C;

- e) The room shall be sound attenuating, limiting the overall noise to the to the average dB level in Table 40. The exterior of room housing the Generator shall be painted as per site specific requirements. Refer to Figure 18 for Emergency Power Distribution with Generator.

5.2.3.5.25.2.3.11.2 Exterior Generator Housing Enclosure Criteria are as follows:

- a) An exterior Generator housing enclosure is an alternative option for Generator Enclosures ~~based on site conditions for existing facilities with no construction taking place~~. In instances where a facility cannot accommodate a self-contained Prime Generator Room, a request for an Exterior Generator Housing Enclosure shall be submitted following the Procedure for Requesting Deviations to Metrolinx Standard Requirements (refer to CKH-ENG-PRC-001 for more details) for consideration by Metrolinx. An exterior Generator housing enclosure shall be sound attenuating, limiting the overall noise to the average dB level in Table 40. The housing shall be aluminum or stainless steel (304L or greater) for a weather proof and sound attenuation enclosure;
- b) Interior walls and ceilings shall be insulated with sound attenuating foam, black stainless steel pad- lockable latches, doorkeepers on all doors and zinc die-cast hinges/grab handles;
- c) The Generator housing enclosure must meet all of the Generator's Manufacturer's operating requirements for ambient outdoor temperatures between -40°C to +40°C; and
- d) Locate Generator housing enclosure in an inconspicuous location and above any threat of flooding. The Generator shall not be located below grade or adjacent to potential water hazards (restrooms, tunnels, areas that may be affected by firefighting operations, sewer water backups and other disasters). Refer to Table 424 for Exterior Enclosure. Exterior Generator housing enclosure with subbase fuel tanks shall be provided with industrial steel grating platform, stairs and railing on all sides of the generator that require maintenance access.

4)

Table 412: Exterior Enclosures

Exterior Enclosure	
Exterior Weatherproof Enclosure:	<ul style="list-style-type: none"> Owner's Common keyed. Compliant with CSA Standard. Sound Attenuated. Capable of withstanding 150mph sustained winds. Designed to resist rainfall angles of up to 45 degrees without interior flooding. Enclosure te-shall be rodent and serpentwildlife proof.
Construction:	<ul style="list-style-type: none"> Stainless steel (304L or greater) for a weather proof and sound attenuation enclosure. Aluminum panel construction for a weather proof and sound attenuation enclosure. <u>Powder coated paint</u>
Roof:	<ul style="list-style-type: none"> One piece pitched roof designed to prevent water accumulation.
Exhaust System:	<ul style="list-style-type: none"> Internally mounted muffler and sound insulating Panels. Catalytic Converter: Include catalytic converter when defined by local codes.
Doors:	<ul style="list-style-type: none"> Door Hardware: Stainless steel. Doors shall be lockable by padlock. Hardware locks te-shall be keyed the same. Door drip caps designed to keep moisture accumulation off the top of doors. Doors hinged to allow 180 degree opening.
Sound Attenuation:	<ul style="list-style-type: none"> Generator te-shall be sound attenuated, both interior walls and ceilings shall be insulated with sound attenuating foam. Average dB level, enclosure limits overall noise see Table 410 (above).
Block Heater:	<ul style="list-style-type: none"> 1500 watt minimum.
Space Heater:	<ul style="list-style-type: none"> Include inside enclosure, thermostatically controlled to maintain a minimum 10 °C, except when engine is running, in accord with CSA C282, 208v.
Motorized Louvers:	<ul style="list-style-type: none"> Include on air intake to meet CSA C282, level 2 sound attenuated.

- b) Central Monitoring System for all UPS units, along with proper interfacing with Metrolinx software, IT communication, and station operations shall be provided in order to display and control all required parameters;
- c) All intercommunication shall be through the Mod bus, BAC Net, etc;
- d) Input isolation transformer for UPS units, where technically required;
- e) Connection of normal AC power from assigned terminals/switch/circuit breaker;
- f) The UPS shall be of commercial type and shall comply with relevant IEC, EIA, NEMA, NFPA 70, IEEE, ISO 9001, ISO 14001, UL-1778, CSA, FCC Class A, and Life Safety certified standards;
- ~~f)g)~~ UPS and its components shall be sized for current and future known loads plus 50% future spare capacity. UPS load summary shall be provided with an itemized breakdown. The load summary at minimum shall provide connected load, demand factor and demand load for each item. The UPS shall not to be loaded more than 80% of its overall capacity
- ~~g)h)~~ Radio frequency interference (RFI) suppression shall be in accordance with CISPR and IEC 50091-2 recommendations;
- ~~h)i)~~ UPS shall be certified for use to support Life Safety Systems;
- ~~i)j)~~ UPS assembly shall include a mimic diagram with digital and LED displays, indicating instruments and control devices, in true relative positions;
- ~~j)k)~~ System overall efficiency shall be not less than 92% at full load and 91% at half load;
- ~~k)l)~~ Noise level of complete assembly is not to exceed 55 dB (A) at 1.0 m distance anywhere within the room that the UPS is located;
- ~~l)m)~~ The system shall have an external maintenance bypass that will allow the removal and replacement of the UPS without rewiring;
- ~~m)n)~~ The Voltage supplied to the UPS shall be the voltages on the output of the UPS;
- ~~n)o)~~ The UPS shall be located inside the main Electrical Room.

5.2.4.2 Rectifier/Charger

- 5.2.4.2.1 For further information refer to Metrolinx Standard Inverter Rectifier Charger Specification 26 33 33.

5.2.4.3 Battery Criteria are as follows:

- a) High rate discharge, heavy duty, industrial, high impact resistant, clear plastic encased, sealed (gas recombination) type cells with automatically re-closing explosion proof safety vents;
- b) Ampere-hour rating shall be sufficient for UPS + Generator period specified with all inverters operating at full rated output, to a discharge limit of not less than 1.65 V per cell.

5.2.5 Inverters

- 5.2.5.1 For further information refer to Metrolinx Standard Inverter Rectifier Charger Specification 26 33 33.

5.2.6 Transfer Switch (Automatic and Manual Bypass Switch)

- 5.2.6.1 The transfer switch shall be 120/208 or 347/600 V, 4 wire, 3 phase, 100% rated in Amperes for total system transfer including control of motors, electric-discharge lamps, electric heating, and electronic ~~and tungsten-filament~~ lamp load. Switches rated 400 A and below shall be suitable for 100% Amp loads. Switches rated above 400 A shall be suitable for 80% Amp loads.
- 5.2.6.2 Automatic transfer switch shall be rated for continuous duty or repetitive load transfer switching. The bypass- selector switch shall provide operating positions: Bypass Normal, Bypass UPS + Generator, and Bypass Open.
- 5.2.6.3 A two-way bypass isolation switch shall provide manual bypass of the load to either source, permit isolation of the automatic transfer switch from all source, and load power conductors. All main contacts shall be manually driven. Electrical and Mechanical interlock arrangements utilizing electrically driven contacts are prohibited.
- 5.2.6.4 The manual bypass handle will provide two operating modes: Bypass Open and Bypass Closed. Bypass to the load-carrying source shall be affected without any interruption of power to the load (make-before-break contacts). Load break-type bypass for ATS test and isolation shall not be acceptable. In the bypass open mode, bypass contacts shall be open so they will not be subjected to fault currents. For additional information on transfer systems refer to Metrolinx Standard Transfer Switch Specification 26 36 23.
- 5.2.7 Distribution of Primary and Secondary Sources
- 5.2.7.1 In general, loads shall be locally fed from power panels, distribution panels, and motor control centers, etc. The electrical rooms, other than the main electrical room, shall service the area around it. (i.e. electrical rooms in station building should supply power to the station building only, or panels in communication rooms shall service only the communication equipment.
- 5.2.7.2 General lighting and system circuits shall be alternately circuited to maintain partial service and illumination in the area lighting in the event of circuit failure. The same principle is to shall be used in communications that have a failure or maintenance on one component and will not remove coverage of the area. This item shall be verified upon commissioning.
- 5.2.8 Stations & Facilities
- 5.2.8.1 Refer to Table 432 for Electrical Requirements at Stations and Facilities.

Table 423: Electrical Requirements at Stations and Facilities

Electrical Requirements at Stations and Facilities	
Feature	Design Requirements
Studies	<p>The following studies need to <u>shall</u> be completed for design:</p> <ul style="list-style-type: none"> • <u>Short circuit</u> • <u>Load Flow</u> • Protective device <u>coordination</u> • <u>Device evaluation and arc flash hazard with coordinated ground fault protection</u> • Grounding, to determine Ground Potential Rise as well as touch and step voltages • Electrical, for information on Arc Flash Hazards and labeling • Feeder plus main brace feeders on the main switchboard
System Voltages	<p>Ensure that system voltages are adequately selected.</p> <p>Provide appropriate main incoming service and transformer.</p>
Power Factor Correction System	<p>Provide a power factor correction system with the following characteristics:</p> <p>Capacitors in banks, automatic switching of banks, maintain power factor between 0.9 and 1.0.</p> <p>Ensure that power is supplied by the nearest available utility freestanding enclosure, located near the main switchboard.</p>
Utility Power Failure	<p>In the event of a utility power failure, provide emergency power by means of an <u>emergency/back-up generator</u> standby diesel generating set or a group of generator sets connected to a common <u>synchronized bus</u>.</p> <p>Provide an uninterruptible power system for critical components.</p>
Electrical Handholes	<p>Electrical handholes shall be precast concrete <u>or fiberglass reinforced</u> and designed for heavy traffic areas.</p> <p>Cast iron covers shall be bolted down. All metal components are to <u>shall</u> be grounded, except the cover.</p>
Surface Mounted or Suspended Equipment	<p>Provide galvanized steel mounting channel for all surface mounted or suspended equipment <u>electrical and communications infrastructure</u>.</p> <p>No electrical and communications infrastructure equipment <u>is to <u>shall</u> be mounted directly to any wall or structural element.</u></p>

Enclosures	<p>Provide enclosures with the following characteristics:</p> <ul style="list-style-type: none"> • Sprinkler proof, NEMA type 1 (dry and damp) • <u>NEMA Type 4 (outdoor and wet dry and indoor)</u> • <u>NEMA Type 4x (outdoor and wet)</u> • 100mm concrete housekeeping pads for floor mounted equipment, disconnect switch at each motor 																						
Disconnect Switches	Provide dedicated disconnect switches at electrical equipment.																						
Grounding System	Provide a grounding system consisting of 19mm copper clad steel ground rods and bare copper conductors around the perimeter of the building.																						
Electrical Equipment Connections	Major electrical equipment connected to systems at 600V and higher to <u>shall</u> be connected to ground system through a minimum of two (2) paths																						
Lighting System	<p>Provide a lighting system that shall to be designed to IESNA recommendations for industrial facilities with the following characteristics:</p> <table border="1"> <thead> <tr> <th>Area</th><th>Specification</th></tr> </thead> <tbody> <tr> <td>Exterior circulation areas</td><td>30 lux</td></tr> <tr> <td>Exterior parking areas</td><td>30 lux</td></tr> <tr> <td>Pedestrian gates</td><td>100 lux</td></tr> <tr> <td>Building entrances and exits</td><td>100 lux</td></tr> <tr> <td>Interior repair garage, general</td><td>500 lux</td></tr> <tr> <td>Interior repair garage, workbenches</td><td>750 lux</td></tr> <tr> <td>Bus garage areas</td><td>300 lux</td></tr> <tr> <td>Utility areas</td><td>200 lux</td></tr> <tr> <td>Office areas</td><td>400 lux</td></tr> <tr> <td>Emergency and night time lighting</td><td>20 lux</td></tr> </tbody> </table>	Area	Specification	Exterior circulation areas	30 lux	Exterior parking areas	30 lux	Pedestrian gates	100 lux	Building entrances and exits	100 lux	Interior repair garage, general	500 lux	Interior repair garage, workbenches	750 lux	Bus garage areas	300 lux	Utility areas	200 lux	Office areas	400 lux	Emergency and night time lighting	20 lux
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Lighting Control	Control interior lighting by local switches, occupancy sensors and lighting control system. Control exterior lighting by means of a photocells, occupancy sensors, central over-ride switches and/or contactors with a manual override; provide a computer based lighting control system to switch various lighting circuits through the building.
Receptacles	All receptacles are to shall be duplex type spec grade to code use. Receptacles are to shall be located in the following places: <ul style="list-style-type: none"> • Offices • Control and Electrical Room • On a dedicated circuit, at each workbench • On the roof adjacent to each HVAC unit • GFCI in wet and outdoor locations • Distributed equally along the building perimeter • Pendant cord mounter single receptacles in the repair garage and the front and rear of each hose location
Welding Outlets	Welding outlets shall be installed at appropriate location for supplying power to portable welders.
Traffic Signals	Provide traffic signals as required near the entrances of the facility.
Fire Alarm Systems	Multiplex fire alarm system to shall be provided.
Storage Garage	Lighting not to interfere with structural components, gas lines, power lines (easily accessible for maintenance).
Stair Shaft	Lighting to shall be easily accessible for maintenance

5.2.9 Service Duct Banks

5.2.9.1 Service duct banks shall conform to OESC (Ontario Electrical Safety Code) latest edition inside property line, or rail corridor per AREMA, CSA Standard C22.3 No. 7 Underground Systems, and OESC, coordinate with local Hydro and Bell for area having jurisdiction and for utility requirements.

