SECTION 26 13 13
MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR
GAS-INSULATED, >1 kV- 42 kV

PART 1 - GENERAL

1.1 SCOPE

A. This specification defines the technical requirements for indoor, gas-insulated switchgear (GIS), equipped with vacuum circuit breakers with rated voltage up to 42 kV. This specification covers the design, manufacture, factory production testing and field service assistance during installation and commissioning of SF_6 gas-insulated vacuum circuit breaker switchgear and associated equipment.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.3 SUBMITTALS

A. Submit shop drawings and product information in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by purchaser's name, location and order number.

B. Approval documents shall include:
1. General arrangement drawing showing dimensioned elevation and floor plan, foundation details and one-line diagram
2. Panel arrangement drawing showing layout of devices on the panel doors
3. Three-line diagrams
4. Schematics
5. Nameplate engraving drawings
6. Electrical bill of material.

C. Final documents shall include:
1. Documents listed in 1.3.B above
2. Wiring diagrams
3. Recommended spare parts list for start-up support
4. Instruction manual
5. Test certificates specially for arc resistance.

D. Product data: Include features, characteristics and ratings of individual circuit breakers and other components.

E. Shop drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components and location and size of each field connection. Include the following:
1. Nameplate legends
2. Bus configuration with size and number of conductors in each bus run, including phase and ground conductors of main and branch buses
3. Current ratings of buses
4. Short-time and short-circuit ratings and arc-resistant details of switchgear assembly
5. Detailed wiring diagrams showing wiring for power, signal and control systems including differentiation between manufacturer-installed and field-installed wiring.

1.4 QUALITY ASSURANCE

A. Manufacturer qualifications: Engage a firm with at least 30 years' experience in manufacturing medium-voltage, gas-insulated, vacuum circuit breaker switchgear. The manufacturer's proposed product shall have been produced for at least 20 years prior to the due date for the

equipment proposal. The manufacturer of the switchgear assembly shall also manufacture the medium-voltage circuit breakers.

B. Comply with requirements of latest revisions of applicable industry standards, specifically including the following:
   1. Gas-insulated switchgear.
      a. IEC 62271-200 - High-voltage switchgear
      b. IEC 62271-1 - High-voltage common requirements
      c. IEC 60044-7 – Current transformers
      d. IEC 60044-8 – Voltage transformers
      e. ANSI/IEEE C37.20.2 (Where applicable.) – Metal-clad switchgear
      f. ANSI C37.55 (Where applicable.) – Conformance tests
      g. UL-Listed (Optional. Availability depends on section detailed requirements.)
      h. ANSI/IEEE C37.20.7-2017 – Internal arcing tests.
   2. Circuit breakers.
      a. IEC 62271-100 – High-voltage circuit breakers
      b. ANSI/IEEE C37.04 - Rating structure for high-voltage circuit breakers
      c. ANSI/IEEE C37.09 – High-voltage circuit breaker testing
      d. ANSI/IEEE C37.06 – Preferred ratings for high-voltage circuit breakers
      e. ANSI/IEEE C37.010
      f. ANSI C37.54 (Where applicable.) – Conformance tests.
   3. Current transformers (CTs).
      a. ANSI/IEEE C57.13 – Instrument transformers
      b. IEC 60044-1 – Current transformers
      c. IEC 60044-8 – Current transformers (electronic).
   4. Voltage transformers (VTs).
      a. ANSI/IEEE C57.13 – Instrument transformers
      b. IEC 60044-2 – Voltage transformers
      c. IEC 60044-7 – Voltage transformers (electronic).
   5. Disconnect, isolation and three-position switches.
      a. IEC 62271-102 – Disconnectors and earthing switches.
   6. General.
      a. National Electric Code (NEC)® NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver in convenient shipping groups. Shipping groups shall not exceed 10 feet in length.

B. Outdoor walk-in single-aisle switchgear shall be shipped fully assembled except for necessary shipping splits for transportation and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ***[The medium-voltage gas-insulated vacuum circuit breaker switchgear assembly shall be type 8DA10 (single-bus) or 8DB10 (double-bus) as manufactured by Siemens or pre-approved equal. Approved manufacturers are as follows:***
   1. ***Siemens***
   2. ***.]***

2.2 RATINGS

A. System configuration: Switchgear shall be suitable for application in three-phase, three-wire, 60 Hz grounded-neutral system.

