**Eaton Guide Specification**

**Notes and instructions to Specwriter**

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**Styles**

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**Outline view**

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Section 26 13 26.13

Metal-Enclosed Medium Voltage front Accessible Drawout Breaker Switchgear

# General

## Scope

### The Contractor shall furnish and install metal-enclosed drawout breaker switchgear equipment as specified herein and as shown on the contract drawings. The switchgear shall be front accessible such that it can be installed against the wall and shall not require rear access for maintenance, inspection, or operation.

## Related Sections

## References

### The medium voltage metal-enclosed switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards as follows:

#### ANSI/IEEE C37.20.3 & C37.20.2

#### ANSI C37.04

#### ANSI C37.09

#### NEMA SG 4

#### NEMA SG 5

#### CAN/CSA-22.2 No. 31-04

### The entire assembly shall be UL (Underwriters Laboratories) or CSA (Canadian Standards Association) listed.

## Submittals – for Review/Approval

### The following information shall be submitted to the Engineer:

#### Master drawing index

#### Front view elevation

#### Floor plan

#### Top view

#### Single line

#### Schematic diagram

#### Nameplate schedule

#### Component list

#### Conduit entry/exit locations

#### Assembly ratings including:

##### Short-circuit rating

##### Voltage

##### Continuous current

##### Basic Impulse Level

#### Major component ratings including:

##### Voltage

##### Continuous current

##### Interrupting ratings

#### Cable terminal sizes

#### Product data sheets.

### Where applicable the following additional information shall be submitted to the Engineer:

#### Busway connection

#### Connection details between close-coupled assemblies

#### Composite floor plan of close-coupled assemblies

#### Electrical Schematic diagram

#### Key interlock scheme drawing and sequence of operations

#### Descriptive bulletins

#### Product data sheets.

##  Submittals – for CONSTRUCTION

### The following information shall be submitted for record purposes:

#### Final as-built drawings and information for items listed in paragraph 1.04

#### Wiring diagrams

#### Certified production test reports

#### Installation information including equipment anchorage provisions

## Qualifications

### The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

### For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

### The manufacturer of this equipment shall have produced medium voltage metal-enclosed and metal-clad switchgear equipment for similar functions for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

### Provide Seismic qualified equipment as follows:

#### The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the [latest International Building Code (IBC)] [latest California Building Code (CBC) with OSHPD Amendments]. [The equipment shall have OSHPD Special Seismic Certification (OSP) Pre-Approval.]

#### The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.

#### The IP rating of the equipment shall be 1.5

#### The Structural Engineer for the Site will evaluate the SDS values published on the [Manufacturer’s] [OSHPD] website to ascertain that they are "equal to" or "greater than" those required for the Project Site.

#### The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

##### The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteriato verify the seismic design of the equipment.

##### The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

##### The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

## Regulatory Requirements

## Delivery, storage and handling

### Each switchgear assembly shall be split into shipping groups for handling as indicated on the drawings or per the manufacturer’s recommendations. All drawout elements must be shipped installed in their respective compartments. If any parts or restraints are added for shipping, those parts must be clearly identified. Clear instructions shall be included as to when and how those parts/restraints are to be removed during the installation. Any special cautions and care to be exercised prior to opening the packaging shall be noted outside the packaging. Shipping groups shall be suitable for shipment by truck, rail or ship. Shipping groups shall be bolted to skids and suitable for loading, unloading, and handling with a fork truck. Each shipping group shall be equipped with lifting provisions for handling by crane. Accessories shall be packaged and shipped separately.

### Equipment unloading, handling, storage, and installation instructions shall be included with the packaging in such a manner that it can be easily located and accessed before unloading the equipment.

### Equipment shall be handled and stored in accordance with manufacturer’s instructions.

## operation and Maintenance Manuals

### Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

# Products

## Manufacturers

### Eaton

### \_\_\_\_\_\_\_\_\_

### \_\_\_\_\_\_\_\_\_

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. To eliminate possible disputes between circuit breaker and switchgear coordination, the manufacturer of the switchgear shall also be the manufacturer of the circuit breaker. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

## Switchgear and circuit breaker Ratings

### The switchgear described in this specification shall be designed for operation on a [2.4] [3.3] [4.16] [4.8] [6.9] [7.2] [8.4] [11] [11.5] [12] [12.47] [13.2] [13.8] [14.4] kV, 3-phase, [3] [4] wire, [solidly grounded] [ungrounded] [low impedance grounded] [high impedance grounded], [50][60] Hertz system.

### The switchgear main bus (when applicable) shall be rated [1200] [2000] amperes. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by fault currents equal to the close and latch rating of the circuit breakers. The short time short circuit current withstand capability of the switchgear busses shall be the same as that of the circuit breakers. The temperature rise of the bus and connections shall be in accordance with IEEE standard C37.20.3 and C37.20.2, and documented by design tests.

### Each circuit breaker shall have the following ratings:

Note to Spec. Writer: Insert circuit breaker ratings below from Table 26 13 26.13

|  |
| --- |
| **Table 26 13 26.13** |
| Rated Maximum Voltage | 1-minute Power Frequency withstand voltage | Impulse withstand voltage (BIL) | Rated Short Circuit Current at Rated Maximum Voltage | Rated Voltage Range Factor | Maximum Sym. Interrupting and 2-second Short Time Current Carrying Capability | Closing and Latching Capability (Momentary) | 3-phase MVA at rated maximum voltage (for reference only) |
| V |  |  | I | K | K \* I | 2.6 \* K \* I |  |
| kV RMS | KV RMS | kV peak | kA RMS sym |  | kA RMS sym | kA Crest | MVA |
| 4.76 | 19 | 60 | 16 | 1.0 | 16 | 42 | 130 |
| 4.76 | 19 | 60 | 20 | 1.0 | 20 | 52 | 165 |
| 4.76 | 19 | 60 | 25 | 1.0 | 25 | 65 | 210 |
| 4.76 | 19 | 60 | 32 | 1.0 | 31.5 | 82 | 260 |
| 4.76 | 19 | 60 | 40 | 1.0 | 40 | 104 | 330 |
| 15.0 | 36 | 95 | 16 | 1.0 | 16 | 42 | 420 |
| 15.0 | 36 | 95 | 20 | 1.0 | 20 | 52 | 520 |
| 15.0 | 36 | 95 | 25 | 1.0 | 25 | 65 | 650 |
| 15.0 | 36 | 95 | 32 | 1.0 | 31.5 | 82 | 830 |
| 15.0 | 36 | 95 | 40 | 1.0 | 40 | 104 | 1040 |

