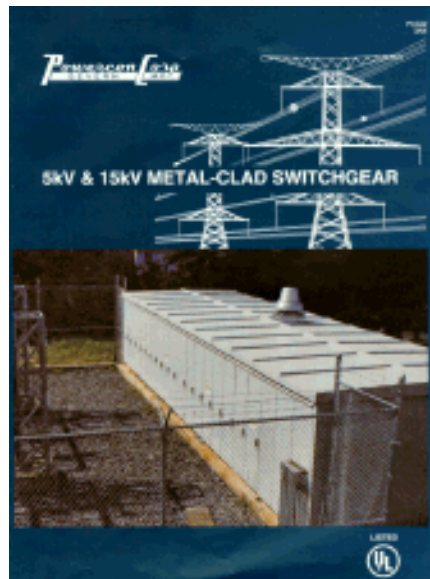


POWERCON CORPORATION



5kV & 15kV METAL-CLAD SWITCHGEAR BROCHURE #PC042

ELECTRONIC VERSION CREATED: 6/30/96

**Powercon Corporation
P.O. Box 477
1551 Florida Avenue
Severn, Maryland 21144
Baltimore: 410-551-6500
Washington: 301-621-7400
Fax: 410-551-8451
email: info@powerconcorp.com**

METAL-CLAD VACUUM SWITCHGEAR

This bulletin describes Metal-Clad Switchgear - one of Powercon's Switchgear product lines.

This advanced switchgear line is completely factory built, wired and assembled. Each cubicle may contain the circuit breaker, bus bars, primary and secondary disconnecting devices, instrument transformers, instruments and relays, secondary wiring and other necessary components. The switchgear is designed so that additional circuit breaker or auxiliary cubicles may be added in the future.

The Circuit Breaker

- Vacuum interrupters with stored energy operating mechanism
- Primary disconnecting devices
- Auxiliary switches
- Ground contacts
- Control wiring
- Interlocks

In addition to the standard equipment described, custom engineered switchgear is offered to meet individual purchaser needs.

With a highly skilled professional engineering manufacturing team, an organizational entity has been developed to provide the material and services our customers require. The engineering staff - application product design - development - manufacturing - has achieved the extensive system experience and knowledge required in the

application, manufacture, delivery, and service of Power Systems Switchgear.

This product is the result of seasoned technical efforts combined with the well versed, skilled competent, veteran work force exerting their combined efforts to provide the best in service and equipment.

Our membership in NEMA, ANSI and IEEE keep us up to date on the ever changing standards so that we meet today's exacting demands.

An all inclusive METAL-CLAD equipment designed, built and tested to the applicable industry standards shown in Table 1.

PORCELAIN (the near ultimate in insulation) for all live part supports including the circuit breaker itself, is available.

Compartmented cable, bus, fuses, voltage and auxiliary transformers.

An interlock system to:

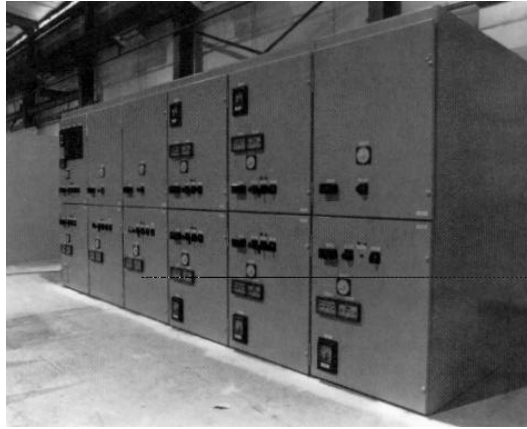
- Prevent breaker closing except in "connect", "test", or "disconnect" position.
- Interference for prevention of any but proper breaker to be inserted in cell.
- Spring discharge prior to removal from cell.

(For Guide Specifications - See Publication PC-029)

Table 1 - Applicable Industry Standards

American National Standards Institute (ANSI) 70 East 40th Street New York, New York 10017		National Electrical Manufacturers Association (NEMA) 2101 L Street N.W., Suite 300 Washington, D.C. 20037	
Standard No	Description	Standard No.	Description
C37.04	CA High-Voltage Circuit Breaker Rating Structure	SG-2	High Voltage Fuses
C37.06	Preferred Ratings of AC High-Voltage Circuit Breakers		
C37.09	Test Procedures for AC High-Voltage Circuit Breakers	SG-4	Power Circuit Breakers
C37.010	Application Guide for AC High-Voltage Circuit Breakers		
C37.11	AC High-Voltage Circuit Breakers Control Requirements	SG-5	Power Switchgear Assemblies
C37.20.2	Switchgear Assemblies and Metal-Enclosed Bus		
C37.100	Definitions of Power Switchgear		