B. Electrical ratings:
   1. Rated nominal system voltage, kV: ***[4.16] [7.2] [12.47] [13.2] [13.8] [16.7] [22.0] [26.0] [34.5] [36.0] [38.0]***

2. Maximum design voltage, kV: ***[4.76] [8.25] [15.0] [17.0] [24.0] [27.6] [38.0] [40.5] [42.0]***
3. Rated main bus current: ***[1,200 A] [2,000 A] [2,500 A] [3,150 A] [4,000 A] [5,000 A]***
4. Rated interrupting (short-circuit) current, kA symmetrical: ***[25] [31.5] [40]***
5. Rated short-time withstand current, kA for 3 sec: ***[25] [31.5] [40]***
6. Rated power-frequency withstand voltage, kV (one-minute): ***[28] [50] [70] [85]***
7. Rated impulse-withstand voltage, kV (BIL): ***[75] [125] [150] [200]***
8. Continuous current rating of the main circuit breaker: ***[1,200 A] [1,600 A] [2,000 A] [2,500 A] [3,000 A]***
9. Continuous current rating of the tie circuit breaker: ***[1,200 A] [1,600 A] [2,000 A] [2,500 A] [3,000 A]***
10. Continuous current rating of the feeder circuit breaker: ***[1,200 A] [1,600 A] [2,000 A] [2,500 A] [3,000 A]***

(Above ratings under 8, 9, and 10 shall be without forced cooling.)

2.3 GENERAL REQUIREMENTS

A. The medium-voltage, gas-insulated vacuum circuit breaker switchgear shall be metal-enclosed and shall meet ANSI/IEEE C37.20.2 except for differences related to fixed circuit breaker construction, gas insulation, and isolated-phase bus arrangement. The components of the switchgear (for example, circuit breaker, busbar, disconnect switch, grounding switch) shall be in grounded aluminum metal enclosures. The current transformers (CTs) and voltage transformers (VTs) should be outside the gas insulation and easily replaceable. The construction shall withstand forces (repeatedly, without distortion) caused by closing and opening of the circuit breaker. The switchgear shall be capable of withstanding all stresses produced by fault conditions up to and including the rated short-circuit current specified in 2.2.B without damage.

B. The switchgear shall be classified as arc-resistant with type 2B accessibility, in accordance with ANSI/IEEE C37.20.7-2017 test requirements for full short-circuit rating and from front, lateral, and rear sides.

C. Each current-carrying component of the equipment shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the ANSI/IEEE and IEC standards.

D. The switchgear lineup shall be designed and manufactured with provision for future expansion on each side without any gas work. Exception to it is where the arrangement does not allow extension. Manufacturer shall offer future bus extension disconnect switch (if requested in the single-line diagram) in order to avoid de-energization of the main busbar. When extending either end of the switchgear, it shall not be necessary to evacuate the bus extension switch SF_6 gas compartment and remove end panels for the associated busbars. No gas compartment should be affected. The future extension switch shall not add any section to the lineup's length.

E. The enclosures housing the primary (medium-voltage) components shall be constructed of gas-tight, cast aluminum. Ferrous metal components shall be finished with electrostatically applied paint finish in manufacturer's standard light gray color. Mechanism parts not suitable for painting shall be plated for corrosion resistance.

F. The medium-voltage enclosure shall be factory assembled and modular in design. Medium-voltage components shall be enclosed in cast aluminum, hermetically sealed, single-pole (phase) enclosures to eliminate the possibility of phase-to-phase faults in the switchgear.

G. The medium-voltage enclosure shall be pressurized with SF_6 gas to isolate energized components from environmental influences, thus allowing no or long intervals between maintenance. The switchgear shall be designed so that normal service, inspection, maintenance, grounding of high-voltage cables and elimination of electrostatic charges can be carried out safely with adjacent sections energized.

H. A continuous ground bus shall run the length of a switchgear group for reliable grounding. Each feeder section housing shall be connected to the switchgear ground bus.

I. Conductors and connectors for the busbars shall be copper, designed to carry rated continuous current at 40 °C ambient temperature and shall withstand the rated short-circuit current specified in 2.2.B. The surfaces of the conductors shall have a smooth finish to prevent any electrical discharges. Disconnect and ground switch contacts shall be silver-plated to provide high conductivity and shall match the rating of the associated busbar or circuit breaker.

J. The front of each switchgear section shall consist of four separate compartments for the following main components:
   1. Protective relays and controls located in the top compartment. Terminal blocks, CT connections, VT connections, and miscellaneous control devices shall be located in this compartment. Connection terminal blocks for purchaser's external connections will be located in this compartment. Operation of the switchgear shall not be affected by opening any of the low-voltage compartment doors.
   2. Three-position switch operating mechanism with all serviceable items accessible from the front.
   3. Circuit breaker operating mechanism with all serviceable items accessible from the front.
   4. The lower compartment shall be available for additional mounting of low-voltage components or external connection, if required.