5.2.9.2 Provide concrete encased duct banks in heavy vehicular areas and fire routes. Minimum 30% spare conduits with no cables or wires except for the ground wire and pull-cords shall be provided in duct banks for future use, coordinate with Metrolinx. ~~Duct bank shall be filled out from bottom to top. Empty conduits shall be sealed at the ends. Conduit locations to ensure easy access for filled and spare conduits.~~

~~5.2.9.2~~

5.2.10 Wiring Methods

5.2.10.1 Raceways and conductors

5.2.10.1.1 Raceways and branch circuitry shall be implemented to minimize failure of a complete system due to failure or malfunctioning of any single electrical component.

~~5.2.10.1.2~~ Distribution minimizing conductors of different circuits sharing common raceways and pull-boxes, etc., shall be implemented.

~~5.2.10.1.3~~ 5.2.10.1.2 Raceways shall not exceed a maximum of 40% capacity.

5.2.10.1.3 Raceways selected shall suitably resist mechanical damage and environmental deterioration effects. In particular, special attention shall be applied to corrosion inhibitors and protective coatings or treatments on surface mounted conduit in underground areas (e.g., tunnels, below grade electrical rooms, Bridges and parking structures etc.). Minimum 30% spare conduits with ground wire and pull-cords shall be provided for future use, coordinate with Metrolinx. Bundling of cables with different operating voltages is not permitted. Empty conduits shall be sealed at the ends.

5.2.10.1.4 -

5.2.10.1.5 A minimum 12 AWG stranded copper wire green insulated RWU90 below grade and RW90 above grade shall be placed inside each raceway. This wire ~~is to~~ shall be used as a tracer wire inside a buried raceway for the purpose of locates after installation.

5.2.10.1.6 Slack wire shall be provided. In all runs, the amount of slack shall be no less than 1.0m at each termination point and 600mm in each pull point. Access wire ~~is to~~ shall be neatly coiled and be available for future use.

5.2.10.1.7 When installing wires in an existing raceway, it shall be the responsibility of the installer to ensure that new wires are neatly installed and tied together with all existing wiring.

5.2.10.1.8 Drip loops shall be provided on all outside hanging raceways or conductors.

5.2.10.1.9 Backbone spare raceways for electrical and communications shall be provided across the length of the platform with separate hand holes. The spare raceways shall consist of nine (9) 53mm power conduits and nine (9) 53mm communication conduits with ground wire and pull-cords for future use. Empty conduits shall be sealed at the ends.

~~5.2.10.1.8~~

~~5.2.10.1.9~~ 5.2.10.1.10 Refer to Metrolinx Standard Specifications: Rail Corridor Raceway Requirements, Raceway for Electrical Systems 36 05 34 and Electrical Conductors and Cables 26 05 21 Refer to Metrolinx electrification standards for electromagnetic interference (EMI) protection of devices and cables.

5.2.10.2 Conduits

5.2.10.2.1 Rigid galvanized steel conduit, or other Metrolinx approved cabling protection methods shall be used for all exposed work in normally dry areas not likely to present corrosion problems.

~~5.2.10.2.1~~ 5.2.10.2.2

~~5.2.10.2.25.2.10.2.3~~ Rigid steel or rigid PVC conduit may be used embedded in slabs where high impact protection is required.

~~5.2.10.2.35.2.10.2.4~~ Rigid non-metallic conduit shall be used below ground, either direct buried or concrete encased.

~~5.2.10.2.45.2.10.2.5~~ ~~PVC or Epoxy~~ coated rigid galvanized steel conduit ~~or other Metrolinx approved raceway methods~~ shall be used in areas that can ~~have condensation on metal~~ are exposed to condensation, exposed to moisture, exposed to wet conditions or areas with corrosion problems areas. Metrolinx approval is required for any variations.

~~5.2.10.2.55.2.10.2.6~~ PVC conduit shall not be installed above ground, or in exposed locations. Conduit, having a minimum of 53mm shall be used in parking lots ~~when deemed necessary~~.

~~5.2.10.2.65.2.10.2.7~~ Concrete encasements shall be provided for bus loops, road crossings, and railway Right-of-Ways.

~~5.2.10.2.75.2.10.2.8~~ In finished areas, all conduits shall be concealed and not visible to the public.

~~5.2.10.2.85.2.10.2.9~~ Refer to GO Standard Specifications for detailed requirements

5.2.10.3 Cable Trays

5.2.10.3.1 Where required, cable trays shall be ladder type; hot dip galvanized steel or aluminum or non-metallic as required for the application, complete with vertical barriers to separate systems or cables as required.

5.2.10.3.2 Class shall be selected based on conductor weight plus 50% spare capacity as a minimum.

5.2.10.3.3 Cable trays shall be cantilever-supported for ease in installation of cables.

5.2.10.3.4 Fire barriers of multi-transit type shall be provided at firewalls and fire separations, and shall be in accordance with the O.B.C. and CAN4-S115-M.

5.2.10.3.5 Types of Cable trays ~~to~~ shall be used:

- a) Wire Cable Trays: Used under raised floors;
- b) Ladder Cable Trays: Used in Electrical/Communication Rooms;
- c) Enclosed Cable Trays-Cable bus from transformers to main substation switch gear, outdoors.

5.2.10.4 Wire and Cable

5.2.10.4.1 All conductors shall be stranded copper.

5.2.10.4.2 Conductors smaller than No. 12 AWG shall not be permitted for lighting or motor branch circuit wiring, except that No. 14 AWG multi-strand type conductors may be used for control circuits only. Provide appropriate connection for terminating and standard wire.

5.2.10.4.3 Conductors shall have a minimum insulation temperature rating of 90°C, but design shall be for 75°C. All conductor insulation shall be colour coded.

5.2.10.4.4 ~~An manufacturer and code approved compliant~~ transition method shall be established when different gauges of wire are to be terminated together.

5.2.10.4.45.2.10.4.5

5.2.10.5 Responsibility

5.2.10.5.1 The Consultant shall specify responsibility for wiring and equipment connections. Examples: For voice-activated intercoms, the type of wiring ~~is to~~ shall be as recommended by the equipment supplier, and ~~is to~~ shall be installed by the electrical contractor, but connected by the equipment supplier.

5.2.10.5.2 For the PA, CCTV, and security systems, the electrical contractor shall provide conduit with pull-strings, and the equipment supplier shall install wiring and the equipment, making all connections, testing and commissioning. Any equipment customization shall have appropriate seals from approved standards authority.

5.2.10.6 Enclosures

5.2.10.6.1 Enclosures shall be selected for the environment in which they are intended to be installed. In general, enclosures for indoor, dry application shall be EEMAC sprinkler proof type 1 or type 12 where applicable. Enclosure for damp and wet areas (e.g., exterior boxes exposed to the weather, tunnels and escalators or elevator pits) shall be EEMAC type 4x. The enclosures requirements are as follows:

a) Where installed in public areas, all enclosures, cover-plates, outlets plates, access panels, and handwells shall be provided with method of securing doors and covers. All enclosures and panels shall have a common key and in an enclosed, protected area where possible;

5.2.10.7 Manholes, Handholes and Pullboxes

b) a) Manholes and handholes shall be located remotely from doors, shelters and main road and pedestrian traffic areas;

c) b) Electrical and communication pull points such as manholes or boxes shall have a maximum 45m distance between manholes;

d) c) No splices are permitted below grade;

e) d) Underground conduits entering Mechanical, Electrical and Communications Rooms from the exterior shall be sloped to ensure positive drainage away from room;

f) e) Underground raceways entering any Mechanical, Electrical or Communications Room shall be interrupted by a drained manhole or handhole within 3000 mm of the room;

g) f) The minimum opening in the top of the handhole shall be no smaller than 460 mm;

h) g) The lip of the handhole and manholes shall be identified as to the type of service within by means of grooves cut into the collar of the handhole or manhole;

h) These markings are on the collar shall be 2 grooves; 3 mm deep for communications in the direction of conduit in and out and 1 groove; 3 mm deep in the direction of conduit in and out for electrical;

i) All electrical or communications handholes placed in the path of vehicular traffic or snow removal equipment shall be OPSD-2112.040 with OPSD-401.030 covers. If OPSD-2112.02 handholes are used, the covers shall be reinforced.

5.2.11 Relay Protection and Metering

5.2.11.1 Relays shall have RS485 communication port and connectivity to monitoring system using Modbus RTU protocol as a minimum. Communication ports of relays and meters on the bus shall be daisy chained from breaker cell to breaker cell and connected to a separate terminal block for connection to a SCADA or BAS system.

5.2.11.2 Phase overcurrent and ground fault devices shall be coordinated such that ground faults, short circuits, or overloads will trip only the immediate upstream protective device from the point where the fault or overload occurs.

5.2.11.3 The Preliminary Arc Flash hazard study analysis shall be submitted along with the design drawings prior to the co-ordination study. The preliminary arc flash study shall be used to modify the design in order to minimize the hazard. The study shall also be used for the floor boundary marking. The Preliminary Short Circuit, Load Flow, and Coordination study analysis shall be submitted with design. The final studies shall be provided after purchasing of equipment.

5.2.11.4 Dedicated incoming power quality digital metering shall be provided, beside Hydro metering, and shall measure true RMS current, voltage and display and provide 32 years history capabilities per phase.; Volts, Amps, kW, KVA KVAR, Pf, Hz, kW demand and peak. Communication port shall be provided; Meters shall be mounted at eye level (approximately at 5'-6" A.F.F) Metering devices shall be housed in a separate compartment enclosure, have no exposure to 600 Volt bus or terminators. Contractor to obtain validation certificate from Hydro Utility for the meter installed on behalf of the owner. The meter shall be part of the BAS.

5.2.11.5 Surge Protective Devices (SPD, formerly known as TVSS), Lightning, Phase Over & Under Current and Ground Fault Protection shall be provided as required for protection and safety of building, equipment and personnel. SPD ~~is to~~ shall be distributed through the distribution system.

5.2.11.6 Dedicated incoming digital metering, ~~besides Hydro metering, and sub-metering,~~ shall be provided for all panelboards, and shall measure true RMS current, voltage, and display, minimum 3 years history capabilities. Units to be measured: per phase Volts, Amps, also kW, KVA KVAR, Pf, Hz, kW demand, and peak. The meters shall be part of the BAS.

5.2.12 Receptacles

5.2.12.1 Receptacles shall be specification grade suitable for back and side wiring and complete with wire ground terminal. Receptacles shall be 20 amp 120 volt duplex non-locking grounding type (CSA configuration 5-20R) in service and public areas. Stainless steel face plates shall be used throughout. Twist lock receptacles and special coloured ground receptacles ~~to~~ shall be used in communications.