HORIZONTAL DRAWOUT



15kV 500MVA Indoor Line-Up

Preferred Ratings for Indoor Oilless Circuit Breakers
Table 2 - ANSI C37.06 - 1987

Rated Max. Voltage (1) kV, ms	Rated Voltage Range Factor K (2)	Rated Continuous Current at 60Hz (3) Amperes, rms	Rated Short-Circuit Current (at Rated maximum kV) (4) (5) (6) (9) AK, rms	Rated Interruption Time (7) Cycles	Rated Max. Voltage Divided by K kV, rms	Max. Symmetrical Interrupting Capability and Rated Short-Time Current (4) (5) (8) kA, rms	Closing and Latching Capability 2.7K times Rated Short-Circuit Current, (4) kA, Crest
4.76	1.36	1200	8.8	5	3.5	12	32
4.76	1.24	1200,2000	29	5	3.85	36	97
4.76	1.19	1200,2000, 3000	41	5	4.0	49	132
8.25	1.25	1200,2000	33	5	6.6	41	111
15.0	1.30	1200,2000	18	5	11.5	23	62
15.0	1.30	1200,2000	28	5	11.5	36	97
15.0	1.30	1200,2000, 3000	37	5	11.5	413	130
38.0	1.65	1200,2000, 3000	21	5	23.0	35	95
38.0	1.0	1200,3000	40	5	38.0	40	108

For service conditions, definitions, and interpretations of ratings, tests, and qualifying terms, see ANSI/IEEE C37.04-1979, ANSI/IEEE C37.09-1979, and ANSI/IEEE C37.100-1981.

Current values have been rounded off to the nearest kilo-ampere (kA) except that two significant figures are used for values below 10kA.

(1)The voltage rating is based on ANSI C84.1-1982, where applicable, and is the maximum voltage for which the breaker is designed and the upper limit for operation.

(2)The rated voltage range factor, K, is the ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical current interrupting capabilities vary in inverse proportion to the opening voltage.

(3)The 25-Hz continuous current ratings in amperes are given herewith following the respective 60Hz rating: 600-700; 1200-1400; 2000-2250; 3000-3500.

(4) Related Required Capabilities The following related required capabilities are associated

with the short circuit current rating of the circuit breaker.

(a) Minimum symmetrical interrupting capability (kA, rms) of the circuit breaker is equal to K times rated short circuit current.

(b) 3-second short time current carrying capability (kA, rms) of the circuit breaker is equal to K times rated Short-Circuit current.

(c) Closing and latching capability (kA, rms) of the circuit breaker is equal to 1.6 K times rated Short-Circuit current. If expressed in peak amperes, the value is equal to 2.7 K times rated short circuit current.

(d) 3-Second short-time current carrying capability and closing and latching capability are independent of operating voltage up to and including rated maximum voltage.

(5) To obtain the required symmetrical current interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum voltage and rated maximum voltage, the following formula shall be used:

$$\text{Required symmetrical current interrupting capability} = \text{rated short circuit current} \times \frac{\text{rated maximum voltage}}{\text{operating voltage}}$$

For operating voltages below 1/K times rated maximum voltage, the required symmetrical current interrupting capabilities of the circuit breaker shall be equal to K times rated short circuit current.

(6) With the limitation stated in 5.10 of ANSI/IEEE C37.04-1979, all values apply for poly-phase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in 5.10.23 of ANSI/IEEE C37.04-1979 apply.

(7) The ratings in this column are on a 60-Hz basis and are the maximum time interval to be expected during a breaker opening operating between the instant of energizing the trip circuit and interrupting of the main circuit on the primary arcing contacts under certain specified conditions. The values may be exceeded under certain conditions as specified in 5.7 of ANSI/IEEE C37.04-1979,

(8) Current values in this minimum are not to be exceeded even for operating voltages below 1/K times rated minimum voltage. For voltages between rated maximum voltage and 1/K times rated maximum voltage, follow (5) above.

(9) Rated permissible tripping delay time (Y) = 2 seconds.

METAL-CLAD SWITCHGEAR HORIZONTAL DRAWOUT

See Guide Specifications - See Publication PC-029

It Consists Of:

- Framework of welded steel
- Sheet steel enclosure, including a hinged front door, which may be used as an instrument panel
- Compartment and inter-unit barriers
- Three-phase insulated bus and connections
- Porcelain bus supports available
- Stationary primary disconnecting devices
- Stationary secondary disconnecting devices
- Circuit breaker racking-in device
- Circuit breaker interlocking device
- Instruments and relays
- Control wiring
- Terminal blocks
- Instrument transformers
- Provision for connecting main cable
- Guide rail on floor of structure
- Wiring channels
- Control cut-outs

