METROLINX

Metal-Clad Switchgears Specification

Specification 26 13 26

Revision 01
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an Agency of the Government of Ontario

Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Cover page	March 2023	Removed 'Capital Projects Group'
1.2.3, 1.3.3, 2.5	March 2023	Added 'the latest version of' and Updated numbering for Electrical Identification and Nomenclature specification
1.5.3, 2.2.11, 3.3.7	March 2023	Updated spare parts requirements, rating requirements and testing requirements for commissioning

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1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Labour, products, equipment and services necessary for metal clad switchgears.

1.2. DESIGN REQUIREMENTS

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

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

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

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

1.2.5. Design shall provide metal clad switchgear assemblies that are floor mounted on housekeeping pad, minimum 103mm high with 53 mm of pad overlap outside the equipment's perimeter;

1.2.6. Design shall provide all equipment ratings shown on Contract Documents.

1.2.7. Design shall include spare unequipped feeders for future use amounting to at least 30% of total switchgear assembly space.

1.2.8. Design shall include spare equipped feeder units for future use amounting to at least 25% of total installed feeder units in switchgear assembly.

1.2.9. For main incoming service, design shall provide equipped feeder units rated to 100% of the maximum switchgear amperage rating.

1.2.10. Design shall allow for future extension at both ends.

1.2.11. Design shall for front and rear access.

1.2.12. Design shall allow for the Metal Clad Switchgears to be monitored by a remote supervisory system (BAS, SCADA, PLC, etc.). The details of the remote supervisory system shall be indicated on the Contract Documents, the interface may be hardwired contacts, digital communications or any system as on the Contact Documents. The design shall include all systems required for a complete interface. At minimum statuses of all breakers, switches, protection devices, and alarms shall be communicated.

1.2.13. Design shall verify that dimensions of switchgear assembly do not exceed spaces provided in Contract Documents.

1.3. RELATED WORKS

1.3.1. Section 26 05 00 - Electrical General Requirements.

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

1.3.3. Section 26 05 23 – Electrical Identification and Nomenclature

1.3.4. Section 26 12 16 - Dry Type Transformer.

1.3.5. Section 26 23 00 - Low Voltage Switchgears.

1.3.6. Section 26 24 13 - Switchboards and Panelboards.

1.3.7. Section 26 24 19 - Motor Control Centres.

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

1.3.9. Section 26 28 23 - Disconnect Switches.

1.3.10. Section 26 29 10 - Motor Starters and Contactors.

1.4. REFERENCE STANDARDS

1.4.1. Ontario Electrical Safety Code (OESC).

1.4.2. Ontario Building Code (OBC).

1.4.3. Metrolinx Standards, Drawings and Specifications.

1.4.4. GO Design Requirement Manual (DRM).

1.4.5. Metrolinx Electrical Safety Document.

1.4.6. CSA Z462, Workplace Electrical Safety.

1.4.7. CAN3 C235, Preferred Voltage Levels for AC Systems, 0 to 50,000V.

1.4.8. EEMAC G8 3.3, Metal Enclosed Interrupter Switchgear Assemblies.

1.4.9. CAN/CSA-C22.2 No.31, Switchgear Assemblies.

1.4.10. CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.4.11. ANSI/IEEE C37.20.2 - Standard for Metal-Clad Switchgear, latest edition.

1.4.12. ANSI/IEEE C37.04 and .06 - Standard ratings and preferred ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear, latest edition.

1.4.13. ANSI/IEEE C37.11 - Requirements for electrical control for AC High-Voltage Circuit Breakers rated on a symmetrical current basis or a total current basis, latest edition.

1.4.14. ANSI/IEEE C37.09 - Standard Design and Production Testing, latest edition.

1.4.15. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment, latest edition.