K. Circuit breaker and three-position switch disconnector switch shall have a mimic diagram of sufficient size. The mimic shall be black in color to contrast with the switchgear finish and be plainly visible to an operator. Mimic diagrams shall show circuit breakers, disconnect switches, grounding switches and busbar connections. Busbar VTs or busbar cable connections should also be shown. The mimic diagram shall be on the front of each section in conjunction with the mechanical switch and circuit breaker position indicators.

L. SF_6 gas compartment: Each busbar to circuit breaker gas compartment shall be suitably divided into separate sections that are isolated by gas-tight bushings. The division of compartments shall consider the effects of faults within the compartments such that in the event of an internal fault, a pressure relief device operates before internal pressure exceeds the design limit of the compartment. The individual gas-sealed compartments shall be capable of being separately evacuated for inspection or maintenance while keeping the adjacent compartments pressurized to rated pressure. Leakage of gas from the switchgear enclosures shall not exceed 0.1% of the gas per compartment per year.

M. Switchgear feeders shall be compartmentalized in single-phase, isolated-phase construction, with:
   1. A minimum of four gas compartments per standard feeder without optional equipment.
   2. If SF_6 gas-insulated busbar voltage transformers are specified, these shall be installed in separate gas housings, isolated from the main busbar by gas-tight bushings with their own gas monitoring and pressure relief system. Busbar voltage transformers shall be furnished with a three-position switch and primary fuses.

N. The gas compartments shall be provided with ring type seals at intersections between compartments and at positions where sliding or rotating shafts enter a compartment. The seals shall be capable of withstanding the gas pressure of the compartments under all service conditions. Seals shall be O-Ring type.

O. Pressure relief devices: Each gas compartment shall be provided with a pressure relief device to limit the pressure in the event of an internal fault. Designs without pressure relief are not acceptable. The pressure relief devices shall be designed such that discharges resulting from internal faults shall be directed away from locations where personnel may be present. The preferred location for the busbar pressure relief shall be such that gases are exhausted through the top of the enclosures. All pressure relief device designs shall be proven by arc-fault design tests in accordance with IEC 62271-200 and ANSI/IEEE C37.20.7 standards.

P. Insulation: Sulfur-hexafluoride (SF_6) gas and epoxy cast-resin insulating materials shall be employed for the insulation of primary conductors of each phase from the grounded metal enclosure. The insulating gas shall be pressurized higher than atmospheric pressure. Solid

insulators shall be non-hygroscopic, epoxy cast-resin, free from voids and contaminants. The contour of the insulators shall be such that a uniform voltage gradient is produced over the entire surface. Epoxy cast-resin bushing-type insulators shall be provided at the intersections between compartments. The bushing-type insulators will support the live conductors and (where necessary) provide a gas-tight barrier between compartments. The design of the gas-tight bushing-type insulator shall be such that it is possible to inspect, maintain, or pressurize each gas section individually without interfering with adjacent gas sections.

Q. Gas monitoring: The gas compartment shall be provided with a gas pressure manometer. Two dry contacts provided on each manometer shall change state if the pressure falls below preset limits. These manometers shall work without any auxiliary supply and provide the real SF_6 gas pressure inside the gas chambers. A separate gas monitoring system is required for each of the following:
   1. Each main busbar phase (phases A, B, and C).
   2. Each set of busbar voltage transformer (VTs), if required. (Three-phase VT compartments shall be monitored together.)
   3. Each circuit breaker. (Three-phase interrupter compartments monitored together.)

R. The switchgear shall have all the operations from the front of the switchgear. There shall not be a need of rear access for any work. For cable termination, switchgear shall be designed for access from bottom entry down.

S. The guaranteed leakage rate of each individual gas compartment must be less than 0.1% p.a. over the lifetime of the switchgear.

T. Each section shall include voltage detectors to indicate phases “L1, L2, and L3”. The voltage detectors shall be connected to each phase on the cable side. The indicators shall be located on front of the section. It may be noted that this unit shall also be suitable to be used for interlocking of grounding switches (voltage-free condition), whenever sections are not equipped with VTs.

U. All of the live parts, including the busbars, should be in continuous SF_6 insulation without any other insulation in between.

2.4 VACUUM CIRCUIT BREAKER

A. The circuit breakers shall be vacuum type. Gas, oil, or air blast circuit breakers will not be accepted. The circuit breaker shall be designed to withstand impacts and vibrations under rated and short-circuit current conditions. The vacuum interrupters shall be made from a metal alloy that will withstand high switching duties and shall include ceramic insulators securely fused to the end fittings. The moving contact activating rod shall be carried on bellows, protected from the sputtering of molten metal during switching operation by a shield. The terminals of the vacuum interrupters shall be supported using epoxy cast resin supports or bushings. Each circuit breaker shall be provided with a suitable mechanically operated indicating device, marked OPEN and CLOSED in wording or symbols. The indicating device shall always be visible from the front of the panel. Circuit breaker operating mechanisms shall be of the motor charged, stored-energy type and equipped with a spring-charged indicator. Circuit breaker mechanisms shall be trip free and designed for operation from a control power source rated ***[24 Vdc] [48 Vdc] [110 Vdc] [125 Vdc] [220 Vdc] [110 Vac] [230 Vac]***.