- 5.2.12.2 Receptacles shall not be on lighting circuits, and there shall be no more than six (6) receptacles per circuit in public areas, and no more than four (4) receptacles per circuit in service areas.
- 5.2.12.3 In general, building areas—janitorial outlets are required for cleaning and maintenance. In public open areas, receptacles shall be spaced at 5 m centres maximum, and at ceiling level for Christmas Lights as directed by GO transit. Tunnel and exterior building receptacles shall be GFCI type outdoors, located at spacing to suit 15 m extension cords or as required by GO user groups during detail design review.
- 5.2.12.4 If switched receptacles are required, or receptacles on UPS, these shall have a unique standard colour identifying the type of receptacle and the use at the site. The colour or marking shall differentiate regular, regular backed up, UPS, and switched or controlled receptacles.
- 5.2.12.5 Other receptacle requirements are as following:
- a) Electrical/mechanical rooms—minimum 2 receptacles per room;
 - b) Station attendant room;
 - c) Elevator and escalator machine room, as required by Code;
 - d) Maintenance facility, shop and garage receptacles shall suit equipment requirements;
 - e) Maintenance/Janitorial – dedicated receptacle located above the AOCS unit to the right side. Confirm cable length of selected system prior to installation and ensure stress-free connection of the provided power cord. Identify circuit number and source Electrical Panel on receptacle plate;
 - f) Charging of Equipment – Dedicated power receptacles shall be provided.
 - g) Receptacles shall also be provided for tenants and vending machines as required;
 - h) Communications room—minimum of 4 receptacles with 2 on emergency power.
- 5.2.12.6 Refer to Metrolinx Standard Electrical Receptacles and Plugs Specification 26 27 26.
- 5.2.13 Switchboards
- 5.2.13.1 The switchboards requirements are as follows:
- a) Factory assembled, dead front, metal enclosed and self-supporting switchboard. Complete with; line and load side terminations;
 - b) Bus material ~~to~~ shall be copper, silver-plated;
 - c) Bus bracing minimum 65 ka rms;
 - d) Enclosure: CSA type 2, indoor use equipped with arc flash reduction protection;
 - e) Control compartments ~~to~~ shall be installed on front of the board away from buses;
 - f) Future Provisions: fully equipped spaces for future devices with bussing and bus connections suitably braced for short circuit current;
 - g) Allow for 25% spare breakers and 25% spaces on new installations.
- 5.2.13.2 Refer to Metrolinx Standard Switchboards and Panelboards Specification 26 24 13 and Low Voltage Switchgears Specification 26 23 00

5.2.13.3 Service Entrance Circuit Breakers

5.2.13.3.1 Provide Sensor and trip plug, solid-state trip circuit breakers, 100% continuous duty rating, factory mounted. Coordination study shall be provided.

5.2.13.3.2 All service entrances, solidly grounded, 10200 amps at 600V or 2000A at 120/208V and above shall have ground fault protection downstream to the loads. The main incoming breaker shall not be provided with ground fault protection for better protection coordination.

5.2.13.3.2

5.2.13.4 Monitoring and Metering

5.2.13.4.1 Provide dedicated digital monitoring meters system and sub-meters c/w remote communication capability and capable of storing data for minimum 3 years.

5.2.13.4.2 All metering shall be part of the BAS system.

5.2.14 Panelboards

5.2.14.1 Shall be flush or surface mounted as required, complete with hinged locking door and flush catch, and finished with corrosion-resistant primer, equipment gray. Surface mounted panelboards shall be installed on unistrut galvanized steel framing channels with 75 mm clear between back of panelboard and wall. Where practical, panelboards shall be grouped in proximity. Swing-door-style inner door trim panelboard shall not be used.

5.2.14.2 Panelboard shall be copper bus type, with full capacity solid neutral design and sequence style bussing, composed of an assembly of bolt-in-place moulded case circuit breakers with thermal and magnetic trip and trip- free position separate from either the "ON" or "OFF" positions. Multi-pole circuit breakers shall have common simultaneous trip.

5.2.14.3 Provide dedicated relay panel, smart panels, powerlink panels, multi circuit monitoring panel or equivalent, for circuit control, energy saving and monitoring capability. Requirements shall be established on site-by-site basis together with Metrolinx. Allow for 25% spare breakers and 25% spaces on new installations.

5.2.14.4 Refer to Metrolinx Standard Switchboards and Panelboards Specification 26 24 13 and Low Voltage Switchgears Specification 26 23 00.

5.2.15 Switches and Disconnects

5.2.15.1 Refer to Metrolinx Standard Disconnect Switches Specification 26 28 23 for detailed requirements.

5.2.16 Switchgear

5.2.16.1 All components at the completed assembly shall be CSA approved and bear a CSA label. Dimensional Coordination: Verify that dimensions of switchgear do not exceed spaces provided.

5.2.16.2 Digital Metering and Relaying: Provide dedicated power monitoring meters system and sub-meters c/w remote communication capability and capable of storing data for minimum 3 years.

- 5.2.16.3 Refer to Metrolinx Standard Low Voltage Switchgears Specification 26 23 00 for detailed requirements.
- 5.2.17 Building Automation System (BAS)
- 5.2.17.1 The site BAS system Head end shall be Located in the main Communication room. Access to the BAS ~~is to~~shall be through access network portal.
- 5.2.17.2 Refer to Metrolinx Standard BAS Performance Specification 25 05 10 for detailed requirements.
- 5.2.18 Circuit Breakers and Fuses
- 5.2.18.1 In order to use existing spare breaker on site, Metrolinx approval is required. The existing spare breaker shall be replaced with a new spare breaker to match the existing breaker ratings. Refer to Metrolinx Standard Circuit Breakers and Fuses Specification 26 28 00 for detailed requirements.
- 5.2.19 Transformers
- 5.2.19.1 The following are the transformer types:
- Current Transformers (CT);
 - Voltage Transformers (VT) or Potential Transformers (PT);
 - Low Voltage Transformers.
- 5.2.19.2 Refer to Metrolinx Standard Liquid Filled Transformer Specification 26 12 13 and Dry Type Transformer Specification 26 12 16 for detailed requirements.
- 5.2.19.3 Refer to Metrolinx Standard Circuit Breakers and Fuses Specification 26 28 00 for circuit overload protection and other details.
- 5.2.20 Motors and Controls
- 5.2.20.1 Motor Starters - Provide auto mode for all life safety motor loads.
- 5.2.20.2 Motor Control Centers (MCC)
- 5.2.20.2.1 In general, circuit breaker type combination starters in Motor Control Centres shall be used for 600-volt motors. However, individually mounted circuit breaker type combination starters may be used where practicable. All starters shall be magnetic, full voltage start, single speed, non-reversing type (except when the driven equipment characteristics or power company limitations require other types), and shall be equipped with an additional one open and one normally closed contact for possible remote status indication at the Motor Control Centre.
- 5.2.20.2.2 Each starter shall be equipped with 120-volt transformer and three thermal overload relays. ~~Shall~~be able to be monitored, solid state overload relays ~~shall~~be equipped with controller capable of remote communication. Each motor starter shall have stop and start button and/or hand/off/auto switch with indicator lights. A local heavy-duty unfused isolating disconnect shall be provided within sight of the motor to safely disconnect equipment for servicing.
- 5.2.20.2.3 Refer to Metrolinx Standard Specifications: Motor Starters and Contactors 26 29 10 and Motor Control Centres 26 24 19 for detailed requirements

- 5.2.21.4.3 Between the box and the Main Power Measurement Controller master unit, install a 19mm conduit and cable inside. The length of the cable must be 25' at the maximum.

5.2.21.5 RS-485

- 5.2.21.5.1 Starting from the Main Power Measurement Controller master unit, install a minimum 19mm conduit between all powers monitoring unit in order to create a daisy chain. The sequence used to link all those units has no importance.
- 5.2.21.5.2 Use #12AWG, 2 conductors cable with metal shield, type FT-4 to link all the power-monitoring units.
- 5.2.21.5.3 The metal shield in the daisy chain sequence must be continuous.
- 5.2.21.5.4 When connecting the cable to the RS-485 port, the shield of the incoming cable must be linked to the shield of the outgoing cable.
- 5.2.21.5.5 The metal shield in the daisy chain sequence must be connected to the terminal of only one (1) power-monitoring unit. This is to avoid a ground loop.

5.2.21.6 120V Power Feed

- 5.2.21.6.1 The 120V power feed of the power monitoring devices must continuous, i.e. come from a UPS or an inverter.
- 5.2.21.6.2 Install a minimum 19mm conduit between the UPS or inverter and the Main Power Measurement Controller master unit.
- 5.2.21.6.3 Starting from the Main Power Measurement Controller master unit, install a minimum 19mm conduit between all powers monitoring unit in order to create a daisy chain. The sequence used to link all those units has no importance.
- 5.2.21.6.4 Connect the 120V power feed of all power monitoring units to one UPS or inverter circuit of 15A.
- 5.2.21.6.5 Use a #12AWG cable, type multi-strand, for the 120V power feed.

5.2.21.7 Commissioning

- 5.2.21.7.1 When the installation activity performed by the electrician is done and that all monitoring units are functional, commissioning of these units must be performed.
- 5.2.21.7.2 An agreement with GO/ Metrolinx ~~has to~~shall be signed for commissioning activities.
- 5.2.21.7.3 Commissioning agent ~~to~~shall be present on site and verify the quality of installation, program and calibrate the monitoring units, verify the communication between the units and between the Power Measurement controller master unit and the server.

5.2.21.8 Power Monitors–Monitoring Program

- 5.2.21.8.1 Install Monitoring Program to locally monitor all Power Meters at selected sites.

5.2.22 Wayside Power

- 5.2.22.1 Wayside power and control requirements are for the storage of trains. Wayside power may be 600 V ac or 480 V ac depending on the consist being stored at the site. Refer to Metrolinx Standard Drawings.
- 5.2.22.2 EV Charging EV charging shall be provided for operations fleet of vehicles.
- 5.2.22.3 Provide empty conduit, complete with #12 AWG green insulated grounding conductor RWU90 for easy tracing terminated in a handwell, sized as per OESC (Ontario Electrical Safety Code) but, not smaller than 2" (50mm).
- 5.2.23 Service Rooms Requirements (General)

5.2.23.1 Design Considerations

Electrical Closet:

An electrical closet is a space in the building dedicated to accommodating electrical services and be constructed in accordance with The Ontario Building Code. The electrical closet shall be built to electrical room requirements and standards as indicated in this document and Metrolinx Specifications. The electrical closet shall be provided with a locked door and clearances as per OESC, CSA and other applicable codes. The electrical closet can only consist of maximum one electrical panel, one lighting relay panel, light switches, junction boxes and electrical conduits. No communication or IT devices shall be installed in the electrical closet unless otherwise required for the electrical equipment in the closet. The electrical closet shall not be used for storage and shall be kept clear of obstruction and arranged to give authorized persons ready access to all parts requiring attention.

Maximum height of Electrical Room, Closet, Hub, and Communications Room shall be 15 feet. Height exceeding 15 feet will need prior approval from Metrolinx.