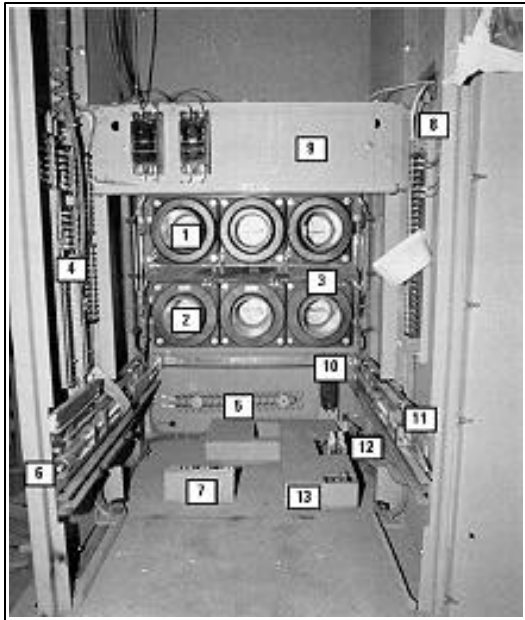
The breaker, bus, potential transformers, current transformers and cables all have their own compartments. And, each function is isolated by rugged partitions.

Powercon metal-clad provides the value of a superior insulation system at vital points, and greater structural strength from a rugged all-welded steel frame.

Relays and instrumentation are mounted on the front door so that the breaker can be removed or inserted without damaging a relay.

Guide rails are provided so that the breaker will roll into proper position in the cubicle. The mechanism assures perfect alignment when the breaker is racked into its operating position.

Porcelain - The Ultimate In Insulation



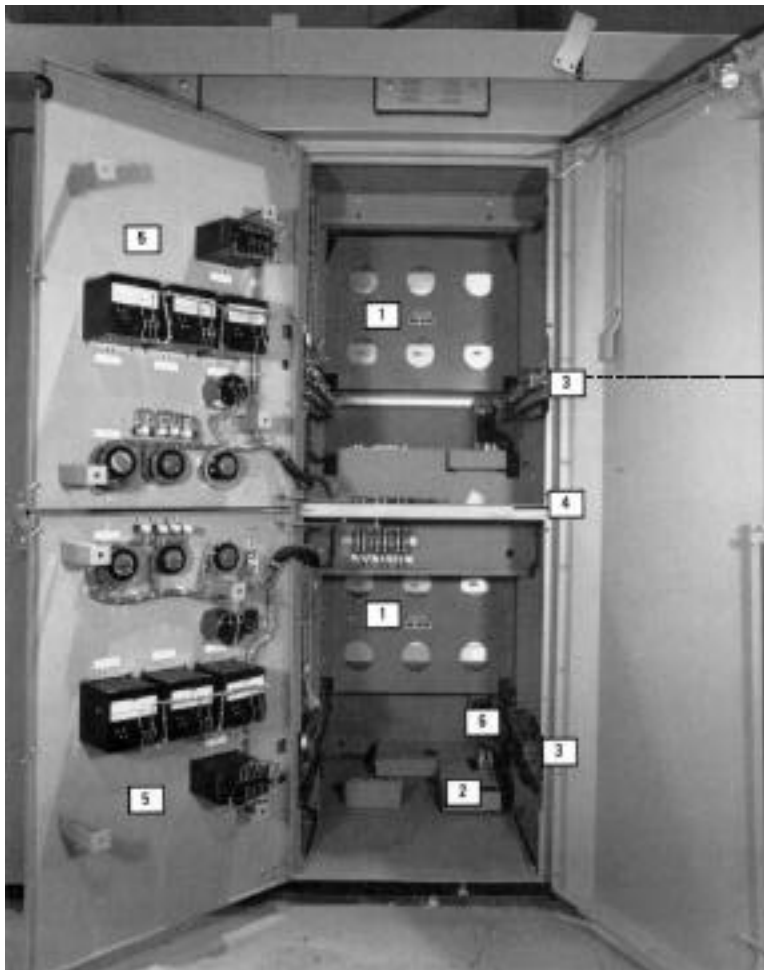
LOWER BREAKER COMPARTMENT CONSTRUCTION
FRONT VIEW - DOORS, SHUTTERS AND SHUTTER
ISOLATION BARRIERS REMOVED

UPPER COMPARTMENT SIMILAR IN CONSTRUCTION WHEN
REQUIRED

1. Upper Primary Disconnects
2. Lower Primary Disconnects
3. Current Transformers
4. Secondary Terminal Blocks
5. Heaters
6. Racking Mechanism
7. Interference Plate
8. Lower Wireway
9. Device Panel
10. Secondary Stationary Coupler
11. Rollout Rails
12. Breaker Ground Shoe
13. Stationary Auxiliary Switch

NOTE: This construction for GE Breaker - functionally similar construction for Westinghouse and Siemens ALL 3 ARE UL LISTED BY POWERCON

WITH A *SUPER STRUCTURE*



FRONT VIEW - BREAKERS REMOVED

1. Auto Shutters
2. Breaker Auxiliary Switch
3. Breaker Rails
4. Metal Partition
5. Relay Doors
6. Ground Shoe

METAL-CLAD SWITCHGEAR WITH A

The Vital Link to Dependable Power

THE CONDUCTORS

All bus systems are designed with either copper or aluminum conductors. The Aluminum bus system weighs less than the electrically equivalent copper bus system. Both copper and aluminum conductors are plated to improve joint contact and to reduce corrosion.