B. The circuit breakers shall be rated in accordance with ANSI/IEEE C37.06 and IEC 62271-100 and shall have the ratings specified in section 2.2.B of this specification. The rated operating sequence (duty-cycle) shall be O-15 sec-CO or 0-0.3 sec-CO-3 min-CO per ANSI/IEEE C37.04 and related IEC standards and the overall switchgear short-time rating shall be two seconds per ANSI/IEEE C37.20.2 clause 5.4.5. The circuit breaker short-time rating shall be three seconds per ANSI/IEEE C37.04 and related IEC standards. The circuit breakers shall be designed to withstand the transient recovery voltage (TRV) that occurs during the interruption of load currents and short-circuit currents within its rating. The vacuum circuit breakers shall not

produce excessive overvoltage as a result of current chopping. The design shall reduce the current chopping value to less than 5 A.

C. The circuit breaker operating mechanism shall be located at the front of the circuit breaker section, allowing access from the front of the switchgear while the primary equipment is in service at any time. All mechanical parts shall be adequately sized to ensure consistent operation of the mechanism when subjected to forces due to specified short-circuit currents. The maximum difference in opening time between the three poles shall not be more than two milliseconds. It shall be possible to lubricate and service the moving or auxiliary parts of the mechanism by removing the front cover plate.

D. Closing shall be accomplished by means of a motor-charged, spring-operated, stored-energy type mechanism with electrical release. In case of no auxiliary supply, it shall be possible to operate the circuit breaker manually with manual charging of the spring without dismantling any parts / mechanism. It shall not be possible for the circuit breaker to close unless the closing spring is fully charged. A visual, mechanical indicating device shall be provided to indicate the status of the stored-energy closing spring. The indicator shall show charged symbol when the mechanism is fully charged (ready-to-close the circuit breaker) and a discharged symbol when it is in any other condition. Provisions for manually charging the closing spring shall be provided. Tripping (opening) of the circuit breaker shall be by means of a spring, that is automatically charged when the circuit breaker is closed.

E. The operating mechanism shall be provided with a shunt release and the necessary auxiliary switches. An operations counter shall be fitted to the mechanism and designed to indicate the total number of opening operations. The operating mechanism shall be provided with the following control and interlocking features:
   1. Local manual close and trip by mechanical push buttons shrouded to prevent inadvertent operation
   2. The operating mechanism shall automatically recharge the closing spring after the completion of a closing operation
   3. A control power cutoff switch for disconnection of the control power
   4. Local electrical close and trip at the circuit breaker
   5. Local-remote selector switch at the circuit breaker with provisions for connection to Purchaser's supervisory control system, if required
   6. Operations counter.

2.5 DISCONNECTING AND GROUNDING SWITCH

A. To isolate the circuit breaker and feeder from the system, a three-phase, three-position (CONNECTED-OPEN-READY-TO-GROUND) switch shall be utilized.

B. The three-position switches shall be in each separate phase of the bus compartment such that when in the DISCONNECTED or GROUNDED position, no live parts are accessible in the interrupter compartment when the main bus is energized.

C. It should be possible to have motorized mechanism of three-position switches with interlocking for grounding function. In the case of no auxiliary supply, it should be possible to operate the three-position switch manually with manual charging of the spring without dismantling any parts / mechanism.

D. Access to the three-position switch operating means shall be mechanically and electrically blocked when the circuit breaker is in the CLOSED position to prevent mis-operation. It shall not be possible to switch directly from CONNECTED to GROUNDED position. A keyed selector shall prohibit simultaneous access to manual disconnect and grounding switch operating means. The grounding position shall allow for safely grounding the feeder circuit by closing of the circuit breaker. The ratings of the three-position switch shall be coordinated with the system ratings. Means shall be provided to allow for visual confirmation of the switch position from the front of the switchgear using a portable computer. The switch positions shall be clearly visible. If view windows are furnished, they shall be illuminated and accessible without opening any

access doors. This provision shall be available for use with the switchgear energized. All operations shall be performed without requiring the opening of any doors.