Rated Maximum Voltage \_\_\_\_\_\_kV
1-minute Power Freq withstand voltage \_\_\_\_\_\_kV rms

Impulse withstand voltage (BIL) \_\_\_\_\_\_kV Peak

Continuous Current As shown on drawings

Rated Short-Circuit Current at Rated

Maximum Voltage \_\_\_\_\_\_kA rms Sym.
Rated Voltage Range Factor K 1.0
Maximum symmetrical Interrupting and
 2-Sec short-time current carrying
 capability \_\_\_\_\_\_\_kA rms Sym

Closing and Latching Capability \_\_\_\_\_\_kA peak
3-Phase MVA at rated maximum voltage. \_\_\_\_\_\_
Rated Interrupting Time 5 Cycle

## construction

### The switchgear assembly shall consist of completely metal-enclosed, dead front vertical sections requiring only front access for connection, maintenance and operation of the switchgear and containing various combinations of circuit breakers and auxiliaries of rating and type noted on the drawings or specified herein.

### The switchgear shall be a metal-enclosed design incorporating the following requirements from IEEE standard C37.20.3 and C37.20.2.

#### Switchgear designed for use with removable switching and interrupting devices as described in C37.20.2.

#### Metal barrier in front of, or a part of, the circuit interrupting device to ensure that, when in the connected (operating) position, no primary circuits are exposed by the opening of the circuit interrupting device’s compartment door.

#### Automatic shutters that cover primary circuit elements when removable element (circuit breaker, VT, CPT, or primary fuse) is moved to the test/disconnected position as described in C37.20.2.

#### Mechanical interlocks for proper operating sequence under normal operating conditions as described in C37.20.2.

#### Bare bus and connections as characterized in C37.20.3. Insulated bus bars and connections shall be used where necessary to meet specified voltage withstand ratings.

#### Metal-enclosed design per C37.20.3, with no barriers between primary circuits in cable pull-sections, or bus-transition sections.

### The switchgear shall meet all applicable requirements of Canadian Standard CAN/CSA-C22.2 No. 31-04.

### The switchgear shall be front accessible such that it can be installed against the wall, and shall not require rear access for its maintenance, inspection, or operation. Primary bus joints and supports that are not accessible from the front are to be designed such that no maintenance is necessary for those joints or supports. All necessary access for owner’s primary cable terminations, joining of main and ground bus joints at shipping splits, and termination of control wires shall be provided from the front or top of the switchgear. Access to primary cable terminals shall not require the removal of any primary or secondary devices.

### Access to any medium-voltage cable or bus connection shall be through removable panels requiring the use of tools and shall be marked with caution signs to indicate the presence of energized conductors behind them.

### Switchgear design shall allow safe installation and removal of all drawout elements into and from their compartments. No high voltage circuits shall be exposed to maintenance personnel when drawout element compartment doors are opened or drawout elements are removed from the compartment. No high voltage circuits shall be exposed when control compartment doors are opened. Clearly visible caution signs and warnings shall be placed on all removable covers or bolted panels provided for access to primary circuits and cables.

### All low voltage devices and their associated control wiring shall be isolated by grounded metal barriers from primary circuits with the exception of short lengths of wires such as at instrument transformer and space heater terminals. Space heaters shall be supplied when noted on the drawings or specified herein.

### The following features shall be supplied on every compartment containing a drawout vacuum circuit breaker:

#### The compartment front door shall be capable of being safely opened. Barrier all high voltage parts with grounded metal, to provide full access to the front of the circuit breaker control faceplate and all low voltage control and instrumentation devices.

#### The stationary primary high voltage contacts in each breaker compartment shall be silver-plated and recessed within insulating tubes. A metal safety shutter shall automatically cover those stationary high voltage contacts when the breaker is in the test or disconnected position or out of the cell. Provide provision for padlocking the shutters in an open position for inspection or in the closed position to prevent inadvertent contact with the stationary primary high voltage contacts, when the breaker is removed from its cell.

#### Each compartment and circuit breaker shall be provided with mechanical interlocks to prevent the insertion of a circuit breaker into the compartment with a higher frame size or interrupting rating.

#### Each circuit breaker shall have three positions within its compartment, with compartment door closed: Disconnected, Test, and Connected.

##### In the DISCONNECTED position, no primary high voltage or secondary control wiring connections shall be made and the safety shutters automatically close over the stationary high voltage contacts in the compartment.

##### The TEST position shall be same as the DISCONNECTED position, except secondary control wiring shall be connected so that the breaker can be opened or closed electrically or manually.

##### In the CONNECTED position, the circuit breaker shall be in the normal operating position inside the compartment, with safety shutters fully opened, and primary and secondary connections fully made. Provide a label or other marking on the compartment floor, visible when compartment door is opened, to indicate that the circuit breaker is fully connected.

#### Provide cell switches with one form -C contact for breaker position status. Two switches shall be provided in each circuit breaker compartment. One switch shall change its state when breaker is moved to connected position, and the other switch shall change its state when breaker is moved to test/disconnected position. When additional contacts are required for controls or interlocking, provide auxiliary relays as required.

### Provide the following interlocks for each drawout circuit breaker to insure safe and proper operation:

#### It shall not be possible to engage levering crank and withdraw the breaker when the breaker is in the connected position and closed.

#### It shall not be possible to close the circuit breaker manually or electrically while it is being levered or while the breaker is in any position between the connected and the test/disconnected.

#### It shall not be possible to insert the circuit breaker into the connected position if the circuit breaker control wiring connector is not properly engaged with its compartment control wiring connector. Interlocking shall also be provided to prevent disconnection of circuit breaker control wiring connector (manually or automatically) while the circuit breaker is in the connected position or in any position between the connected and the test/disconnected.

