SECTION 26 13 26 .13

MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

Note to Specifier/Designer: To quicken the editing process all choices/options have a red font color and all choices with selections have a red font and brackets as [choice 1] [choice 2]. A note in parenthesis may be included to signify if it is a selectable option, e.g. *(Note – This item is an option, the standard offering is…..)* *Specifier/Designer to delete all italicized notes prior to publishing specification.*

Text in green to be used when specifying digital switchgear (in addition to common standards or common requirements)

Black text is ABB standard offerings.

# GENERAL

## SCOPE

* + 1. The seller shall furnish the switchgear lineup as specified herein and as shown on the drawings for medium voltage, free-standing, 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][cUL] labeled. *(Note: This is an option, the standard offering is no UL or cUL label.)* [The digital switchgear shall be [UL][cUL] labeled]. *(Note: This is an option, the standard digital switchgear offering is no UL or cUL label.)*
		4. Switchgear shall be located {indoors in a [brick and mortar building] [E-House]} {outdoors in an [Outdoor sheltered aisle enclosure] [Outdoor non-walk-in enclosure]}.

## REFERENCES

* + 1. IEEE
			1. C37.04 Standard Rating Structure for AC High-Voltage Circuit Breakers
			2. C37.09 Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
			3. C37.010 Application Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis
			4. C37.011 Guide for the Application of Transient Recovery Voltage for AC High-Voltage Circuit Breakers
			5. C37.012 Guide for the Application of Capacitance Current Switching for AC High-Voltage Circuit Breakers Above 1000 V
			6. C37.11 Standard Requirements for Electrical Control for AC High-Voltage (>1000 V) Circuit Breakers
			7. [IEEE/IEC 62271-37-013 International Standard for High-voltage switchgear and controlgear – Part 37-013: Alternating-current generator circuit-breakers] *(Note: This standard only to be referenced when generator rated circuit breakers are required.)*
			8. C37.20.2 Standard for Metal-Clad Switchgear
			9. C37.55 Metal-Clad Switchgear Assemblies - Conformance Test Procedures
			10. C37.2 Standard Electrical Power System Device Function Numbers, Acronyms and Contact Designations
			11. C37.90 Standard for Relays and Relay Systems Associated with Electric Power Apparatus
			12. C57.13 Standard Requirements for Instrument Transformers
			13. C37.20.6 – Standard for 4.76 kV to 48.3 kV Rated Ground and Test Devices Used in Enclosures
		2. International Electrotechnical Commission (IEC)
			1. 61850 Communication Networks and Systems for Power Utility Automation
			2. 60044-7 Instrument transformers - Part 7: Electronic voltage transformers
			3. 60044-8 Instrument transformers - Part 8: Electronic current transformers
			4. 61869-10 Instrument transformers - Part 10: Additional requirements for low-power passive current transformers
			5. 61869-11 Instrument transformers - Part 11: Additional requirements for low power passive voltage transformers

## RELATED SECTIONS

* + 1. Section 26 09 11 – Protective Relays
		2. Section 26 18 29 – Metal-Enclosed Bus – Medium Voltage
		3. Section 26 13 23 – Medium-Voltage Metal-Enclosed Switchgear
		4. Section 26 09 13 – Electrical Power Monitoring

## 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. Approval copies of the following documents shall be submitted to the engineer/owner for review and evaluation. Manufacturing of the equipment shall not begin until the submitted documents are noted “APPROVED” or “APPROVED AS NOTED” by the engineer/owner and officially released for manufacturing by the contractor/installer/distributor/owner:
		4. Drawing Classes shall be as defined below. Class II drawings are not to be submitted until Class I drawings are approved or approved as noted.
			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. Project Specification Sheet
				8. Cable Termination Sizes
			2. Class II
				1. 3-phase Elementary Diagrams
				2. Schematic Diagrams
		5. AS BUILT or RECORD copies of the following documents shall be provided to the engineer/owner after the equipment has shipped.
			1. All the same documentation provided under the Class I and Class II sections.
			2. Class III
				1. Interconnection Diagrams
				2. Connection Wiring Diagrams
				3. Instrument Layout
				4. Modbus mapping (if SwitchgearMDTM asset health monitoring is remote)
		6. Installation, operation and maintenance manual shall cover switchgear and breaker installations and shall be provided in electronic format via email submittal within 4 weeks from date of shipment.

## QUALIFICATIONS

* + 1. The manufacturer of the assembly shall also be the manufacturer of the major components within the assembly including circuit breakers, sensors and instrument transformers.
		2. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years.
		3. The manufacturer of the switchgear must be ISO 9001 or 9002 certified.
		4. Seismic certification [is] [is not] required. *(Note: Performance requirements and testing levels for seismic certification must be described in this paragraph. ABB standard is based on IBC 2021, seismic design category D, SDS=1.0g, @ z/h=1, w/IP of 1.0.)*
			1. [Switchgear shall be qualified to IBC-2021, seismic design category D, with component importance factor Ip1.5, SDS = 2.0g, SS=3.0g, @ z/h=1]
			2. [Switchgear shall be qualified to CBC-2022]
			3. [Switchgear shall be qualified to ASCE 7-16]
			4. [Switchgear shall be qualified to NEHRP 2009]
			5. [Switchgear shall be qualified to ACI 2012]
			6. [Switchgear shall be Inherently Acceptable to IEEE-693-2018]

## DELIVERY, STORAGE AND HANDLING

* + 1. Switchgear shall be shipped to site following INCOTERMS 2010 [CPT Carriage Paid To] [DAP – Delivered at Place] terms.
		2. Switchgear shall be stored and handled in accordance with manufacturer’s recommended practices by the contractor/installer to prevent damage to any components.
		3. The medium voltage metal-clad switchgear lineup(s) shall have shipping splits no larger than three (3) frames wide for ease of handling.
		4. Shipping sections shall be designed to be shipped by truck. Shipping sections shall be bolted to removable shipping bases and include provisions for lifting. Breakers and accessories shall be shipped separately in individual crates.
		5. It shall be the responsibility of the contractor/installer to inspect and report concealed damage to the carrier within the specified time.
		6. The contractor/installer shall store the equipment in a clean, dry, climate-controlled space, and shall maintain factory protection or cover it with heavy canvas or plastic to keep out dirt, water, construction debris and traffic.
		7. The contractor/installer shall handle the equipment in accordance with the manufacturer’s written instructions to avoid damaging it, as well as any installed devices and the enclosure finish.