Selection of conductor material, whether it be aluminum or copper is most important. The correct temper and conductivity is extremely critical and is specified by the Engineering Group to be held within exacting tolerances.

THE INSULATION SYSTEM

The insulation system is of equal importance. It is nominally designed to withstand 40,000A (or more) asymmetrical short circuit but is dependent upon Customer requirements. It is designed and manufactured to ANSI standards and has an ANSI Class 105 degree C temperature limit.

Powercon's bus insulation system is a family of carefully selected and applied materials that have resulted from many years of experience. Detailed laboratory and field-proof testing, as well as in-service experience have confirmed the critical engineering considerations necessary to insure a reliable insulation system. Such factors include but are not limited to:

- Dielectric strength and moisture absorption under 100% humidity and cycling conditions.*
- Insulation power factor considerations under varying conditions.*
- Flame retardance.*
- Mechanical and thermal strength - shock characteristics under normal operating conditions, fault conditions, and possible shipment problems.*
- Dimensional and electrical creep under normal operating conditions.*

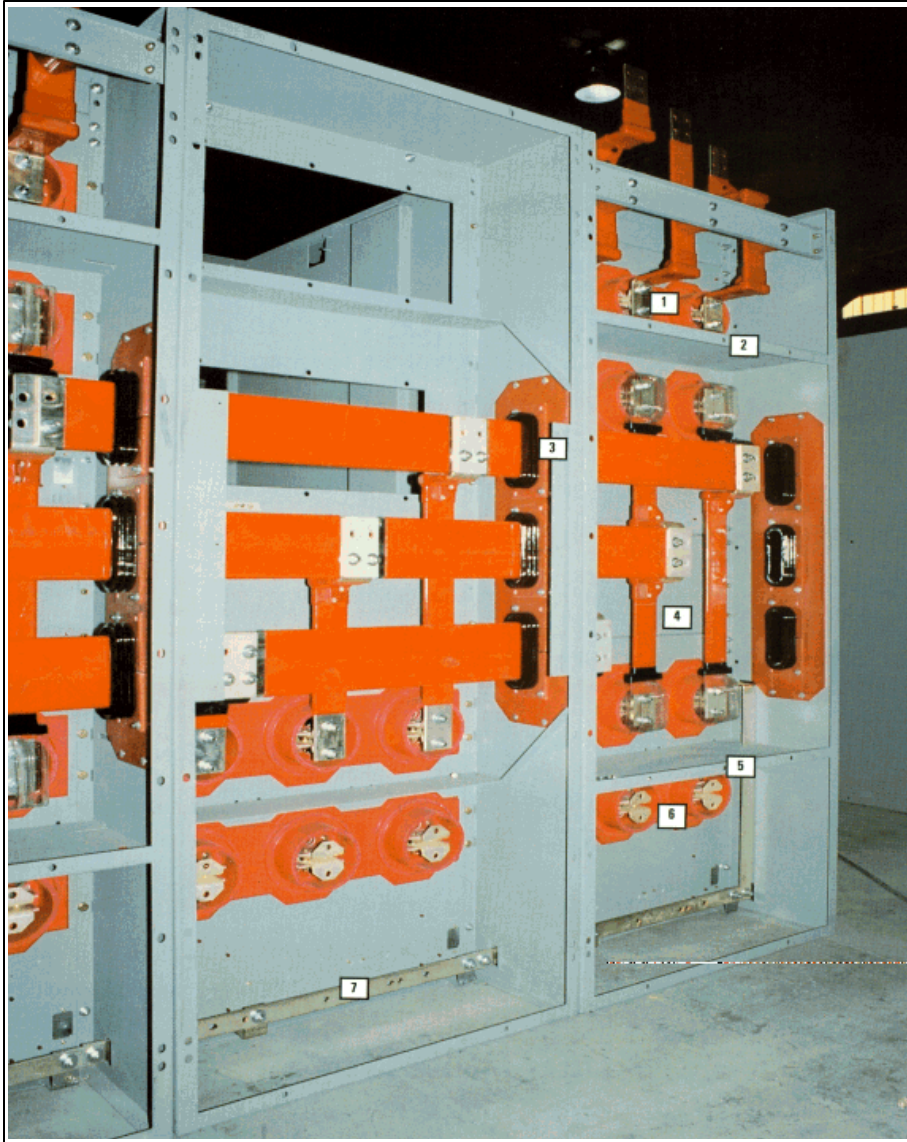
SAFETY AND RELIABILITY

Safety in power distribution is of the utmost importance. In order to achieve a high degree of safety, the bus is completely metal-enclosed with all live parts isolated and fully insulated. The enclosure is tied into the switchgear ground bus.

