S&C CUSTOM METAL-ENCLOSED SWITCHGEAR

INDOOR AND OUTDOOR DISTRIBUTION (4.16 KV THROUGH 34.5 KV)

Switchgear is crucial to maximizing your reliability and minimizing expenses. However, metal-clad and pre-engineered metal-enclosed switchgear options increase the risks of downtime and waste your money.

Introduction

S&C's Custom Metal-Enclosed Switchgear is a highly customizable, durable, and low-maintenance choice for your commercial and industrial facilities. Incorporating interrupter switches and power fuses in rugged monocoque enclosures, the gear permits you to tailor reliable, economical, medium-voltage switching and protection packages totally matched to your power distribution system requirements.

Contents

Available in ratings through 290 MVA at 4.16 kV, 960 MVA at 13.8 kV, 1080 MVA at 25 kV, and 1000 MVA at 34.5 kV, the custom switchgear is especially suited for those applications having unique requirements beyond the scope of typical pre-engineered metal-enclosed switchgear. For example, custom switchgear is often used when complex automatic source-transfer schemes are necessary, such as those involving three or more incoming power sources and using multiple split-bus sections or ring-bus arrangements.

Custom switchgear is also appropriate where special installation requirements must be satisfied, which is often necessary for transformer primary unit substations, and those applications requiring special-purpose components, which include grounding switches, control power transformers, extensive metering panels, capacitors for power-factor correction, etc. Unusual combinations of components, such as hot-sequence metering,

or particular floor-space restrictions that require unusual switchgear layouts–"U shaped" configurations for example—are also applications for which S&C Custom Switchgear is ideally suited.

For your medium-voltage systems through 34.5 kV, S&C Custom Metal-Enclosed Switchgear uses highly engineered, thoroughly tested, and field-proven switching, protection, control, and insulation components. These components are effectively integrated into an S&C enclosure of unmatched security, versatility, and durability.

With S&C Metal-Enclosed Switchgear, you are assured the components and enclosure selected to match your specific requirements are all built to exacting standards of quality by a single manufacturer. As a result, you receive an exceptional comprehensively engineered switching and protection package that ensures the unparalleled level of reliability you should demand for your power distribution system.

This superior performance is complemented by UL® and CSA listings of all S&C Metal-Enclosed Switchgear rated 4.16 kV and 13.8 kV with 600-ampere or 1200-ampere main bus, even including Category A enclosures when needed. S&C Custom Metal-Enclosed Switchgear is available with all types of S&C Power Fuses, including S&C SM-20, SM-40, SM-4Z, SM-5S, SM-5SS, and Fault Fiter® Electronic Power Fuses, which provide ratings through 720E amperes continuous. This broad choice of fuses provides a wide variety of ampere ratings and time-current characteristics to give you the utmost flexibility in meeting your protection and coordination needs.

For all three-phase switching duties, S&C Custom Switchgear offers a choice of field-proven, three-pole group-operated switches—Mini-Rupter® Switches and Alduti-Rupter® Switches. These switches cover the range of full-load switching through 1200 amperes with no external arc or flame and offer duty-cycle fault-closing ratings matched to the ratings of the entire switchgear lineup.

FIGURE 1. S&C Custom Metal-Enclosed Switchgear offers design flexibility with a choice of components tailored to each application. The lineup shown here in final assembly at S&C is configured to match the floor space at the installation. Lineups are completely factory-assembled and tested to facilitate installation in the field.

S&C Switch Operators provide power operation of these switches for automated switching applications. The switches with switch operators can be used for remote supervisory control or, in combination with S&C automatic control equipment, to implement power distribution systems featuring:

- Automatic source transfer using S&C Micro-AT® Source-Transfer Controls
- Source-side and load-side open-phase detection using S&C Open-Phase Detectors
- Protection from single phasing using S&C Over-current Relays.

S&C switches, switch operators, and source-transfer controls can also be incorporated into custom switchgear for implementing special sophisticated automatic switching schemes, such as fault-clearing on resistance-grounded systems, load shedding, and high-speed source transfer for use in combination with Uninterrupted Power Supply (UPS) systems.

The combination of interrupter switches for switching and fuses for protection eliminates the need for expensive circuit-breaker gear (metal-clad switchgear), particularly on cable distribution systems where the rare and permanent nature of the faults makes the Automatic Reclosing feature of circuit-breakers an unnecessary extravagance. The interrupter switches never need adjusting, setting, or dielectric testing. Only an occasional inspection and exercising is required.

The maintenance-proof fuses, unlike relays, never need setting or testing. With metal-enclosed switchgear, there are no batteries requiring special facilities and monitoring. The simplicity of metal-enclosed switchgear, its exceptional dependability, its low first cost, and its minimal maintenance cost make it the best choice for your system.

S&C has developed an inventory of engineering concepts and techniques compiled during more than 50 years of metal-enclosed switchgear design and manufacture. Sophisticated CAD/CAM computer systems further enhance efficiency and accuracy in the drawing preparation process and in the manufacturing process.