5.2.23.1

- 5.2.23.1.1 Incoming utility services at Metrolinx facilities shall be located in the primary Substation and/or Electrical Room, closet, kiosk, bunker, Hub and Communications Room.
- 5.2.23.1.2 All Electrical Rooms and Communications Rooms shall be dedicated and not be shared with other functions, including, but not limited to: custodial, access services, communications, electrical, mechanical and storage.
- 5.2.23.1.3 Access to Electrical Rooms and Communications Rooms via (pass through) shall be avoided.
- 5.2.23.1.4 The main Electrical Room and the main Communications Room shall be located next to each other with exterior access.
- 5.2.23.1.5 Electrical Room, Closet, Hub, and Communications Room walls shall not have windows, skylights, roof access hatches/doors, etc.
- 5.2.23.1.6 Locating Electrical Room and Communications Room on perimeter curtain walls where windows comprise the entire surface of walls shall be avoided.
- 5.2.23.1.7 All electrical and communication rooms shall be designed to accommodate a 47" x 95" x 80" scissor lift (with access for an employee to operate it) in all facilities with an interior/exterior height of >3500mm.
- ~~5.2.23.1.6~~
- ~~5.2.23.1.7~~5.2.23.1.8 The Service rooms' floor plan shall always be rectangular or square in shape. The room shall never be L- shaped, triangular or any other odd shape. Electrical Room, Closet, Hub and Communications Room shall always be a one level room and preferably above grade (grade is considered platform level). The room shall be sized for the known (current and future) equipment with a provision for a minimum of 25% extra wall space to accommodate future additional equipment.
- ~~5.2.23.1.8~~5.2.23.1.9 Drawings shall indicate to scale the arrangement of allocated equipment inside Electrical Rooms, Closets, Hub, and Communications Rooms, including spaces and clearances. Elevation drawings shall show to scale all related wall mounted equipment for each wall.
- ~~5.2.23.1.9~~5.2.23.1.10 A minimum 1 m clear working space shall be provided in front of access points, which may occur behind equipment and patch panels, and in front of and behind racking. Racking shall not be positioned closer than 1 m from any wall.
- ~~5.2.23.1.10~~5.2.23.1.11 A wall mounted, flip down work surface will be provided in each communication room. The work surface will be 25.4 mm thick, 762 mm wide by 610 mm deep, solid wood, plastic laminate on both main surfaces with a vinyl self-edge. The work surface will be mounted at a height of 915 mm above the finished floor. The location of the work surface will be adjacent to the main communication cabinet rack and maintain all regulatory clearances from exit and equipment as required by code when in the open position. One (1) duplex receptacle and one (1) RJ-45 data connection will be provided at the workstation and mounted above the tabletop in the open position. Provide heavy duty stainless steel mortise hinges, mechanism to hold the table open and blocking in the wall as required.

~~5.2.23.1.11~~ **5.2.23.1.12** No liquid piping, steam piping, drainage piping, and/or dry liquid piping shall pass through or within walls of any Electrical Room, Closet, Hub, or Communications Room, except for refrigerant and condensate piping for the A/C unit in the room. Sprinkler systems that are located in these rooms shall be a dry type pre-action system.

~~5.2.23.1.12~~ **5.2.23.1.13** All Electrical Rooms, Hub, and Communications Rooms shall have a break in all ducts within 3000 mm of the building by a junction box, handhole, or manhole. All manholes or handholes shall be designed so that water is drained away. All ducting shall have the piping slope away from the room.

5.2.23.1.14 Ducting in the Electrical Room, Hub, and Communications Room shall be tray and rigid galvanized steel conduit above floor. EMT is accepted only with compression type connectors (screw connectors are not allowed).

5.2.23.2 Walls Design Requirements

5.2.23.2.1 The building envelope shall be insulated to meet or exceed ASHRAE 90.1 requirements. Walls shall extend from finished floor to the structural ceiling and shall be structurally sound for wall-mounted equipment. Concrete cinder blocks shall be used on all walls where poured concrete structural walls are not present. Studded walls are not permitted. Walls shall be fire-rated as required by the applicable codes and regulations and shall be painted with a minimum of two coats of non-dust producing white or light gray paint. For rooms with Plywood on the walls the Plywood must be fire rated and have two coats of fire retardant paint.

5.2.23.2.2 1200 mm wide x 2440 mm x 21 mm A-C grade or better fire retardant plywood, void free, shall be installed all around Communications and Hub Room walls for wall mounted communications equipment. The bottom of plywood shall be mounted 150 mm above finished floor. Paint plywood with a minimum of two coats of fire-retardant white or light gray paint. The fire rating designation shall be placed in an area that is visible and shall not be painted over.

5.2.23.3 Floors Design Requirements

5.2.23.3.1 Poured concrete sealed floor shall be provided in Electrical Room, Hub and Communications Room. Floor finish shall be antistatic dissipative light gray epoxy sealer, applied per manufacturer's published specifications. A 100 mm rubber wall base shall be provided. No floor drain is allowed.

5.2.23.4 Doors Design Requirements:

- a) The doors shall be at least 915 mm wide x 2135 mm high and shall be hollow metal slab type (no windows) with hollow metal frames;
- b) Double or oversized doors shall be provided for rooms that have large equipment ~~shall~~ be installed and maintained;
- c) If the door to the Room is in a fire separation, then the door shall have an appropriate fire resistance rating per O.B.C.;
- d) When feasible, the rooms shall have exterior access, but doors shall not open onto a public space;
- e) The Electrical Room and Communication Room within a parking structure may be exempt from having an exterior door access, providing access to the Room door is unrestricted;

- f) Doors shall not open in to the path of vehicle traffic;
- g) Access shall be provided through GO Transit uniform master key system and a centrally controlled alarm keypad and proximity access device system, with an access override feature;
- h) The door shall be lockable from outside only.

5.2.23.5 Ceiling Design Requirements:

- a) No suspended ceiling shall be installed;
- b) Finished ceiling minimum height shall be 3050 mm (10' - 0");
- c) Prime and paint the ceiling with a minimum of two coats of non-dust producing paint. White paint is required;
- d) Where OWSJ are present, prime and paint all exposed structures to meet flame spread and smoke developed ratings designated by local Code requirements.

5.2.23.6 Flood Prevention Design Requirements

- 5.2.23.6.1 Locate Electrical Rooms/Closets and Communications Room above any threat of flooding. Avoid locations that are below grade or adjacent to potential water hazards (restrooms, tunnels, etc.). Roof drains and pipe penetrations into the room shall be avoided.

5.2.23.7 Fire Protection Design Requirements:

- a) Fire-stop all room penetrations (cables, pipes, pathways, trays, conduit slots). Ensure that the fire-resistance rating of installed fire-stopping assembly shall be not less than the fire-resistance rating of surrounding floor and wall assembly to match the corresponding fire rating of fire separation.
- b) For fire suppression, install a hand held 10lbs CO2 (10 B:C rated) fire extinguisher, with current certification, meeting NFPA 10 requirements. The extinguisher shall be wall mounted on the latch side of the entry door and installed in accordance with manufacturer's recommendations. All panels, boxes, and conduit shall be sprinkler proof if required.

5.2.23.8 HVAC Design Requirements:

- 5.2.23.8.1 Heating, ventilation, and air conditioning of Electrical Room/Closet, and Communications Room shall be provided by a heat pump AC unit with the following features:
 - a) Low ambient cooling;
 - b) Heating at -25°C;
 - c) R 410A refrigerant;
 - d) Variable compressor speed.

5.2.23.8.2 A fan-forced heater shall be provided as a redundancy in case the heat pump does not provide enough heating during the extreme cold days. Because a Hub Room is smaller than a typical Communications Room and a bunker or kiosk is smaller than an Electrical Room, a heat pump with hyper-heating may not be available on the market. If this is the case, a split A/C unit with ambient cooling would provide cooling and the fan-forced heater will provide heating. Control of both systems shall be central in order to avoid both systems fighting each other. The heat pump and heater shall be fed from the regular-generator backed up power panel located in the Room where available. Temperature and humidity requirements are on a 24 hours, 7 days a week basis, regardless of the heat generated by normally operating electrical and communications equipment.

5.2.23.8.3 The required capacity shall be calculated based on the following:

- a) For sensible heat gain from electrical equipment use a minimum 5000 Watts per rack (in the Communications Room);
- b) Sensible heat gain from lighting;
- c) Include the future growth of systems by 25%;
- d) Determine heat gain/loss to the room from the outside (heat transfer through building structures, including solar load) g the following design criteria;
- e) Outdoor temperatures.

5.2.23.8.4 Use 1% winter & 2½% summer design temperatures per Ontario Building Code for the geographical location. Indoor temperatures:

- a) Winter design: 15°C;
- b) Summer design: 22°C D B with a maximum of 50% relative humidity;
- c) An infiltration rate from outside of 0.5 air changes per hour;
- d) A recirculation rate of 100% for the air conditioning system;
- e) A safety factor of 5%.

5.2.23.8.5 The air conditioning system shall be selected to suit the specific capacity by taking into consideration the room's very high sensible load factor. Heat loss calculation shall not include credit for equipment and lighting heat gain.

5.2.23.9 Emergency Cooling

5.2.23.9.1 Provisions for emergency cooling in mini hub room, hub room, elevator control room, communication and electrical rooms:

- a) Provide a 150mm diameter vent opening provision, secured from inside, for portable A/C unit in both electrical and communication rooms, venting to the outside;
- b) Provide dedicated 120V, 20A, 5-20R and 120V, 30A, 5-30R power receptacles (generator backed-up) from dedicated circuit breakers for portable A/C unit, in Electrical and Communication rooms;
- c) Receptacles shall be mounted at 300mm height above finished floor;
- d) Contractor to provide Labels above receptacles stating: the respective Amps, panel and circuit numbers and "DEDICATED FOR PORTABLE A/C UNIT";
- e) Provide an exhaust fan controlled by a reverse acting thermostat and an override switch;

- f) High/low temperature alarm;
- g) All alarm inputs shall be placed in Chubb System and BAS.

5.2.23.9.2 The sequence of operations shall be as follows:

- a) When A/C unit fails and temperature starts rising, the high temperature sensor sends an alarm to the current corporate supplier of security and of monitoring services;
- b) Station Operations will be notified to send a portable A/C unit and the HVAC service contractor is notified to repair the broken A/C unit;
- c) The ventilation system will then kick-in to help reduce the temperature until a portable A/C unit is installed;
- d) Station Ops will install the portable A/C unit and switch off the ventilation system.

5.2.24 Electrical Rooms

5.2.24.1 Design Considerations

5.2.24.1.1 Electrical service Substations are typical at GO/ Metrolinx Rail Service Centres but can occur at a large station, maintenance facilities or where ever else Metrolinx requires them.. For an example of a substation, see Standard Layover drawings. Install a dedicated HVAC in all electrical rooms w/auto changeover.

5.2.24.1.2 Whenever possible there shall be one main Electrical Room that feeds the entire site, as it is the goal at most facilities a requirement to have only one utility power source. Sub Room(s) shall be strategically placed around the main Electrical Room to facilitate an efficient distribution of power to loads to boilers, tunnels, bridges, main and sub- structures (e.g. parking structures, stations, service and storage buildings and maintenance facilities), as required. Electrical closets shall be provided to minimize the number of home runs from distribution panels to their respective sub-panels or equipment loads, and to reduce the number of conductors and minimize voltage drop or in preparation for future requirements.

5.2.24.1.3 The typical Electrical Room at Metrolinx facilities shall include space for locating:

- a) Distribution panels, switches and boards;
- b) Metering Cabinets;
- c) Transformers;
- d) Uninterruptible power supply (UPS);
- e) Transfer Switches;
- f) Battery Pack backup emergency lighting above and beyond the generator backed up lighting and UPS lighting of the space;
- g) Automatic Transfer Switch (ATS);
- h) Data and telephone outlets;
- i) A service-working station by the door with power and data connections;
- j) The station shall be a cabinet-lectern combination sized to hold ANSI B drawings, to serve as a working surface and storage for drawings, manuals and onsite component and parts;
- k) A minimum continuous 17 m of wall space is required for equipment installation.

5.2.24.1.4 All wall installed panels and conduits or ducts shall be installed on strut channel mounting system. All floor mounted panels and equipment shall be installed on housekeeping concrete pads. The housekeeping pad shall be a minimum of 100 mm above the floor and shall extend beyond the equipment footprint as per manufacturer's requirements.

5.2.24.1.5 A non-fade single line diagram of the electrical system related to the room shall be framed and posted under a polycarbonate cover adjacent to the entrance of the Electrical Room and Communication Room. The diagram shall be legible from a distance of 1 m.

5.2.24.1.6 Provide markings on the floor showing the arc flash boundaries in around equipment and panels.

5.2.25 Communications and Hub Rooms Design Considerations

5.2.25.1 All Communications Rooms shall be designed in accordance with ANSI/TIA/EIA-569-A-Commercial Building Standard for Telecommunications Pathways and Spaces.

