SECTION 26 13 26 .16

ARC-RESISTANT METAL-CLAD SWITCHGEAR

# GENERAL

## SCOPE

* + 1. The seller shall furnish the switchgear lineup as specified herein and as shown on the drawings for medium voltage, free-standing, arc-resistant metal-clad switchgear with vacuum circuit breakers.
    2. The Seller shall develop interlocks as required to implement the controls strategy described and the protective relay philosophy indicated on the drawings.
    3. The switchgear shall be UL Labeled.
    4. Switchgear shall be located indoors in a brick and mortar building or in a PDC or outdoor sheltered aisle.

## REFERENCES

* + 1. American National Standards Institute (ANSI/IEEE)
       1. C37.04 Standard Rating Structure for AC HV Circuit Breakers
       2. C37.06 Preferred Ratings for AC HV Circuit Breakers
       3. C37.09 Standard Test Procedure for AC HV Circuit Breakers
       4. C37.010 Application Guideline for AC HV Circuit Breakers
       5. C37.011 Application Guide for TRV for AC HV Circuit Breakers
       6. C37.012 Application Guide for Capacitance Switching
       7. C37.11 Requirements for Electrical Control
       8. C37.20.2 Standard for Metal-clad and Station-type Cubicle Switchgear
       9. C37.20.7 IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38kV for Internal Arcing Faults
       10. C37.55 Conformance Testing Procedure of Metal-clad Switchgear
       11. C57.10 Requirements for Instrument Transformers
       12. C57.13 Requirements for Instrument Transformers
       13. 47 Guide for Surge Withstand Capability Tests
    2. National Electrical Manufacturers Association (NEMA)
       1. CC1 Electrical Power Connectors
       2. SG-4 Standards for Power Circuit Breakers
       3. SG-5 Power Switchgear Assemblies

## SUBMITTALS

* + 1. All engineering data provided for the equipment shall show equipment as specified and ordered. Engineering data, as listed below, shall be supplied in the quantities shown.
    2. Drawings shall indicate all equipment in the switchgear scope of supply. All user connection and interface points shall be clearly marked, including primary and secondary cable entrances and connection points, installation details, generic inter-frame assembly and connection details for shipping splits.
    3. Drawing Classes shall be as follows and shall be submitted as requested.
       1. Class I
          1. Single Line Drawing
          2. Front Elevation
          3. Floor plan
          4. Section View Drawings
          5. Nameplate Drawings
          6. Electrical Bill of Material
          7. Assembly Ratings
          8. Cable Termination Sizes
       2. Class II
          1. 3-phase Elementary Diagrams
          2. Schematic Diagrams
          3. Instrument Layout
       3. Class III
          1. Interconnection Diagrams
          2. Connection Wiring Diagrams
    4. Installation, operation and maintenance manual shall cover switchgear and breaker installation, operation and maintenance and shall be shipped with equipment in three-ringed binders or on CD-ROM disks.

## QUALITY ASSURANCE

* + 1. The manufacturer of the assembly shall also be the manufacturer of the major components within the assembly including circuit breakers and instrument transformers.
    2. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 10 years.
    3. The manufacturer of the switchgear must be ISO 9001 or 9002 and 140001 certified.

## DELIVERY, STORAGE AND HANDLING

* + 1. Switchgear shall be shipped to site following INCOTERMS 2010 Carriage Paid To terms.
    2. Switchgear shall be stored and handled in accordance with manufacturer’s recommended practices to prevent damage to any components.
    3. Shipping groups shall be designed to be shipped by truck. Indoor groups shall be bolted to shipping bases. Breakers and accessories shall be shipped separately in individual crates.