Reliability is achieved through a coordinated engineering and manufacturing design, achieving a minimum of maintenance, excellent accessibility for inspection, and the selection of materials monitored by a superior quality control program.

REAR VIEW WITH CABLE COMPARTMENT &
BARRIERS REMOVED

1. Upper Load Primary Disconnects
2. Barrier
3. Porcelain Bus Thru Bushings
4. Bus Compartment
5. Barrier
6. Lower Load Primary Disconnects
7. Ground Bus



QUALITY FEATURES

LIKE A DIAMOND.....

IT IS THE HIDDEN FACETS WHICH MAKE POWERCON SWITCHES AND SWITCHGEAR OUTSTANDING AND SUPERIOR!

ENGINEERING

HIGHLY QUALIFIED EXPERIENCED

- APPLICATION
- DESIGN
- DEVELOPMENT
- MANUFACTURING
- TESTING

POWERCON'S TOP MANAGEMENT ARE REGISTERED PROFESSIONAL ENGINEERS

FACILITIES

200,000 SQ. FT. WITH SOME OF THE MOST MODERN & SOPHISTICATED MACHINERY IN THE INDUSTRY. AUTOMATIC MACHINERY FOR:

- BUS MANUFACTURING
- WIRING, CUT TO LENGTH, MARKED AND LUGGED
- CNC SHEET METAL
- WELDING
- MACHINE CENTERS
- ETC.

COMPUTERIZED DOCUMENTATION

POWERCON UTILIZES SOPHISTICATED AND UNIQUE COMPUTER CAPABILITIES TO ASSIST THE ENGINEERING AND MANUFACTURING OF SWITCHGEAR. DOWNLOADING FROM ENGINEERING TO MANUFACTURING PRODUCES A HIGH QUALITY PRODUCT.

LABORATORY

AN ELECTRICAL-MECHANICAL LAB TO VERIFY DESIGNS AND CONFORMITY TO PROJECT REQUIREMENTS AND MONITOR VARIOUS COMPONENTS OF PRODUCTION.