##  Project Site Conditions (Site Environmental Conditions)

* + 1. The contractor/installer shall follow all applicable standard and service conditions before, during and after the switchgear installation.
		2. The switchgear shall be in a well-ventilated area, free from excess humidity, dust and dirt and away from hazardous materials. The ambient temperature of the area must be between minus 30 degrees C (minus 22 degrees F) and plus 40 degrees C (plus 104 degrees F). Indoor locations shall be protected to prevent moisture from entering the switchgear enclosure.

## Warranty

* + 1. The manufacturer shall warranty the equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of shipment, whichever occurs first. The equipment must be received, stored and installed in accordance with the manufacturer’s installation publications and/or maintenance manuals to avoid nullifying this warranty.
		2. If any warranty work needs to be performed, a representative of the manufacturer shall be notified in writing/email of the problem. The factory will then issue instructions and any materials to correct the problem. All warranty work must be performed by the manufacturer at the manufacturer’s discretion in order to maintain the manufacturer’s warranty.

## Field Measurements

* + 1. The contractor/installer shall make all necessary field measurements to verify that the medium voltage metal-clad switchgear lineup(s) shall fit in the allocated space in full compliance with minimum required clearances specified in the National Electrical Code or as required by any applicable local codes and standards, as well as any facility requirements.

# PRODUCTS

## MANUFACTURER

* + 1. ABB [Advance] [Advance 27] medium voltage metal-clad switchgear with ABB type [ADVAC] [AMVAC] [ADVAC G] circuit breakers, and related ABB instrument transformers/sensors shall be supplied. *(Note: Use Advance for 5-15 kV and Advance 27 for 27 kV ratings. Also, ADVAC or ADVAC G not available for Advance 27.)*
		2. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_]
		3. [\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_]

The listing of specific manufacturers above does not imply acceptance of the products. All products must meet the specified ratings, functions and features.

## 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. All vertical sections for 5 – 27 kV ratings shall utilize a standard width of 36 inches. Depths shall be 85/92 inches for 5-15 kV ratings and 92 inches for 27 kV ratings. Height shall be 95 inches, not including any vent box assemblies on top of switchgear.
			3. The basic structure will be of modular construction and fabricated of highly reflective, durable 14-gauge or thicker galvanized, stainless and painted steel and comply with the requirements of IEEE C37.20.2.
			4. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate major primary sections of each circuit.
			5. 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 injury to personnel or damage to wiring.
			6. Cooling vents may be provided in the switchgear for heat ventilation purposes.
				1. [Rodent proofing for vents] (*Note: Rodent proofing for vents is an option and may require de-rating of the equipment. Standard offering is no rodent proofing for vents.)*
				2. [Dust filters for vents] *(Note: Filters for vents is an option and may require de-rating of the equipment. Standard offering is no filters on vents.)*
			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, sensors or instrument transformers, metering and relaying as per one-line diagram. [The cubicle shall be equipped for a future breaker element.]
			9. All front doors shall be securely held with tamper-resistant hinges and sealed with a single-handle, multi-point latch door [bolted doors]. [Padlock provisions are to be supplied on all doors. Padlock is to be supplied by buyer.]
			10. All rear doors are to be hinged, bolted type. [All rear doors are to be hinged and secured with single handle, multi-point latch mechanisms.] [All rear access compartments to have bolted panels installed to prevent access to the compartments.]
			11. 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.
			12. [A mimic bus applied to the front of the switchgear shall functionally represent the primary circuits. Mimic bus shall be made of automotive grade Mylar tape.] *(Note: Mimic bus is optional. Standard is no mimic bus.)*
			13. [Advance switchgear is to be close coupled to Rockwell Arcshield medium voltage MCC]
			14. [Advance switchgear is to be close coupled to \_\_\_\_\_\_ *(specify brand)* MV MCC]
			15. [Advance switchgear is to be close coupled to \_\_\_\_\_\_ (brand/type) power transformer]

 *(Note: Maximum ratings for Advance close coupled to MV MCC is 7.2 kV, 60kV BiL, 3000A)*

* + 1. Ratings
			1. Rated Maximum Voltage: [5] [7.2] [8.25] [15] [27] kV
			2. Operating Voltage: *X* kV (*Note: Specify the actual operating voltage.)*
			3. Main Bus Continuous Rating: [1200 A] [2000 A] [3000 A] [4000 A Forced Air Cooled] *(Note: for 27kV applications only 1200 or 2000 A are available.)*
			4. Control Bus Voltage: [48] 125 [250] VDC, [120] [240] VAC  *(Note: Standard control bus voltage is 125 VDC.)(Note: If integral racking motor is required for breaker racking, then the preferred control voltage shall be 125VDC only)*
			5. Short Circuit Rating: [16] [25] [31.5] [40] [50] [63] kA *(Note: For 27kV applications, only 16 and 25kA ratings are available. 16kA not available for 5-15kV ratings)*
			6. The three-phase system is [ungrounded] [solidly grounded] [resistance grounded] [high resistance grounded]
			7. The frequency of the system is 60Hz.
			8. The enclosures and circuit breakers shall have a basic impulse rating (BiL) of [60] [95] [125] kV. *(Note: 60 kV is used for 5-7.2kV rated maximum voltages; 95 kV is used for 8.25-15kV rated maximum voltages and 125 kV is used for 27kV rated maximum voltages.)*
		2. 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.
				1. [All main bus shall be tin plated.]
			2. The bus stand-off support insulators shall be made of glass polyester for all 5-15 kV applications and porcelain for all 27 kV applications.
			3. Through-wall main bus supports (inter panel supports) shall be glass polyester for 5-15 kV, 1200-2000 A bus ratings, porcelain for 5-15 kV 3000 A and 27 kV 1200 – 2000 A applications, and epoxy for 5-15 kV 4000 A applications.
			4. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents and short circuit values as specified in the standards for the switchgear rating.
			5. The main bus compartment shall be separated from the other compartments by a minimum 11-gauge steel barrier (or equivalent as allowed by ANSI/IEEE C37.20.2) and shall fully enclose the main bus.
			6. The main bus compartment shall be accessible from the rear through the cable compartment.
			7. The shape of the bus bar shall be full round edge. The main bus shall not be tapered.
			8. All bus joints shall be [silver plated] [tin plated], bolted, and insulated with molded plastisol boots secured with nylon fasteners.
			9. Temperature rise of the bus and connections shall be in accordance with IEEE C37.20.2 standards and documented by design test certifications.
			10. A ¼ by 2-inch tin plated copper ground bus shall extend the entire length of the switchgear for ratings up to 50kA. A ½ by 2-inch tin plated copper ground bus shall extend the entire length of the switchgear for 63kA ratings.
		3. 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. Breaker primary bushings shall be made of epoxy capable of supporting the weight of the current transformers for 5 & 15kV rated equipment, up to 63kA. For 27kV rated equipment, breaker primary bushings are to be made of porcelain.
			3. Primary contacts shall be made of pure copper and designed to accept the round, tulip style connectors of the AMVAC, ADVAC and ADVAC G circuit breakers.
			4. For 5-15 kV rated voltage applications solidly grounded metal shutters shall be used. For 27kV applications, non-metallic Lexan shutters shall be used. All 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 [sensors] for personnel safety.
				1. [For 5-15 kV rated voltage applications shutters shall be non-metallic Lexan]  *(Note: Lexan shutters are optional. Standard for 5-15kV applications is metal.)*
			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. *(Note: Use of ground wires on shutters not applicable when Lexan shutters are used.)*
			7. The closing of the shutters must be made by the movement of the circuit breaker. Gravity operated shutters are not acceptable.
			8. Window-type current transformers (CTs) [Rogowski coil sensors] shall be located behind the shutters on the breaker primary bushings and shall be accessible from the front. Bushings shall accommodate up to four standard accuracy CTs [eight current sensors] per phase for all ratings.
				1. Bushings shall accommodate up to two high accuracy CTs per phase for all ratings. *(Not applicable to digital switchgear)*
			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.
			11. [Circuit breaker compartment doors shall be equipped with the SmartRackTM remote racking system adapter plates.] *(Note: This is only required if SmartRack remote racking system is specified. See section 2.03)*
		4. 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 drawings or other specifications.
			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 spacing requirements of NEMA CC1-4.05 and shall typically be the NEMA 4-hole pattern.
				1. [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 and supported as required to meet momentary/short time ratings.
			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 diagram.
			6. [IR viewing ports shall be included for viewing of cable terminations.] *(Note: This option is not needed if a 24x7 switchgear monitoring system is included.)*
			7. [[Distribution] [Intermediate] class surge arresters shall be provided as shown on the single line diagram.] *(Note: Standard is no surge arresters)*
		5. Auxiliary Compartment
			1. Auxiliary enclosures shall be provided where necessary for mounting of auxiliary units such as potential transformer (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 and accessories as circuit breakers with connected and disconnected positions. [All auxiliary units shall be designed to be used with the ABB SmartRack™ electric racking device.]*(Note: This is only required if SmartRack remote racking system is specified. See section 2.03)*
			3. Primary fuses shall be temporarily grounded to discharge any residual voltage on the voltage transformers during withdrawal of the auxiliary unit to the disconnect position.
			4. 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.
			5. The auxiliary enclosure bushings shall be glass-filled polyester or epoxy for 5-15 kV applications, and epoxy for 27kV applications.
			6. A window shall be provided on the door to allow observation of draw-out unit position with door closed.
			7. For 5-15 kV applications, 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. Separate, removable rails that must be stored elsewhere are not acceptable. For 27 kV applications, the auxiliary units shall be mounted on a removable truck to facilitate changing of fuses and maintenance.
			8. PT configurations shall be as defined in the project 1-line diagrams and/or specifications (Wye-Wye vs Open Delta, single phase vs three phase, etc.)
		6. 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. Space may be made available on the left and right side of the breaker compartment frames in front of the breaker for wiring of intermediate connection points. These areas must have grounded metal covers.
			5. Customer connections shall be made on terminal blocks located inside the instrument compartments.
			6. Devices mounted on instrument compartments shall be arranged in an approved, logical symmetrical manner.
		7. Wiring
			1. Control wiring shall be enclosed in a grounded metal wire way when routed through a high voltage compartment.
			2. All voltage circuits used for control, relaying or metering shall be protected within the metal-clad switchgear in accordance with the requirements of section 7.3 of ANSI/IEEE C37.20.2.
				1. Primary and secondary protective devices are not to be utilized for voltage sensors.
			3. Flame retardant, 600 V insulated stranded copper wire shall be used for internal wiring between components of switchgear assemblies and to terminals for connection to external controls, metering, or instrumentation. Wire types shall be in accordance with section 7.3 of IEEE C37.20.2.
			4. The switchgear manufacturer is responsible for the performance of the wiring system provided by the manufacturer within the switchgear. This applies to the integrity of the internally generated signals in the control wiring and may require the use of special precautions such as shielded wire and segregation of certain wires.
			5. Sleeve type wire markers shall be provided at both ends of each wire. Wire markers shall not be handwritten. Wire markers shall be printed.
			6. 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.
			7. Terminal blocks shall be provided for terminating all power and control wiring. Terminal blocks shall be rated at 600V.
			8. Wiring across a hinge shall be suitable for this use, as defined by section 7.3 of IEEE C37.20.2.
			9. Wire protection and support shall be in accordance with section 7.3 of IEEE C37.20.2.
			10. Current and voltage sensors will connect to the protection and control relays with industrial grade CAT 6 ethernet cable with RJ45 connectors. Where one set of current and one set of voltage sensors are to be wired to the same relay, they shall be connected through ABB type AR4 or AR5 connector adapters.
		8. Space Heaters
			1. Space heaters shall not be required for indoor, climate-controlled applications.
			2. Space heaters shall be standard on outdoor equipment applications.
				1. For outdoor equipment applications, a minimum of three (3) 300W 240 Vac space heaters, operating at 120 Vac 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 thermostats and/or humidistats.
			4. When space heaters are required, and storage of the equipment is planned, provide terminal points accessible for connection of temporary [120] [240] Vac control power.
		9. [Utility Metering Cabinet]
			1. [Where shown on drawings, provide utility metering compartment or structure as per the [insert utility name] requirements.]
		10. [Outdoor Enclosures]
			1. [Switchgear shall be provided with an outdoor (weatherproof) non-walk-in (aisle-less) enclosure.]
			2. [Switchgear shall be provided with an outdoor sheltered aisle enclosure with enough room to easily operate a breaker lift truck and test cabinet. The outdoor enclosure shall be compliant with ANSI/IEEE C37.20.2]
			3. [Switchgear shall be provided inside an E-House/Power Distribution 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 utilizing vacuum interrupters.
				1. [Circuit breakers to be ABB type AMVAC, model 4, utilizing a magnetically actuated operating mechanism, for ratings of 5-15kV, up to 50kA.]
				2. [Circuit breakers to be ABB type ADVAC, model 4, utilizing a spring type stored-energy actuated operating mechanism and a mechanical anti-pump device in lieu of an anti-pump relay, for ratings of 5-15kV, up to 50kA.]
				3. [Circuit breakers to be ABB type ADVAC 63, utilizing a spring type stored energy actuated operating mechanism, for ratings of 5-15kV, 63kA.]
				4. [Circuit breakers to be ABB type AMVAC, utilizing a magnetically actuated operating mechanism for ratings of 27kV, 16-25kA.]
				5. [When required by the system design and/or single line diagram, ABB ADVAC G generator breakers conforming to the dual logo standard IEEE/IEC-62271-37-013 are to be included.] (Note: ADVAC G breakers are not available for 27 kV.)
			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 when AMVAC breakers are specified.
			4. Circuit breakers of the same type, rating and control circuits shall be electrically and mechanically interchangeable. [Breakers of higher ratings shall be capable of installation into equal or lower rated compartments]
			5. [When included, breakers specifically rated for generator protection shall have interference plating that allows their use within generator breaker compartments only]
			6. Breakers shall use vacuum interrupters embedded in epoxy for protection against dust, water and debris accumulation on the interrupters and for protection against accidental impact during breaker transport.
		2. [Integrated Electric Breaker Racking]
			1. Each circuit breaker shall include integrated electric breaker racking equivalent to the ABB Breaker Borne Racking (BBR) assembly integrated into the racking truck. The BBR will be used to rack the breaker between the disconnect, test and connect positions.
				1. The BBR assembly shall include all necessary components and circuitry for 3-position racking system, including, but not limited to position limit switches, interlock release solenoids, racking motor, chain drive assembly and passive controller.

A mechanical clutch shall be included to allow manual racking of the circuit breaker using the standard racking handle accessory

* + - * 1. [A device 43, local-remote switch shall be used to disable the pendant controller and/or any external racking control inputs when local manual racking is being performed] (Note: This is optional)
				2. A detachable umbilical cable, electrically independent of breaker secondary control wiring, shall be used to connect the BBR system to the switchgear low voltage compartment.
				3. Mechanical and electrical interlocks shall be included to prevent electric racking when the breaker is in the closed position.
				4. Mechanical and electrical interlocks shall be included as required by ANSI/IEEE C37.20.2 to prevent closing of the breaker while electric or manual racking is used.
				5. The BBR shall be utilize 125 VDC control power for operations. Inverters, converters, transformers and/or other components necessary to convert the specified control power to 125VDC shall be included by the manufacturer.

The control power for the BBR system shall have circuit protection independent of all other control circuits.

* + - 1. [An overcurrent relay shall be included to monitor the integral racking motor and used to disable the racking should over-torque be seen in the circuit]
		1. Control Options for Integrated Electric Breaker Racking
			1. [The BBR shall be controlled through the Electro-Switch (ES) Smart breaker racking switch.]  *(Note: This is optional) (Note: If the Smart breaker racking switch is used, the overcurrent relay for monitoring the racking motor current is not required.)*
				1. [The ES breaker racking control switch shall be mounted in the LV compartment associated with the breaker to be racked.]
				2. [The ES breaker racking control switch shall be located remotely of the switchgear.]
			2. [The BBR shall be controlled remotely via control contacts from customer’s external control devices] *(Note: This is optional)*
			3. [A discrete I/O interface module shall be supplied for each breaker for control of the BBR via customer’s SCADA system using Modbus TCP interface] *(Note: This is optional)*
			4. [The BBR shall be controlled via local protection relay I/Os wired directly to the BBR.]
			5. [The BBR shall be controlled via the ABB EnRack pendant controller from a distance of at least 30ft from the switchgear breaker door. A Cat5E cable shall connect the pendant controller to the LV compartment door.] *(Note: This is optional)*
				1. The breaker position shall be indicated on the pendant controller by indicating lights. A blinking light shall indicate that the breaker is in motion to the selected position. A solid (non-blinking) light shall indicate the breaker has reached the indicated position.
				2. The pendant controller shall monitor the condition of the racking and display the appropriate error codes in case normal operation fails.
				3. [It shall be possible to enable/disable the pendant controller via customer’s external contacts] *(Note: This is optional)*
				4. The pendant controller shall include a permissive button which shall be pushed simultaneously as the rack-in/rack-out button and held for a period of 1 second or more to enable operation.
				5. The pendant controller shall include an Emergency Stop button. This will immediately stop the execution of the racking signal. The racking signal can be continued by pushing the appropriate permissive/racking button
				6. [The pendant controller shall include push buttons for opening and closing the breaker] *(Note: This is optional)*

[The permissive button shall also be required for the open and close operation of the pendant controller]

[Open and close buttons shall include backlighting that indicates green on the open button and red on the close button]

[Pendant controller shall be selectable for breaker status colors required by CSA 22.2, no. 31 switchgear standards]

* + 1. [ABB SmartRackTM electrically operated remote racking system shall be provided. The electric racking system shall be capable of operating all breakers, auxiliary units and Ground & Test devices.]
		2. Ratings
			1. The ratings of the breaker shall be chosen from the following values:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Maximum Voltage****(kV)** | **Power 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 |
| 55 | 1919 | 6060 | 5063 | 130164 | 1.01.0 |
| 5 | 19 | 60 | 40 | 115\* | 1.0 |
| 5 | 19 | 60 | 50 | 137\* | 1.0 |
| 5 | 19 | 60 | 63 | 174\* | 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 |
| 8.25 | 36 | 95 | 40 | 115\* | 1.0 |
| 8.25 | 36 | 95 | 50 | 137\* | 1.0 |
| 15 | 36 | 95 | 25 | 65 | 1.0 |
| 15 | 36 | 95 | 31.5 | 82 | 1.0 |
| 15 | 36 | 95 | 40 | 104 | 1.0 |
| 1515 | 3636 | 9595 | 5063 | 130164 | 1.01.0 |
| 15 | 36 | 95 | 40 | 115\* | 1.0 |
| 15 | 36 | 95 | 50 | 137\* | 1.0 |
| 15 | 36 | 95 | 63 | 174\* | 1.0 |
| 27 | 60 | 125 | 16 | 42 | 1.0 |
| 27 | 60 | 125 | 25 | 65 | 1.0 |

\*= Increased peak ratings for ADVAC G breakers qualified to IEEE/IEC 62217-37-013

* + 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. Charge, trip and close circuits shall be separately protected by the use of [Dead front pull-out fuses.] [molded case circuit breakers]
		2. Auxiliary Contacts
			1. For 5-15kV, 25-50kA and all 27kV applications (9) ‘a’ and (8) ‘b’ auxiliary contacts will be mounted on the breaker and wired through the automatic secondary disconnect system. For all 5/15kV, 63kA applications (9) “a” and (7) “b” auxiliary contacts, and (1) early “b” auxiliary contact will be mounted on the breaker and wired through the automatic secondary disconnect system.
			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 (TOC) switch assembly shall be provided to indicate when the breaker is in the fully connected position, for each breaker as noted.] *(Note: TOC is optional. Standard is no TOC.)*
				1. [16 contact truck-operated cell 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. [Interference blocking shall allow a higher rated breaker be installed in a lower rated breaker compartment.]
			7. All draw-out modules shall have manually actuated locking devices to prevent inadvertently withdrawing a module from a compartment.
			8. Grounding shall occur in the test position and shall be continuous during racking and in the connected position.
			9. Breaker racking mechanism shall be included in the breaker truck, installed on the breaker and not integrated into the breaker cell.
			10. Option: [Roll on Floor (ROF) circuit breakers shall be provided for breakers in the bottom compartment. When 2-high stacked breaker configurations and ROF options are required, then all circuit breakers are to be supplied with ROF wheels].

## SENSORS AND INSTRUMENT AND CONTROL TRANSFORMERS

* + 1. Electronic Instrument Transformers (Sensors) for voltage and current measurements.
			1. Current and voltage (potential) transformers may only be used for utility metering and when protection is required for transformers, large motors or generators.
		2. Electronic Instrument Transformers (Sensors)
			1. Voltage sensors shall be based on voltage divider principle and shall comply with IEC 60044-7 and/or 61869-11. ABB type [KEVA 17.5 B21] [KEVA 17.5 B41] for 5-15 kV applications] [KEVA 24 B21] [KEVA 24 B41] for 27 kV applications] shall be used. *(Note: specify B41 sensors when they are to be used as bus stand-off insulators.)*
			2. Current sensors shall be based on the Rogowski coil principle and shall comply with IEC 60044-8 and/or 61869-10. ABB type KECA 80 C184 shall be used for all ratings through 27 kV.
		3. Current Transformers (Not to be used when specifying digital switchgear, unless protection and control schemes require a combination of CTs and sensors)
			1. CT nameplates shall be located on the CT housing and ratings and accuracies provided shall be in accordance with IEEE 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] [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.] *(Note: Standard is no zero sequence CTs) (Note: These zero sequence CTs can be used with current sensors on the phase connections if the output is 0-1A. For use with ABB Relion relays only.)*
			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 [10] gauge wire with ring tongue lugs.
		4. Potential Transformers (Not used when specifying digital switchgear)
			1. PTs shall be designed to withstand the basic insulation level (BIL) of the switchgear.
			2. Potential transformers shall always be fused in accordance with C37.20.2 requirements and mounted on a draw-out unit which disconnects them from the primary contacts safely with the door closed.
			3. ABB Type VIY or VIZ PTs shall be supplied in accordance with the single line.
			4. PTs shall be connected to the bus or load via solid copper rod, shielded cable or solid bus.
			5. Each transformer shall have a 120 V secondary and an IEEE C57.13 accuracy classification meeting the requirements as shown on the single line.
		5. Control Power Transformers (CPTs)
			1. CPTs shall be dry type with disconnecting type current limiting primary fuses and molded case breaker secondary.
			2. CPTs up to single phase 15 kVA 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. CPTs larger than single phase 15 kVA 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.
			5. Three phase, fixed mounted, CPTs installed within the switchgear shall be a maximum of 75 kVA. Single phase, fixed mounted, CPTs installed within the switchgear shall be a maximum of 50 kVA.
			6. Interlocks shall be included with all CPTs, fixed or drawout, to ensure that the secondary loads are disconnected before withdrawal of the CPT or Fuse drawout can be performed. These interlocks may be made by direct mechanical linkages or using a Kirk Lock type system.

## RELAYING, METERING & CONTROLS

1. Relays (For digital switchgear, include all requirements listed plus those in green text. Note: A mix of conventional and Relion relays may be used in digital switchgear)
	* + 1. Relays and instruments shall be provided and wired as specified on the project single line diagram and schematics.
			2. When drawout type protective relays are used, they shall be capable of being withdrawn from the case while energized.
			3. Protective relays shall accept ring type lugs in all terminals in the back of the relay.
			4. Multifunction/Microprocessor Relays
				1. A multi-function, 3-phase microprocessor-based ABB Relion relay or approved equivalent shall be used.
				2. Whenever shown in the one-line diagrams, for the feeder, small motors, and line differential protection an [ABB Relion relay] [Schweitzer SEL 751 relay] with low energy analog inputs shall be used. [ABB relays shall be type REF615, REX615, RED615, REM615 or REX640]
				3. Whenever shown in the one-line diagrams, for transformer differential, motor differential, and generator differential protection an ABB REX Relion relay with low energy analog inputs and standard CT inputs shall be used.
				4. Whenever shown on the line-line diagram for bus protection, the SSC600 shall be used to provide low impedance bus protection to the bus by using the Relion relays as merging units and passing current information for each breaker to the centralized protection and control unit SSC600.
				5. GOOSE messaging for bus differentials and MTM transfer schemes shall be used whenever possible to limit wiring between cubicles.
				6. [Relion REF or REX series relays shall be used for feeder applications.]
				7. [Relion RET or REX series relays shall be used for transformer protection]
				8. [Relion REM or REX series relays shall be used for motor protection.]
				9. [Relion REG or REX series relays shall be used for generator protection.]
				10. [Relion RED or REX series relays shall be used for differential protection.]
				11. The application of the REX relay for 2-high frame configurations shall be restricted to the use of a single base unit and two HMI units.
				12. All relays shall have, at minimum, the following basic functions:

Visual display capable of showing the one-line of the application

Multilevel password access for changing settings

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.

Multilevel password access for changing settings

Programmable logic capabilities

IEC 61850, Modbus, or DNP communications

* + - * 1. (For digital switchgear) All relays shall have, at minimum, the functions listed in section L and the following advanced functions:

Dual Ethernet ports supporting either HSR or PRP communications.

Embedded web HMI for programming, monitoring, and visualizing events.

The relay should be able to act as a protective unit and merging unit at the same time

Support IEC 61850 Ed2, and IEC 61850-9-2LE (Sampled Measured Values).

* + - * 1. (For digital switchgear) All amplitude and phase correction factors for current and voltage sensors are to be input into the protective relays at the factory, based on the actual sensors used on each phase.
		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.
			4. [Satec PM175 meters shall be provided. Inputs to these meters shall be via current and voltage sensors. A dedicated set of current sensors and voltage sensors shall be provided for each PM175 meter]
		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] [ABB FT-14D type] *(for digital switchgear applications). (Note: Standard is no test switches provided.)*
			4. Meter switches shall have knurled knob handles. Switches are to Electroswitch Series 24 or equivalent. *(Not used for digital switchgear)*
		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.

## [SWITCHGEAR ASSET HEALTH MONITORING] *(Note: Standard is no asset health monitoring)*

* + 1. Switchgear shall be equipped for 24x7 monitoring of the bus temperature at all incoming and outgoing primary cable connections using the ABB SwitchgearMD™ [wireless] [infrared] monitoring systems. *(Note: If partial discharge is required, then only wireless can be selected. Standard offering is infrared.)*
		2. Switchgear shall be equipped for 24x7 monitoring of internal humidity.
		3. [Switchgear shall be equipped for 24x7 monitoring of partial discharge activity in designated compartments.] *(Note: Partial Discharge monitoring is optional. Must use wireless monitoring system if PD detection is required. Standard is monitoring of the bus cable connection temperatures and switchgear humidity only.)*
		4. [Main bus and non-cable lug pad joints to be monitored for temperature.] *(Note: Standard is monitoring of incoming/outgoing cable connections only.)*
		5. Monitoring system shall trigger alarms based on configurable thresholds.
		6. Monitored data will be displayed on an ABB SWICOM HMI unit mounted on the door of an instrument compartment.
		7. [Monitored data will be displayed on an Exertherm HMI.] (Note: The Exertherm HMI can only be used when Exertherm IR sensors are used for temperature monitoring.)
			1. [Monitored data to be made available to a remote system such as a SCADA or a Data Historian.] *(Note: Standard is no data made available to remote systems.)*

## [ACTIVE ARC MITIGATION] *(Note: Standard is no active arc mitigation)*

* + 1. Arc Flash Mitigation using the ABB REA Arc Detection System
			1. Provide a complete arc flash mitigation system suitable for attachment to the switchgear as indicated on the design documents for the protection of the equipment against the effects of internal arcs, to ensure personnel safety and to minimize damage and outage to the equipment.
			2. The arc flash mitigation system shall be designed and constructed for indoor installation and operated under the following conditions:
				1. Altitude: up to 1,000 m above sea level
				2. Ambient air temperature: -10ºC to 55 ºC
				3. Relative humidity: up to 90% non-condensating
			3. The arc monitoring unit (arc flash detector) shall detect the occurrence of short-circuit arcing my means of arc detectors/sensors and current sensing units and immediately transmit a tripping signal to trip and lock out all relevant circuit breakers connected to the affected main bus.
				1. The arc monitoring unit power supply shall be [Vn = 110/120/220/240 V AC] , [Vn=110/125/220/250 V DC], Or [Vn = 24/48/60 V DC]
				2. Fiber optic detectors without galvanic wires shall be used.
				3. Current sensing units:

Current setting for 3-phase: 0.5 ….. 6.0 x In, where In is 1A or 5A

Current setting for ground unit: 0.05….0.6 x In where In is 1A or 5A

* + - * 1. Indicators to include:

Fault indication and location

 Relay self-supervision of internal electronics, fiber optic loop check supervision, communication link supervision

* + - 1. Operating time from detection to initiate circuit-breaker tripping shall be not more than 2.5 msec.
			2. The arc flash mitigation system shall not respond to interfering light sources, electro-magnetic influences, vibration and touching. Automatic or manually adjustable ambient light compensation shall be provided.
			3. The protection principle of the arc flash mitigation system shall consist of two (2) important criteria: Light intensity and simultaneous overcurrent. Note: It shall be possible to select light intensity only.
			4. The system shall perform the proper protection even if all outgoing feeders are supplied by one)1) incoming feeder by closing the bus tie breaker. If the internal arc occurs at any point I the bus section fed through the bus tie breaker, only the affected bus section shall be removed from service. In the case of an internal arc on the busbar section with fault current supplied from an outgoing feeder, the arc flash mitigation system shall perform complete busbar protection according to applicable scheme using light only without supervision of fault current detectors.
			5. The system shall be complete with control and indicating devices, and testing facilities for routine functional testing of the protection system while switchgear is energized.
			6. The arc monitoring unit with current sensing shall provide three-phase over current measurement, switchgear existing current transformers shall provide the current inputs for the current sensing unit. The current sensing unit shall block circuit breaker tripping via the arc-monitoring unit at load currents below a preset value. Integrated circuit breaker failure protection shall be provided.
			7. Fault current supervision (fault detectors) of the optical system shall be switch selectable.
			8. The system shall be capable of indicating the affected cubicle as well as selective tripping by using the appropriate extension unit.
			9. The manufacturer shall have a minimum of 5 years’ experience in the design, manufacturing and testing of the Arc Flash Mitigation System.
			10. The Arc Flash Mitigation system shall be UL recognized.
			11. The manufacturer shall submit complete drawings of the arc mitigation system components and drawings showing the placement of system components, routing of sensor cables and network communication cables in the switchgear sections.
			12. The manufacturer shall furnish operating and maintenance manuals covering installation, operations and servicing procedures for the Arc Flash Mitigation System.
		1. Approved equipment for use in REA arc flash mitigation systems are:
			1. Arc detection monitoring unit REA 101 (Master Unit) with integrated current sensing unit. This unit will communicate with REA 105 units via a network connection cable for tripping of associated circuit breakers.
			2. Arc detection unit REA 105 for fast fault tripping of compartment feeder breaker upon compartment detector/sensor cable detection of arc flash or upon signal from the REA 101. To include one dry contact output for alarming.
			3. Detection/sensor cables shall be fiber optic light sensitive cable with a maximum length of 65 meters.
			4. Network connection cables shall be at least Cat 5E communication cables with RJ-45 connectors.
			5. Cables between REA 101 devices shall be optolink transmitting and receiving cables for transmitting light or current trip threshold signals.
		2. Arc Flash Mitigation using the ABB Ultra Fast Earthing Switch (UFES) arc mitigation system.
			1. Provide the UFES for the purpose of reducing the incident energy levels, rated to match the voltage ratings as indicated in this specification or the project single line diagrams. *(Note: Contact ABB factory for UL label availability when UFES is required.)*
			2. The UFES system is to include the appropriately rated Primary Switching Elements (PSE), the Electronic tripping unit (QRU1 or QRU100) and all associated fiber optic sensors and wiring.
			3. [The UFES system shall utilize light collecting lens-type sensors and operate as a stand-alone system using the QRU1 electronic tripping unit.] [The UFES system shall utilize the QRU100 electronic tripping unit in combination with the ABB REA arc fault detection system, using non-shielded, bare fiber sensors that detect light along its entire length.] *(Note: Standard is to use the UFES system with the REA system)*
			4. The manufacturer shall develop and provide a fiber optic loop scheme showing all locations the fiber is to be routed throughout the switchgear, the zones of protection, the QRU1/QRU100/REA relay fiber connections and the QRU1/QRU100/REA relay protection and controls.
			5. The manufacturer shall test the [UFES] [UFES/REA] arc mitigation system at the factory. The manufacturer shall not operate the Primary Switching Elements (PSE) during factory testing.
		3. Arc detectors/sensors and cables. (To be used with either the REA or UFES systems)
			1. The arc detectors shall be light detecting sensors and shall be installed in each high-voltage compartment of the switchgear frames as follows:
				1. Main bus compartment
				2. Breaker compartment
				3. Cable compartment
				4. Auxiliary unit compartment
			2. The detectors/sensors shall be arranged so that every internal arc can be detected.
			3. Sensor cables shall be fiber or lens type. Note: When using the REA system as a stand-alone, or with the UFES system, light sensing fiber cables only shall be used.
			4. The light signal from the extension units shall be transmitted to the main units by shielded FTP type RJ45 communication cables.
			5. Continuous self-supervision of sensor-fiber loops, operating voltages and cabling between central units and extension units shall be provided.
			6. Supervised opto-connection links up to a distance of 2 km for fast signal transfer of light/current/trip signal between main units shall be provided.

## ACCESSORIES AND SPARE PARTS

* + 1. Accessories
			1. All accessory items purchased with the switchgear 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 to be elevated and then inserted or withdrawn. One breaker lift truck per switchgear lineup shall be provided. *(Note: Breaker lift truck may not be required if all breaker compartments are at floor level and have Roll On Floor wheel options. Fewer than one lift truck per lineup may be utilized if multiple switchgear lineups are in same or nearby rooms.)*
				2. Breaker/CPT/PT/Fuse racking handle. (1 per switchgear lineup)
				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 rack breakers and auxiliary units remotely. Minimum cord length shall be 50 feet.]
				6. [An additional EnRack Pendant Controller shall be provided.]
				7. [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.]
				8. [The vendor’s standard manually electrically operated ground and test device shall be supplied for main bus and system grounding during maintenance. The G&T device shall be a 6-port device for grounding the [upper][lower] terminals.] *(Note: Electrically operated G&T device not available for Advance 27.)*
				9. [Relay test plugs shall be included.]
				10. [All type FT test switches to include test plugs.]
		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]
			16. [Spare current sensor]
			17. [Spare voltage sensor]

## FINISH

1. All steel structure members, except galvanized and stainless steel, shall be cleaned using a multi-stage cleaning process. The cleaning stage shall use a multi-metal safe alkaline based cleaner, followed by at least 2 stages of purified reverse osmosis water rinses. The treatment stage shall use an eco-friendly Zirconium based pretreatment, followed by another RO water rinse. A final Zirconium sealer is to be applied and dried prior to painting.
2. For all indoor switchgear all metal parts to be painted, including the outer enclosure shall be painted ANSI 61 gray.
3. For all outdoor switchgear, the interior parts that require paint are to be painted ANSI 61 Gray, and the exterior enclosure is to be painted ANSI 70 Gray.
4. All paint finishes must meet the performance requirements of IEEE C37.20.2.

# EXECUTION

## FACTORY TESTING AND EXAMINATION

* + 1. The equipment shall be factory assembled in its entirety and tested in accordance with production testing requirements in IEEE C37.20.2 prior to shipment. It shall not be necessary to install the main bus between shipping sections at the factory.
		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 second test of 1800V 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. If necessary, instruments shall be energized from the low voltage winding of the PTs and the low current winding of the CTs. [Current sensors used in digital switchgear to be verified by applying current on the primary bus and reading the output at the relay.]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 any potential transformers shall be functionally checked to verify conformance to the electrical drawings and electrical bills of material. [Voltage sensors used in digital switchgear to be verified by applying low voltage on the primary bus and reading the output at the relay.]
				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 individually and 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 IEEE C37.20.2 or C37.20.3.

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. [All temperature, humidity and partial discharge asset health monitors to be tested to ensure proper phasing and operation.] *Note: Only needed when asset health monitoring is specified.*
				2. [All Active Arc Mitigation devices to be factory tested as per the relay and control unit testing instructions.]
			1. Factory Witness Testing *(Note: Standard is no 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 facilitate arrangement of travel plans.]

## EXAMINATION

* + 1. The contractor/installer shall verify that the medium voltage metal-clad switchgear is ready to install.
		2. The contractor/installer shall examine the installation area to assure there is enough clearance to correctly install the switchgear.
		3. The contractor/installer shall check concrete pads for uniformity and surface levelness as defined in the switchgear manufacturer’s drawings. Should any housekeeping pad be provided, the contractor/installer shall assure that the pad extends no further than 6 inches from the front of the switchgear to prevent breaker lift truck interference. The concrete in front of the switchgear shall not interfere with the lower compartment door openings.
		4. The contractor/installer shall verify that the field measurements are as shown on the drawings.
		5. The contractor installer shall verify that the required site utilities are available, in the proper location and ready for use.
		6. Commencement of installation signifies that the installer accepts these conditions.
	1. **LOCATION**
		1. Refer to the project site drawings / equipment layout drawings / data sheets for details.

## INSTALLATION

* + 1. The contractor/installer shall have a minimum of 10 years documented experience in installing medium voltage metal-clad switchgear.
		2. The contractor/installer shall furnish and completely install the equipment as shown on the drawings per the manufacturer’s instruction books and/or drawing instructions.
		3. [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.]
	1. **FIELD TESTING AND COMMISSIONING**
		1. Field testing and commissioning (T&C) contractors shall have a minimum of 10 years of documented experience in testing and commissioning medium voltage ANSI metal-clad switchgear.
		2. All testing and commissioning is to be performed per the latest NETA and/or local requirements.
		3. When SwitchgearMDTM system is installed, the T&C contractor, owner or operator must record baseline data from temperature, humidity and partial discharge sensors at least 4 but no more than 24 hours after energization.
		4. For all digital switchgear applications, the T&C contractor shall follow the ABB ANSI MV Metal-clad Digital Switchgear Commissioning and Testing Guide.
		5. When the UFES system is provided, the contractor shall follow the testing guide as provided for the device.
		6. All active arc mitigation systems shall be tested in the field by the T&C contractor per the recommendations set forth in the relay and control unit installation, operation and maintenance manuals.

## FIELD QUALITY CONTROL

* + 1. The contractor/installer shall inspect the installed switchgear for anchoring, alignment, grounding and physical damage and remedy any discovered issues.
		2. The contractor/installer shall check tightness of all accessible mechanical and electrical connections with a calibrated torque wrench. Minimum acceptable values are specified in the manufacturer’s instructions.
		3. The contractor/installer shall test each key interlock system for proper functioning.
		4. The contractor/installer shall refer to the manufacturer’s instruction books for any required details.

## FIELD ADJUSTMENTS

* + 1. The contractor/installer shall adjust all access doors and operating handles for free mechanical and/or electrical operation as described in the manufacturer’s instructions.
		2. The contractor/installer shall refer to the manufacturer’s instruction book to make any adjustments to mechanisms, doors, handles, interlocks, etc,, as required.
		3. The contractor/installer shall refer to the Short Circuit and Coordination Study for the requirements to set all adjustable protective devices. The contractor/installer shall set all the devices to the values recommended in the coordination study, or as directed by the engineer/owner.
		4. Return “odd” or extra Kirk keys to the engineer/owner before energizing equipment.
	1. **CLEANING**
		1. The contractor/installer shall clean the interior and exterior of the equipment to remove construction debris, dirt, and shipping materials.
		2. The contractor/installer shall repaint scratched or marred exterior surfaces to match original finish.
	2. **TRAINING**
		1. [Manufacturer to provide x hours of switchgear operations training.] *(Note: Training is not included as standard.)*
		2. [Provide x hours of SwitchgearMD™ asset health monitoring training.] *(Note: This training is only required if SwitchgearMD is specified. Eight (8) hours training minimum is recommended.)*