# PRODUCTS

## BASIC CONSTRUCTION

* + 1. Basic Frame
       1. The switchgear assembly shall consist of individual vertical section housing various combinations of circuit breakers and auxiliary devices bolted to form a rigid metal-clad switchgear assembly.
       2. The basic structure will be of modular construction and fabricated of highly reflective, durable 14 gauge galvanized steel. 12 gauge steel shall be used for 63kA equipment.
       3. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate major primary sections of each circuit.
       4. The frame shall consist of hem bent galvanized steel to increase durability and reduce arc-propagation by introduction of an air gap between frames. Hem bends shall also be used to eliminate sharp edges which may cause damage to personnel or wiring.
       5. Switchgear shall be of robust construction to pass arc-resistance test criteria for accessibility types as detailed by C37.20.7. Arc gases shall be vented via a plenum. Designs to allow ventilation of arc gases into the switchgear room are not acceptable
       6. Cooling vents may be provided in the switchgear for heat ventilation purposes.
       7. The switchgear shall be capable of extension from either end at future date without modification to existing structural members.
       8. Cubicles designated as future shall be furnished with all bus work, current transformers, metering and relaying as per one-line diagram. The cubicle shall be equipped for a future breaker element.
       9. All doors shall be securely held with tamper-resistant hinges and sealed with a single-handle, multi-point latch door with padlock provisions. Padlock is to be supplied by buyer.
       10. All non-galvanized steel within the switchgear and bus enclosures shall be cleaned, iron phosphate treated and painted in accordance with the applicable standards and the manufacturer’s standard practice for the environmental conditions specified. Paint color shall be ANSI 61.
       11. Option: A mimic bus applied to the front of the switchgear shall functional represent the primary circuits. Mimic bus shall be made of automotive grade mylar tape.
    2. Ratings
       1. Rated Maximum Voltage: 5 / 8.25 / 15 kV
       2. Operating Voltage: *X* kV
       3. Main Bus Continuous Rating: 1200 / 2000 / 3000 A
       4. Control Bus Voltage: 48 / 125 / 250 VDC OR 120 / 240 VAC.
       5. Short Circuit Rating: 25 / 31.5 / 40 / 50 / 63 kA
       6. Arc-resistant switchgear shall be supplied. Accessibility type 2, 2B or 2BC shall be used.
    3. Main Bus
       1. The main bus shall be pure copper and have flame-retardant and track-resistant epoxy insulation except at bolted joints. All exposed bus shall be silver plated.
       2. The bus supports shall be glass polyester for bus ratings up to 2000A and epoxy at 3000A. Bus supports for 63kA equipment shall be epoxy regardless of main bus rating.
          1. Option: All bus supports at 50kA and below shall be porcelain.
       3. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents as specified in the standards for the switchgear rating.
       4. The main bus compartment shall be separated from the other compartments by an 11 gauge steel barrier and shall fully enclose the main bus.
       5. The main bus compartment shall be accessible from the rear through the cable compartment.
       6. The shape of the bus bar shall be full round edge. The main bus shall not be tapered.
       7. All bus joints shall be silver plated, bolted, and insulated with molded epoxy boots secured with nylon fasteners.
          1. Option: all bus joints shall be tin plated.
       8. Temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests certifications.
       9. A ¼ by 2 inch tin plated copper ground bus shall extend the entire length of the switchgear.
    4. Breaker Compartment
       1. The circuit breaker enclosure shall include stationary support bushings and primary contacts for engagement with the circuit breaker or ground and test (G&T) device.
       2. Bushings shall be made of glass-reinforced polyester or epoxy capable of supporting the weight of the current transformers.
       3. Primary contacts shall be made of pure copper and designed to accept the round, tulip style connectors of the AMVAC or ADVAC circuit breaker.
       4. Solidly grounded metal shutters shall automatically open when the circuit breaker or G&T device is racked into the connected position and close when racked to the test or disconnect positions. While closed, these shutters shall cover the primary contacts and current transformers for personnel safety.
       5. Shutters shall be equipped with padlocking provisions in the closed position.
       6. Shutter grounding shall be by dedicated ground wires and shall not be dependent on grounding through hinges or moving contact surfaces.
       7. The closing of the shutters must be by the movement of the circuit breaker. Gravity and spring-operated shutters are not acceptable.
       8. Auxiliary ring-core-type current transformers (CTs) shall be located behind the shutters. They shall be bushing mounted and accessible from the front. Bushings shall accommodate up to four standard accuracy CTs per phase for all ratings.
          1. Option: Bushings shall accommodate up to two high accuracy CTs per phase for all ratings.
       9. Automatic Secondary Disconnects:
          1. A fully-automatic, self-aligning secondary disconnect device shall be provided to connect the circuit breaker and switchgear controls.
          2. The disconnecting device shall be positioned and constructed as to not expose the operator to live parts.
          3. The secondary disconnect shall connect automatically when the circuit breaker is racked into the test and connected positions.