### Each auxiliary drawout compartment shall be provided with safety shutter to cover stationary high voltage connections when the auxiliary drawer is withdrawn from the connected position.

### Vertical section construction shall be of the universal frame type using die-formed bolted and welded parts. All enclosing covers and doors shall be fabricated from steel whose thickness shall be equal to or greater than those specified in ANSI/IEEE C37.20.3.

### Width, depth, and height of each vertical section containing circuit breakers or drawout auxiliary equipment shall not exceed 26-inches wide, 61.5-inches deep, and 92-inches high, excluding handles or other device projections on the door, skid, or lifting eye/angles. When a cable pull box is required adjacent to a single-high or two-high breaker structure, or when a bus transition section is required adjacent to a bus-tie breaker structure, width of such pull-box or transition section shall not exceed 19-inches.

## Bus

### All bare buses shall be continuously [silver-plated] [tin-plated] copper. Insulated buses only need to be plated at the joints.

### Ground bus conductor shall be [bare] [silver-plated] [tin-plated] copper and be directly fastened to a bare metal surface of each vertical section, and be of a size sufficient to carry the rated momentary and short time short circuit current of the switchgear assembly.

## bus SUPPORTING SYSTEMS

### Main bus shall be supported utilizing a high strength glass polyester support. Bus support devices within vertical sections shall have either molded fins of highly track-resistant Aramid Nylon or be glass polyester type A-20 insulators

## Wiring/Terminations

### All control, CT and VT secondary wiring shall be minimum #14 AWG, type SIS or an equivalent, rated 600 volt, 90 degrees C. Wiring for logic-level and/or supervisory circuits shall use wire size and type as required by the circuit function or device termination.

### Provide sleeve type wire markers on all control wiring at each termination. Each wire marker shall indicate wire identification as shown on three line and schematic diagrams.

### The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams. Terminal blocks shall be provided for customer connections to other apparatus.

### One NEMA 2-hole terminal pad per phase shall be provided for attaching contractor supplied power cable terminal lugs for a maximum of two conductors per phase of the sizes indicated on the drawings. Sufficient space shall be allowed for Contractor supplied electrical stress relief termination devices.

## Circuit Breaker

### Circuit breakers shall utilize vacuum interrupters for interruption and switching functions. The current transfer between the circuit breaker and primary circuits conductors in the compartment shall be via heavily silver plated and spring loaded copper finger cluster (primary disconnect) on the breaker, and rigidly mounted silver plated copper stabs within the insulated housing mounted on the compartment wall. The current transfer from vacuum interrupter moving stem to the primary disconnect cluster on the breaker shall be non-sliding type via heavily silver or tin plated flexible copper leaf conductors attached on each end.

### Each circuit breaker shall be supplied with contact surface erosion (contact wear) indicator that requires no tools or measurements for the checking of the contact surface erosion.

### Each circuit breaker shall be equipped with high-speed stored energy operating mechanism and shall permit open-close-open (OCO) operating sequence without recharging the closing springs.

### The breaker front panel shall be removable when the compartment door is open for ease of inspection and maintenance of the mechanism.

### Each circuit breaker shall be equipped with mechanical operations counter on the front of the breaker to provide record of the number of circuit breaker operations.

### Each circuit breaker shall include contacts Open/Close and spring Charged/Discharged status indications on the front of the breaker.

### Each circuit breaker shall be supplied with an auxiliary switch with 5 NO and 5 NC contacts. The switch shall be heavy duty, double break type with wipe type contacts. All unused contacts from this switch shall be wired out to terminal blocks for owner’s use.

### Circuit breakers shall be manually operated (MO) unless shown on the drawings as electrically operated (EO). Energy required for closing and opening of the circuit breaker shall be provided by manual charging of springs. The spring charging handle shall be integral to the breaker and conveniently located on the front of the circuit breaker.

### Each circuit breaker shall be supplied with Manual “ON” and “OFF” push buttons located on the front of the circuit breaker for opening and closing the breaker manually, without a need for external control power.

### Where indicated on the drawings as EO, each circuit breaker shall be electrically operated. Energy required for closing and opening of the circuit breaker shall be provided by charging of springs by an electrical motor. Electrical closing/opening of the circuit breaker shall be accomplished by energizing spring release coil/shunt trip coil. Control voltage required for electrical operation of the breakers shall be [derived from a control power transformer mounted within the switchgear] [supplied by owner from an external source] and shall be as follows:

#### [120] [240] Vac CLOSE and AC Capacitor Trip.

-- OR --

#### [24] [48] [125] Vdc CLOSE, and [24] [48] [125] Vdc Trip.

### One control circuit cutout device shall be provided and installed in the control compartment of each circuit breaker for control circuit isolation and short circuit protection.

### All EO circuit breakers shall also be supplied with a spring charging handle located on the front of the circuit breaker for manually charging closing springs during an emergency or for maintenance. Manual “ON” and “OFF” push buttons shall be located on the front of the circuit breaker for opening and closing the breaker manually.

### For MO circuit breakers, provide pad lockable hinged plastic cover to limit access to Manual “ON” and “OFF” push buttons.

### For EO circuit breakers, provide pad lockable hinged plastic cover to limit access to Manual “OFF” pushbutton and completely prevent access to Manual “ON” pushbutton.

## overcurrent protective Trip system

### The switchgear manufacturer shall furnish and install, in the metal-enclosed switchgear, the quantity and type of overcurrent protective trip systems and current sensors or protection relays and current transformers as indicated on the drawings and described hereinafter in this specification.

### Microprocessor Based Three-Phase & Ground Overcurrent Protection Trip System (Eaton type Digitrip 520MCV or equivalent)

**Note to Spec Writer** - The Digitrip 520MCV is a protective relay integral to the circuit breaker. It can be applied with Manually Operated circuit breakers, without a need for external control power. Application of this device with manually operated circuit breakers can result in cost savings compared to electrically operated circuit breakers with external relays.