All custom switchgear uses proven components and construction techniques. Manufacturing is done in ultramodern facilities, including automated production methods using computer numerically controlled machine tools, many equipped with direct numerical control capabilities, as well as robotic welding systems, laser cutting centers, and electronically controlled finishing systems.

This sophisticated equipment produces accurately fabricated and finished components and matching assemblies of a classic quality not achievable with simple manual punching, forming, and welding equipment. The resultant switchgear is uniquely professional in every aspect. It meets your mechanical, electrical, and finish specifications while providing the ultimate in operating simplicity, flexibility, durability, and reliability.

S&C Custom Metal-Enclosed Switchgear can solve your power distribution problems, and it is especially valuable for those applications requiring special components and features not available in modular switchgear. The combinations of system circuitry and switchgear configurations you can use to achieve the desired level of economy, functionality, and power availability in medium-voltage switching and protection are virtually limitless.

To see how in-plant power distribution systems can be implemented using custom metal-enclosed switchgear, refer to S&C Information Bulletin 620-55. For assistance in selecting S&C Custom Metal-Enclosed Switchgear matched to your specific needs, contact your nearest S&C Sales Office.

Enclosure—Construction and Finish

Rely on S&C Custom Metal-Enclosed Switchgear to thwart the environment and the curious.

Metal-enclosed switchgear is often located in outdoor areas and is thereby exposed to all environmental conditions and to vandals. To keep out windblown rain, sleet, and snow and the unauthorized, S&C Custom Metal-Enclosed Switchgear for outdoor applications features a unique system of gasketing, sealing, and forming techniques to close off all openings, ensuring the interior remains dry and free of contaminants and eliminating points of entry.

All enclosures feature comprehensive access controls and security measures to guard against unauthorized entry. And, when specified, S&C Metal-Enclosed Switchgear provides the industry's highest standard of security for this class of equipment: Category A enclosures. Compliance with the Category A security requirements of ANSI/IEEE C37.20.3 was verified by conformance testing in accordance with ANSI C37.57 during UL certification of 4.16 kV and 13.8 kV switchgear. Many of the extraordinary sealing techniques and tamper-resistant features used to isolate the internal components from the environment and the curious are illustrated on pages 5, 6, and 7.

Guarding against corrosion is S&C's Ultradur® II Outdoor Finish, an unparalleled finishing system proven to provide lasting protection for outdoor gear. It's a high-performance comprehensive finishing system.

First, all steel surfaces are meticulously cleaned, phosphatized, and sealed in a fully automated multistage pretreatment process to improve the finish-to-metal bond and to resist rust.

Next, a cohesive, impenetrable, baked on, epoxy powder initial coating, the keystone for the exceptional durability of S&C's Ultradur II Outdoor Finish, is applied, followed by a superior high solids acrylic topcoat that ensures lasting protection against deterioration of the finish by ultraviolet radiation.

Then, an electronically monitored and controlled final bake produces the tough, beautiful finish, a dense, hard shield that's almost ceramic in appearance and performance. All hardware is protected against corrosion, too because it's galvanized, zinc-nickel plated, stainless, or of nonferrous materials.

To demonstrate the superiority of the Ultradur II Outdoor Finish over conventional finishes, it has been comprehensively tested using a battery of industry-recognized ASTM tests designed to evaluate the capabilities of protective coatings. All test results obtained for S&C's Ultradur II Outdoor Finish meet or exceed the requirements of applicable industry standards, including ANSI C57.12.28, as shown by the following highlights of test methods used and results obtained:

Salt-spray testing. The exceptional corrosion resistance of the Ultradur II Outdoor Finish is demonstrated by its ability to withstand at least 4000 hours of exposure to ASTM salt-spray testing while limiting underfilm propagation of corrosion to less than 1/32-inch (0.8 mm) from the scribe, and loss of adhesion from bare metal to less than 1/8-inch (3 mm) from the scribe.

Humidity testing. Confirming the outstanding finish-to-metal bond and resistance to moisture penetration achieved with the Ultradur II Outdoor Finish is its ability to withstand at least 1000 hours of exposure to ASTM testing with no blistering.

Ultraviolet accelerated weathering testing. The Ultradur II Outdoor Finish's superior resistance to weathering is corroborated by its ability to withstand at least 500 hours of exposure to ASTM weathering testing with no chalking and with less than 15% reduction in gloss.

Adhesion testing. Verification of the Ultradur II Outdoor Finish's remarkable resistance to scratching and chipping is demonstrated by its ability to withstand ASTM crosshatch adhesion testing with absolutely no loss of paint and by its ability to withstand ASTM impact testing using a 160-inch-pound impact by a pointed weight with no chipping or cracking.