1.4.16. ANSI/IEEE C57.13 - Requirements for Instrument Transformers, latest edition.

1.4.17. NEMA SG4 - Alternating Current High Voltage Circuit Breakers, latest edition.

1.4.18. NEMA SG5 - Power Switchgear Assemblies, latest edition.

1.4.19. CSA C22.2 No. 0.4, Bonding of Electrical Equipment.

1.4.20. CSA C 22.2 No. 94, Enclosures for electrical equipment, non-environmental considerations.

1.4.21. CSA C22.2 No. 0, General Requirements - Canadian Electrical Code, Part 2.

1.4.22. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvanealed) by Hot-Dip Process.

1.4.23. NFPA 130, National Fire Protection Association Standard for Fixed Guideway Transit and Passenger Rail System.

1.4.24. UL, Underwriters' Laboratories.

1.5. SPARE PARTS

1.5.1. Provide one set of spare control fuses for each set installed.

1.5.2. Provide one set of spare power fuses for each set installed.

1.5.3. Provide 25% spare breakers inside the metal clad switchgear circuit breaker compartment. Provide at least one spare breaker with frame and trip unit ratings to match main breaker ratings.

1.6. TRAINING

1.6.1. Contractor shall train Metrolinx personnel, including training on transfer switch components, operations, safety, and troubleshooting.

1.6.2. Contractor shall allow for two separate training sessions to fully train Metrolinx personnel in all the equipment provided in the Contract.

1.6.3. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

1.7. WARRANTY

1.7.1. The contractor shall provide a manufacturer warranty for the work of this section with a minimum warranty period of two years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING

1.8.1. Contractor to protect equipment from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.8.2. Provide energized strip heater in each cell to maintain dry condition during storage.

1.8.3. Manufacturer responsible to ship product to site once approval to ship has been given by the Contractor.

1.8.4. Contractor to accept equipment on site and inspect for shipping damage.

1.8.5. When shipped separately, load-break switch, power fuses, breakers and other equipment shall be individually crated and tagged with their proper unit number and the equipment number to which they belong.

1.8.6. Relays shall be shipped installed in the stationary structures and shall be adequately blocked and braced to prevent damage during shipment.

1.9. SUBMITTALS

1.9.1. Product Data Package:

a) Submit manufacturer's Product data indicating:

1) Technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;

2) Performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol;

3) Product transportation, storage, handling, and installation requirements;

4) Time-current characteristic curves for air circuit breakers; and

5) Product identification.

1.9.2. Shop Drawings Package:

a) Submit manufacturer's shop drawing indicating:

1) Elevations, sections and details of operating components, dimensions, gauges, finishes, and relationship of operating components to adjacent construction;

2) Complete electrical wiring diagrams including electrical schematics and sequence of operation;

3) Floor anchoring method and foundation template;

4) Dimensioned cable entry and exit locations;

5) Dimensioned position and size of bus;

6) Overall length, height and depth of complete switchgear;

7) Dimensioned layout of internal and front panel mounted components;

8) Identification; and

9) Mimic-bus diagram

1.9.3. Commissioning Package

a) Submit the following:

1) Commissioning Plan;

2) Commissioning Procedures;

3) Certificate of Readiness;

4) Performance criteria and maintenance data;

5) Safety precautions;

6) Test Reports: factory tests report;

7) Manufacturer's installation Instructions; and

8) Manufacturer's Field Reports: commissioning report on field tests, including test forms and confirming proper installation prior to energization.

1.9.4. Record Documents

a) As built drawings including any field modifications.

b) As built drawings to be submitted in printed and electronic format in accordance with Metrolinx standards.

c) Operation and Maintenance Data: As built product data including any field modifications.

1.10. QUALITY ASSURANCE

1.10.1. See Section 26 05 00.

1.10.2. Manufacturers Qualifications: Company specializing in metal-clad switchgear with at least five years documented experience. The manufacturer of the switchgear must be the same as the manufacturer of the circuit breaker.

1.10.3. Regulatory Requirements: Furnish Products listed and classified by CSA and ULC, as suitable for application, and shall be stamped accordingly

2. PRODUCTS

2.1. GENERAL

2.1.1. The equipment shall be able to withstand the environmental conditions stated in Section 26 05 00 without damage or degradation of operating characteristics.