#### The three-phase and ground overcurrent protection trip system shall consist of Eaton Digitrip 520V or equivalent trip unit, Type-V or equivalent current sensors and matching rating plug for the trip unit, and mechanical trip actuator. The trip unit shall be UL recognized, CSA approved, and carry CE mark.

#### The mechanical trip actuator assembly and the trip unit shall be installed on the circuit breaker. The trip unit shall be front accessible. The current sensors shall be installed over insulated bushings, one in each phase, in the primary circuit. The assembly of the bushings and current sensors shall withstand rated impulse voltage of the assembly. Each trip unit shall have rating plug installed that is matched to the associated current sensor rating. Provide an additional rating label on the back surface of the compartment door as a reference to indicate the current sensor and rating plug ratings used for primary circuit associated with that compartment.

#### The current sensor rating for each circuit shall be as indicated on the drawings or specified hereinafter in this specification. The current sensors produce a secondary output current proportional to the load current. The current sensors and rating plug defines the maximum continuous current rating of the circuit breaker (In). The trip unit shall be self-powered from the current flowing in the secondary of the current sensors, and shall continuously analyze the secondary current signals and, when preset current levels and time delay settings are exceeded, send an initiating trip signal to the trip actuator of the circuit breaker. The trip actuator shall cause tripping of the circuit breaker by providing the required mechanical force for the tripping. The circuit breaker mechanism shall automatically reset the trip actuator each time the circuit breaker opens.

#### The trip unit shall provide ANSI 50/51 protection functions for each of the (3) phases, and 50/51N or 50/51G protection function for ground as shown on the drawings or as determined by the coordination study. The trip unit shall be microprocessor based that operates from secondary output of current sensors and provide true RMS sensing of each phase and ground, and suitable for application to either 50 or 60 Hz systems. The ground protection shall be capable of being utilized in residual scheme, zero sequence scheme, or deactivated.

#### The phase and ground time-overcurrent response curves shall have following characteristics:

##### Phase Long Delay: I2t

##### Phase Short Delay: FLAT or I2t (selectable)

##### Phase Instantaneous: FLAT

##### Ground Overcurrent: FLAT or I2t (selectable)

##### Phase Long Delay protection shall have memory feature, when enabled, shall cause breaker to trip in progressively shorter time if the circuit breaker trips and recloses on repeated overload conditions. The memory feature shall reset when at least 10 minutes have elapsed between the overloads.

##### The sensing current for Ground protection shall be derived from the residual connections of the phase sensors or a separate Eaton Type-V or equivalent zero sequence sensor as indicated on the drawings or specified herein after in this specification.

#### Zone Interlocking

##### The Phase Short Delay time overcurrent and Ground time overcurrent protection functions shall be capable of being zone interlocked between two or more trip units, to provide the fastest possible tripping for faults within the zone of protection of the circuit breaker and yet also provide positive coordination among all breakers in the system to limit power outage to only the affected part of the system. Zone Interlocking wiring shall be provided when indicated on the drawings. When Zone Interlocking is employed, a fault within the zone of protection of the circuit breaker shall cause the trip unit to simultaneously: trip the affected circuit breaker immediately and send a signal to upstream trip unit to restrain from tripping immediately. The restraining signal shall cause the upstream trip units to follow their set coordination times, so that the service is only minimally disrupted while the fault is cleared in the shortest possible time.

#### The trip unit shall be provided with a green LED (for unit status) that blinks approximately once every second to indicate that the trip unit is energized and operating properly. The trip unit shall be energized (become self-powered) once the 3-phase load current through the circuit breaker exceeds approximately 10-12% of the current sensor rating or 1-phase load current exceeds approximately 30% of the current sensor rating.

#### The trip unit shall be provided with representation of the time-current curve depicted on the faceplace of the unit that indicates the protection functions. The trip unit shall have battery backed-up LEDs strategically located in the related segment of the time-current representation to indicate mode of trip following an automatic trip operation. A reset/battery test button shall be provided to turn off the LEDs and reset the trip unit after an automatic trip. All protection function of the unit shall be independent of the battery. The battery shall be used to for automatic trip indication only. The battery shall be 3 volt, 1/3N lithium cell. It shall be front accessible and shall not affect operation of the trip unit or its protection function when installing/removing even when circuit breaker is in service.

#### The trip unit shall have a test access port, protected by removable plexiglass cover, for interface with a hand held tester capable of testing trip elements of the trip unit, and mechanical trip assembly of the circuit breaker.

#### Provide one hand held tester.

-- OR --

### Microprocessor Based Three-Phase & Ground Overcurrent & Voltage Protection Trip System with metering and on-board display capability (Eaton type Digitrip 1150V or equivalent)

**Note to Spec Writer** -The Digitrip 1150V is a protective relay integral to the circuit breaker. It can be applied with Manually Operated (without a need for external control power) or Electrically Operated circuit breakers. Application of this device with MO or EO operated circuit breakers can result in cost savings compared to EO circuit breakers with external relays.

#### The three-phase and ground overcurrent and voltage protection trip system shall consist of Eaton Digitrip 1150V or equivalent trip unit, Type-V or equivalent current sensors and matching rating plug for the trip unit, and mechanical trip actuator. The trip unit shall be UL recognized, CSA approved, and carry CE mark.

#### The mechanical trip actuator assembly and the trip unit shall be installed on the circuit breaker. The trip unit shall be front accessible. The current sensors shall be installed over insulated bushings, one in each phase, in the primary circuit. The assembly of the bushings and current sensors shall withstand rated impulse voltage of the assembly. Each trip unit shall have rating plug installed that is matched to the associated current sensor rating. Provide an additional rating label on the back surface of the compartment door as a reference to indicate the current sensor and rating plug ratings used for primary circuit associated with that compartment.