Scab corrosion testing. The Ultradur II Outdoor Finish's corrosion resistance in severe environments such as coastal areas is validated in ASTM testing that shows its ability to limit corrosion creepback to less than 1⁄16-inch (1.6 mm) from the scribe without blistering or loss of adhesion after 35 cycles of exposure to various corrosive conditions.

Oil resistance. The Ultradur II Outdoor Finish exhibits excellent resistance to insulating oil (S&C Metal-Enclosed Switchgear uses in-air insulation but oil may spill from some other equipment). Immersion in mineral oil for 72 hours produces no changes, such as color shift, blisters, loss of hardness, or streaking.

Abrasion resistance. The Ultradur II Outdoor Finish's superlative resistance to wear (such as would be encountered during transit, handling, and installation) is demonstrated by its ability to be subjected to Taber Abraser testing for at least 3,000 cycles without wearing through to the substrate.

As proven by the ability to withstand this severe battery of tests and achieve results far surpassing industry standards, S&C has an outstanding finishing system for outdoor metal-enclosed gear. The Ultradur II Outdoor Finish resists deterioration to provide unequaled protection from the elements, which is a key factor in assuring enclosure integrity for enhanced security.

A **Channel gasketing** at interbay bus openings provides added protection against water entry

B **Gasket seals** at the top and side edges of adjoining bays keep water from entering between bays

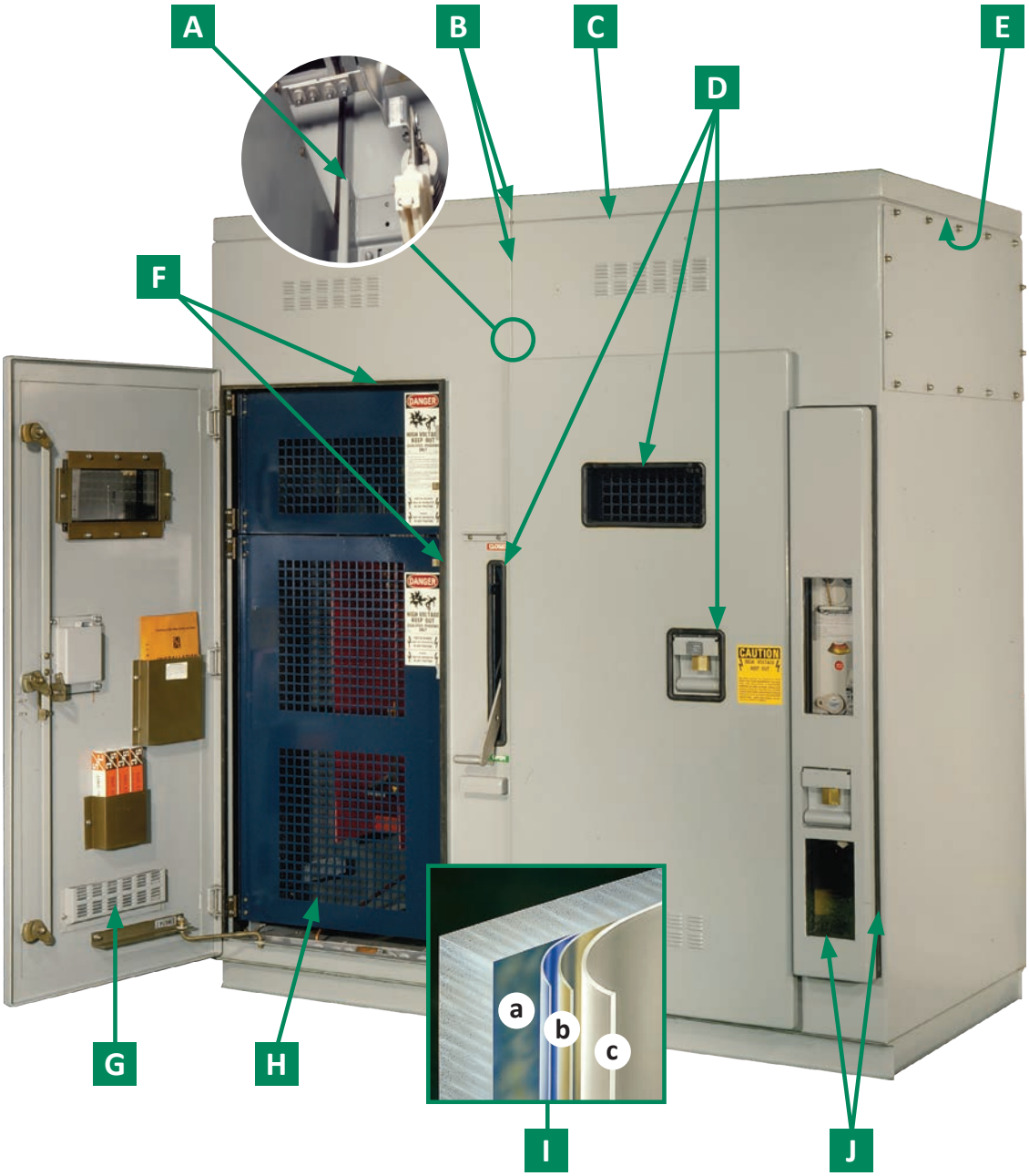

FIGURE 2. Outdoor S&C Custom Metal-Enclosed Switchgear has enclosures with the environmental checks to ensure service continuity in all atmospheric and weathering conditions. Some of the features that thwart the environment are described above; features providing structural Integrity and access control are described on pages 6 and 7.

C **Closed-cell gasketing** weather-seals the roof in place

D **Molded continuous gasket seals** handle and window openings, protects sheared edges

E **Insulating "no-drip" compound** on the inner underside of the roof checks condensation, and resilient compression gasket around door openings keeps water out

F **Durably resilient compression gasket** around door openings keeps water out

G **Rainproof vent construction** keeps water out but lets air circulate as an aid to moisture control. Baffles and screens inside the enclosures cover all vents and discourage wire-poking by the curious

H **Space heaters** (not visible) maintain air circulation inside the enclosure; they keep the air moving and help keep the interior dry

I **S&C's exceptional Ultradur II Outdoor Finish** protects the steel with:

a. A multistage pretreatment process of high-pressure spray cleaning, rinsing, phosphatizing, and sealing

b. A durable, baked on, epoxy powder initial finish coat

c. For outdoor switchgear, a tough, stable high solids acrylic topcoat

J **Gasket covers** with sealants at window edges guard against water entry to electronic controls and switch operators

Whatever your system, you'll have greater service continuity and operating flexibility by ensuring your switchgear has all these features.

S&C Custom Metal-Enclosed Switchgear features monocoque construction. Each bay is fabricated from 11-gauge steel sheet and is a freestanding unit with an integral steel-channel base around the four sides. The accurately formed, matching enclosures ensure perfect alignment in multibay assemblies.

Because of the cellular design, there are always double walls between the adjoining bays. There are no externally bolted-on side sheets, rear sheets, or roofs to attract a vandal to S&C outdoor gear.

Even future bus extensions are secured internally. By design, the gear discourages the inquisitive. To guard against poking and prying, corners of doors and door openings are welded, latching mechanisms use a cam action to pull doors tightly closed, and handles are flush-mounted. Enclosures specified with Category A construction include additional features, such as window covers, handle covers, and the S&C Penta-Latch® Mechanism, to provide the industry's highest standard of security for this class of equipment.

Enclosures are designed for complete front accessibility, except where unusual combinations of components require an extra-deep bay, so S&C gear may be placed back-to-back or against a wall. It fits in a minimum of floor space. And because it's unquestionably rugged yet light by comparison to circuit-breaker gear, only a level floor or pad is required for installation, never a foundation or support channels. It can be installed anywhere, even on balconies or outdoors on rooftops.

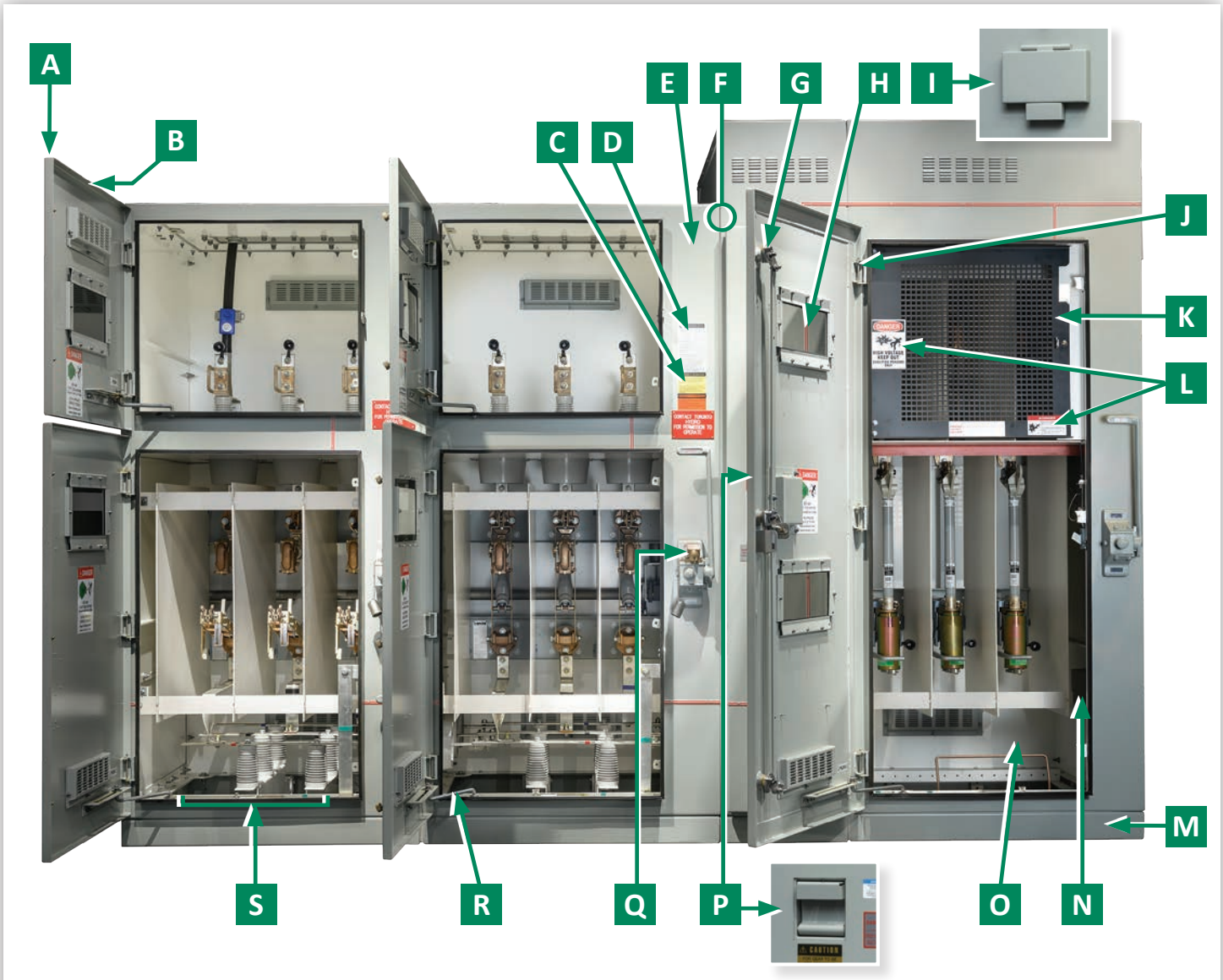

FIGURE 3. Highlighted above are the many features of S&C Custom Metal-Enclosed Switchgear, including those that provide structural integrity, resistance to the environment, and access control necessary to assure enclosure security. Testing by UL of 4.16-kV and 13.6-kV switchgear has confirmed conformance with ANSI standards on enclosure security, including the requirements for Category A enclosures when specified. And this is all in addition to the environmental checks described on pages 4 and 5.

A Wide bulkhead-type doors provide for easy access to all bays.

B Deep 90-degree flanges on the extra-rugged doors ensure rigidity and discourage tampering. Sheared edges are folded back toward the inside of the door to limit exposure, helping prevent corrosion.

C Exterior signage alerts to hazards.

D Nameplate provides ratings of the switchgear assembly.

E 11-gauge steel is used for roof, side, and rear sheets, front, and door.

F Full side sheets for each bay result in double-wall construction between bays.

G Three concealed, high-strength latches seal the doors shut.

H Wide-view windows that are both impact- and mar-resistant facilitate checking of switch positions, blown fuse indicators, and status of controls without opening the doors.

I Padlockable window covers are included on Category A enclosures.

J Full-length doors have three concealed, extra-heavy-duty hinges with stainless steel pins that won't corrode so the doors pivot with ease.

K Protective screen doors bolt closed and serve as a second barrier guarding against inadvertent entry to bays containing medium-voltage components.

L Interior hazard-alerting signs are unmistakably bold and clear.

M Integral steel base around all four sides of each bay keeps enclosure rigidly positioned and helps block interbay openings at bottom of bay.

N Storage racks keep replacement fuse components in a convenient location.

O There's an exceptional amount of room for pulling cable and making terminations.

P Padlockable handles on doors and covers shield the padlock shackle and thwart tampering by vandals. Enclosures specified with Category A construction use S&C's Penta-Latch Mechanism, providing coordinated latching and padlocking on door handles. Storage racks keep replacement fuse components in a convenient location.

Q Key interlocks and padlocks help control access to medium-voltage compartments.

R Self-latching door holders securely hold the doors open against accidental or windblown closing, and they unlatch with a touch of the toe for closing.

S Low-voltage wiring is in grounded cable trays isolated from medium voltage.

Components

S&C Custom Metal-Enclosed Switchgear offers an extensive selection of standard S&C components, allowing you to tailor a switchgear package to your switching and protection needs.

S&C Interrupter Switches are completely factory adjusted and perform the full spectrum of live switching duties, including duty-cycle fault-closing matched to the rating of the switchgear.

Cypoxy™ Insulators that use S&C's cycloaliphatic epoxy resin system insulate all live parts from ground. Cypoxy Insulators are nontracking, self-scouring, and nonweathering, and they have extremely generous leakage distances.

S&C medium-voltage power fuses (Type SM Power Fuses and Fault Fiter® Electronic Power Fuses) provide full-fault-spectrum protection. Fuses rated through 720E amp are available.

Aluminum bus connections are wire-brushed and coated with an oxide-inhibiting compound, and then bolted to a uniform torque of 50 ft.-lbs. with two spring-steel washers per bolt to maintain optimum contact pressure.

Nonremovable front-operated switch operating handles for manually operated switches are readily accessible for immediate use, and they are padlockable whether switch is open or closed. Handle covers are also available.

Switch operators provide power operation; models are available with high-speed stored-energy switching and with convenient decoupling to permit exercising plus full checkout of automatic control schemes.

Continuous ground bus in multibay lineups has a short-circuit rating equal to that of the integrated assembly.

Grounding provisions matched to the short-circuit rating of the gear are conveniently located "up front" on the ground bus and lower terminal of each fuse mounting, switch, or bus-tap section for easy access and installation of grounding clamps.

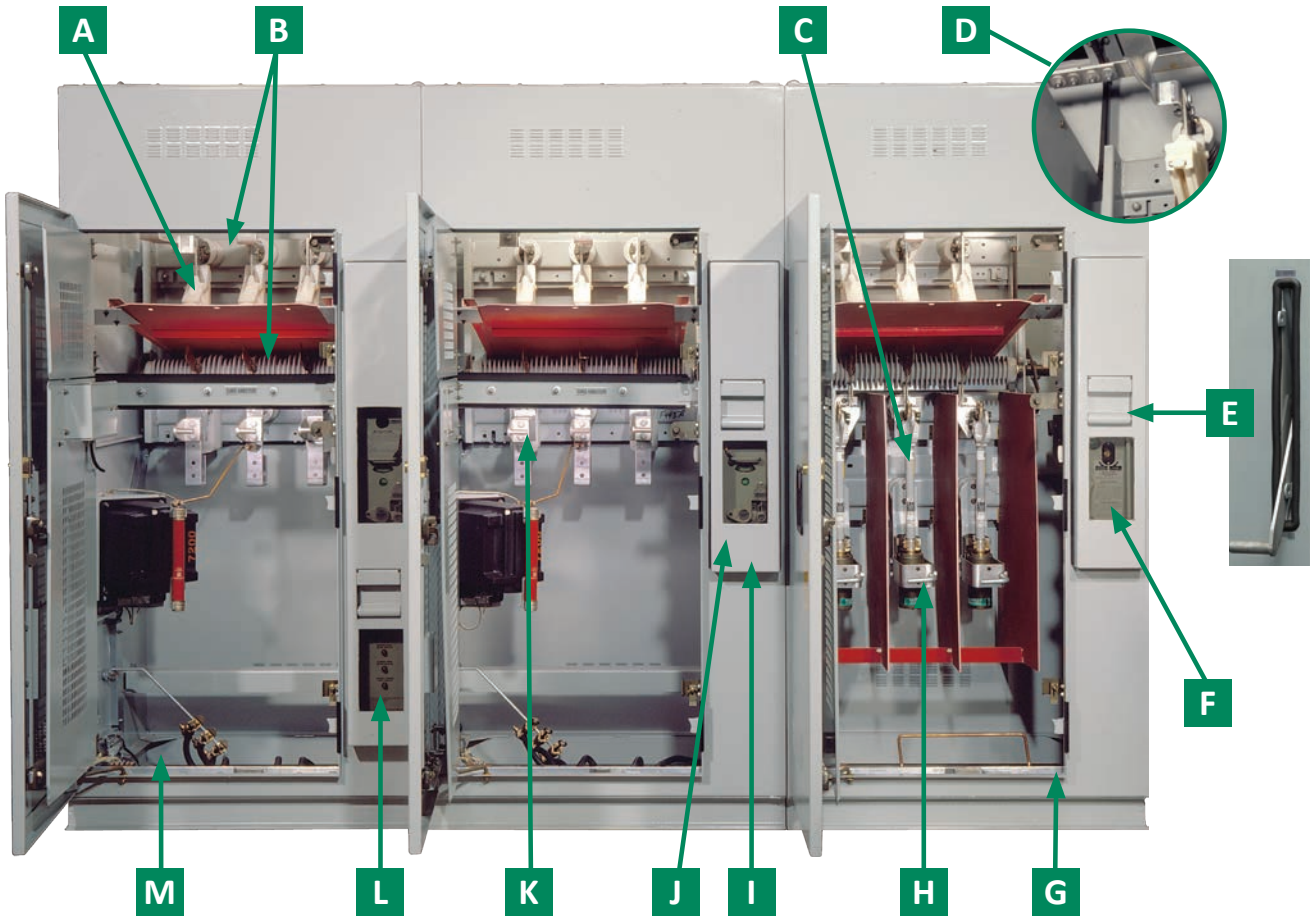

FIGURE 4. Illustrated above is a typical lineup of custom switchgear featuring many of the available standard components. A variety of S&C switch, fuse, and electronic components are highlighted.

Hinged protective covers for low-voltage components are permanently attached to gear to avoid becoming contaminated, damaged, or lost. Access to controls is achieved without exposure to medium voltage.

Internal covers (not visible) inside bays isolate low-voltage components from medium voltage.

S&C Voltage Sensors for sensing loss of voltage in source-transfer and open-phase detection schemes.

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K S&C Voltage Sensors for sensing grounded systems in source-transfer and open-phase detection schemes.

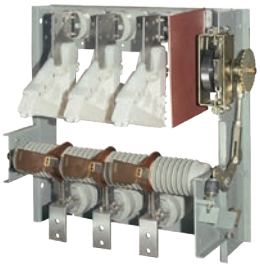
L Automatic controls, including Micro-AT® Source-Transfer Controls, ZSD Overcurrent Relays, and SPD Open-Phase Detectors, in grounded metal-enclosed low-voltage compartments isolated from medium voltage.

M Ground cable connectors (not visible) at each end of lineup permit connecting ground bus to station ground.

S&C switches, fuses, switch operators, and electronic controls are exhaustively tested and field-proven to ensure the utmost in reliability for your switching and protection systems.

S&C Interrupter Switches handle all live-switching duties and feature duty-cycle fault-closing ratings, a requisite for automatic control schemes.

Mini-Rupter Switch (pictured), rated to 600 amperes continuous and interrupting.



Alduti-Rupter Switches, rated to 1200 amperes continuous and interrupting, are also available.

S&C Type MS Switch Operators (pictured) provide automatic Trip Open operation and a choice of manual or automatic Trip Closed operation. These operators are specially designed for high-speed operation of Mini-Rupter Switches—circuit interruption in 4 cycles, automatic transfer as fast as 10 cycles. AS-30 Switch Operators are also available for Alduti-Rupter Switches.

SM Power Fuses are offered in a wide variety of ampere ratings and time-current characteristics, permitting close fusing ratios for optimal coordination and maximum protection. Their time-current characteristics are precise and permanently accurate.

Type SM-40 Power Fuse (pictured), 400 amperes max continuous.

Other Type SM Power Fuses are available in rating from 200 through 720 amperes max and continuous.

Fault Fiter Electronic Power Fuses, with their exceptional TCC versatility and higher continuous current ratings, provide features and performance previously unavailable in any other protective device.

Fault Fiter fuses have ratings of 600 amps max continuous with an interrupting rating of 61,000 amps RMS Asymmetrical.

S&C Electronic Relays applied on individual load feeders protect three-phase loads from single-phasing resulting from blown fuses and other Open Phase conditions.

Micro-AT Source-Transfer Controls combine standardized designs, including a wide choice of options, with solid-state reliability and the power and versatility of microprocessor electronics. They're the complete control package for most automatic transfer needs. Custom controls are available to meet special automation requirements.

FIGURE 5. A sampling of S&C components available In S&C Custom Metal-Enclosed Switchgear. For additional information on S&C components, consult the nearest S&C Sales Office.

Accessories

Custom accessories are engineered by S&C's experienced team of specialists to meet your specific application parameters.

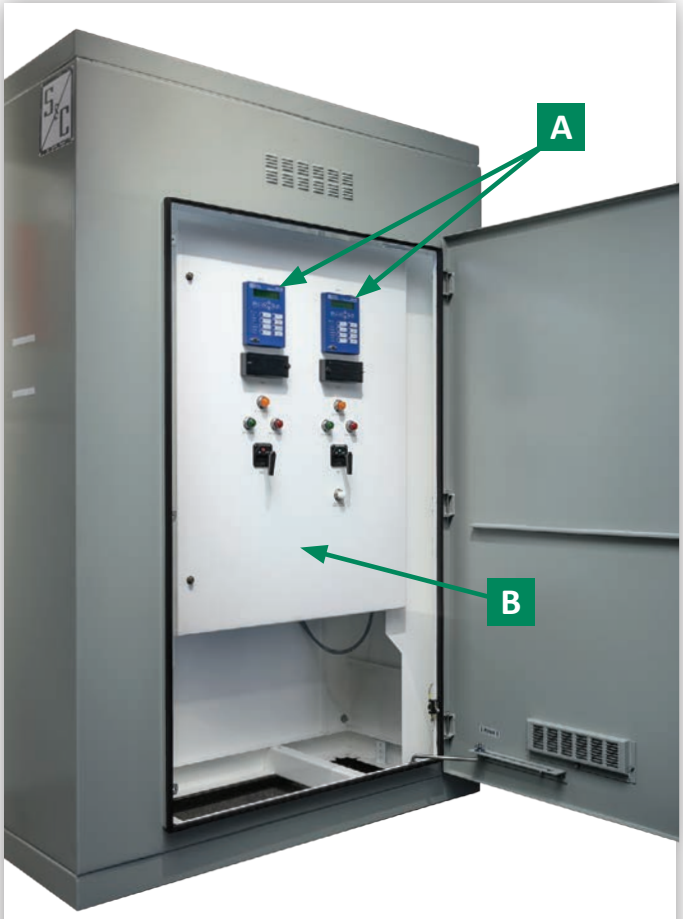


FIGURE 6. A hinged panel is designed with an array of relays to implement feeder-protection and control schemes.

A Feeder-protection relays with time and instantaneous overcurrent provide ground-fault sensing for resistance-limited ground-fault switching.

B Hinged panel permits complete access to relays, which are isolated from medium voltage.

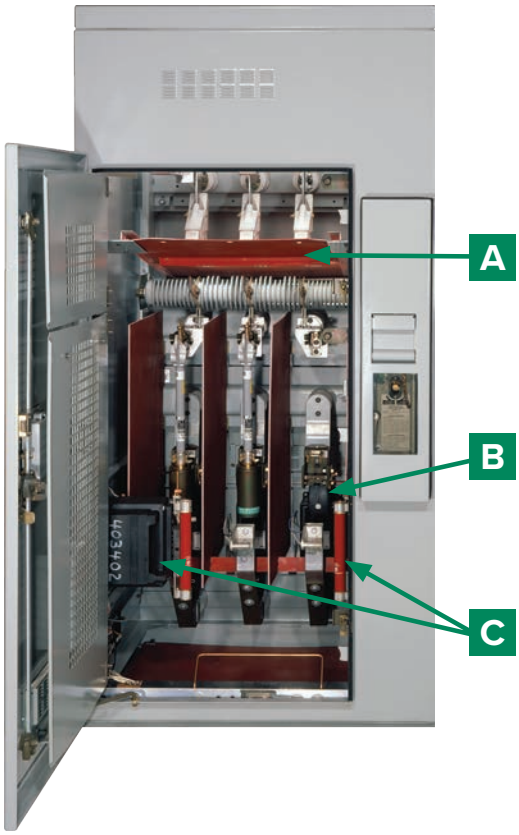


FIGURE 7. A custom, power-operated, outdoor feeder bay with an interrupter switch and power fuses features a slide-in barrier and metering transformers in a 90-inch (229-cm) high enclosure.

A **Slide-in barrier** prevents inadvertent access to the energized bus while accessing cables (protective screen open for clarity), terminations (not shown), current transformers, voltage transformers, and fuses when lower terminal of fuses are de-energized and grounded.

B **Current transformers** (wound type) for revenue metering are mounted behind fuse terminals.

C **Fused voltage transformers** are used in 2½-element metering scheme.

FIGURE 8. Three-bay, custom, power-operated, indoor, switchgear assembly with remotely operated interrupter switches in left-hand and center bays and a mechanical cam interlock in the center bay for sequencing of switch operations. Bay at right is a bus-tap entrance with low-voltage components at the bottom.

A **1200-ampere grounding switch**

B **Mechanical cam interlock** ensures the entrance interrupter switch in the left-hand bay or grounding switch in the center bay is always closed. Circuit is always grounded when entrance interrupter switch is open.

C **Low-voltage controls** provide automatic transfer between external preferred and alternate control-power sources. Isolating switches are interlocked to de-energize low-voltage circuits before accessing compartment, and a sequential switching circuit provides electrical nonparalleling of the interrupter switch and grounding switch.

D **Switch operators** provide power operation for remote supervisory control of interrupter switches.

Design Flexibility

With S&C Custom Metal-Enclosed Switchgear, you can develop a virtually unlimited array of configurations specially tailored to the application.

Fifteen bays of S&C Custom Metal-Enclosed Switchgear (see **Figure 9**) are arranged in an "L" configuration and serve as a power-operated split-bus primary-selective service-entrance switching center. Automatic switching of the two source switches and the bus-tie switch by means of S&C Switch Operators and an S&C Source-Transfer Control ensures service continuity for the feeder circuits. Normally, the bus-tie switch is open and the bus sections receive power from independent sources. Should one source circuit fail, the associated switch is automatically opened and the bus-tie switch is automatically closed, with the remaining source then serving all loads. Current sensors and voltage transformers provide sensing and control power for source-transfer control and switch operators. The switchgear assembly also includes S&C Fault Fiter Electronic Power Fuses and other features providing enhanced flexibility and operating convenience.

FIGURE 9. Fifteen bays arranged in an "L" configuration.

The manual, primary-selective, eight-bay lineup of S&C Custom Metal-Enclosed Switchgear (see Figure 10) is configured in a split-bus arrangement. Each bus section is supplied power through a normally closed incoming switch, with the bus-tie switch normally open between bus sections. Three-phase load circuits are switched and protected by power-operated S&C Interrupter Switches with Power Fuses. Automatic Trip Open operation of these switches is initiated by S&C Open-Phase Detectors on single-phasing resulting from blown feeder fuses or from source-side open-phase conditions at the same system voltage as the metal-enclosed switchgear. Three-phase voltage sensing for each power-operated switch is provided by S&C Voltage Sensors. Manually operated S&C Interrupter Switches with Power Fuses switch and protect single-phase load circuits. Provisions for future bus extensions are included.

FIGURE 10. Eight-bay lineup.

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