THE LEADER IN VALUE - SECOND TO NONE

ASSURED QUALITY CONTROL

A QUALITY CONTROL SYSTEM TO PROVIDE SWITCHGEAR FEATURES-

- SAFETY
- PERFORMANCE
- CONFORMANCE
- RELIABILITY
- DURABILITY
- SERVICEABILITY
- REQUIRED FEATURES

ALONG WITH U.L. CERTIFICATION

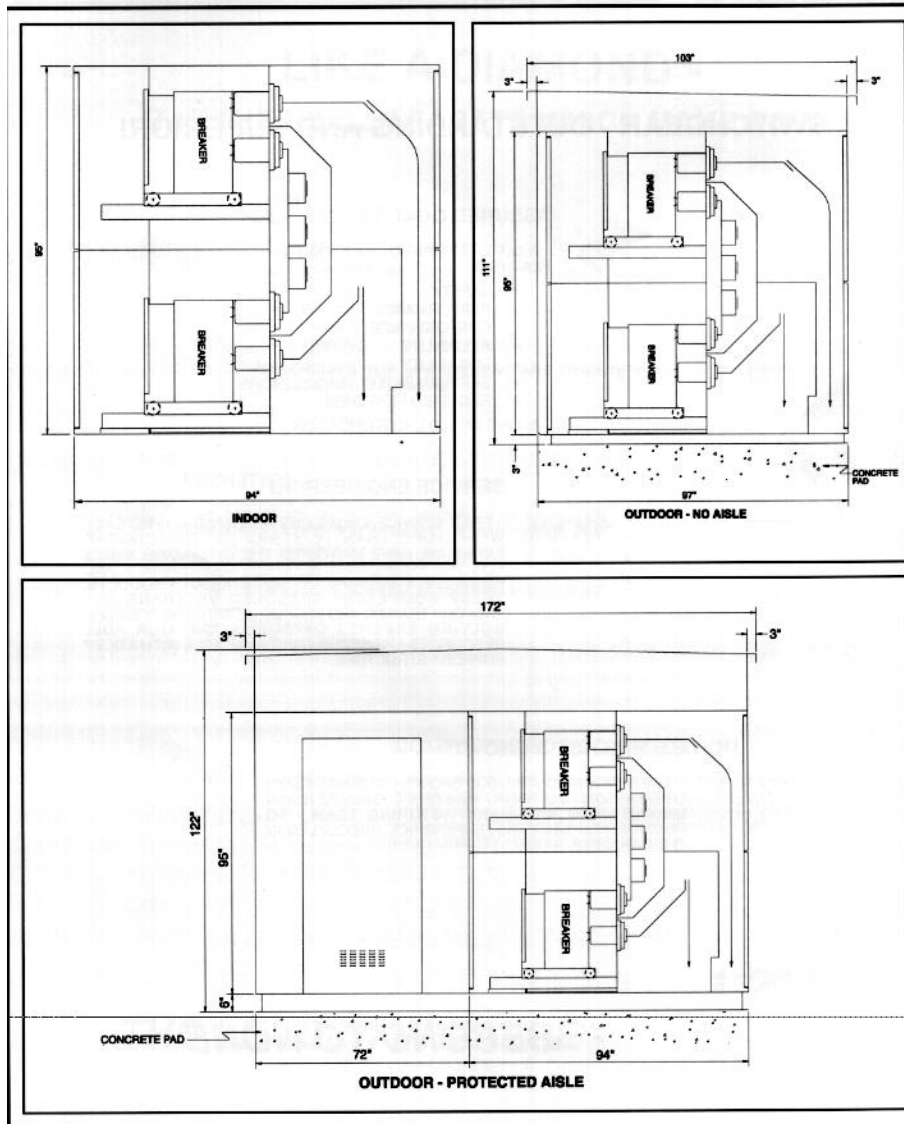
SERVICE ENGINEERING

FIELD SERVICE ENGINEERS AND SPECIALISTS, EACH WITH MORE THAN 10 YEARS OF SWITCHGEAR EXPERTISE HAVE MASTERED THE DEMANDING SKILLS FOR THE PROPER INSTALLATION, MAINTENANCE AND EMERGENCY REPAIRS OF SWITCHGEAR PRODUCTS. THESE COMPETENT SEASONED VETERANS ARE FACTORY TRAINED AND BACKED UP WITH THE PROBLEM SOLVING EXPERTS OF POWERCON. OUR FULL RESOURCES ARE IMMEDIATELY AVAILABLE WITH A DEEP SUPPORT STRUCTURE.

EXPERIENCE & GROWTH

35 YEARS OF CONTINUOUS GROWTH FROM AN 8 MAN OPERATION TO OUR PRESENT 350 PERSON ENGINEERING AND MANUFACTURING TEAM - TO PROVIDE YOU WITH THE EXPERIENCE UNEQUALED IN THE INDUSTRY.