E. The manually operated mechanism for the three-position switch shall require one operating handle for changing the switch position from CONNECTED to DISCONNECTED (OPEN). A different handle shall be required for changing the switch position from DISCONNECTED to READY-TO-GROUND position. A mechanism operated position indicator shall be located on the front of the switchgear panel and indicate CONNECTED-OPEN-READY-TO-GROUND. Additionally, a mechanical indicator shall be visible from the rear of the switchgear. This flag indicator shall be located on the main shaft of the switch operator.

F. The three-position switch operating mechanism shall be provided with the following control features:
   1. Local manual operation of the three-position switch, utilizing two separate operating handles, provided as accessories.
   2. ***[Optional: If an electrically operated mechanism is provided, manual operation shall block electrical operation. The operating mechanism shall allow local and remote electrical operation of the disconnect switch with automatic cutoff when switch has reached complete travel between positions.]***
   3. Auxiliary switches as required for interlocking and remote indication.
   4. The position of the switches shall have a means of visual verification according to NFPA 70. The use of permanently installed micro-cameras and a laptop computer shall be acceptable.

G. Where two switching devices (for example, circuit breaker and three-position switch) require interlocking, the interlocks shall be designed to prohibit simultaneous operation of the devices. The interlock system shall prevent either device from being blocked in an intermediate or undefined position. The system shall operate effectively for either electrical switching commands or manual.

2.6 CURRENT TRANSFORMERS (CTs)

A. CTs utilized with the GIS shall be low-voltage, toroidal type, free from dielectric-stressed cast-resin components and shall be located outside the gas-tight enclosure.

B. Each main circuit breaker shall have one set of CTs, ***[1,200:5 A] [Specific ratio required]***.

C. Each feeder circuit breaker shall have one set of CTs, ***[1,200:5 A] [Specific ratio required]***.

D. Each tie circuit breaker shall have one set of CTs, ***[1,200:5 A] [Specific ratio required]***.

E. All CTs shall be installed around the outside of the cast aluminum phase housings or around the feeder cables so that the CT is free of dielectric and thermal stress. CTs shall be located on the cable termination side of the circuit breaker.

F. CTs shall be multi-ratio (MR) as shown on the drawings and shall have a short-circuit ratings not less than that of the associated switchgear. They shall be capable of carrying the rated primary current for a period of one minute with the secondary windings open-circuited as specified in IEEE C57.13 or related IEC 60044-1 standards.

2.7 VOLTAGE TRANSFORMERS (VTs)

A. VT ratings and locations shall be as indicated on the drawings. They shall comply with the requirements of this section. VTs shall be according to ANSI/IEEE C57.13 or related IEC 60044-2 standards.

B. Busbar VTs single-phase, inductive VTs shall be housed outside gas but having connections in individual SF_6 gas-filled compartments or shall be solid-insulated, metal-enclosed and mounted on the top of the appropriate busbar phase enclosure.

C. Each busbar VT shall be primary fused (current limiting type) to avoid a bus shutdown resulting from a VT failure. The current limiting fuses shall be in a SF_6 gas-insulated housing or solid-insulated metal housing.

D. The busbar VTs shall be equipped with a three-position switch (CONNECTED-OPEN-READY-TO-GROUND) to allow for maintenance on the busbar VT or fuses without de-energizing the switchgear.

E. The busbar voltage transformer and fuse housings for each phase shall be connected by a piping system, resulting in an individual gas-compartment and monitoring system for each busbar voltage transformer/fuse set. The pressure shall be monitored by means of a manometer on the front of the switchgear, if they shall be SF_6 gas insulated.

F. For evacuating and gas filling the busbar voltage transformer, fuse system or replacement of a manometer (pressure gauge), a separate valve with identification label shall be provided.

G. Each single-phase busbar VT/fuse enclosure shall be provided with its own pressure relief device.

H. All secondary leads for VTs shall be wired to a molded-case circuit breaker, located in a corresponding low-voltage compartment.

2.8 CABLE TERMINATIONS

A. The design of the cable terminations (inclusive of its accessories) shall meet the design objectives of the gas-insulated switchgear, including electrical ratings, loss of SF_6 gas, “safe-to-touch”, etc. Cable termination system shall be outer cone type, such as MV-CONNEX from PFISTERER Kontaktsysteme GmbH plug-in cable termination system or approved equivalent. The design of the complete cable termination shall be suitable for the switchgear short-circuit current and BIL as specified. Cable termination system shall be plug-in type as per DIN 47637 and EN 50181 standards.

B. The number of cables, size, and type for each incoming and outgoing feeder shall be shown on the drawings or provided as an Appendix to this specification. Each termination kit shall include suitable tinned copper braid for connection of the cable ground shield. A copper lug shall be crimped at one end of each grounding braid. A suitable shipping cover shall be provided and fitted securely at each cable termination point in the switchgear. These covers should only be removed just prior to field termination of cables. Shipping covers must be replaced with dielectric-rated cable plugs or dielectric rated covers prior to energization.