#### The current sensor rating for each circuit shall be as indicated on the drawings or specified hereinafter in this specification. The current sensors produce a secondary output current proportional to the load current. The current sensors and rating plug defines the maximum continuous current rating of the circuit breaker (In). The overcurrent protection functions of the trip unit shall be self-powered from the current flowing in the secondary of the current sensors. The trip unit shall continuously analyze the secondary current signals and, when preset current levels and time delay settings are exceeded, send an initiating trip signal to the trip actuator of the circuit breaker. The trip actuator shall cause tripping of the circuit breaker by providing the required mechanical force for the tripping. The circuit breaker mechanism shall automatically reset the trip actuator each time the circuit breaker opens.

#### The trip unit shall provide following ANSI/IEEE protection functions:

##### 51/50 (time and instantaneous overcurrent) for each of the (3) phases

##### 51/50N or 51/50G (time and instantaneous overcurrent) for ground

##### 37 (phase loss, with adjustable time delay)

##### 46 (current unbalance, with adjustable time delay)

##### 27 (3-phase undervoltage, with adjustable time delay)

##### 59 (3-phase overvoltage, with adjustable time delay)

##### 81U (underfrequency, with adjustable time delay)

##### 81O (overfrequency, with adjustable time delay)

##### 47 (voltage unbalance, with adjustable time delay)

##### 32 (reverse power, with adjustable time delay)

### The trip unit shall be microprocessor based that operates from secondary output of current sensors and external voltage transformers and provide true RMS sensing of each phase and ground, and suitable for application to either 50 or 60 Hz systems. The ground protection shall be capable of being utilized in residual scheme, zero sequence scheme, or deactivated. The overcurrent protection functions of the trip unit shall be self-powered from the current flowing in the secondary of the current sensors. The auxiliary power required for voltage and frequency related protection and alarm functions shall be [120 Vac] [230 Vac] [24 to 48 Vdc] [125 Vdc] +/- 10%, and shall be [supplied by an owner from a reliable external source] [derived from UPS module powered from a CPT within the switchgear lineup].

#### The phase and ground time-overcurrent response curves shall have selectable characteristics as follows:

##### Phase Long Delay: I2t, I4t, IEEE Moderately Inverse, Very Inverse, or Extremely Inverse

##### Phase Short Delay: FLAT or I2t

##### Phase Instantaneous: FLAT or I2t

##### Ground Overcurrent: FLAT or I2t

### Phase Long Delay protection shall have memory feature, when enabled, shall cause breaker to trip in progressively shorter time if the circuit breaker trips and recloses on repeated overload conditions. The memory feature shall reset when at least 10 minutes have elapsed between the overloads.

### The trip unit shall have ground fault memory to protect loads in the event of a sputtering arc to ground. The ground protection shall remember the sputtering ground for up to ten (10) times the ground fault time setting to allow detection of the sputtering arcing faults. After the expiration of the memory time, the unit shall reset automatically.

### The sensing current for Ground protection shall be derived from the residual connections of the phase sensors or a separate Eaton Type-V or equivalent zero sequence sensor as indicated on the drawings or specified herein after in this specification.

#### Trip unit shall accept secondary output of 110 or 120 V, derived from a set of external primary voltage transformers, connected in two line-to-line or three line-to-ground configurations. The primary voltage transformer ratio shall be programmable for correct display of measured primary voltages, power, and energy values.

#### The trip unit shall have a built-in 24-character alpha-numeric LED display to allow programming and viewing of settings, menus, trip and alarm logs, and real time metering data. All settings shall be programmable through use of appropriate buttons located on the front of the unit.

#### Trip unit shall be capable of displaying following meter values:

##### Individual phase and ground currents in RMS amperes, real time

##### Individual phase and ground currents in avg RMS ampere (5 min average)

##### Individual phase and ground currents, maximum and minimum (since last reset)

##### Line-to-Line Voltages – Vab, Vbc, Vca

##### Forward/Reverse kW, kW Demand, and Max kW Demand

##### KVA, kVA Demand, and Max kVA Demand

##### Watt and VA demand, maximum W and VA demand

##### Forward/Reverse kWh

##### KVAh

##### Total Harmonic Distortion for each phase current

##### Individual harmonic currents up through 27th harmonic for each phase

##### Power factor, minimum, maximum

##### Frequency

##### Circuit breaker operations count

##### Metering accuracy shall be minimum:

###### +/- 1% of full-scale (In) for currents for currents in the range of 5 to 100% of (In)

###### +/- 3% of full-scale for voltages (full-scale is equal to VT primary voltage)

###### +/- 4% of full scale for power and energy readings

#### The trip unit shall be capable of communication to a remote master computer. The communication shall include display of monitored values, trip/alarm events, remote open/close controls, and waveform capture and display.

####  Provide one interface module to translate Eaton INCOM protocol to MODBUS protocol for communication with remote Modbus master.

#### The trip unit shall have programmable output contacts, designated as Relay contacts A, B, and C. The Relay contact A can be programmed and activated for one or more trip or alarm conditions or it can be programmed for use as a pulse initiator for either kWh or kVAh functions to transmit kWh or kVAh pulses to an external counter. The Relay contact B can be programmed and activated for one or more trip conditions for use as blocking relay to prevent closing of the circuit breaker after a trip until the trip unit is reset. The Relay contact C can be programmed and activated and latched for one or more trip conditions.

#### Zone Interlocking

##### The Phase Short Delay time overcurrent and Ground time overcurrent protection functions shall be capable of being zone interlocked between two or more trip units, to provide the fastest possible tripping for faults within the zone of protection of the circuit breaker and yet also provide positive coordination among all breakers in the system to limit power outage to only the affected part of the system. Zone Interlocking wiring shall be provided when indicated on the drawings or specified herein after in this specification. When Zone Interlocking is employed, a fault within the zone of protection of the circuit breaker shall cause the trip unit to simultaneously: trip the affected circuit breaker immediately, and send a signal to upstream trip unit to restrain from tripping immediately. The restraining signal shall cause the upstream trip units to follow their set coordination times, so that the service is only minimally disrupted while the fault is cleared in the shortest possible time.

#### The trip unit shall be provided with a green LED (for unit status) that blinks approximately once every second to indicate that the trip unit is energized and operating properly. The overcurrent functions of the trip unit shall become self-powered once the 3-phase load current through the circuit breaker exceeds approximately 10-12% of the current sensor rating or 1-phase load current exceeds approximately 30% of the current sensor rating.