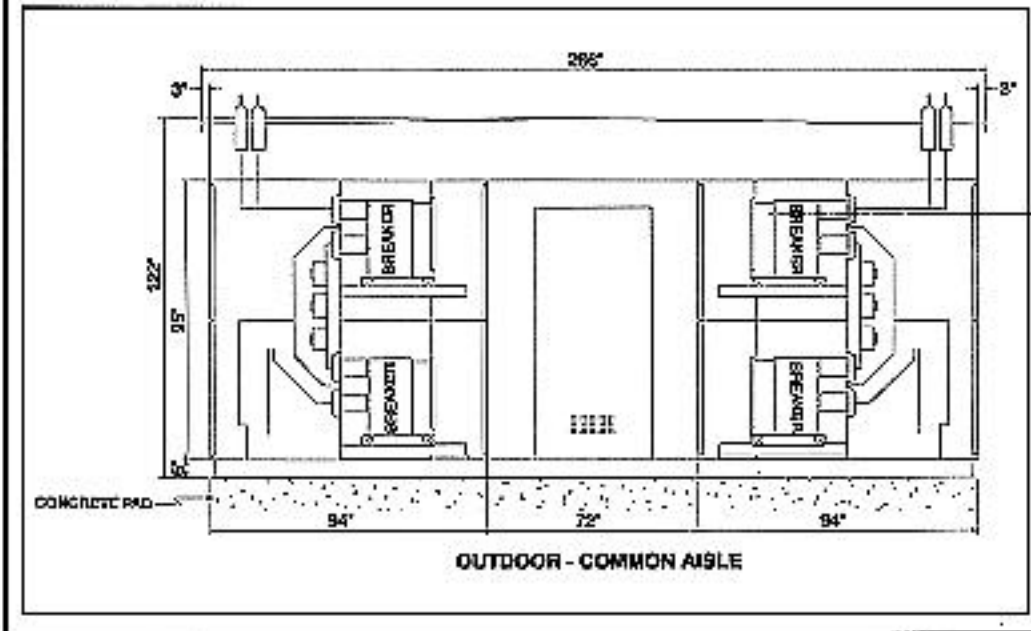
METAL-CLAD SWITCHGEAR



TYPICAL SECTION DIMENSIONS

			INDOOR				OUTDOOR***						INDOOR & OUTDOOR						
Breaker I/NR/A	Current Rating (Amps)	Breaker Height	Height	Depth	Basic Vertical Section (Less Breaker)		Auxiliary Vertical Section		Height	Depth	Regular Vertical Section (Less Breaker)		Auxiliary Vertical Section		For Protection ASAL, ASD To Each Vertical Section	Kilovolt Rating (PT-CPD)	Required Clearance		
					Width	Width	Width	Width			Width	Depth	Width	Depth			Front Kilovolt Min.	Rear Kilovolt Min.	
4.1G-250	1200	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
4.1G-250	1200	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
	3000	750																	
7.2-500	1500	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
50.5-500	1200	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
25.6-150	1200	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
12.4-150	1200	550	25	94"	36	2100	36	3000	111 116 or 112 see below	181 176 or 167 see below	36	3000	36	3000	75	1500	550	60"	25
	2000	650																	
	3000	750																	

* An optional 82" depth is available for some applications if limited to one breaker per vertical section.
 ** 20" minimum installable space available for indoor.
 *** For common aisle construction, add 1500 pounds to weight of 2 indoor vertical sections.



CONSTRUCTION

FLEXIBILITY

The flexibility of Powercon switchgear is demonstrated with photos of the indoor equipment shown on the left. The upper photo shows transformer feeders supplying large induction motors and synchronous motors along with various plant feeds and ties to plant generation.

The other indoor equipment is supplied by two utility lines with bus tie to distribute power to various processes in the system.

Other applications include capacitor, arc furnace, reclosing, generator controls, etc.

WEATHERPROOFED EQUIPMENT

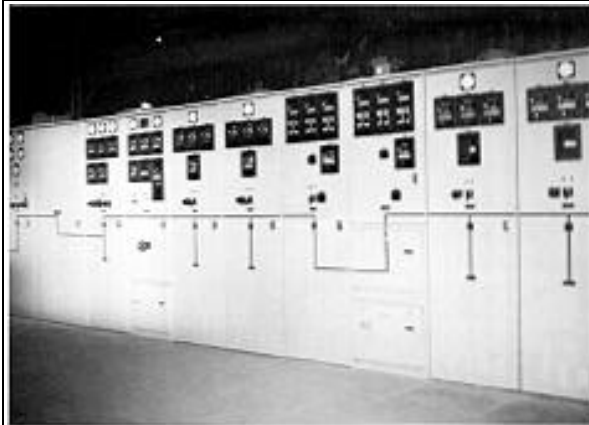
The versatility of packaging Powercon Switchgear is demonstrated. The additional features include:

- *Doors, side sheets and frames sealed with long-lasting gaskets.*
- *All parts treated for rust resistance, painted prior to assembly to protect the metal against rust and corrosion, even between overlapping points.*
- *Bottom of the entire unit undercoated.*
- *Front and rear doors hinged and louvered. Louvers include a filter.*
- *Interiors equipped with lights, heaters, and convenience outlets.*
- *Structures strong enough to be pier mounted.*

Non-Walk-in

In weather-tight steel enclosure units, the complete control panel - with instruments, relays, switches, etc. - is at the front of the unit for easy access. The panel is directly above the breaker, providing the same amount of space, in the same position, as indoor equipment. The control device panel is hinged to swing aisle easily and allow access to the rear of the panel.

The design puts the device panel up front and reduces the space required for an outdoor installation. Foundations can be smaller, reducing installation costs.



13.2kV Metal-Clad Switchgear for Large Oxygen Plant



13.2kV Metal-Clad for Wastewater Treatment Plant



Outdoor Non-Walk-in 4160V Metal-Clad Switchgear to Service Large Hospital

TAILORED TO FIT YOUR REQUIREMENTS

Protected Aisle

The protected aisle metal-clad switchgear is assembled together as a complete unit at the factory.

Your maintenance crew works indoors while servicing. With outdoor protected aisle housings, you can plan your year-round maintenance schedule with confidence.

The reinforced steel floor is at the same level as the floor of the metal-clad enclosures to Permit breaker removal and servicing without a use of a transfer truck.

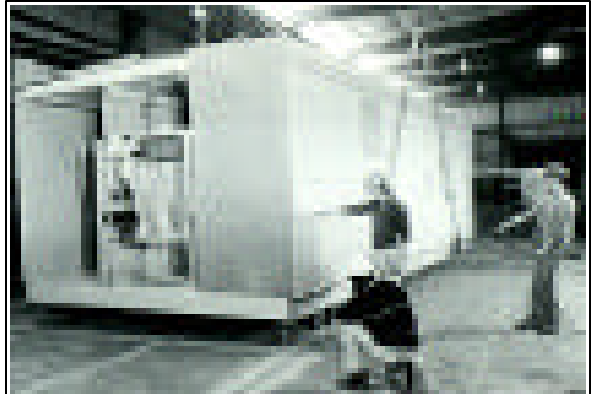
Common Aisle

For common aisle switchgear, as for protected aisle, the basic switchgear units and compartments are similar to those used for conventional outdoor equipment, except the individual weatherproof doors are omitted and hinged access doors are provided in the front of each breaker compartment.