C. Cable preparation and assembly of termination tool kits shall be the responsibility of the purchaser or the purchaser’s installing contractor.

2.9 METERING AND RELAYING

A. Multifunction digital-meters shall be UL-Listed or UL-Recognized, microprocessor-based units suitable for three- or four-wire systems. Units shall be mounted on the instrument compartment door and as follows:

1. For incoming monitoring for main circuit breakers, Siemens model ***[P850/P855] [Q100] [Q200] [PAC3200] [PAC4200] [9410] [9810]*** multifunction power meter with ***[Profibus] [Modbus] [DNP3.0] [Modbus RTU/TCP] [IEC61850]*** communication protocol shall be provided.
2. For feeder circuit breakers, Siemens model ***[P50/55] [PAC3200] [PAC4200]*** multifunction power meter with ***[Profibus] [Modbus] [DNP3.0] [Modbus RTU]*** communication protocol shall be provided.

B. Multifunction protective relaying. Microprocessor-based three-phase relays shall be UL-Listed or UL-Recognized and shall be provided as follows:

1. Main circuit breakers.
   a. The relays shall be Siemens type 7SJ82 or 7SJ85 bay controller or equivalent. The relays shall include the following protection functions: 50/51, 50N/51N, 67/67N, 27, 59, 81O/U and 25 or as per ANSI as indicated on the single-line diagram.
   b. The relays shall provide monitoring of the CT and VT circuits and alarm on circuit failure.

c. The relays shall provide a graphic mimic display visually indicating the position (OPEN/CLOSED) of the circuit breaker, protection function trip and metering data. Unlimited user-configurable Human Machine Interface (HMI) screens shall allow the user to create unique single line displays with a simple tool or from an existing library.
d. The relays shall provide key locking to prevent unauthorized switching either local or remote.
e. The relays shall be capable of internally performing main-tie-main auto-transfer and auto-restore functions.
f. The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software must be compliant with IEC 61131 standard for PLC programming.
g. The relays shall have a modular communications processor to permit field change between ETH Modbus, Profinet, ETH DNP3.0, IEC 60870-5-103, and IEC 61850 protocols.
h. The relays shall be capable of running IEC61850+Modbus TCP or IEC61850+DNP3.0 simultaneously on the same communication module. The relays shall be able to support either RS-485, RJ45, or fiber-optic communications.
i. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times.
j. The relays binary inputs shall be provided with chatter blocking and filter time. The chatter blocking shall block a binary input indication and prevent the generation of indications when the signal cannot be interpreted. The filter time indicates how long a signal must be present before it shall be interpreted as an indication. This shall serve to suppress short, intermittent changes. These two features shall be available and settable separately for each binary input indication.
k. The relays shall provide four protection settings groups. Setting group changes shall be available locally through front function key and binary input; remotely through operator or service communication interface using a personal computer and via system interface (i.e., Profinet, Modbus ETH, DNP3.0 ETH, IEC61850, etc.).
l. The relay should be a modular relay in case additional binary inputs, outputs, communication modules, CTs, VTs need to be added.
m. The relay should have the capability of multi-feeder protection in case the application needs to be customized.
n. The relay shall have the possibility to install a redundant power supply.
o. The relay shall provide the flexibility to add or remove any additional function protections that may be required for the same type of application, such as Transformer Protection, Breaker Protection, etc.

2. Bus protection – full differential protection shall not be required if Siemens type 8DA10 or 8DB10 is used.
a. The relays shall be Siemens type 7UT87 or equivalent. The relay shall be low-impedance percentage differential relays.
b. The relays shall have three restraint winding inputs.
c. The relays shall have a through-fault restraint setting to prevent tripping due to high-current external faults.
d. The relays shall have a CT monitoring element to block differential trip if a CT secondary circuit has failed and shall provide alarm function.
e. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times.
f. The relay shall have the capability to be applied as single-phase bus relays.
g. The relays shall have a modular communications processor to permit field change between ETH Modbus, Profinet, ETH DNP3.0, IEC 60870-5-103, and IEC 61850 protocols.

h. The relays shall be capable of running IEC61850+Modbus TCP or IEC61850+DNP3.0 simultaneously on the same communication module. The relays shall be able to support either RS-485, RJ45, or fiber-optic communications.
i. The relay shall be able to detect the CT saturation.
j. The relay shall provide the flexibility to add or remove any additional function protections that may be required for the same type of application, such as Transformer Protection, Breaker Protection, etc.