5.2.25.2 The Room shall accommodate the following equipment (refer to IT Telecommunications and Systems Document for list of IT equipment):

- a) Network System Rack;
- b) CCTV System Rack;
- c) PA System Rack;
- d) Passenger Notification System (PINS, Whiteboard, etc.);
- e) Telephone Infrastructure;
- f) Two-way Communication Infrastructure (elevator cab intercom and information intercom);
- g) Fare Collection Equipment: Presto and legacy;
- h) Alarm and Security Monitoring Equipment;
- i) Fire Safety System;
- j) Space Counting System (in parking structures);
- k) Building Automation System Server (all support systems shall be located appropriately with the equipment).

5.2.25.3 Communications Room shall be located next to the Electrical Room with exterior access if possible, within parking garages these rooms shall open onto the interior of the garage.

5.2.25.4 At facilities where the distance of cable runs exceeds 90 m (300 ft.) between the end device and accumulation point as deemed necessary by Metrolinx, Communications Hub Room(s) shall be implemented. Hub Rooms are satellite Communications Rooms, designed to accommodate a minimum of two floor-mounted racks. Hub Room's purposes are to minimize the number of home runs from remote devices to their respective head end equipment; reduce usage of optical fiber and associated equipment; concentrate the distribution of collocated devices; facilitate future implementation of Communications systems.

5.2.25.5 Mini Hub Rooms

5.2.25.7.6 Illumination shall be provided in front of the racks and be tied to a hinge switch.

5.2.25.7.7 High/Low temperature sensors and access control utilizing Keypad/FOB for entry shall be implemented.

5.2.25.7.8 Power bars shall not ~~to~~ be used within the Mini-~~Hub~~ rooms.

5.2.25.8 Utilization

5.2.25.8.1 Rail platforms used by GO Transit are minimum 315 m long. To provide infrastructure for the number of current and future systems, it is necessary to provide more than one Mini Hub Room for each rail platform.

5.2.25.8.2 Mini Hub Rooms shall be located adjacent to elevator enclosures to maximize infrastructure support for all platform devices and adjoining tunnel and bridge area devices. When this location is not available or feasible, locate the Mini Hub Room at the closed end of a stairwell opening. All alternative locations shall be pre-approved by Metrolinx.

5.2.25.8.3 The Mini Hub Rooms location shall not impede with passenger flow and be positioned so they don't disrupt sight lines ~~shall~~ be compliant with CPTED.

5.2.25.8.4 Mini Hub Rooms shall meet or exceed rail corridor regulations and all regulatory items that apply.

5.2.25.9 Exterior

5.2.25.9.1 Exterior cladding shall match adjoining structural material palette to give a consistent, cohesive, uniform appearance. This includes the wall shared by the Mini Hub Room and an enclosure.

5.2.25.9.2 Where a Mini Hub is located under a platform canopy, extend the exterior enclosure of the Mini Hub Room ~~shall~~ be continuous to the underside of the platform canopy. Where the location does not have a canopy, extend the exterior finish of the Mini Hub Room to the height of the adjacent structure (elevator or stairwell).

5.2.25.9.3 Where possible, the Mini Hub Room shall be installed outside of the OCLZ.

5.2.25.9.4 At multi-level parking structures, Communications Hub Room(s) shall be strategically placed directly above the main Communications Room and centrally located to meet the 90 m (300 ft.) cable run distance limitation. One Hub Room can serve more than one floor. In Parking Structures, careful planning is required when locating the Communications and Hub Rooms. Attention must be paid to equipment placement within these rooms in relation to the structural ceiling elements. The required vertical clearance above the racks must also be taken into account. Ideally, cable trays shall be kept level, precast openings in structural "T's" as determined by the structural engineer, to get to the sidewalls of the room.

5.2.25.9.5 Communications Hub Rooms and Mini Hub Rooms shall be dedicated and not be shared with other functions, including, but not limited to: custodial, access services, electrical, mechanical and storage. Access to Communications Hub Rooms and Mini Hub Rooms via (pass through) Electrical, Mechanical, Maintenance/Janitor Rooms, etc., shall not be permitted. The Hub Rooms may share space with an electrical-sub room e.g. at stairways for bridges, tunnels and elevator machine rooms, provided that the following requirements are met:

5.2.25.11 Communications and Hub Rooms Construction

5.2.25.11.1 For Room dimensions (minimum wall to wall) Refer to Table 43.

Table 3943: Minimum Room Dimensions

Location	Size
Communications Hub Room	3200 mm wide x 3600 mm long
Communications Rooms at stations and small to medium sized facilities	3200 mm wide x 4800 mm long
Communications Rooms at Large Facilities and/or Parking Structures Note: Small, medium, and large size facilities are determined by the number of racks that are needed to house all equipment systems and varies per facility.	3200 mm wide x 5400 mm long
For Type A Bus and Rail Facilities	3200 mm x 6600 mm Space for 6 Racks
Type B Bus Facilities	3200 mm x 5400 mm Space for 5 Racks
Type C Bus Facilities	3200 mm x 4800 mm Space for 4 Racks

5.2.25.12 Communications and Hub Rooms Communications Connectivity

5.2.25.12.1 A minimum of nine (9) 53 mm (2") dedicated conduits shall provide connectivity from the Communications Hub Room to its respective Communications Room. If more than one Hub Room is required, then each Room must have its own direct dedicated set of conduits linking it to the Communications Room, which may be designed as a pass-through layout.

5.2.25.12.2 If more than one Communications Room on site, a minimum of nine (9) 53 mm (2") dedicated conduits shall provide connectivity from one Communications Room to the other. Refer to IT Telecommunications and Systems Document for list of equipment.

5.2.25.13 Communications and Hub Rooms Electrical Requirements

5.2.25.13.1 All communications equipment in the Communications Room shall be serviced minimum by a dedicated 120/208 V 3 phase 4W 225 A panel located inside the Room, and fed from an UPS placed inside the Electrical Room. If 208 V service is not available, 120/240 V 1 phase 3W 225 A panels shall be used. There is one exception, Presto shall be fed from a dedicated 120/208-V, 3 phase, 4W, 225-A regular generator backed up panel located inside the Room

5.2.25.13.2 All communications equipment in the Hub Room shall be powered from a sub-panel fed from the dedicated back-up UPS-electrical panel located in the Communications Room.

5.2.25.13.25.2.25.13.3 All communications equipment shall be powered from the UPS panels located in the Communications Room, Hub Rooms, or Mini-Hub rooms.

5.2.25.13.35.2.25.13.4 A dedicated electrical panel shall be provided for regular power inside each Communications Room. This panel grounding shall be connected to the Electrical Room grounding system.

5.2.25.13.45.2.25.13.5 All panels shall be sized to meet DRM requirements. All panels shall have remote monitoring and control of all circuits' capabilities.

5.2.25.13.55.2.25.13.6 All panels and boxes shall have NEMA ratings designations.

5.2.25.13.65.2.25.13.7 Half of the light fixtures inside Communications and Hub Room shall be powered from the UPS backed-up panel.

5.2.25.13.75.2.25.13.8 Heating and air conditioning of the Communications and Hub Room shall be generator backed-up only (no UPS back-up).

5.2.25.13.85.2.25.13.9 All panels, boxes, and conduit shall be sprinkler proof.

5.2.25.14 Communications and Hub Rooms Power Outlets

5.2.25.14.1 Each communications equipment rack shall be fed from two independent tray mounted twist lock L-20R single specification grade receptacles. Each such receptacle shall be fed from a dedicated circuit. Refer the IT telecommunications and Systems document for detailed specifications.

5.2.25.14.2 Communication racks are required to be on UPS.

5.2.25.14.3 See Presto subsection under Fare Handling Systems section for power requirements.

5.2.25.14.4 Provide a minimum of three (3) normal power 5-20R 120 V duplex receptacles, powered from three dedicated circuits, for maintenance and identified as such. These receptacles shall be wall mounted and not located on cable tray or cable ladders, as not to be confused with communication-dedicated receptacles.

5.2.25.14.5 Provide an approved for use power bar for the equipment mounted on the plywood backboard. Each connection on the power bar shall have nameplates to provide power tracing ease. The power bar shall be a multi-outlet raceway. All equipment connecting to the power bar shall have nameplates indicating model, capacity, and electrical data. Install equipment in accordance with manufacturer's recommendations.

5.2.26 Illumination

5.2.26.1 Lighting Design

5.2.26.3 Lighting Design Considerations as follows:

- a) The levels and quality of lighting for the various types of areas shall be as outlined to meet the latest edition of the Illuminating Engineering Society of North America (IES) Lighting [HandbookLibrary](#), Ontario Building Code and Ontario Electrical Safety Code. They shall take into consideration the aging population and the needs for accessibility of all groups (e.g. CNIB recommendations). The lighting design shall be done by a qualified lighting designer;
- b) Illumination systems design shall incorporate requirements of: minimal maintenance, shall be energy efficient and readily accessible, designed for passenger safety and security;
- c) Illumination shall be designed to provide visual comfort and minimum glare for GO staff and passengers;
- d) The illumination systems lighting levels shall be compatible with CCTV systems requirements;
- e) Building luminaries in public areas shall be integrated with the architecture;
- f) Luminaries shall be in locations dictated by the architect in conjunction with the lighting designer, complementing daylight sources;
- g) All luminaries must be accessible for maintenance and lamp replacement without having to construct special means of approaching the fixture;
- h) The illumination systems component maintenance requirement shall be easy to access, tool-less maintenance, easily removed and replaced;
- i) Public area lighting such as tunnels, bridges, and station buildings, shall have LED Fixtures with quick connects / support system and safety chains. The fixtures shall come complete with pigtail plugs that connect to a twist lock receptacle or by a manufacturer designed plug and play wiring system;
- j) Illumination sources whenever possible should not be visible to the public;
- k) 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;
- l) Wayfinding through each station site shall be supported by using fixtures that are common to the scale of the user wherever possible. For example, for lighting fixtures on 6 meter poles shall look the same or very similar to the fixtures on the 12 m poles in look and shape. This is to provide a uniform look and feel throughout the site;
- m) Light fixture design shall be simple, elegant and contemporary;
- n) 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;
- o) Lighting controls shall support daylight harvesting where applicable;
- p) Lighting controls shall support reduction when not occupied;
- q) Lighting controls shall support dimming to Metrolinx levels;
- r) Photosensors ~~are to~~ shall be located so that there is a direct view of the sun and that no shadows or obstructions will interfere with readings;
- s) Occupancy sensors ~~are to~~ shall be provided in the following areas: Parking garage, tunnels, bridges, service rooms, outdoor lighting, offices and other areas as required;
- t) Non-proprietary controls and occupancy sensors shall be used;

- u) Photosensors shall be provided for site lighting in the following areas:
 - 1) Bus platforms, including shelters;
 - 2) Surface parking lots;
 - 3) Station plaza;
 - 4) Rail platforms;
 - 5) Open bridges, including stairways;
 - 6) Closed bridges.

5.2.26.3.1 Refer to GO Standard specifications for detailed requirements.

5.2.26.3.2 Lighting in enclosed stairways and parking garages shall remain on at all times, unless otherwise noted.

5.2.26.3.3 Lighting fixtures and ballasts/drivers shall be selected and installed to ensure ease of access for servicing and ease of maintenance.