#### The trip unit shall be provided with representation of the time-current curve depicted on the faceplate of the unit that indicates the protection functions. The trip unit shall have battery backed-up LEDs strategically located in the related segment of the time-current representation to indicate mode of trip following an automatic trip operation. A battery test button shall be provided to confirm battery status and to reset the LEDs. All protection function of the unit shall be independent of the battery. The battery shall be used to for trip indication LEDs only. The battery shall be 3 volt, 1/3N lithium cell. It shall be front accessible and shall not affect operation of the trip unit or its protection function when installing/removing even when circuit breaker is in service.

#### The trip unit shall provide following data through its front panel display to help plan inspection and maintenance schedules of the circuit breaker and circuit it is protecting:

##### Total number of instantaneous and short delay trip operations by the circuit breaker since last reset

##### Total number of overloads (long delay trips) and ground fault trips since last reset

##### Total number of Close Operations by the circuit breaker since last reset

##### The last time the circuit breaker was operated (Opened or Closed or Tripped) with time and date

##### Maximum chip temperature in degrees C as seen by the trip unit

#### The trip unit shall have a test access port, protected by removable plexiglass cover, for interface with a hand held tester capable of testing trip elements of the trip unit, and mechanical trip assembly of the circuit breaker.

#### Provide one hand held tester

#### Provide communication cable (TripLink) to transfer settings from one trip unit to another via test access ports of the trip units.

### When shown on the drawings or specified herein after, provide circuit breakers with Overcurrent Trip Switch (OTS). The switch shall operate when the circuit breaker has been tripped by the action of an integral trip unit. The switch shall have one Form-C contact wired out to terminal blocks, unless noted otherwise on the drawings. When the switch operates, its contact shall change state and remain in that state until the switch is manually reset.

## PROTECTIVE RELAYS

**Note to Spec Writer:**  Selecting integral trip unit protection (see Section 2.08, Digitrip 520MCV or 1150V) can eliminate need for external discrete relays described in this section, resulting in cost savings.

### The switchgear manufacturer shall furnish and install, in the metal-enclosed switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.

### Microprocessor Based Protective Relay

#### Eaton Type EDR-3000, microprocessor based multifunction overcurrent protection relay, ANSI device function 51/50, 51/50N, or 51/50G and 86.

#### Eaton Type EDR-5000, microprocessor based multifunction protection and metering unit, ANSI device functions: 51/50, 51N/50N, 50BF, 25, 32, 46, 67, 27, 59, 47, 81-O, 81-U, and 86. The relay shall be powered from an external \*[48 Vdc] [125 Vdc] control power provided by the owner.

#### Eaton Type EMR-3000, microprocessor based motor protection relay, ANSI device functions 49, 50, 51, 46, 50G, 51G, 37, 38, 66, 2/19, 74, and 86.

### Current and voltage input for the protective relays shall be derived from conventional CTs and VTs connected in the primary circuits. Zero sequence CTs are to be included when shown on the drawings or specified herein after in this specification.

## interface/control devices

### Switchgear HMI

#### When indicated on the drawings, provide an HMI equal to Eaton’s Power Xpert Dashboard [mounted locally on one of the switchgear compartment door] [for mounting remotely from switchgear] for access, monitoring, and display of parameters of multiple Digitrip and EDR relays. When the Dashboard is locally mounted on one of the switchgear compartment door, all required communication wiring to between the Dashboard and the relays shall be factory installed. When the Dashboard is located remotely from the switchgear, all required wiring between relays shall be factory installed and brought out to terminal blocks for field connections to the Dashboard.

## AUXILIARY DEVICES

### Ring type current transformers shall be furnished when required for protective relays and metering. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be adequate for the type of relay/meter burden connected to each CT. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

### Voltage transformers or resistive voltage dividers shall be supplied as shown on the one-line diagram.

#### The voltage transformers shall be mounted on tilt-out trunnions or drawout drawer assemblies and equipped with current limiting primary fuses. In the withdrawn position, the fuses and the potential transformers shall be disconnected and grounded to permit safe inspection and/or replacement of the fuses. The trunnion frame shall be connected to ground by a flexible copper cable that is attached directly to the frame. The mechanism shall be arranged so that full access to potential transformers or fuses cannot be accomplished until they are disconnected from high voltage and grounded. Live parts shall be isolated when the voltage transformers are in the withdrawn position to prevent accidental contact by operating or maintenance personnel. Stationary contacts shall be silver plated copper and mounted on porcelain or glass polyester supports. Cables connected to voltage transformer primaries shall be rated for the full voltage and BIL rating of the switchgear.

#### Resistive voltage dividers can be used in place of voltage transformers. Resistive voltage dividers shall carry the same rating as the specified voltage transformers. They are to be mounted in the cable compartment of the switchgear assembly. Resistive voltage dividers must consist of 4 total non-inductive resistors (two paralleled medium voltage resistors and two paralleled low voltage resistors). When the nominal service voltage is applied, the resistive voltage divider system shall provide a 120 V signal to the auxiliary devices for protection and controls. The resistive voltage divider system shall be agnostic of the auxiliary devices to which they connect.

### A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer can be withdrawn.

## Utility metering

### Where indicated on the drawings, each utility metering vertical section shall contain provisions for current and voltage transformers as required by the utility. The construction shall conform to the utility company’s metering standards. It shall also conform to the general electrical and construction design of the switchgear specified above.

## OWNER metering

### Provide current transformers for metering as shown on the drawings.

### Provide voltage transformers including primary and secondary protective devices for metering as shown on the drawings.

### Microprocessor Based Metering Devices When indicated on the drawings or specified herein after, provide metering devices as follows:

## Accessories

### Provide a key interlock on the circuit breaker to prevent circuit breaker from closing, when it is in locked position.

### Provide surge protection as shown on the drawings.

**Note to Spec Writer**:

For all applications where a MV breaker is close-coupled or connected with less than 75 feet of cables to primary side of a power transformer, Eaton strongly recommends that the transformer be protected against high frequency voltage transients caused by interaction of the transformer, switching device, and the power system. The surge protection device selected should be located and connected at the transformer primary terminals or it can be located inside the switchgear and connected on the transformer side of the primary breaker. If the surge protection is not already included at the power transformer, Eaton can provide surge arresters plus transient surge protection device such as Protec Z to be installed and located within the switchgear. A custom engineered RC snubber can also be provided.

For all other applications, refer to Eaton’s surge protection recommendations given in Eaton’s Consulting Application Guide, Tab 5.

## Nameplates

### Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum. Furnish master nameplate giving information in accordance with IEEE Standard C37.20.2-1999, section 7.4.1 for each switchgear lineup. Circuit nameplates shall be provided with circuit designations as shown on purchaser’s single-line diagrams.

### Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer’s three line and schematic diagrams.

## Finish

### Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, and then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils. The finish shall have the following properties:Impact resistance (ASTM D-2794) 60 direct/60 indirectPencil hardness (ASTM D-3363) HFlexibility (ASTM D-522) Pass 1/8-inch mandrelSalt spray (ASTM B117-85 [20]) 600 hoursColor ANSI 61 gray

## Special switchgear configurations

### Automatic Transfer Control – Two Breaker Automatic Transfer Control with Common Load Bus

#### Furnish, where shown on the drawings, a switchgear assembly with microprocessor-based automatic transfer control system for two (2) main breakers with a common load bus. The system shall consist of the two (2) breakers with electrical operators as herein specified, and an integrated microprocessor-based automatic transfer control system containing sensing devices, low voltage logic control, and auxiliary equipment, as indicated on the drawings and specified here. The automatic transfer control system, when placed in the “automatic” mode, shall automatically transfer the load bus circuit to the alternate power source upon failure of the preferred source.

#### The basic sequence of operation based upon two normally energized sources shall be as follows. Normal operation shall be with the preferred source main breaker closed and standby main breaker open. Upon detection of an undervoltage to the line side of the preferred main breaker and after a field adjustable time delay, that main breaker shall open and after an additional field adjustable time delay, the standby breaker shall close restoring power to the facility. Upon restoration of voltage to the line side of the preferred main breaker and after a field adjustable time delay the standby main breaker shall open and after a field adjustable time delay the preferred main breaker shall close.

#### The logic of the transfer shall function via a microprocessor controller equal to Eaton ATC-900. The set points shall be field adjustable without the use of special tools. LED lights shall be included on the controller to show:

##### Normal Source Available

##### Emergency Source Available

##### Normal Source Connected

##### Emergency Source Connected

##### Load Energized.

#### A digital readout shall display each option as it is functioning. Readouts shall display actual line-to-line voltage, line frequency and timers. When timers are functioning, the microprocessor shall display the timer counting down. All set points shall be re-programmed from the front panel of the controller when it is in the program mode. In addition the controller shall display date, time and reason of last 16 transfers, set points of timers, voltage pickup and dropout set points. A communications port shall be provided for communication to an external Power Monitoring System or other system..

#### The transfer system shall include the following:

##### A time delay transfer from the normal power source to the standby power source and from the standby power source to the normal source, forcing a neutral position to ensure the load voltage has decayed before reconnecting to the source from which the load is to be fed (0 seconds to 30 minutes).

##### A time delay to override a momentary power outage or voltage fluctuation (0 seconds to 120 seconds).

##### A time delay for transferring from the standby power source to the normal power source (0 seconds to 30 minutes).

##### A Form C relay contact that changes state when the power is available on the normal source.

##### A Form C relay contact that changes state when the power is available on the standby source.

##### A preferred source selection (Source 1 or Source 2, or none).

##### Electrical Interlocking shall prevent paralleling of two sources in manual mode.

#### Two (2) sets of three-phase “line side” voltage transformers (open delta for 5 kV or 15 kV) with primary fuses and secondary supplementary protectors to provide both sensing and control power.

#### The automatic transfer system shall contain:

##### One (1) selector switch with automatic and manual positions.

##### One (1) open-close control switch for manual electrical operation of each controlled breaker.

##### One (1) pushbutton to initiate manual retransfer to preferred source when the IQ Transfer Controller is functioning in automatic mode and programmed for manual retransfer.

### Automatic Transfer Control – Three Breaker Automatic Transfer Control with Two Mains and Normally Open Tie.

#### Furnish, where shown on the drawings, a switchgear assembly with automatic transfer control system for two (2) mains and normally open tie. The automatic transfer switchgear shall consist of a dead front, metal-enclosed and integrated assembly including two (2) main breakers and one (1) tie breaker each being driven by a motor operator, and an integrated automatic transfer control system containing sensing devices, low voltage logic control and auxiliary equipment, as indicated on the drawings. Operation shall be such that upon loss of voltage to the line side of a main, that main shall open and then the tie shall close.

#### The basic sequence of operation based upon two normally energized sources shall be as follows. Normal operation shall be with the main breakers closed and the tie-breaker open. Upon detection of an undervoltage to the line side of a main breaker and after a field adjustable time delay, that main breaker shall open and after an additional field adjustable time delay, the tie breaker shall close restoring power to the affected portion of the facility. Upon restoration of voltage to the line side of the preferred main breaker and after a field adjustable time delay the tie breaker shall open and after a field adjustable time delay the open main breaker shall close. Electrical Interlocking shall prevent paralleling of two sources in manual or automatic mode.