       10. For the safety of operating personnel, it shall not be required to open or keep open the door of the circuit breaker compartment after the breaker has been locked in the disconnected position, even during racking operations.
    5. Cable Compartment
       1. For cable connections, a rigid, pure copper runback bus shall be provided from the circuit breaker primary disconnects to the cable compartment to allow for cable terminations.
       2. Cable entry or bus duct entry shall be from either the top or bottom entry as indicated on the single line.
       3. Cable termination bus arrangement shall allow for at least 36” from floor to lug pad for connections. Standard terminations shall meet the bolt hole requirements of NEMA CC1-4.05 and shall typically be the NEMA 4-hole pattern.
          1. Optional: Vendor will provide compression type cable lugs as shown on single line for number of cables and cable size.
       4. Riser bus connections to bus duct shall be rigid.
       5. Bar type and zero-sequence current transformers, lightning arrestors, surge capacitors, stationary control power transformers or other auxiliary equipment shall be mounted in the cable compartments and included as shown on single line.
       6. Optional: IR viewing ports shall be included for viewing of cable terminations.
    6. Auxiliary Compartment
       1. Auxiliary enclosures shall be provided where necessary for mounting of auxiliary units such as potential transformers (PT), control power transformers (CPT) or primary current-limiting fuses for control power transformers (draw-out fuses).
       2. Draw-out units shall use the same racking system, accessories and solid grounding as circuit breakers with connected and disconnected positions. Primary fuses shall be grounded in the disconnect position and when withdrawn.
       3. All primary contacts of auxiliary draw-out units shall be of the arc-extinguishing probe type. The contact shall minimize and suppress arcing at the primary contacts. Successful arc extinguishing shall not be dependent on operator speed. The fixed mounted contacts shall be insulation encapsulated and touch safe.
       4. The auxiliary enclosure bushings shall be glass-filled polyester.
          1. Option: Bushings shall be porcelain.
       5. A window shall be provided on the door to allow observation of draw-out unit position with door closed.
       6. The auxiliary compartments shall incorporate extension rails to allow changing fuses and general maintenance without the need to remove the truck assembly from its compartment.
    7. Instrument Compartments
       1. Instrument compartments shall be constructed of galvanized, hem bent steel for superior illumination and personnel and wiring protection.
       2. Instrument compartments shall be separated from medium voltages by grounded metal barriers and have a dedicated door for instrument mounting.
       3. In general, all protective relays, auxiliary relays, indicating instruments, recording instruments, indicating lights, transducers and all other secondary equipment shall be housed in the instrument compartment.
       4. Customer connections shall be made on terminal blocks located inside the instrument compartments.
       5. Devices mounted on instrument compartments shall be arranged in an approved, logical symmetrical manner.
    8. Wiring
       1. Control wiring shall be enclosed in a grounded metal wireway when routed through a high voltage compartment.
       2. Control circuits shall incorporate all necessary protective devices. Wire running across hinges shall be protected by plastic conduit sleeves and bundled.
       3. Sleeve type wire markers shall be provided at both ends of each wire. Wire markers shall not be hand written. Wire markers shall be printed.
       4. Ends shall terminate with insulated ring-tongue terminals on screw-type terminal blocks, unless prohibited by the design of connection points on control devices. Terminal block screws shall be captive and use vibration-resistant hardware.
       5. Control wire shall be 14 gauge SIS stranded, extra-flexible, 600V flame retardant gray color and UL listed except where larger sizes are needed for current carrying requirements.
       6. Terminal blocks shall be provided for terminating all power and control wiring. Terminal blocks shall be rated at 600V.
    9. Space Heaters
       1. Space heaters shall be standard on outdoor equipment applications.
       2. 300W 240VAC space heaters, operating at 120VAC shall be provided on each vertical section to reduce condensation.
       3. Space heaters shall be separately fused for each vertical section or breaker, as applicable. Heater controls shall include disconnect switches, bypass switches, ammeters, and thermostats.
    10. Plenum
        1. Arc gases shall be vented using internal flap systems and plenum duct to direct gases outside of the enclosure. Designs to allow ventilation of arc gases into the switchgear room are not acceptable.
        2. Plenum shall be of robust construction and sized to prevent rupture from pressure and safely vent gases outdoors to a safe area.
        3. Plenum sections located indoors shall be painted ANSI 61. Plenum sections located outdoors shall be painted ANSI 70.
    11. Optional: Utility Metering Cabinet
        1. Where shown on drawings, provide separate utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements
    12. Optional: Outdoor Enclosures
        1. Switchgear shall be provided with an outdoor sheltered aisle enclosure with enough room for lift truck and test cabinet. Switchgear itself shall be indoor rated.
        2. Switchgear shall be provided inside a PDC (Power Distribution Center) building to be packaged with other equipment and components. Switchgear itself shall be indoor rated.