5.2.26.3.4 All light fixtures shall be LED with the following criteria:

- a) CRI (Colour Rendering Index) ~~to shall~~ be a minimum of 80 unless otherwise noted;
- b) Colour temperature ~~to shall~~ be 4000K unless otherwise noted;
- c) Exterior luminaires to have CSA or CUL Wet Location labels;
- d) Use light fixtures equipped with industry standard LED light engines that are equal or better in; performance and build quality to Bridgelux or Xecato or equivalent
- e) Specify light fixtures that limit glare and uplight, and support dark sky policy with the exception of color temperature;
- f) The light fixtures shall come with a lens over the LEDs to allow for easy cleaning;
- g) Specify light fixtures that are locally distributed and serviced;
- h) Lighting fixtures to have a minimum 5-year warranty;
- i) Negotiate longer warranties where option is offered by the manufacturer;
- j) Where accessible by the public, light fixtures are to have vandal resistant features;
- k) The underside of ceiling mounted fixtures is ~~to shall~~ be a minimum of 2750mm above the finished floor;
- l) 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;
- m) Exit lights shall be of the fully self-contained and low energy LED type. LED replacement bulb-style is permitted;
- n) Emergency lighting shall be in accordance with the OBC, the Ontario Electrical Safety Code, and the latest CSA standards;

- o) 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 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;
- p) 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 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 (e.g. parking identification, PA speakers, etc.) to avoid obstruction of the lowering device;
- q) Standard Light Pole Drawings: Digital drawing files are available for 3 and 6 ~~metre~~meter hinged pole, 6 ~~metre~~meter, 12 ~~metre~~meter and 30 meter (high mast) pole under PMPS GO Standard Drawings;
- r) The following are the Uniformity Ratio:
 - 1) Maximum to minimum: 4:1 or better;
 - 2) Average to minimum: 3:1 or better;
- s) Where lighting is of a complex or unique nature or if required by GO, the Consultant shall engage the services of a qualified Illumination Designer;
- t) Design photometric digital file in PDF or DWG format, complete with printouts using recognized computer lighting design software, shall be provided for GO review of design illumination levels. These photometric files shall be included in the As-built drawings.

5.2.27 Lighting Design Requirements

5.2.27.1 Pole design shall adhere to the Metrolinx standard lighting drawing for poles (3, 6, 12 and 30 meter) unless instructed otherwise by Metrolinx.

5.2.27.2 Placement of light fixtures shall not provide glare to fare device screens, staff workspaces or provide discomfort to customers.

5.2.27.3 Access to light fixtures for re-lamping shall be facilitated without the use of specialized equipment (except parking lot fixtures which require a scissor lift). Consideration shall be given to allow relamping to be done without impacting primary or critical customer access points.

5.2.27.4 Selection of lighting fixtures shall be assessed against insect or animal related matters such as nesting for birds.

5.2.27.5 All light fixtures shall have long lasting drivers to maximize reliability, be non-proprietary and have a 5 year warranty.

5.2.27.6 Light fixtures and luminaires shall be readily available, off the shelf versions. Custom lights are not desirable due to cost, maintenance, and reliability issues and are only permissible if luminaires are easily accessed and readily available to replace locally.

5.2.27.7 Parking lot fixtures on high mast lighting shall be lowered for maintenance.

5.2.27.8 Heat sinks are required to ensure consistent use throughout various weather conditions.

5.2.27.9 Fixtures shall be modular in design with easily replaceable boards, drivers, lenses etc.

5.2.27.10 Fixtures shall not be placed in inaccessible environments such as over stairs or above fixtures or equipment. Luminaires shall be easily accessed for removal and replacement without the need for specialized tools (excluding tamper resistant screws or scissor lifts).

5.2.27.11 Suspended light fixtures shall be strategically placed to provide even light distribution and not interfere with access to any services. Lighting shall not be an obstacle to ongoing maintenance.

5.2.27.12 Luminaires shall be operable/maintainable/replaceable by Metrolinx technicians and provide toolless entry (when applicable) and not require a certified electrician for fixture maintenance.

5.2.27.13 Light covers shall be durable, easily removable and replaceable without tools (when above height level due to safety concerns).

5.2.27.15.2.27.14

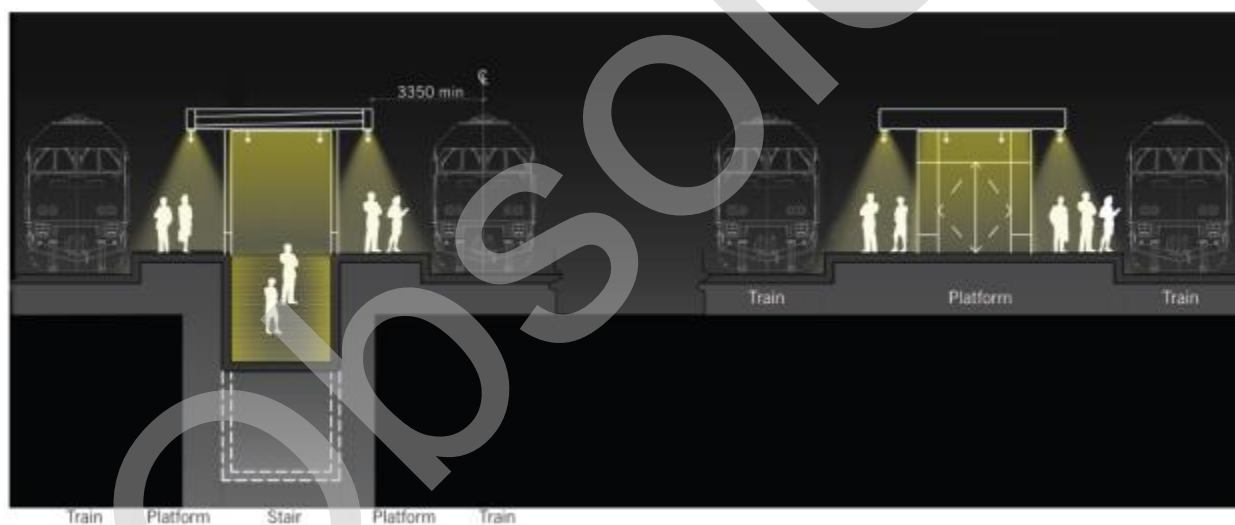
5.2.27.25.2.27.15 Bus Loops lighting requirements:

- a) General illumination for bus platform shall be provided by a line of full cut-off single-headed downlights on lampposts aligned with the back of bus shelters;
- b) Lamppost height shall be kept to a minimum, based on site layout and context. Refer to Figure 19;

5.2.27.65.2.27.19 Rail Platforms lighting requirements:

- 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, Refer to Figure 22;
- b) At platforms without roof soffits, lighting ~~is to~~ shall be provided by direct full cut-off lighting. The platform shall be uniformly illuminated;
- c) Lamp post height shall be 6m pole, based on site layout and on a raised base above grade;
- d) Stairwells shall have lighting which is easily accessible for maintenance;
- e) There shall be step lighting as well as general overhead lighting provided;
- f) Avoid placing lights in the ceiling above stairs;
- g) Minimum average maintained illumination levels shall be:
 - 1) Platform Boarding Area: 100 lux horizontal, 50 lux vertical;
 - 2) Platform: 50 lux horizontal, 25 lux vertical;
 - 3) Stairwells: 200 lux horizontal;
 - 4) Colour temperature shall be 4000K.

Figure 22: Lighting Design Requirements - Rail Platform



5.2.27.75.2.27.20 Station Plaza lighting requirements:

- 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;
- b) One head will provide roadway lighting, the other head will provide pedestrian scale lighting on the plaza;
- c) Lamppost height shall be kept to a minimum, based on site layout and context;
- d) Lighting of the station building shall be taken into consideration in calculations and overall balance of lighting design;
- e) Minimum average maintained illumination levels shall be:
 - 1) Plaza Edge/Drop Off and Pick-up Area: 50 lux horizontal, 25 lux vertical;

- 2) 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;
- 3) Plaza: 50 lux horizontal;
- 4) Colour temperature shall be;
- 5) Plaza Edge/Drop Off and Pick-up Area: 4000K.

5.2.27.85.2.27.21 Bridges lighting requirements:

- 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) Light sources shall not to be visible from the point of view of train conductors;
- d) Enclosed stairs to bridges shall have lighting integrated into side walls above head height, and lighting integrated into handrails;
- e) Open stairs to bridges shall have lighting integrated into walls or handrails;
- f) railing lights shall not be integral with handrail requiring replacement of handrail on light failure;
- g) Minimum average maintained illumination levels shall be:
 - 1) Enclosed and Open Bridges: 150 lux horizontal, 75 lux ~~horizontal~~vertical;
 - 2) Enclosed and Open Stairs: 200 lux horizontal;
 - 3) Colour temperature shall be 4000K.

5.2.28 Lighting Control Design Criteria

5.2.28.1 For additional information on lighting control, refer to Metrolinx Standard Lighting and Controls Specification 26 50 00.

5.2.28.2 Early Morning Period Interior Controls

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

- a) Station Building and/or Bus Terminal lighting ~~shall~~be 100% ON excluding ancillary area;
- b) Tunnel and Bridge lighting shall be 100% ON;
- c) Parking structure lights ~~shall~~be 100% ON.

5.2.28.2.2 Switches and ceiling mounted occupancy sensors shall be provided in driver washrooms, maintenance rooms, mechanical, electrical, and communications rooms, staff service and back-of-house area.

5.2.28.2.3 All areas with more than two fixtures shall have multiple circuits and switches. The area cannot go dark if there is maintenance or failure of a circuit.

5.2.28.2.4 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%.

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

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

5.2.28.3 Early Morning Period Exterior Controls

5.2.28.3.1 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 ~~shall~~ be 100% ON;
- b) Bus loop and bus loop shelter lighting ~~shall~~ be 100% ON;
- c) Parking lot lighting shall be 100% ON.

5.2.28.4 Evening Period Interior Controls

5.2.28.4.1 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.

5.2.28.5 Evening Period Exterior Controls

5.2.28.5.1 One (1) hour after the last PM train and/or Bus:

- a) Platform, platform canopy, platform shelter, information signs and shelters, and building canopy lighting ~~shall~~ be 100% OFF;
- b) Building canopy security lighting (i.e. 30% or better, as determined by Station Services) to remain on;
- c) Parking lot lighting to drop to security lighting (i.e. 30% or better, as determined by Station Services);
- d) Illuminated Station ID sign to turn OFF;
- e) Bus loop and bus loop shelter lighting ~~shall~~ be 100% OFF.

5.2.28.5.2 Lighting control ~~shall~~ be incorporated into a BAS ~~when required~~.

5.2.28.6 Exterior Lighting On/Off Controls

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

- a) The lighting controller (i.e. timer) shall be programmable controlled, PLC, complete with automatic daylight savings adjustment;
- b) Provide a photocell control on all control designs where the default is “dusk to dawn”;
- c) Sites that are being rehabilitated shall have their lighting controls modified to meet these requirements;
- d) Wireless lighting control shall be permitted;

- e) Exterior override lighting control shall be added as well for wireless systems.

5.2.28.7 Dimmable Illumination requirements:

- a) Photocells, motion and occupancy sensors ~~are to~~ shall be used within multi-level parking structures, tunnels and pedestrian bridges;
- b) Occupancy sensors ~~are to~~ shall be placed to allow no blind spots;
- c) Refer to Illumination Levels section for minimum lighting levels within multi-level parking structures, tunnels and pedestrian bridges as recommended by IESNA;
- d) The lighting control shall be flexible i.e. programmable controlled per circuit complete with IP addressable and remote access and control;
- e) 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.

5.2.28.8 Override Switches

5.2.28.8.1 Station lighting ~~is to~~ shall be wired into separate zones listed in the table and controlled independently by one of three master override switches. Switches shall be strategically located at the following 3 locations within:

- a) Service Counter area;
- b) Electrical Room;
- c) Exterior of the station.

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

5.2.28.8.3 Remote parking shall have its own override switches following the same requirements as above.

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

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

5.2.28.8.6 Zones for Override Switches as follows:

- a) Station building;
- b) Surface parking;
- c) Multi-level parking;
- d) Bus loop;
- e) Rail Platform;
- f) PUDO;
- g) Access Road;
- h) Overall Master turn on or shut off.