#### Provide an HMI equal to Eaton’s Power Xpert Dashboard for user interface to the Automatic Transfer Control system.

## Accessories

### The switchgear manufacturer shall furnish accessories for operation and maintenance, including:

#### One – Levering crank for moving the breaker between test and connected positions

#### One –Lifting device for installation/removal of breaker to/from its compartment

#### One Manual type Ground and Test Device, 1200A

#### One Manual type Ground and Test Device, 2000A

## Bills of Material

### The metal-enclosed switchgear **auxiliary section** for control and instrumentation shall include the following:

#### [Two – Line-to-Line] [Three – Line-to-Ground] voltage transformers

#### Three – Current transformers

#### One – [3] [5] kVA Single-phase control power transformer

#### One – Eaton PowerXpert microprocessor-based metering system

#### Additional requirements as shown on the plans.

### The metal-enclosed switchgear main circuit breaker section for control of a **main circuit breaker** shall include the following:

#### One – Manually Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three - Current sensors, ratings as shown on drawings

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One - Circuit nameplate

#### One – Set of 2-hole NEMA drillings for primary cable connections

-- OR --

### The metal-enclosed switchgear main circuit breaker section for control of a **main circuit breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three - Current sensors rated, ratings as shown on drawings

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One - Circuit nameplate

#### One – Set of NEMA drillings for primary cable connections

-- OR --

### The metal-enclosed switchgear main circuit breaker section for control of a **main circuit breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three – Current transformers, single secondary, ratio as shown on drawings

#### One – [EDR-3000 or equivalent microprocessor-based three-phase and ground overcurrent relay, ANSI device number 51/50/N, and 86].[EDR-5000, or equivalent microprocessor based multifunction protection and metering unit, ANSI device functions: 51/50, 51N/50N, 50BF, 25, 32, 46, 67, 27, 59, 47, 81-O, 81-U, and 86]

#### One – [PowerXpert][IQ 200] microprocessor-based metering system

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One – Circuit nameplate

#### One – Set of NEMA drillings for primary cable connections

### The metal-enclosed switchgear tie breaker section for control of a **bus tie breaker** shall include the following:

#### One – Manually Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three - Current sensors, rating as shown on drawings

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One - Circuit nameplate

-- OR –

### The metal-enclosed switchgear tie breaker section for control of a **bus tie breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three - Current sensors rating as shown on drawings

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One - Circuit nameplate

-- OR –

### The metal-enclosed switchgear tie breaker section for control of a **bus tie breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker rated [600] [1200] [2000] ampere

#### Three – Current transformers, single secondary, ratio as shown on drawings

#### One – [EDR-3000 or equivalent microprocessor-based three-phase and ground overcurrent relay, ANSI device number 51/50/N, and 86][EDR-5000, or equivalent microprocessor based multifunction protection and metering unit, ANSI device functions: 51/50, 51N/50N, 50BF, 25, 32, 46, 67, 27, 59, 47, 81-O, 81-U, and 86]

#### One – [PowerXpert][IQ 200] microprocessor-based metering system

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One – Circuit nameplate

### Each metal-clad switchgear feeder breaker section for control of a **feeder circuit breaker** shall include the following:

#### One – Manually Operated Drawout power circuit breaker, rated current as shown on drawings

#### Three - Current sensors, ratings as shown on drawings

#### One –Zero sequence current sensor, ratio 50:1

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One - Circuit nameplate

#### One – Set of NEMA drillings for primary cable connections

-- OR –

### Each metal-clad switchgear feeder breaker section for control of a **feeder circuit breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker, rated current as shown on drawings

#### Three - Current sensors, ratings as shown on drawings

#### One – Zero sequence current sensor, ratio 50:1

#### One - [Digitrip 520MCV] [Digitrip 1150V] or equivalent integral trip unit

#### One – Overcurrent Trip Switch (OTS)

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One - Circuit nameplate

#### One – Set of NEMA drillings for primary cable connections

-- OR –

### Each metal-clad switchgear feeder breaker section for control of a **feeder circuit breaker** shall include the following:

#### One – Electrically Operated Drawout power circuit breaker, rated current as shown on drawings

#### Three – Current transformers, single secondary, ratio as shown on drawings

#### One – Zero sequence current transformer, ratio 50:5

#### One – EDR-3000 or equivalent microprocessor-based three-phase and ground overcurrent relay, ANSI device number 51/50/N, and 86.

#### One – [PowerXpert][IQ250][IQ260] microprocessor-based metering system

#### One – Circuit breaker Control Switch with Red and Green indicating lights

#### One – Circuit nameplate

#### One – Set of NEMA drillings for primary cable connections

# execution

## Factory Testing

### 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 ANSI and NEMA standards.

#### Electrically operated circuit breaker shall be operated over the range of minimum to maximum control voltage

####  When circuit breakers are equipped with Digitrip 520V or 1150V integral trip units, functional operation of the trip units and breaker tripping through trip actuator shall be verified by secondary current injection into the secondary circuits of the applicable current sensors.

#### Factory setting of contact gap

#### One (1) minute dielectric test per ANSI standards

#### Final inspections and quality checks.

### The following production test shall be performed on the circuit breaker housing:

#### One (1) minute dielectric test per ANSI standards on primary and secondary circuits

#### Operation of wiring, relays and other devices verified by an operational sequence test

#### Final inspection and quality check.

### The manufacturer shall provide three (3) certified copies of factory test reports.

### Factory tests as outlined above shall be witnessed by the owner’s representative.

#### The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.

#### The manufacturer shall include the cost of transportation and lodging for up to three (3) owner’s representatives. The cost of meals and incidental expenses shall be the owner’s responsibility.

## Field Quality Control

### The Contractor shall provide the services of a qualified factory-trained manufacturer’s representative to provide start-up of the equipment specified under this section for a period of \_\_\_\_ working days.

### The Contractor shall provide three (3) copies of the manufacturer’s field start-up report.

## Training

### The Contractor shall provide a training session for up to five (5) owner’s representatives for \_\_\_\_ normal workdays at a jobsite location determined by the owner.

### The training session shall be conducted by a manufacturer’s qualified representative and consist of instruction on the assembly of switches, circuit breaker(s), protective devices, and other major components.

## Installation

### The Contractor shall install all equipment per the manufacturer’s recommendations and the contract drawings.

### All necessary hardware to secure the assembly in place shall be provided by the contractor.

## Field Adjustments

### The relays or trip units shall be set/programmed in the field by [The Contractor in accordance with settings designated by the Engineer.] [The Contractor in accordance with settings designated in a coordination study of the system as required elsewhere in the contract documents.] [A qualified representative of the manufacturer, retained by the Contractor in accordance with settings designated in a coordination study of the system as required elsewhere in the contract documents.]

## Field Testing