## POWER CIRCUIT BREAKERS

* + 1. Construction and Type
       1. The power circuit breakers shall be electrically operated, 3-pole, draw-out type with vacuum interrupters and magnetically actuated utilizing capacitor stored energy. Circuit breakers to be ABB type AMVAC. AMVAC to be supplied for ratings up to 50kA.
          1. Optional: The power circuit breakers shall be electrically operated, 3-pole, draw-out type with vacuum interrupters and a spring type stored-energy actuated operating mechanism. Circuit breaker to be ABB type ADVAC. All 63kA applications shall use ABB type ADVAC breakers.
       2. The power circuit breaker shall be provided with self-aligning line side and bus side disconnecting devices.
       3. Opening and closing speed shall be independent of the operator or of control voltage within the rated control voltage range.
       4. Circuit breakers of the same type, rating and control circuits shall be electrically and mechanically interchangeable.
    2. Ratings
       1. The ratings of the breaker shall be chosen from the following values:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Maximum Voltage**  **(kV)** | **Low Frequency Withstand (kV)** | **Impulse Level (BIL) (kV)** | **Rated Short Circuit Current  (kA rms)** | **Close and Latch (kA peak)** | **Rated Voltage Range Factor (K)** |
| 5 | 19 | 60 | 25 | 65 | 1.0 |
| 5 | 19 | 60 | 31.5 | 82 | 1.0 |
| 5 | 19 | 60 | 40 | 104 | 1.0 |
| 5 | 19 | 60 | 50 | 130 | 1.0 |
| 5 | 19 | 60 | 63 | 164 | 1.0 |
| 8.25 | 36 | 95 | 25 | 65 | 1.0 |
| 8.25 | 36 | 95 | 31.5 | 82 | 1.0 |
| 8.25 | 36 | 95 | 40 | 104 | 1.0 |
| 8.25 | 36 | 95 | 50 | 130 | 1.0 |
| 15 | 36 | 95 | 25 | 65 | 1.0 |
| 15 | 36 | 95 | 31.5 | 82 | 1.0 |
| 15 | 36 | 95 | 40 | 104 | 1.0 |
| 15 | 36 | 95 | 50 | 130 | 1.0 |
| 15 | 36 | 95 | 63 | 164 | 1.0 |

* + 1. Controls
       1. Circuit breaker trip and close circuits shall be electrically separate.
       2. Provisions shall be provided for manual breaker tripping. These provisions shall be mounted and easily accessible on the front of the breaker.
       3. The breaker shall have flags to indicate open or closed position. Only the correct status flag for any single function shall be visible.
       4. All control devices shall be universal AC/DC or DC supplied through rectifiers.
       5. Charge, trip and close circuits shall be separately fused. Dead front pull-out fuses shall be used.
          1. Option: Or separately protected with a MCCB.
    2. Auxiliary Contacts
       1. (9) ‘a’ and (8) ‘b’ auxiliary contacts will be mounted on the breaker and wired through the automatic secondary disconnect system. (9) ‘a’, (7) ‘b’ and (1) early ‘b’ contact shall be provided with 63 kA breakers.
       2. Breaker mounted auxiliary contacts shall operate in connected and test positions. Spare contacts shall be wired to terminal blocks for easy access and future use.
       3. An 8-contact (4 ‘a’ and 4 ‘b’) truck-operated cell switch assembly shall be provided as an option to indicate when the breaker is in the fully connected position, for each breaker as noted.
          1. Option: 16 contact truck-operated contact switch shall be provided.
    3. Racking and Interlocks
       1. The circuit breaker module shall include all necessary interlocks for proper sequencing and safe operation.
       2. The racking system shall allow movement of the breaker with the door closed and have three distinct positions in addition to the withdrawn position.
          1. Connected: primary and secondary contacts engaged
          2. Test: primary contacts disconnected and shutters closed; secondary (control) contacts engaged.
          3. Disconnected: both primary and secondary contacts disengaged.
       3. The circuit breaker shall stop and lock in all three positions requiring deliberate operator action to continue insertion or withdrawal of the breaker. A racking padlock provision for all three positions shall be provided. Padlocks to be provided by buyer.
       4. It shall not be possible to insert or withdraw a closed circuit breaker. The breaker shall not be allowed to close within a cell unless it is in a positive connect, test or disconnect position.
       5. Interference blocking shall prevent insertion of a lower rated breaker into a higher rated compartment.
       6. All draw-out modules shall have manually actuated locking devices to prevent inadvertently withdrawing a module from a compartment.
       7. Grounding shall occur in the test position and shall be continuous during racking and in the connected position.
       8. Breaker racking mechanism shall be separate truck mounted to the breaker and not integrated into the breaker cell.
       9. Option: Roll-out circuit breakers shall be provided for breakers in the bottom compartment.