5.2.29 Illumination Levels requirements:

- a) The lighting control shall be flexible i.e. programmable controlled per circuit complete with IP addressable and remote access and control;
- b) The design shall consider methods of reducing energy usage and maintenance. LED Lighting shall be continuous dimmable (0 to 10 V DC);
- c) The design shall consider occupied and a 50% reduction in light levels when unoccupied. Light harvesting systems shall also be considered;
- d) The system shall be controlled by a Programmable Logic Controller which can handle multiple lighting levels and areas complete with unique on and off, a remote override, and a changeable daylight savings time;
- e) The changes to the on and off configurations shall be done either remote or local computer connections;
- f) Service areas like electrical rooms are to have ceiling mounted occupancy sensors on all light switches;
- g) Exterior decorative, illuminated signage and perimeter lighting shall be all part of the design;
- h) Pole lighting shall be to GO Standards for referenced in the DRM;
- i) Reduction of light pollution of flood lights and wall washers (spill off into surrounding canopies) ~~is to~~ shall be considered;
- j) Station locations with a high probability of vandalism shall have extra bright illumination, if required and viable in terms of adjacent neighbourhoods;
- k) Photocells and occupancy sensors ~~are to~~ shall be used.
- l) The lighting levels for inside a covered parking facility shall be to a minimum recommended by IESNA and Table 47;
- m) Illumination levels to further meet the requirements of Table 44, Table 45, Table 46 and Table 47.

Table 4044: Illumination Levels

Location	Working Plane Height
<i>Circulation Areas</i> <i>both public and non-public including exterior traffic areas</i>	<i>Floor level</i>
Public Seating (waiting areas)	850 mm
Workshops	850 mm
Vertical illumination (task lighting)	At the task

5.2.31 LED Lighting Requirements:

- a) LED light fixtures shall be warranted for a minimum of five years;
- ~~b)~~ b) LED light fixtures shall work with the available power supply on site;
- ~~b)c)~~ c) LED light fixtures shall be provided with quick connect or receptacle connection. Direct connection to light fixtures are not permitted.
- ~~d)~~ d) Every fixture shall have surge suppression;
- ~~e)~~ e) Fixtures shall be provided with a lighting facts label;
- ~~f)~~ f) Outdoor fixtures must have an IP65 general use rating. For locations subject to high pressure washing (tunnels, platforms, or parking structures) the fixtures shall have an IP66 rating;
- ~~g)~~ g) The lighting design shall be such that the specified minimum lighting levels shall be maintained for a minimum of 15 years;
- ~~g)h)~~ h) Fixtures' lighting efficiency shall equal the most current industry accepted standard;
- ~~h)i)~~ i) The lighting efficiency shall not be achieved by overdriving the LEDs;
- ~~i)j)~~ j) The LEDs in the fixture must be of the same colour temperature;
- ~~j)k)~~ k) LEDs with CRI below 75 are not acceptable for indoor lighting;
- ~~k)l)~~ l) Colour temperature of LED light fixtures shall be uniform throughout the area (3500 K for indoors, 4000 K for outdoors);
- ~~l)m)~~ m) The fixture shall meet LM 79 rating and the chips shall meet LM 80 rating. LED B50 and L70 lifetime graph shall be provided;
- ~~m)n)~~ n) The fixture must be vandal resistant and shall be modular in design for easy upgrade of the LED light engine, simple maintenance (straightforward part replacement) and installation;
- ~~n)o)~~ o) The component connections shall be of plug-in type, tool-less removal and replacement;
- ~~o)p)~~ p) The fixture shall be dark sky compliant, with the exception of colour temperature with good light control and minimum to no glare;
- ~~p)q)~~ q) Lens, if required, shall be flat tempered glass, unless otherwise noted;
- ~~q)r)~~ r) The fixtures shall have network connectivity option and be remotely dimmable.

5.2.32 Lightning Protection, Grounding and Bonding

5.2.32.1 Grounding and Bonding

5.2.32.1.1 This Section outlines protective grounding and equipotential bonding requirements, based on the TN-S system arrangement, including:

- a) Transformer neutral grounding;
- b) Electrical and Communications Rooms;
- c) Exposed conductive parts of electrical equipment;
- d) Extraneous conductive parts;
- e) Building main ring electrode.

5.2.32.1.2 The design of the ground system shall be based on:

- a) Ground resistivity data;

- b) Ground resistance of the whole system and its components;
- c) Ground potential rise;
- d) High ground resistance;
- e) Systems fault currents and their duration;
- f) Conductor ratings.

g) Electrified Territory (For grounding requirements in electrified territories, refer to Electrification Standards and Specifications)

5.2.32.1.3 The design calculations shall show that the fault currents and DC stray currents will not damage the grounding system.

5.2.32.2 Soil and Survey Calculations

5.2.32.2.1 A ground resistivity survey shall be carried out at each site. The weather conditions prior to and at the time of the surveys shall be recorded in the report and an assessment made of the seasonal variations in resistivity based on meteorological data for the area.

5.2.32.3 System Requirements

5.2.32.3.1 Grounding system components include:

- a) Ground electrode;
- b) Main grounding terminals or bars;
- c) Grounding conductors;
- d) Protective conductors;
- e) Equipotential bonding conductors;
- f) Electrically independent ground electrodes for special systems (clean ground).
- g) Grounding test pits

5.2.32.3.2 Shared neutral is not allowed. Ground electrode total combined resistance value shall not exceed 5.0 ohm, during any season of the year and before interconnection to other grounded systems or grounding means.

5.2.32.3.3 Protective conductors shall not be formed by conduit, trunking or ducting. Ground Fault Loop Impedance for complete circuits shall be recorded. Supplementary Equipotential Bonding: Connect all extraneous conductive parts of the buildings such as metallic conduit and raceways, cable trays and cable armour to nearest grounding terminals by equipotential bonding conductors.

5.2.32.3.4 A Ground Inspection Chamber shall be provided for each ground rod where connected to a grounding conductor and shall extend 150 mm below top of ground rod.

5.2.32.4 Transformer Grounding

5.2.32.4.1 Transformer body grounding terminal shall be connected to MV main grounding bar by insulated copper grounding conductor not less than 3 AWG per 100 kVA of transformer rating, with a minimum of 2 AWG.

5.2.32.4.2 Transformer neutral (star point) for solidly grounded system shall be connected by insulated grounding conductor (colour White) directly to independent grounding electrode. Neutral grounding conductor shall be sized for maximum ground fault current for 5 seconds.

~~5.2.32.4.2~~5.2.32.4.3 Transformer neutral (star point) for resistance grounded system shall be connected by insulated ground conductor (colour white) directly to the resistance grounding resistor. Neutral grounding conductor shall be sized one size larger than the minimum requirement indicated in Ontario Electrical Safety Code.

5.2.32.5 Grounding of Distribution Boards, Lighting Installations and Wiring Accessories

5.2.32.5.1 Distribution, lighting and power panel boards shall be connected by separate insulated protective conductors run together with incoming feeder cable, connecting ground terminals in panel boards with respective main distribution board grounding bar.

5.2.32.5.2 Final Ring Sub-circuits: Protective conductor of every final ring sub-circuit shall be in the form of a ring having both ends connected to ground terminal at origin of circuit in panel board.

5.2.32.5.3 Lighting fixtures and other exposed conductive parts of electrical installations, such as switches, heaters, air conditioning units, etc. shall be connected by protective ground conductors to grounding terminals of their respective panel boards.

5.2.32.6 Grounding of Electrical and Communications Rooms, and Fixed Machinery

5.2.32.6.1 A common 50 mm wide x 6 mm thick grounding copper bus shall be connected to the door frame and encircle the Electrical Room and Communications Room.

5.2.32.6.2 Motor and other equipment ground terminals shall be connected also by protective ground conductors of each branch circuit to ground terminal/bar at motor control centre, panel, or distribution unit.

5.2.32.6.3 Conductors shall be securely fixed, recessed in floor grooves or niches, or fixed to walls by appropriate staples. Ground bar or loop shall be securely fixed to building wall with copper or brass saddles.

5.2.32.7 Grounding of Road/Parking Lot Lighting Poles requirements:

- a) All circuits require dedicated ground wires;
- b) Every other pole shall have a dedicated grounding rod;
- c) Any metal surfaces associated with handwells and manholes, including non-conductive metal surfaces, must be grounded;
- d) Every second pole shall be grounded with a minimum of one ground rod complete with inspection chamber.

5.2.32.8 Grounding of Signal and Communication Systems

5.2.32.8.1 For telephone, alarm, voice and data, and other communication systems, provide a clean system to each service location, terminal cabinet, wiring closet, and central equipment location. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

5.2.32.9 Clean Ground

5.2.32.9.1 In general, clean ground grounding system shall be provided for data system, telephony and other communication systems, and:

- a) Shall be single point ground to main electrical system ground;
- b) Grounding cables shall not be run parallel with other grounding cables or power cab.

5.2.32.10 Grounding of Fences

5.2.32.10.1 Metallic fences within 1.8 m of any equipment or structure above the surface of the ground, which is connected to the main grounding system, shall be bonded to the grounding system.

5.2.32.10.2 Ground rods shall be driven adjacent to the posts inside the fence line to a depth of not less than 3.0 m. Where no metallic posts are provided, the ground rods shall be connected directly to the metal wires, mesh, or other components of the fence.

5.2.32.11 High Resistance Grounding Systems

5.2.32.11.1 The high resistance grounding system shall limit the ground fault through the transformer neutral. The equipment will be located indoors in a climate-controlled building. The resistor shall be stainless steel edge wound type. The resistor shall be provided with taps for the adjustment of ground current magnitude in several steps.

5.2.32.11.2 Meter relay with auxiliary contacts shall sense voltage across the grounding resistor and initiate remote annunciation of a ground fault condition. The high resistance grounding system shall be provided with self-monitoring capabilities with Modbus or BACnet protocol. The monitoring system shall be connected to the SCADA or BAS system for alarms and monitoring. The resistor to include appropriate taps to limits the ground current flow between 0.9 to 5.0 Amperes for 600V.

5.2.32.12 Service, Communications and Hub Room Grounding

5.2.32.12.1 The Communications rooms and Hub rooms shall form a Dedicated Ground Zone (DGZ).

5.2.32.12.2 All communications equipment in the Communications and Hub Room shall be electrically insulated from the building structure.

5.2.32.12.3 A single point grounding method shall be employed in grounding the communications equipment.

5.2.32.12.4 The access doorframe and door to the communication room shall be grounded using the same grounding method and loop as the Communications and Hub Room.

5.2.33 Lightning Protection

5.2.33.1 Lightning protection system is designed to protect structures from damage due to lightning strikes by intercepting such strikes and safely passing their extremely high voltage and current to "ground." Such system shall be installed were there are no surrounding structures that would provide a cone of protection.

5.3.4.17 Connections Requirements:

- a) All copper connections shall be copper-to-copper compression type with insulating covers.
- b) Poles with cameras shall have one-meter slack cable in raceway.
- c) Fish cord in all CCTV raceways shall be installed for future use.
- d) Splices involving CCTV connections are not allowed.

5.3.4.18 Hand Wells Requirements:

- a) Dedicated hand wells, located away from doors and main traffic areas, shall be provided for CCTV, separate from power.
- b) Where installed in public areas, all enclosures, cover-plates, outlet plates, access panels, and hand wells shall be provided with keyed temper-proof hardware.
- c) Drainage shall be considered for all hand wells.

5.3.4.19 CCTV Camera Placement

5.3.4.19.1 Placement shall include the following considerations:

- a) Mount cameras at 6 m height to prevent damage and provide good field of view;
- b) 6 m dedicated poles are to be used for normal mounting;
- c) If higher installation is required, firm mounting masts shall be used to prevent motion;
- d) Utilize and include existing physical characteristics and infrastructure using CPTED principles;
- e) Civil structures—roads, building, windows, important rooms, etc. existing barriers and fencing, terrain and ground contours;
- f) Use of lens, zoom, and terrain conditions when setting and selecting camera locations;
- g) Be aware of rising and setting sun when setting camera alignment to avoid the flare and blinding effects on the camera;
- h) Mount cameras inside secure areas and provide tamper protection assume all cameras are subject to tamper;
- i) Outdoor, cold, hazardous conditions, etc. Provide appropriate camera housings for worst-case environmental conditions;
- j) Existing lighting; existing power; existing data and communication networks;
- k) Existing environmental controls;
- l) Impact considerations on neighbouring properties;
- m) At a minimum, an illumination of 2 foot-candles throughout assessment area shall be maintained.