3. ***[Feeder protection with communications.***
   a. ***The relays shall be Siemens type 7SJ82 protective relay or equivalent. The relays shall provide the following functions: 50/51, 50N/51N, 67, 64, 87N, 37, 49, 46, 27, 59, 81O/U, 50BF, 46, 47, 25, 79, and 21FL.***
   b. ***The relays shall monitor the CT circuits and alarm on circuit failure.***
   c. ***The relays shall be capable of being used in a reverse interlocking bus protection scheme.***
   d. ***The relays shall have nine programmable function keys to replace control switches.***
   e. ***The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software shall be compliant with IEC 61131 standard for PLC programming.***
   f. ***The relays shall have a modular communications processor to permit field change between ETH Modbus, Profinet, ETH DNP3.0, IEC 60870-5-103 and IEC 61850 protocols.***
   g. ***The relays shall be capable of running IEC61850+Modbus TCP or IEC61850+DNP3.0 simultaneously on the same communication module. The relays shall be able to support either RS-485, RJ45, or fiberoptic communications.***
   h. ***All relay terminal blocks including CT blocks shall be pluggable to ensure ease of relay replacement and maintenance testing.***
   i. ***The housing shall be a sealed, dustproof environment for the relay internal electronics. Head build up must be dissipated through the surface area of the steel enclosure. The relays thus shall be designed to maintain their tested insulation characteristic standards per IEC, IEEE, even if deployed in environments not covered in IEEE C37.90 "usual service conditions."***
   j. ***The relay shall provide the flexibility to add or remove any additional function protection that may be required for the same type of application, such as Transformer Protection, Breaker Protection, etc.]***

4. Generator circuit breaker protection – simple overcurrent with communications.
   a. The relays shall be Siemens type 7UM85. The relays shall provide the following protection functions: 21, 25, 27, 59, 51V, 81, 32/32R, 40, 78, 87G, 46, and 51G.
   b. The relays shall provide current differential protection for the generators.
   c. The relays shall monitor the CT and VT circuits and alarm on circuit failure.
   d. The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software shall be compliant with IEC 61131 standard for PLC programming.
   e. The relays shall recognize and alarm CT open circuit or short circuit conditions.
   f. The relays shall support either RS-485 or fiberoptic communications.
   g. The relays shall have modular communication for simple integration into SCADA systems. The communication protocol shall be ***[Profinet] [Modbus ETH] [DNP3.0 ETH] [IEC 61850]*** running simultaneously at the same communication module.
   h. The relays shall be capable of running IEC61850+Modbus TCP or IEC61850+DNP3.0 simultaneously on the same communication module. The relays shall be able to support either RS-485, RJ45, or fiber-optic communications.
   i. The relay needs to provide the flexibility to add or remove any additional function protection that may be required for the same type of application such as Transformer Protection, Breaker Protection, etc.

5. Software/data information – relay software.
    a. The relay shall be configured through Windows®-based software current up to Windows 10 Professional.
    b. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds under all conditions. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times. All internally and externally generated binary values shall be configurable to appear in the custom generated fault. Information containing time, date, interrupted current amperes per phase, time in pickup, trip open, close or user-programmed status points, etc., shall be displayed.
    c. Logging of system and protective events, last 2,000 events (accessible via front USB port and rear service communications port used to connect to a personal computer).
    d. Log of last eight faults (maximum five second record time) containing date and time stamps, pickup and tripping signals, interrupted current amperes, voltage, etc. The analog quantities displayed in the oscillography shall have the option for viewing in either primary or secondary quantities.
    e. Fault records shall be in the industry standard COMTRADE format that shall be imported or exported.
    f. The relay shall provide four protection settings groups. Setting group changes shall be available locally through front function key and binary input; remotely through operator or service communication interface using a personal computer and via system interface (Profinet, Modbus ETH, DNP3.0 ETH, IEC61850, etc.).
    g. All logging settings, annunciations, fault records, binary I/O and LED assignments must have easy to print options and easy file transfer capabilities.
    h. Relay software shall have feature for archiving or retrieving an entire project that includes all subfolders and relay files in one simple to use feature.
    i. A measurement supervision feature shall be providing for monitoring external current and voltage transformers connected to the relay.
    j. The software shall have the capability of entering the settings in both primary and secondary quantities.
    k. The current transformer polarities shall be reversible using a setting in the software when it becomes necessary.
    l. The software shall include a commissioning tool for all hardware (BI/BO/LEDs) and SCADA mapped points.
    m. The software shall be compatible with earlier version relay firmware releases.
    n. The software shall have a capability to assign an IP address to the relay allowing for a web browser commissioning tool feature to view relay information online.
6. Automatic transfer scheme: (if required)
    a. The main circuit breaker protection relay bay controller shall be factory programmed to operate a three circuit breaker transfer (main-tie-main) scheme as indicated on the drawings accomplished through the logic program capability and digital input and output capability of the protection relay/bay controller.
    b. The main circuit breaker relay/bay controllers shall control and monitor the position of the two main circuit breakers and the tie circuit breaker as defined on the drawings. The status of each circuit breaker shall be monitored from each main circuit breaker.
    c. When the voltage and/or frequency protection reaches the transfer setting and maintains that value for the programmed delay period, the automatic transfer sequence shall be initiated.
    d. The transfer shall not occur unless the source to receive the load has voltage and frequency within the specified ranges and is not in overcurrent pickup.
    e. Phase rotation shall be determined by the relays and shall match between sources prior to transfer.

f. All time delays range and incremental adjustment shall be programmable via software. Settings shall be adjustable at the LCD display and keypad or via software of the normal power supply relay.

g. An external three-position momentary-type test switch shall be provided for the test-automatic-reset modes. The test mode shall simulate one source failure. The reset position shall bypass the time delays on either the initial transfer to or retransfer to normal.

h. LED indicating lights on the front of both the normal power main circuit breaker relays shall be set and labeled as follows:
   1.) Circuit breaker closed
   2.) Alternate source circuit breaker closed
   3.) Normal source available
   4.) Alternate source available
   5.) Trip
   6.) Pickup
   7.) Local control
   8.) Automatic control

i. One of the function keys on the front of the relay/bay controller for each main circuit breaker shall be labeled Metering. The factory default metering display shall be displayed on the LCD screen by pressing the Metering function key. The screen shall display voltage per phase, current per phase, power functions including watts, vars and VA, power factor, and frequency.

2.10 CONTROL WIRING

A. Factory installed, complete with bundling, lacing and protection where necessary and complying with the following:
   1. Flexible conductors of No. 14 AWG for wires across hinges, control and CT and VT circuits and for interconnections between shipping units.
   2. Conductors sized according to NEC® NFPA 70 for the duty required.

2.11 ACCESSORIES

A. Voltage indication test LEDs: three voltage indication test LEDs suitable for verification of voltage present at the cable side of the circuit breaker to work with the installed LRM voltage indication system.

B. Operation tools: set of operation tools shall be provided such as one operation handle for the disconnect switch, one operation handle for grounding switch, one charging handle for circuit breaker, two selector keys, touch-up paint and grease packs.

C. Video monitor: one laptop computer, one copy of software to view the micro-cameras and required one firewire and one USB 2 cable shall be provided for verification of three-position switch position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General electrical contractor or switchgear installer shall install switchgear in accordance with manufacturer's written instructions and the following specifications. It is mandatory that the installing contractor or switchgear installer shall utilize a factory-trained and certified service representative to supervise the installation and commissioning of the MV GIS.

3.2 ADJUSTMENTS AND CLEANING

A. Protective-relay settings: Set relays in accordance with the purchaser's coordination study (not part of this Contract).

B. Inspect interior and exterior of installed switchgear. Remove paint splatters and other spots, dirt and debris. Touch-up scratches and mars of finish to match original finish.

3.3 TESTING

A. The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.

B. As a minimum, the following production tests shall be conducted for the medium-voltage portion of the switchgear in accordance with IEC 62271-200:
1. Power-frequency voltage (high-potential) test one minute
2. Dielectric test of auxiliary circuit
3. Measurement of the resistance of the main circuit
4. Partial discharge test
5. Mechanical operation test
6. Pressure test of gas-filled compartments
7. Gas tightness test of factory gas-filled compartments as per shipping splits
8. Test of auxiliary devices
9. Verification of the correct wiring
10. Measurement of gas condition after filling.

C. All of the type test certificates / reports shall be submitted at the time of offering if required.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed by ***[the installing contractor.] [a testing firm under separate contract to owner.]***

B. Visually inspect for physical damage.

C. Perform site tests as specified in manufacturers' instruction manuals.

D. Touch-up paint to repair any damaged surfaces using manufacturer-furnished paint. Leave remaining touch-up paint with owner.

E. Verify operation of interlocks.

F. Perform power-frequency withstand voltage tests in accordance with ANSI/IEEE C37.20.2, clause 6.5.

3.5 WARRANTY

A. Equipment manufacturer shall warrant that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than 18 months from date of shipment.

3.6 DEMONSTRATION

A. Switchgear manufacturer shall provide a factory-authorized service representative for a period of three days to train Owner's maintenance personnel in the following:
1. In procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance
2. Review data in the instruction manuals.

B. Schedule training with Owner with at least three weeks advance notice.

END OF SECTION