2.1.2. The metal-clad switchgear assembly shall be a free standing dead front steel structure. It shall be floor mounted on a level concrete pad. The assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

2.1.3. The metal-clad switchgear assembly shall be arc-resistant. Vendor shall provide details describing the arc-resistant testing of equipment.

2.1.4. The metal-clad switchgear assembly shall include all switching devices and the necessary accessory components as required for a fully functional system.

2.1.5. The metal-clad switchgear assembly shall be fully factory assembled except for necessary shipping splits and be operationally checked as an assembly.

2.1.6. The metal-clad switchgear assembly shall include mimic diagram on front exterior surface showing all main internal components.

2.1.7. The metal-clad switchgear assembly shall be either indoor or outdoor type

a) Indoor assembly

1) The switchgear enclosure shall be minimum CSA Type 3R sprinkler proof when installed indoor.

2) Provide space heater complete with thermostat in each cubicle suitable for 120 V AC operation where indicated on Contract Documents.

b) Outdoor assembly

1) The switchgear enclosure shall be minimum CSA Type 4X when installed outdoor.

2) Outdoor assembly can be non-walk-in type, walk-in front aisle or outdoor common aisle double row.

3) Provide gaskets on all covers and doors.

4) Provide space heater complete with thermostat in each cubicle suitable for 120 V AC operation.

2.1.8. System Voltage shall be as per Contract Documents, three-phase 60 Hz.

2.1.9. Maximum Design Voltage and BIL as follows:

Table 2-1: Maximum Design Voltage and BIL Table

Nom (kV)	BIL (kV)	IC (MVA)
5	60	350
15	95	500
30	125	800

2.1.10. Main Bus continuous ampacity shall be as per Contract Documents.

2.1.11. Momentary Current Ratings shall be equal to the circuit breaker close and latch rating.

2.1.12. The metal-clad switchgear assembly shall be suitable for either solid grounding or high-resistance grounding as per local Hydro requirement and Contract Documents.

2.1.13. The metal-clad switchgear assembly shall be grounded in accordance with the OESC.

2.1.14. All components at the completed assembly shall be CSA approved and bear a CSA label.

2.1.15. The metal-clad switchgear assembly shall be configured for top entry or bottom entry as indicated on the Contract Documents.

2.1.16. Each shipping section of stationary structures shall be furnished with removable lifting angles and/or plates suitable for crane hooks or slings so lifting and erection can be done without danger of dropping or damaging the equipment.

2.1.17. Each shipping section shall also be furnished with removable steel channel base plates that will permit using pipe rollers or dollies without damaging the frame steel to the equipment.

2.2. COMPONENTS

2.2.1. Stationary Structure

a) The switchgear shall consist of compartment required to achieve design noted on Contract Documents that includes switch compartments, breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections.

b) The sections shall be divided by metal barriers into the separate compartments including:

1) Circuit breaker compartment(s);

2) Disconnect switch compartment(s);

3) Bus compartment(s);

4) Potential transformer compartment(s);

5) Control compartment(s) (a.k.a. low voltage compartment); and

6) Cables termination compartment(s).

c) A common steel base frame in a single length shall be provided for the full switchgear assembly.

2.2.2. Doors and Covers

a) Front doors to be provided for all compartments and include latching handles and a locking mechanism.

b) Rear doors to be provided for all rear compartments and include latching handles and a pad-locking mechanism.

c) All doors shall be formed, and vertically hinged.

d) Relays, meters, control switches, etc., shall all be mounted on a door associated with each switch or circuit breaker compartment.

e) Provide a metal pocket complete with weatherproof envelope and one full set of drawings and diagram prints on inside surface of front door.

f) Each cable termination section to have separate door.

g) Where ventilating louvers are provided they shall be vermin and insect proof with easily replaceable fiber glass filters.

2.2.3. Disconnect Switch Compartment(s)

a) Each disconnect switch compartment shall be designed to house a switch as required by the Contract Document.

b) Provide viewing window for inspection of disconnecting switch position.

c) For fused switch configurations:

1) Provide enough space in the fuse compartment to house three (3) spare fuses; and

2) Access to the fuses shall be key interlocked with the disconnect switch operating handle so that access cannot be obtained unless the switch is locked in the open position and the switch cannot be closed with the fuse access open.