5.3.4.19.2 Table CCTV Coverage Type (Image Quality) provides image resolution for CCTV Camera Placement Tables below 50 thru 55.

- h) Power Supply;
- i) Back Plate.

5.3.5.17 Zone Cards

- 5.3.5.17.1 Each Zone Card shall provide independent audio level adjustment, all audio inputs shall have independent level control in order to adjust incoming signal
- 5.3.5.17.2 Any audio channel shall be capable of automatically being connected to any combination of zones for broadcast of PA messages
- 5.3.5.17.3 "Power On" and "Status" LED indicators shall be provided on the front panel of the Display Card in addition to a processor reset button. All system processor modules shall be interchangeable
- 5.3.5.17.4 All PA system components shall be protected by electrical current limiting and thermal overload devices.

5.3.5.18 Amplifiers

- 5.3.5.18.1 Amplifiers in the PA rack shall provide input for telephone and microphones
- 5.3.5.18.2 Amplifiers shall have automatic voice limiter circuit to compensate for varying voice levels and paging styles
- 5.3.5.18.3 Amplifiers shall include RFI filtering, input/output overload protection, and open short circuit protection

5.3.5.19 Speakers—Outdoor Pole-Mounted

5.3.5.19.1 Mounting Requirements:

- a) Speakers shall be outdoor weatherproof types mounted on lighting poles in such a manner as to eliminate the necessity of drilling the lighting poles (by stainless steel banding) and to provide resistance to vandalism;
- b) Speakers shall be resistant to the environment and provide for the direct entry of any connected PA cable;
- c) Speakers shall use an NPT threaded gland entry with liquid tight cable gland and be coupled to the pole gland plate using liquid tight flexible conduit;
- d) No exposed PA cable is allowed. Refer to GO Standard Electrical Drawings.

5.3.5.19.2 Height Requirement:

- 5.3.5.19.2.1 The mounting height for speakers on light standards shall be generally 4m above grade.

5.3.5.19.3 Audio Coverage Requirement

- 5.3.5.19.3.1 The distance between speakers and the number of speakers required to achieve the specified audio coverage will depend upon the station's inherent acoustic properties and the locations of the light standards and shelters on the platform.

5.3.5.19.4 Temperature Requirement:

- 5.3.5.19.4.1 The operating temperature shall be between -430 °C to 70 °C

5.3.5.21.4 Brackets

5.3.5.21.4.1 When used in exposed areas or inside tunnels, a stainless steel speaker-mounting bracket must be used.

5.3.5.21.5 Features Requirements:

- a) Line voltage 70V and maximum wattage 8W RMS continuous;
- b) Operating temperature range of ~~-30°C~~40°C to +50°C.

5.3.5.22 Installation

5.3.5.22.1 PA Cabling Requirements:

- a) All cables shall be run in a neat and orderly fashion in a conduit system;
- b) PA cables shall be designated at both ends as per information supplied on tender;
- c) All cables that run from speakers to terminating equipment shall be single length (splices ~~to in~~ these cables are not allowed—that is: no splices in conduits);
- d) Sufficient slack (1 meter) shall be left in case it is necessary to re-terminate the cable;
- e) Emergency power—all systems and components shall be powered via a single source from the emergency power panel.

5.3.5.22.2 PA Cabling Specifications Requirements:

- a) AWG: 14;
- b) Stranding: 41 x 30;
- c) Conductor: TC, 2 conductors;
- d) Insulation: 0.02" Polyolefin;
- e) Capacitance: 30 pF/ft. (conductor to conductor);
- f) 58 pf/ft. (1 cond. and other cond. connected to shield);
- g) Shield: Delfoil Aluminum/Polyester;
- h) Jacket: Blue or White Polyvinylchloride (depending on application);
- i) Nom. Cable OD: 0.302";
- j) Voltage: 600;
- k) Temp: 80°C;
- l) Weight: 56 lbs/mft;
- m) CSA: AWM, CMG;
- n) UL: CM;
- o) Flame Test: FT4;
- p) Application: 70V PA Speaker Applications.

5.3.5.22.3 Conduits Requirements:

- a) Conduits shall be designated with "PA" at terminating ends;
- b) Wiring shall be run in conduit;
- c) Outdoor cable shall be run in epoxy coated galvanized rigid steel; indoor cable may be R.G.S. or E.M.T. depending on the location;
- d) All underground conduits shall be Rigid PVC.

5.3.5.22.4 Connections Requirements:

- a) All speakers connected in a single zone shall be run in a single line configuration;
- b) All splices or connections shall be copper-to-copper compression type with insulating covers;
- c) Poles with speakers shall have one ~~metre~~metre slack cable in raceway;
- d) Fish cord in all PA raceways shall be installed for future use.

5.3.6 Telephone Network

- 5.3.6.1 The main telephone switch shall consist of trunk lines supplied as either individual or T1 circuits to allow for local and/or long distance calling. The network is to be capable of interfacing with 4-digit dialing as well as integrating with the voice mail system.
- 5.3.6.2 Telephone switches at remote sites such as Middlefield or Woldale shall be linked to the main switch at Head Office to permit 4-digit dialing between all sites.
- 5.3.6.3 All systems are to be provided with backup power supplies from Uninterruptible Power Sources at each location and where available by generator power.
- 5.3.6.4 The network shall be capable of permitting paging to be performed through the local telephone system at all stations.
- 5.3.6.5 Provision shall be made for local caller I.D., call hold, call waiting, transfer, and conferencing.
- 5.3.6.6 Individual telephones shall be speaker type, capable of accepting multiple lines and speed dialing.
- 5.3.6.7 Conduits and power for the telephone network shall be provided at each trunk switch location.
- 5.3.7 Talk-Thru System
- 5.3.7.1 The talk-thru system provides instant 2-way voice communication between the public and station attendants through the glass divider at the station service counter.
- 5.3.7.2 The talk-thru unit provides hands free and effective duplex communication between the station operator and the passengers. The voice switching function is automatically biased in the direction from the passenger to the operator. Noise cancelling and omnidirectional microphones will be mounted on the passenger and service attendant sides respectively, of the booth glass divider. Two rotary encoded controllers will be provided to adjust the volume of each microphone. The operator's boom microphone will automatically override the passenger microphone when activated. Provision will be made for inter speech pause time. Components:
 - a) Microphone Override Pushbutton;
 - b) Power On/Off L.E.D. Switch;
 - c) Noise Cancelling Microphone;
 - d) Seller's Mike-Off Switch;
 - e) Wiring—Conduits and 120 volt A/C source power outlets for each voice link assembly.

5.3.8.16.4 High Battery Voltage: Shall indicate that the battery voltage has risen above a pre-set limit during the charging process.

5.3.8.16.5 Charger Failure: Shall indicate the charger is not providing any output to the batteries.

5.3.8.16.6 The occurrence of any of the above conditions will provide a common alarm.

5.3.8.17 AC Failure Output Alarm Set

5.3.8.17.1 No AC Output: This alarm shall trigger upon the absence of AC output for any reason.

5.3.8.18 Smoke Detector Bypass Switch

5.3.8.18.1 A smoke detector bypass pushbutton switch, a double contact shunt switch, shall be provided to indicate to central monitoring that the detector is in the by-pass mode when not connected to the main fire alarm control panel. The smoke detector bypass push button switch is not required when the detector is connected to the main fire alarm control panel.

5.3.8.19 System Functional Performance

5.3.8.19.1 Actuation of any intrusion alarm-initiating device will cause the system local alarm panel to operate as follows:

- a) To transmit a signal, depending on the location and type of alarm, to a central alarm monitoring location and to annunciate on the local keypad;
- b) An audible alarm signal in the station will sound continuously for 5 minutes and then be automatically silenced.

5.3.8.19.2 Actuation of any fire alarm initiating devices will cause the system local panel to operate as follows:

- a) To transmit a digital signal, depending on the location and type of alarm, to a central alarm monitoring location and to annunciate on the local keypad;
- b) Actuation of a hold-up push-button will cause the alarm control panel to transmit a silent alarm to a central alarm monitoring location, identifying to the operator the station where the alarm originated and the type of alarm.

5.3.8.19.3 Actuation of a thermostat for low temperature, AC power failure, inverter system trouble, or security system trouble, will cause the alarm panel to:

- a) Transmit a digital signal, depending on the location and type of alarm, to a central monitoring location and to annunciate on the local keypad after the pre-set time delay has expired;
- b) An audible signal in the keypad will sound continuously for 5 minutes and be automatically silenced.

5.3.8.20 Sequence of Operation

5.3.8.20.1 The following is a typical procedure for entry into and exit from a station:

- a) Entry – The designated door is unlocked and the time delay intrusion alarm is immediately activated;

Room	C Winter Min.	C Summer Max	Energy Source
Passenger Waiting Room (including vending/ concessions)	18	25	HVAC
Station Attendant	22	22	HVAC
Staff Room	22	22	HVAC
Dispatcher Room	22	22	HVAC
Office Room	22	22	HVAC
Communication room	15	22	HVAC (Note 1)
Hub room	15	22	HVAC (Note 1)
Mini-hub Mini-Hub room	15	22	HVAC (Note 1)
Electronics Workshop	22	22	HVAC
Washroom	22	N/A	Ventilation & Heating
Janitor Room	18	N/A	Ventilation & Heating
Battery Room	18	N/A	Ventilation, Heating & Gas Monitoring
Electrical Room	15	25	HVAC (Note 1)
Elevator control room	15	25	HVAC (Note 1)
Mechanical Room	18	N/A	Ventilation & Heating
Sump pump room	18	N/A	Ventilation & Heating
Maintenance Room	18	25	HVAC
Boiler Room	18	N/A	Ventilation, Heating & Gas Monitoring
Elevator Hoistway	15	25	HVAC (Note 2)
Workshop	22	22	HVAC
Storage Room	20	22	HVAC

- 5.5.4.1.1 The Two Way communication device is a customer service amenity, which assists customers with inquiries at rail station site to provide an enhanced customer service amenity at our platforms, elevators, bike shelters, parking structures, universal washrooms and maintenance facilities. The devices shall be placed in a manner that is easily accessible by staff and customers and shall not be hidden from public view to ensure safe and legitimate-reliable use.
- 5.5.4.1.2 Two Way Communication Devices shall be placed at the following locations at a typical GO Rail station site, easily accessed by staff and shall not be in hidden from public view to ensure safe and legitimate-reliable use for customers:
- a) At each elevator lobby on site including tunnels, pedestrian bridges and parking structures (new device technology to address current technical and operational issues);
 - b) In the vicinity of the Mini platform and cannot be on the Mini platform or the ramps leading to it (to replace existing Bell telephones);
 - c) In all universal washrooms;
 - d) Secure entrance points for GO Operational Facilities;
 - e) In each elevator cab; Bike Shelters
 - e) At each Carpool/Park and Ride site;
 - f) Designated gates;
 - f) Designated waiting areas
- 5.5.4.1.3 The Call flow shall be made to service attendant with call backup available 24/7 by Transit Safety in accordance to I&IT
- 5.5.4.1.4 Refer GO Standard Specifications for detailed two way communication device requirements.

5.5.5 Elevators

- 5.5.5.1 The requirements do not constitute a project specification. Each project shall have its own specification based upon the GO Master Elevator Performance Specification.
- 5.5.5.2 Variance requests shall be supported by an explanation of the reason for the deviation and detailed information on the proposed alternative.
- 5.5.5.3 Important: Refer to Metrolinx Standard Elevator Performance Specification 22 01 52 for details.
- 5.5.5.4 Configuration requirements are:
- a) GO Transit elevators shall be Machine-Room-Less (MRL) elevator type;
 - b) Generator standby power shall be provided to permit continued operation of the elevator(s);
 - c) All electric elevators shall be provided with their own back-up battery power system;
 - d) All elevators shall be provided with battery powered emergency lighting;
 - e) All serviceable equipment, not directly connected to elevator operation, shall be serviceable from the exterior of the shaft.

5.5.5.5 Communications requirements are: