

# Technical Specification

## Metal-clad Switchgear

This specification covers the basic design and functional requirements medium voltage metal-clad switchgear with vacuum circuit breakers and optional arc resistance. It is intended as a supplement to single line diagrams and data sheets for switchgear projects.

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## Introduction

This specification describes all standard and optional features of ABB's SafeGear and Advance metal-clad switchgear. References to arc-resistance relate to SafeGear only.

Technical data and dimensions can be found in the Reference Section. A set of data sheets is provided at the end of this booklet for simple specification of project details and for guidance through the selection of standard features and options. Duplication or photocopy of the data sheets is permitted.

The text below can also be used as a standard design specification for proposal or bid requests by following a simple procedure.

1. Select the applicable paragraph from those marked as "Choice" and erase those that do not apply.
2. Delete undesired paragraphs marked as "Option."
3. Remove the sidebars: "Choice" or "Option."

## Specification

This specification covers the general requirements for medium-voltage metal-clad switchgear.

Specific requirements are on the data sheets and the one-line diagram(s). In general, when resolving conflicting information, the following order of precedence shall apply:

1. One-line diagram(s)
2. Data sheets
3. This specification
4. Purchase Order
5. Other referenced specifications

## General Description

SafeGear and Advance Metal-clad Switchgear shall consist of metal-clad freestanding vertical structures. Modules and provisions shall include: circuit breaker compartments and circuit breakers, primary bus system, ground bus system, auxiliary compartments and transformers, protection and control devices, control bus (as required) and connection provisions for primary, ground and control circuits. System details are described in the attached data sheets and one-line diagrams.

SafeGear and Advance Metal-clad switchgear shall be of modular construction and available in one-high and two-high arrangements. Design features shall include: a system allowing connection of circuit breaker and auxiliary modules with the door closed, fully automatic primary and secondary disconnects, and assembly and module grounding utilizing a solid ground bus system throughout the equipment.

The lineup shall be extendable on either end by removal of the end dress panels and the main bus covers.

Accommodations shall be provided for Power RICH System, PRICOM Plus and Arc Guard.

- Choice:** Indoor applications shall be NEMA 1, indoor construction.  
Indoor applications shall be NEMA 1A, indoor gasket construction.  
Outdoor applications shall be NEMA 3R, walk-in outdoor construction.  
Outdoor applications shall be NEMA 3R, non walk-in outdoor construction.

## Applicable Documents and Industry Standards

ANSI/IEEE	C37.04	Standard Rating Structure for AC HV Circuit Breakers
	C37.06	Preferred Ratings for AC HV Circuit Breakers
	C37.09	Standard Test Procedure for AC HV Circuit Breakers
	C37.010	Application Guide for AC HV Circuit Breakers

	C37.011	Application Guide for TRV for AC HV Circuit Breakers
	C37.012	Application Guide Capacitance Switching
	C37.11	Requirements for Electrical Control
	C37.20.2	Standard for Metal-Clad and Station Type Cubicle Switchgear
	C37.55	Conformance Testing Procedure of Metal-Clad Switchgear
	C57.13	Requirements for Instrument Transformers
NFPA	70	NEC Code 1996 Edition
CSA	C22.2	Switchgear Assemblies
NEMA	CC1	Electrical Power Connectors
	SG-4	Standards for Power Circuit Breakers
	SG-5	Power Switchgear Assemblies NEC/NFPA
	250	Enclosures for Electrical Equipment
EEMAC	G8-3.2	Standard for Metal-clad and Station type Cubical Switchgear
	G11-1	Guide for the Measurement of Corona in Switchgear

#### Other Standards

PIP	ELESSG02	Medium Voltage Metal-Clad Switchgear
Municipal Code of Chicago		Relating to Electrical Inspection 1998
California Code of Regulations		High-Voltage Electrical Safety Orders

#### Arc-Resistance

**SafeGear Only** SafeGear shall be designed in accordance with the testing requirements of EEMAC G14-1 Type B for one-high construction.

For two-high construction, the switchgear shall be designed in accordance with the requirements of EEMAC G14 Type B with additional arc-resistance protection between adjacent vertical sections, and between circuit breaker and auxiliary compartments within the same vertical section.

**Option:** SafeGear metal-clad switchgear shall be of Type C arc resistance for one-high arrangements.

A flange shall extend along both sides and the top and bottom of each vertical section to maintain an arc-resistant seal. In case of an internal arc fault, all related exterior vents shall automatically close and pressure shall be directed through the roof of the unit.

Connections between frames shall be made only at auxiliary compartments, or shall use fittings and materials to prevent propagation of damage due to an internal arc fault.

### Standards for Arc Resistance Testing

ANSI	C37.20.7	Guideline for Testing of Metal-Enclosed Switchgear for Internal Arcing Faults
EEMAC	G14-1	Procedure for Testing the Resistance of Metal-clad Switchgear under Conditions of an Internal Fault

### Materials and Construction

The frame of SafeGear and Advance metal-clad switchgear shall be of modular construction, fabricated primarily from 14-gage Galvalume® material (zinc-aluminum over cold-rolled carbon steel).

Welded components or components that require greater than 14-gage material, shall be of carbon steel that has been phosphate treated and painted with ANSI 61 (gray) baked-on corrosion resistant epoxy enamel.

**Option:** The external surfaces of doors and panels shall be painted in color as specified in data sheets Painted surfaces shall be color \_\_\_\_\_.

Hem-bends (rigid overlap bending) shall be consistently used to enhance strength and to minimize potential exposures to sharp steel edges during installation and maintenance.

SafeGear shall be in accordance with NEMA 250, Type 12.

Advance shall be in accordance with NEMA 250, Type 1.

Switchgear shall be certified for Uniform Building Code (UBC) Seismic Zone 4.

## Circuit Breaker Module

### Circuit Breaker

The ADVAC circuit breaker shall be a 3-pole drawout type, vacuum circuit breaker, electrically operated, with electric motor and manual charging of a spring type stored energy operating mechanism. The breaker is a general-purpose device in accordance with applicable ANSI/IEEE standards in ratings of 1200 A, 2000 A and 3000 A.

Opening and closing speed shall be independent of the operator or of control voltage within the rated control voltage range.

Circuit breakers of the same type, rating and control circuits shall be electrically and mechanically interchangeable.

### Controls

Circuit breaker charge, close and trip circuits shall be electrically separate. Control voltages for each circuit shall be independently selectable from the full range of ANSI/IEEE preferred control voltages.

Manual provisions shall be provided for spring charging and breaker closing and tripping. These provisions shall be mounted and easily accessible at the front of the breaker.

The breaker shall have flags to indicate open or closed position, and spring charge status. Only the correct status flag for any single function shall be visible. Additionally, the breaker shall have a 5-digit, non-resettable operations counter.

All control devices shall be universal AC/DC, or DC supplied through rectifiers.

**Option:** Dual isolated direct-acting shunt trip coils shall be supplied for breakers as noted on data sheets, wired through separate secondary voltage sources for complete redundancy.

A direct-acting undervoltage trip shall be supplied for breakers. The undervoltage trip shall operate when the control voltage drops to the minimum value of the rated control voltage range.

#### **Auxiliary Contacts**

Up to 17 contacts shall be mounted on the circuit breaker and wired through the automatic secondary disconnect system. The standard switch configuration shall include (4) "a" contacts and (4) "b" contacts.

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.

**Option:** An optional (4-contact [2a, 2b]) (8-contact [4a, 4b]) truck-operated contact (TOC) actuator and switch assembly shall be provided to indicate when the breaker is in the fully Connected position, for each breaker as noted on project data sheets.

#### **Maintenance and Handling**

The operating mechanism shall be front-accessible. All routine maintenance shall be performed with the circuit breaker in an upright position. Circuit breakers shall have self-contained wheels designed for easy insertion, removal and transport on flat indoor surfaces.

#### **Circuit Breaker Accessories**

The following accessories shall be provided for each lineup: A hand crank for manually operating the circuit breaker, PT/CPT/drawout fuse racking system; a handle for manually charging the stored energy system on circuit breakers.

#### **Circuit Breaker Enclosure**

The enclosure door shall be securely held with tamper resistant hinges and a manual fastening system.

**Options:** Enclosure doors shall be provided with padlocking provisions. Locks shall be supplied by others.

The enclosure doors shall be provided with a single handle, multi-point latching mechanism for interrupting ratings up to 750 MVA.

The stationary support bushings and the primary contacts engage with an ADVAC circuit breaker or an optional Ground and Test (G&T) device. Standard bushings

shall be glass-reinforced polyester in 1200 A and 2000 A enclosures, and porcelain bushings in 3000 A enclosures.

**Option:** | All bushings shall be porcelain.

Auxiliary ring core type current transformer (CT) shall be located behind the shutters. They shall be bushing-mounted and accessible from the front. Bushings shall accommodate up to four standard accuracy CTs per phase for all ratings.

### ***Racking System and Interlocks***

The circuit breaker module shall include all necessary interlocks for proper sequencing and safe operation.

The racking system shall allow movement of the breaker with the door closed and have three distinct positions, in addition to the withdrawn position (free movement):

- ◆ Disconnected (both primary and secondary contacts disengaged),
- ◆ Test (primary contacts disconnected and shutter closed, but control contacts engaged) and
- ◆ Connected (primary and secondary contacts engaged).

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 positive positions shall be provided. Padlocks not included.

It shall not be possible to insert or withdraw a closed breaker. The breaker shall not be allowed to close within a cell unless it is in a positive Connected, Test, or Disconnected position.

Interference blocking shall prevent insertion of a lower rated breaker into a higher rated compartment.

All drawout modules shall have manually actuated locking devices to prevent inadvertently withdrawing a module from a compartment.

Grounding shall occur in the test position and shall be continuous during racking and in the connected position. Grounding shall be made by solid copper contacts connecting to a solid copper ground bus.

### ***Automatic Secondary Disconnect***

A single 25 pin fully automatic, self-aligning, secondary disconnect shall be provided as standard. The female portion of the disconnect system is inside the circuit-breaker enclosure, so that energized contacts are recessed and remain "touch safe."

**Option:** | A second 25 pin disconnect in a double arrangement with the standard disconnect (total of 50 pins) shall be provided.

## **Shutters**

Shutters shall cover primary contacts when the breaker is in the Disconnected or Withdrawn position. The motion of the circuit breaker truck or G&T device shall positively open or close the shutters independent of a gravity or spring return system.

Shutters shall be equipped with padlocking provisions in the closed position.

**Option:** | Dedicated wires shall ground the shutters. Insulated shutters shall be standard on all designs with a BIL rating greater than 95 kV.

The shutters shall be made of transparent Lexan.

## **Bus and Cable Compartments**

The main bus enclosure shall be separated from the other enclosures by an 11 gage steel barrier or equivalent and shall fully enclose the main bus.

The main bus enclosure shall be accessible from the rear through the cable compartment. Main bus ratings shall match the highest rated circuit breaker continuous current ratings and comply with ANSI temperature rise requirements.

**Choice**

| Split rear panels shall be bolted to the frame with standard grade 5 hardware.

| Rear panels shall be full height hinged panels with grade 5 hardware.

The primary cable-entry plates shall be easily removable. Advance Cable-entry plates shall be of aluminum. SafeGear cable-entry plates shall be non-magnetic stainless steel.

The entry plates shall be of Non-magnetic stainless steel.

Current transformers, lighting arrestors, surge capacitors, stationary control power transformers, ground sensors, or other stationary auxiliary equipment shall be mounted in the cable compartments as shown on the single line diagram and project data sheets.

**Option:** | A 10" rear extension shall be provided to accommodate additional equipment and power cable.

## **Bus Bars and Supports**

Bus bars shall be made of copper. The bus bars shall have full rounded edges. The main bus shall not be tapered. The main bus shall be in accordance with applicable ANSI self-cooled bus ratings.

**Choice**

| Connection joints shall be silver plated.

| Connection joints shall be tin plated.

Primary bus conductors shall be epoxy insulated, except at bolted joints. Bus joint covers shall be reusable for field inspection and maintenance.



Bus bar connections shall be mechanically secured with reusable fasteners that shall maintain adequate pressures within the operating temperature range of the switchgear.

Standard supports for 1200 A and 2000 A units shall be glass-reinforced polyester. Standard supports for 3000 A shall be porcelain.

**Option:** | All bus supports for shall be porcelain.

### **Termination Bus**

A termination bus shall be provided from the circuit breaker or switchgear primary disconnects to a location that allows cable connections to other equipment. Bus connections to cables and bus duct shall be rigid. Termination bus arrangement shall allow at least 36 inches for primary cable terminations and stress cones. Connections to roof entrance bushings shall be of flexible type. The self-cooled rating of the termination bus shall be in accordance with ANSI C37.20.2, Table 4 at 45°C.

The equipment shall be adaptable for top and bottom primary entrance arrangements, as specified on project data sheets.

**Options:** | The switchgear shall be supplied with cable lug boots.  
Vendor shall supply crimp or compression type cable lugs.

### **Ground Bus**

A copper ground bus, to which the entire metallic enclosure is solidly connected, shall extend through the length of the switchgear. The ground bus shall be accessible in the cable compartment and shall have connection points in each switchgear section.

### **Auxiliary Module**

Auxiliary enclosures shall be provided where necessary for mounting of auxiliary units such as potential transformers (PT), control power transformers (CPT) or primary current-limiting fuses for CPT.

### **Racking System**

Drawout units shall use the same racking system, accessories and solid grounding as the circuit breakers but without a Test position. Primary fuses shall be grounded in the Disconnect position and when withdrawn.

### **Arc-quenching Snuffer**

All primary contacts of auxiliary draw-out units shall be of the arc-extinguishing probe type. This contact shall minimize and suppress arcing at the primary contacts.

Terminal blocks for customer connections shall be provided in the auxiliary or the low voltage module.

The auxiliary enclosure bushings shall be glass filled polyester.

**Options:**

The bushings shall be porcelain.

A window shall be provided on the door to allow observation of drawout unit position with the door closed.

## Control and Protection

### Low Voltage Module

In general all protective relays, auxiliary relays, indicating instruments, recording instruments, indicating lights, transducers and all other secondary equipment shall be housed in a low-voltage module. Relays and instruments shall be provided and wired as specified on the project single line diagram and data sheets.

**Option  
Advance Only:**

A front extension shall be provided to allow door mounting of additional relays and instruments.

A multi-function, 3-phase microprocessor based relay and control package shall be used in two-high arrangements. Alternative relay types may be used in one-high configurations to the extent allowed by mounting space in the low-voltage enclosure.

Electromechanical meters, when used, shall be the flush-mount 1% accuracy taut-band switchboard type, with a minimum 250 degree scale.

### Current Transformers

CT ratings and accuracy shall be in accordance with ANSI/IEEE, C57.13 and C37.20.2. The CT winding shall terminate in a screw type terminal on the CT housing and shall be wired to shorting terminal blocks.

### Potential Transformers

Potential transformers shall be drawout type with ratings and accuracy in accordance with ANSI C57.13. PT's shall be fused.

### Interconnection

Control wiring shall be enclosed in a grounded metal wireway when routed through a high voltage compartment.

Control circuits shall incorporate all necessary switching and protective devices. Charge circuits and close and trip circuits shall be separately fused. Dead-front pullout fuse blocks shall be used for circuit protection and disconnect.

**Option:**

Sleeve type wire markers shall be provided at both ends of each wire.

Ends shall terminate with non-insulated ring-tongue terminals on screw-type terminal blocks, unless prohibited by the design of connection points on control devices. Terminal block screws shall use vibration-resistant hardware.

**Option:**

Ends shall terminate with insulated ring-tongue terminals.

## Power Distribution Center – Outdoor Enclosures

A Power Distribution Center (PDC) shall provide weatherproof housing for SafeGear and Advance metal-clad switchgear. The PDC shall be completely assembled for installation on a foundation. The PDC shall be metal-enclosed, completely dead-front and in accordance with the applicable sections of the standards listed above.

The PDC enclosure shall be for general-purpose applications.

### SafeGear Only:

When installed in a PDC, arc-resistant SafeGear shall be supplied in single row, walk in configuration with a plenum (available ratings 5 kV/250 MVA, 15 kV/500 MVA and 15 kV/750 MVA) that covers all roof-mounted vents.

In case of an internal arc fault the plenum shall vent gases and particles to a location outside and protect the PDC.

### Construction

The PDC shall be equipped with lifting lugs. The outer roof shall be sloped. All panels shall be double wall construction with interlocking seams. All exterior seams shall be gasketed or chalked.

The PDC shall be equipped with a personnel entrance door at each end.

The PDC shall have a front aisle of at least 36-inches width. The aisle floor shall be finished with a skid-resistant coating.

The PDC shall be equipped with a hood ventilation system and air intake louvers.

All PDC utilities shall be UL listed. Interior lighting shall consist of ceiling-mounted fluorescent fixtures, with 3-way switches located near each personnel entrance door. Wall-mounted duplex receptacles shall be provided.

Rear access to the switchgear shall be through hinged removable doors with padlock provisions, located directly behind each switchgear frame.

### Cable Entry and Equipment Connections

Bus duct or cable entry provisions shall be provided as required for power transformers and other equipment. An opening shall be provided under each vertical structure for conduit access. Covers shall be supplied for all floor openings.

### Finish

All interior and exterior surfaces shall be primed before application of the finish coating. Interior and exterior colors shall be as specified on project data sheets. The floor shall have a finish coat of ANSI 61, gray polyurethane enamel, with a non-skid additive.

### **Field Service**

The supplier shall provide the assistance of a factory-trained field service technician to support commissioning the equipment. The supplier shall provide a detailed summary of field service rates.

### **PDC Options**

The PDC has many optional features available. Some of the options available are:

- Air conditioning, heating, thermostat control and filtration systems
- Accommodation of seismic, special or unusual structural loading
- Professional Engineer's certification with structural calculations
- Aluminum or stainless steel construction
- External platforms, stairs and handrails
- Pressurization (Class 1, Division 2, Group D)
- Special lighting
  - Emergency
  - Outdoor
  - Incandescent interior
- Alarm horns and/or beacons
- Pneumatic door closers
- Rubber aisle mats
- Base undercoating and/or insulation
- Interior removable walls and doors for future expansion
- Windows or additional entry doors
- Toilet facilities
- Wall mounted lighting panel
- Fire suppression system
- Roof bushings, throats, bus duct, etc.
- Customized thermal insulation levels
- Thermal insulation

### **PDC Instruction and Maintenance Literature**

- Instruction books shall show the customer step by step installation instructions.
- Reassembly of shipping splits.
- Instructions on how to install shipped loose items.
- Methods of attaching skid to foundation.
- Recommended testing.
- Recommended cleaning and touch up of the building.
- A video showing all of the above

**Option:** |



## Options

### Kirk Key

A Kirk Key interlock system shall be provided in accordance with project data sheets and the single line diagram.

### Mimic Bus

A mimic bus applied to the front of the switchgear shall functionally represent the primary circuits. Mimic bus shall be made of automotive grade adhesive tape.

### Space Heaters

Space heaters shall be standard on outdoor equipment.

150 W, 120 V Space heaters shall be provided in each vertical section.

300 W, 240 V Space heaters, operating at 120 V, shall be provided each vertical section to reduce condensation.

Space heaters shall be separately fused for each vertical section or breaker, as applicable. Heater controls shall include disconnect switches, bypass switches, ammeters and thermostats.

## Optional Accessories

A transport and lifting device shall allow a circuit breaker, or auxiliary drawout unit [PT, CPT or fuse] to be elevated and then inserted or withdrawn.

An electrical test jumper shall connect the breaker to the switchgear control circuit while the breaker is completely out of the cell.

An electrical test cabinet with door-mounted open and close pushbuttons shall be supplied for testing the circuit breaker away from the switchgear.

Vendor's standard, manually operated, Ground & Test device shall be supplied for main bus and system grounding during maintenance.

**Choice:** G&T device shall be equipped with 3 terminals.

G&T device shall be equipped with 6 terminals.

A lifting yoke or similar device shall provide capability to overhead lift drawout modules.

Relay/test plug for each type of device, as applicable.

## Documentation

Standard Class I drawings shall consist of a system single line drawing; general arrangement, front view, floor plan, nameplate drawing and bill of materials.

Standard Class II drawings shall consist of Class I drawings plus 3-phase elementary and schematic diagrams. Standard Class III drawings shall consist of Class I and II drawings plus interconnection wiring diagrams.

Drawings shall be professionally prepared on AutoCAD release 12, or later, to the maximum extent practical and provided to the customer on disk, or on reproducible copies.

An instruction manual shall be provided with necessary information for receiving, handling, storage, installation, start-up and maintenance.

## **Testing and Certification**

Design tests, to verify ANSI/IEEE ratings as identified in this specification, shall be documented as required by ISO 9001 and available for review and inspection.

- Options** | The switchgear shall be UL certified.  
The switchgear shall be CSA certified.