2.2.4. Circuit Breaker Compartment(s)

a) Each circuit breaker compartment shall be designed to house a horizontal draw-out circuit breaker. The stationary primary disconnecting contacts are to be tin-plated copper and mounted within porcelain support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.

b) Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment.

c) Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions.

d) Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment.

e) Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

f) It shall be possible with indoor or outdoor walk-in switchgear to install a circuit breaker into a bottom compartment without use of a transport truck or lift device.

2.2.5. Cable Compartment/Ground Bus

a) Sufficient space must be provided to permit installation of stress cones, conduit seals, current transformers, and surge arrestors and for proper training of cables.

b) Cable supports shall be provided for top entry or bottom entry as indicated on the Contract Documents.

c) Provision shall be made for two-hole long barrel compression type cable lugs

d) Provide an inspection and viewing window shall be furnished for all cable terminations compartments.

e) The ground bus shall extend through this compartment for the full length of the switchgear.

f) Auxiliary bus, if needed, and load bus support NEMA Class A-20 standoff insulators shall be epoxy.

g) Provide insulated ground studs on each phase at each cable connection point.

h) Potential Indicators Lamps

1) A set of potential indicators shall be provided for all cable termination points.

2) Potential indicators shall be adjusted to be visible through each viewing window.

3) Potential indicators to be rated in accordance with switchgear assembly.

i) Furnish, for complete phase isolation, phase to phase and phase to ground isolating barriers in cables termination compartment(s).

2.2.6. Main Bus Compartment

a) Access to this compartment is gained from the front or rear of the structure by removing a steel barrier.

b) Provide standard provisions for future extension without requiring any cutting of modification of the structure.

2.2.7. Busbars

a) Three-phase with continuous current rating as per Contract Document, self-cooled, extending full width of switchgear, suitably supported on insulators.

b) Neutral bus where required shall be fully rated.

c) Busbars and main connections: 99.30% conductivity copper.

d) Main connections between bus and major switching components to have continuous current rating to match major switching components.

e) Provision for extension of bus on both sides of unit without need for further drilling or preparation in field.

f) Tin surfaced plated joints, secured with non-corrosive bolts and Belleville washers.

g) Identify phases of busbars by suitable marking.

h) Bus bars shall be fully insulated with all connections to be provided with insulated boots that cover all current carrying parts. Bus bars to be insulated with a CSA approved permanent insulation. A taped bus is not acceptable.

i) Busbar connectors shall be provided when assembly is shipped in more than one section.

j) Brace bus bar system including ground bus to withstand stresses resulting from short circuit currents

k) Where a bus connection is required to external equipment the switchgear Manufacturer is responsible to coordinate the design requirements of the bus connection.

2.2.8. Grounding

a) Copper ground bus minimum 50 x 6 mm extending full width of switchgear and situated at bottom.

b) Copper ground bus shall allow connection to all units and equipped with solderless #2/0-4/0 cable connectors at each end.

c) If identified within the Contract Documents, provide a complete operating high resistance ground system including pulsating capabilities and clamp on meter

2.2.9. Load-Break Disconnect Switches

a) The closing and opening of the switch must be quick-make, quick-break type (i.e. be independent of speed of the operating handle or motor operator).

b) The switch must be operable from the front of the switch compartment. The spring charging mechanism must be as specified on the Contact Documents. If a motor operator is specified, the motor must be suitable for auxiliary supply as specified, and the motor control pushbuttons, starting contactor, overload protection and all wiring must be included in the switchgear.

c) Provisions must be made for manual operation of the switch for emergency purposes.

d) The single load-break switch must be: air-break type, two-position and three-pole, gang operated.

e) The switch shall close safely on fault current up to rated fault closing capacity.

f) The switch shall carry rated continuous current after closing without exceeding the allowable temperature rise.

g) Each pole of the switch shall consist of:

1) Moveable main blade(s);

2) Spring loaded arcing contact blade;

3) Stationary main contacts;

4) Arc chute with stationary arcing contacts; and

5) Line and load side insulating supports.

2.2.10. Fuses

a) The fuses shall be part of a power fuse assemblies. A fuse assembly shall consist of a renewable fuse unit complete with exhaust filter and blown fuse indicator."

b) The fuse units shall be full range, non-aging and non-damageable. The time current characteristics shall be NEMA "E" type. A standard and slow speed shall be available for each rating, size to be established by detail design and shown on Contract Documents. Each fuse shall contain a silver arcing rod surrounded by epoxy cemented boric acid.

c) The fuse units shall be able to withstand voltage upon interrupting, thereby not requiring trip-pin operation of the switch. The fuses shall not have an MBC (minimum breaking current) nor shall they limit current such that over-voltages occur upon interruption.

d) The fuses shall be constructed with a hinge on one end and a disconnecting latch on the other. It must be possible to remove the holder from the bay with only a grappler equipped hook stick.

2.2.11. Circuit Breakers

a) General circuit breaker requirements are provided in Section 26 28 00 for low and medium voltage applications. Additional requirements that pertain to circuit breakers within Metal-Clad Switchgear are provided in this Specification.

b) Each circuit breaker compartment shall include:

1) A breaker control switch (Open/Close); and

2) Status indicating lights (LED cluster type):

i) Breaker open (Green);

ii) Breaker closed (Red); and

iii) Trip Alarm (Amber)

c) The circuit breakers shall be rated for the maximum voltage of the switchgear, 60 Hz, with a continuous current rating as shown on the Contract Documents and a maximum symmetrical interrupting rating to match the rating of the switchgear.

d) The main incoming circuit breaker shall be rated for the maximum voltage and amperage of the switchgear, 60 Hz and a maximum symmetrical interrupting rating to match the rating of the switchgear.

e) Circuit breakers of same type and rating shall be completely interchangeable.

f) Circuit breakers shall be fixed or withdrawable as indicated on the Contract Documents.

g) A minimum of 4 auxiliary contacts (2 N.O. and 2 N.C), shall be provided for external use by Metrolinx. Contacts shall be wired to a terminal block.

h) Provisions shall be made for 10 additional cell-mounted auxiliary contacts both MOC and TOC type for external use by Metrolinx. Contacts shall be wired to a terminal block.

2.2.12. Control Voltage

a) The control voltage for protection and control functions shall be 120 V dc unless indicated otherwise on Contract Documents.

b) A 120/208 V ac 3 phase 4 wire voltage source for auxiliary devices such as lighting, heaters and receptacles shall be supplied from an external AC panel by Others. A terminal strip and circuit breaker shall be provided to accept this source.

c) DC control voltage shall be supplied through an external DC power battery cabinet. A terminal strip and circuit breaker shall be provided to accept this source.

d) The DC power battery cabinet shall be supplied under this scope of work. Provide pre-manufactured battery charger and batteries in accordance with CSA and Metrolinx standards.

2.2.13. Instrument Transformers

a) Potential and current transformers shall be selected with a sufficient insulation to withstand a 5-minute dielectric proof test as specified by ANSI C57.13.

b) Current transformers

1) Each switchgear circuit bay shall have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker.

2) The current transformer assembly shall be insulated for the full voltage rating of the switchgear.

3) All current transformers shall be selected to meet or exceed the short-time rms current requirements for mechanical rated current and thermal rated current as shown on the Contract Documents.

4) Relaying and metering accuracy shall conform to ANSI and the local utility Standards.

5) Each current transformer shall have a short-circuiting device (shorting type terminal block) located remote from the high voltage compartment.

6) Current transformers shall be securely mounted on a metal support with the polarity marking towards the bus, the non-polarity side of the secondaries shall be wired together and grounded at the first terminal block (and not at the CT) to be in the control compartment.

c) Potential Transformers (Voltage transformers)

1) Potential transformers shall be draw out type. On opening the compartment, the contacts shall automatically withdraw for inspection and maintenance. PT compartments and drawers shall be padlockable in the open or drawn out position.

2) Potential transformers shall be protected with current limiting primary fuses and secondary breakers and shall be designed to withstand the basic impulse level of the switchgear.

3) Potential transformers shall have 120V secondary.

4) Potential transformers shall be grounded at first terminal block and not at the Potential transformers directly.

5) Potential transformers shall have mechanical rating equal to the momentary rating of the circuit breakers

6) Potential transformers shall have metering accuracy per ANSI and the local utility standards.

2.2.14. Control Wiring

a) All secondary and control wiring shall be isolated completely from main buses, cables and connections by means of metal conduit, armour or other suitable barriers. There shall be no exposed low voltage wiring in high voltage compartments.

b) All wiring shall be firmly fixed in place with clamps of a type which will not injure the insulation. Wiring shall be neat with all wires grouped as much as possible.

c) Terminal blocks with marking strips shall be provided for all secondary and control circuits leaving the switchgear or passing to other bays in the assembly.

d) Wiring and terminal shall be identified as per Identification requirements in this Specification. Adhesive wire labels are not acceptable.

e) Control wiring shall be 600 V rated Type SIS copper, 90 deg. C, minimum #14 AWG, minimum Class B stranded, except for wires crossing hinged joints and swinging panels which shall be flexible Class K stranded.

f) Terminal blocks shall be provided for all control wiring. Terminal blocks shall be grouped by function. External wiring shall be provided with dedicated terminal blocks. 20% spare used terminal blocks shall be provided for each control compartment.

g) All wiring shall have insulated compression type terminal lugs with fork type tongue lugs, except CT secondary circuits which shall be provided with non-insulated ring type lugs.

h) All terminal blocks shall be rated 600 volts minimum and shall be screw pressure clamp type.

i) A maximum of two wires shall terminate at any one terminal.

2.2.15. Protective Relays

a) Protection relays shall be provided when indicated on the Contract Documents.

b) Protection relays shall be of the plug in, draw out type and equipped with test plug stabs.

c) Protection relays shall be installed using multi-pole pole test switches. Each relay element shall be wired to current test switches, such that the relay can be isolated and taken out of service without interrupting the connection to the other devices in the current loop."

d) All associated voltage and current measurement transformers shall be provided for the relay.

e) All relay settings shall be fully adjustable via a relay mounted digital screen and keypad with range of adjustment as indicated on the Contract Documents.

f) The relay display screen shall indicate: Trip indication, trip reason, trip current, and phase current.

g) Minimum relay protection functions shall include:

1) Inverse definite minimum time (IDMT) overcurrent;

2) Instantaneous overcurrent;

3) Reverse power;

4) Overvoltage;

5) Undervoltage;

6) Over frequency;

7) Under frequency;

8) Ground fault current;

9) Negative sequence overcurrent; and

10) Lock out.

h) Protection relay shall be monitored by a remote supervisory system (BAS, SCADA, PLC, etc.). The details of the remote supervisory system shall be indicated on the Contract Documents, the interface may be hardwired contacts, digital communications or any system as on the Contact Documents.

i) Protection relays shall be mounted at a readable level (approx. 1675 mm A.F.F.).

2.2.16. Control & Auxiliary Devices

a) Auxiliary relays associated with protective protection, control or metering functions may be surface mounted inside the switchgear, except lockout relays, which shall be mounted on the door.

b) Duplex receptacles shall be furnished in each switchgear control compartment for 120V AC operation of small tools or portable lamps as an aid to inspection and maintenance.

c) LED lamp shall be furnished in each switchgear control compartment for 120V AC complete with an easily accessible control switch.

2.2.17. Metering

a) Where the switchgear assembly serves as a service point for the Utility incoming supply metering bay shall be provided with revenue accuracy CTs and PTs in accordance with Utility requirements. These devices shall be sent to the Manufacturer prior to shipping to be factory installed. The CT and PT data shall be included in the manufacturer's final drawings for record purposes.

b) Provide a digital power meter for each cell, both incoming or feeder circuits. Digital metering system shall measure true RMS current and voltage and display per phase volts and amps, kW, kVA, kVAR, PF, Hz, MWh and kW demand. Communication port shall be provided per Contract Documents. Digital metering system shall be monitored by a remote supervisory system (BAS, SCADA, etc.).

c) Digital power meters shall have provisions for testing and calibrating using an external power supply without disconnecting permanent wiring.

d) Meters shall be installed using multi-pole pole test switches. Each meter element shall be wired to current test switches, such that the meter can be isolated and taken out of service without interrupting the connection to the other devices in the current loop."

e) Digital power meters shall be mounted at a readable level (approx. 1675 mm A.F.F.).

2.2.18. Lightning Arrestors

a) Provide lightning arrestors in the equipment as shown on Contract Documents, at the incoming cells and at the cells feeding transformers.

b) Manufacturer shall perform and provide insulation co-ordination study to verify system is suitably protected.

2.2.19. Infrared Windows

a) Provide infrared windows in the switchgear to provide view of all bus bar and cable connections, circuit breaker connections as well a full view of the breaker or switch mechanism and fuse holders.

b) The window lens shall be compatible with most popular IR cameras, fusion capable and shall transmit electromagnetic radiation in:

1) Short, Mid and Long Wave Infrared;

2) Visual; and

3) UVA and UVB Ultraviolet

c) Label each window to provide the thermographer with full information necessary to properly set and aim the infrared camera and correctly interpret readings. The information shall include but not be limited to:

1) IR window location and number;

2) Lens material, range and the effective wavelength;

3) Lens Transmission Rate and proper compensation values; and

4) Target(s): name, location (in respect to window) and target(s) emissivity.

d) Infrared windows shall be CSA approved, UL/cUL listed, comply with IEEE Std. C37.20.2. Range, size, NEMA/IP and voltage rating suitable for the application.

2.2.20. Accessories

a) For all switchgear with draw out circuit breakers or switches provide one circuit breaker lifting device. It shall be portable, floor-supported with a roller base. All four wheels are to be swivelling type to allow the lifting device to be moved in any direction. Also provide same portable lifting device with each outdoor non-walk-in line-up(s). Provide one lifting device in each room containing draw out circuit breakers.

b) Provide one manual racking handle(s) with switchgear assembly.

c) Provide one motorized remote-control racking accessory with switchgear assembly.

d) Provide charging handle for each breaker mechanism.

e) Provide one test cabinet with one test jumper cable.

f) Provide maintenance tool for manually charging the breaker closing spring and manually opening the shutter.

2.3. FABRICATION

2.3.1. Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit.

2.3.2. Minimum sheet metal thickness shall be 11-gauge steel on all exterior surfaces.

2.3.3. Adjacent bays shall be securely bolted together to form an integrated rigid structure.

2.3.4. The rear covers shall be removable to assist installation and maintenance of bus and cables.

2.3.5. Each individual unit shall be braced to prevent distortion.

2.3.6. Large line-ups shall be split to permit normal shipping and handling as well as for ease of re-joining at the job site.

2.4. FINISHING

2.4.1. All steel parts, except galvanized (if used), shall be cleaned and a zinc-phosphate (outdoor equipment) or iron phosphate (indoor equipment) pre-treatment applied prior to paint application.

2.4.2. Paint colour shall be ANSI-61. TGIC polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard and durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in colour and free from blisters, sags, flaking and peeling.

2.4.3. Adequacy of paint finish to inhibit the build-up of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be performed on a periodic basis to provide conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment) or 600 hours minimum (indoor equipment).

2.5. IDENTIFICATION

2.5.1. Furnish colour coding in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 23.

2.5.2. Provide identification for equipment and the sub-components in accordance with Metrolinx Electrical Identification and Nomenclature Specification 26 05 23.

2.5.3. Provide continuous mimic bus applied to the front of the switchgear, arranged in single line diagram format.

2.5.4. Provide nameplates, warning signs and labels as required by the AHJ.

3. EXECUTION

3.1. FACTORY TESTING

3.1.1. All standard factory testing shall be witnessed by the Metrolinx representative(s).

3.1.2. The Manufacturer shall notify Metrolinx two (2) weeks prior to the date the tests are to be performed.

3.1.3. The switchgear shall be fully assembled, inspected, and tested at the factory prior to shipment.

3.1.4. Protection devices shall be set-up as per coordination study.

3.1.5. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of CSA or ANSI standards:

a) Alignment test with master cell to verify all interfaces and interchangeability;

b) Circuit breakers operated over the range of minimum to maximum control voltage;

c) Factory setting of contact gap;

d) One-minute dielectric test per ANSI standards;

e) Final inspections and quality checks;

f) Alignment test with master breaker to verify interfaces;

g) One-minute dielectric test per ANSI standards on primary and secondary circuits;

h) Operation of wiring, relays and other devices verified by an operational sequence test;

i) Final inspection and quality check; and

j) Perform low frequency withstand (Hi-Pot) tests according to ANSI/IEEE C37.20.2.

3.2. INSTALLATION

3.2.1. The Contractor shall install all equipment per the Manufacturer's recommendations and Contract Documents.

3.2.2. Once equipment is on site, the Contractor must take appropriate provisions for the equipment to remain clean and dry. If equipment is stored in an un-heated area, temporary heat is to be provided in the enclosures to prevent moisture build-up and corrosion.

3.2.3. Touch-up paint all chips and scratches with manufacturer-supplied paint and leave remaining paint with Metrolinx.

3.2.4. Prior to installation the Contractor shall visually inspect switchgear for evidence of damage and ensure that surfaces are ready to receive work.

3.2.5. The switchgear manufacturer shall provide vibration and noise isolators using soft (maximum 40 durometer) multi-layer rubber pads sized for a minimum static deflection of 12.7 mm at no more than 2/3 of the manufacturers maximum load rating for the pad material. The pads shall be installed at the corners of each individual vertical section.

3.2.6. Complete all field wiring and bus connections identified by the manufacturer. All connections to be torqued as per manufacturer's recommendations. Check factory made connections for mechanical security and electrical continuity.

3.2.7. Prior to commissioning and prior to turning the equipment over to Metrolinx, the equipment shall be cleaned thoroughly to ensure there are no traces of construction materials or dust.

3.2.8. Visually inspect to confirm that all items and accessories are in accordance with Specifications, Contract Documents and Shop Drawings.

3.2.9. Verify field measurements are as shown on Shop Drawings and instructed by Manufacturer.

3.2.10. Verify that required utilities (e.g., control voltage for heater circuits on outdoor switchgear) are available, in proper location, and ready for use.

3.2.11. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.2.12. Check factory made connections for mechanical security and electrical continuity.

3.3. COMMISIONING

3.3.1. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under Contract. The Manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

3.3.2. The protection device settings shall be verified in the field and tested by the Contractor as defined in the coordination study.

3.3.3. A qualified factory-trained Manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the Manufacturer's recommendations.

3.3.4. When the Contractor is ready for final inspection, set-up and testing to begin, the Contractor is to provide in writing that the equipment has been installed and include the Manufacturer's certification.

3.3.5. Field inspection, final set-up and testing will be performed by the Contractor.

3.3.6. All final site testing to be witnessed by Metrolinx or it's representative.

3.3.7. Testing shall be conducted in accordance with the latest edition of ANSI/NETA ATS – Standard for Acceptance Testing for Electrical Power Equipment and Systems.

3.3.8. Contractor to perform:

a) Visually inspect all equipment for physical damage;

b) Confirm that all wiring has been connected as per the manufacturer drawings;

c) Perform start-up tests in accordance with manufacturer's instruction manual;

d) Verify interlock operation;

e) Confirm operation of all relays and any control sequences. Adjust relays and settings and document changes made;

f) Repeat all factory testing performed on the equipment;

g) Check insulation of switchgear assembly with suitable megger. If values not satisfactory, clean, and dry switchgear and repeat tests until readings acceptable to Engineer's Representative;

h) Check phase rotation of each feeder; and

i) If any test fails, Metrolinx is to be notified immediately.

END OF SECTION