## INSTRUMENT AND CONTROL TRANSFORMERS

* + 1. Current Transformers
       1. CT nameplates shall be located on the CT housing and ratings and accuracies provided shall be in accordance with ANSI C57.13.
       2. CT wiring shall terminate on screw type terminals on the CT housing and be wired to shorting terminal blocks. ABB Type SAB CTs shall be used.
       3. Zero sequence CTs shall be ABB type BYZ-S, BYZ-O or BYZ-L properly sized for the size and number of cables per phase as detailed on the single line diagram. BYZ-S shall be used when no information is given.
       4. Each current transformer shall have a 5 ampere secondary and a primary rating as shown on the single line.
       5. CT wiring shall be no less than 12 gauge wire with ring tongue lugs.
          1. Option: 10 gauge wire with ring tongue lugs.
    2. Potential Transformers
       1. PTs shall be designed to withstand the basic insulation level (BIL) of the switchgear.
       2. Potential transformers shall always be fused and mounted on a draw-out unit which disconnects them from the primary contacts safely with the door closed.
       3. In the withdrawn position, the fuses shall be completely disconnected from service.
       4. PTs shall be capable of being withdrawn to the disconnected position with the door closed at all times.
       5. ABB Type VIY or VIZ PTs shall be supplied in accordance with the single line.
       6. PTs shall be connected to the bus or load via solid copper rod, shielded cable or solid bus.
       7. Each transformer shall have a 120V secondary and an ANSI C57.13 accuracy classification meeting the requirements as shown on the single line.
    3. Control Power Transformers
       1. CPTs shall be dry type with disconnecting type current limiting primary fuses and fused secondary.
       2. Transformers up to single phase 15kVA shall be truck mounted and employing the same racking mechanism as a breaker or potential transformer.
       3. CPTs or fuses shall be capable of being withdrawn to the disconnected position with the door closed at all times.
       4. Transformers larger than single phase 15kVA shall be mounted in the rear cable compartment or in a remote compartment with a draw-out fuse unit employing the same racking mechanism as a potential transformer.

## RELAYING, METERING & CONTROLS

* + 1. Relays
       1. Relays and instruments shall be provided and wired as specified on the project single line diagram and schematics.
       2. Protective relays shall be draw-out type and semi-flush mounted whenever practical.
       3. Multifunction/Microprocessor Relays
          1. A multi-function, 3-phase microprocessor based ABB Relion relay or approved equal shall be used.
          2. GOOSE messaging for bus differentials and MTM transfer schemes shall be used whenever possible to limit wiring between cubicles.
          3. Relion REF series relays shall be used for feeder applications.
          4. Relion RET series relays shall be used for transformer protection
          5. Relion REM series relays shall be used for motor protection.
          6. All relays shall have, at minimum, the following basic functions:

3-Phase overcurrent protection (time and instantaneous)

Ground overcurrent (time and instantaneous)

Ammeter, demand and peak ammeters

Event recording

Continuous self-checking

Accumulation of breaker interrupting duty

RS-232 and Ethernet ports for communications and remote terminal connection.

* + 1. Meters
       - 1. Electromechanical meters, when used, shall be the flush-mount 1% accuracy taut-band switchboard type, with a minimum 250 degree scale.
         2. Meter potential coils shall be 120V and current coils shall be 5A.
         3. Digital meters shall be provided as outlined on single line drawings.
    2. Controls
       1. Control devices, auxiliary contacts and small mechanisms shall be enclosed, protected and accessible for maintenance.
       2. Breaker control switches shall not be mounted adjacent to meter switches and shall have pistol grip handles. Switches are to be Electroswitch Series 24 or equivalent.
       3. Test switches shall be provided and wired in accordance with specified single line diagrams and data sheets and will only be mounted on low voltage compartment doors and panels. Test switches are to be ABB FT-1 type.
       4. Meter switches shall have knurled knob handles. Switches are to Electroswitch Series 24 or equivalent.
    3. Nameplates
       1. Externally visible, permanent nameplates shall be provided to identify each instrument, instrument switch, meter, relay, control switch, indicating light, circuit breaker compartment, potential transformer compartment and auxiliary compartment.
       2. Relays shall be designated as to use and device to which they are connected.
       3. Nameplates shall be laminated plastic. Characters shall be black letters on a white background.
       4. Circuit identification nameplates shall be placed on the front and rear of each frame.

## ACCESSORIES AND SPARE PARTS

* + 1. Accessories
       1. All accessory items shall be shipped with switchgear. Boxes and crates containing accessories shall be clearly marked with the contents.
       2. Accessories shall include:
          1. Breaker lift truck to allow a circuit breaker or auxiliary draw-out unit to be elevated and then inserted or withdrawn.
          2. Breaker/PT/CPT racking crank
          3. Test Jumper to connect to the switchgear control circuit while the breaker is withdrawn
          4. Test Cabinet with door mounted open and close pushbuttons shall be supplied for testing the circuit breaker away from the switchgear.
          5. SmartRack Remote Racking System to safely remote rack breakers. Minimum cord length shall be 50 feet.
          6. The vendor’s standard manually operated ground and test device shall be supplied for main bus and system grounding during maintenance. The G&T device shall be equipped with 6 terminals.
          7. Relay or test plugs shall be included.
    2. Spare Parts
       1. Touch Up Paint 1 Quart
       2. Circuit Breaker Trip Coil for ADVAC
       3. Circuit Breaker Close Coil for ADVAC
       4. Circuit Breaker Charge Motor for ADVAC
       5. Spare 1200/2000/3000A breaker
       6. Lubricant
       7. Spare LED indicating lights
       8. Spare Colored caps for lights
       9. Spare breaker fuses
       10. Spare primary PT fuses
       11. Spare secondary PT fuses
       12. Spare CPT primary fuses
       13. Spare PT
       14. Spare capacitor for AMVAC
       15. Spare control board for AMVAC

# EXECUTION

## FACTORY TESTING AND EXAMINATION

* + 1. The equipment shall be factory assembled in its entirety and tested prior to shipment.
    2. The levels of factory testing shall be as follows:
       1. Standard Factory Tests
          1. The assembled control equipment and wiring connections shall be insulated for 600V and shall be subjected to a one minute test of 1500V AC at the factory.
          2. The control circuits shall be operated at the normal voltage and current for proper operation of circuit breakers, circuit breaker simulators, switches, contactors, interlocks, etc.
          3. Instruments shall be energized from the low voltage winding of the PTs and the low current winding of the CTs. Where practical, each instrument shall be operated through its range of voltage, current and/or phase angle and frequency to produce deflections over the entire scale.
          4. The ratio and interconnections of all potential transformers shall be functionally checked to verify conformance to the electrical drawings and electrical bills of material.
          5. Relays shall be testing by applying rated current and/or voltage as required to determine proper performance characteristics. Each relay shall be tested to determine its proper operation in itself and also in the total overall circuit performance.
          6. A static circuit check shall be performed for auxiliary switches, external circuit connections and parts of circuitry that have not been checked or cannot be checked functionally. The devices shall be checked for mechanical function and for conformance to the schematic and wiring diagrams
          7. After all electrical and mechanical checks have been completed and corrections have been signed off, the following dielectric tests shall be performed:

Each bus shall be given a high voltage withstand test from phase to phase and phase to ground at the specified voltage, frequency and time domain indicated in the Standard C37.20.

Control wire shall be given a high voltage withstand test from wire to ground at the specified voltage, frequency and time duration with reference to the proper standard.

* + - 1. Factory Witness Testing
         1. Factory witness testing shall be included in the price of the switchgear.
         2. Factory witness testing shall allow up to 3 members the applicable number of days to witness the factory tests as listed above.
         3. Buyer must be made aware of factory test dates in advance to make arrangements of travel plans.

## INSTALLATION

* + 1. Optional: Installation shall be completed by the seller or other parties in accordance with the recommended installation practices of the switchgear manufacturer. 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.