Panic lockable doors at each end of the protected aisle keep unauthorized persons out. However, the inside opening latch is designed to permit door opening at all times when actuated from inside the protected aisle housing, even if the door is padlocked on the outside.

Climatized

Protected aisle switchgear is also available with insulated enclosures call Power Control Complexes, shown being unloaded. Here the walls, roof, floors as required are insulated for the environment of the installation. Air conditioners, heaters, pressurizers, communication and fire suppression systems can be added along with personal conveniences such as kitchens, bathrooms, etc.



13.2kV Walk-In for Utility Service



Climatized 13.8kV Metal-Clad for Petrochemical Plant



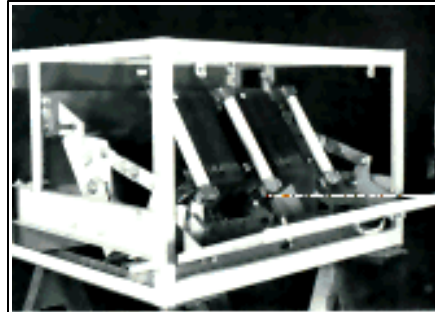
Interior Switchgear of Climatized Unit

ADDITIONAL FEATURES

Drawout Potential Transformers

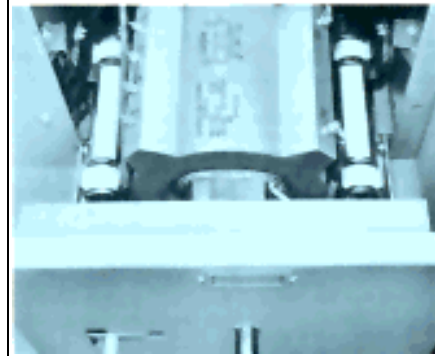
Featuring:

- Porcelain through bushings for PT leads above 5kV.*
- Phosphor bronze primary contacts spring loaded*
- Porcelain live part contact supports above 5kV*
- Shutters to block access to live parts when PT's are drawn out.*
- When fully withdrawn:*
 - PT windings are grounded*
 - PT secondaries are open*



Wiring

Color coded vulkene SIS control wiring provides ease of inspection and field maintenance. All wire is 14 AWG type SIS, 41 strand, tinned copper. Un-insulated ring lugs are provided for all CT circuits and spade lugs for all other circuits. Other options are available upon request. All secondary wiring in high voltage compartments is run in conduit, wire trough or armored wire except for the short lengths necessary to connect to instrument transformer secondaries. Wiring outside high voltage compartments is bundled, secured and terminate in molded terminal blocks. Hinge wiring is terminated in terminal blocks. Control wiring troughs are provided for interconnecting wiring between circuit.



Control Power Transformers

Control Power Transformers up to 75 kVA 3-phase at 15 kV are available in metal-clad construction. Transformers are epoxy or oil and have BIL levels equivalent to the switchgear rating. Transformers rated 15kVA single-phase and below are mounted on drawout carriage with their fuses. Above 15kVA the fuses are drawout and the transformers are stationary. Interlocking is provided as specified.

ADDITIONAL FEATURES

Quality Assurance

Powercon's Assembly Methodology allows its Quality Control & Inspectors to review all portions of the product prior to bolting on covers or obscuring critical parts.



Metal-Clad Switchgear Assembly Line



Outdoor Walk-in Metal-Clad During Final Assembly

Drawings and Instruction Books

Drawings are prepared in accordance with the applicable standards.

Drawings included are:

- A) Dimensional plan, elevation and section views.
- B) Plans showing location and details of channels, cell and anchor bolts furnished by customer and termination of the power control cables.
- C) Schematic or elementary wiring diagram.
- D) Detail control wiring diagram (These diagrams generally follow the approval drawings.)
- E) Bill of materials, which provide a listing of all devices that are furnished with the equipment.

Instruction books are provided to cover operating and maintenance instructions for each piece of equipment required. The number of instruction books are limited to a maximum of three (3) without charge). Consult Powercon factory for additional books.

World Wide Service.....



Powercon Field Service Engineering

Powercon's 24-hour-a-day field service is provided through factory Field Service Engineers. Our Field Service Engineers are highly skilled SWITCHGEAR experts extremely proficient in providing the highest quality service for switchgear and its components.

Powercon is prepared to provide you with:

- *Emergency Service*
- *Repair and Maintenance Services for Existing or Obsolete Equipment*
- *Installation Supervision of New Equipment*
Advice and instruction of Preventive Maintenance Procedures
- *Coordination Check of New Equipment*
- *In Warranty Service*
- *Other Required Installation and Engineering Services*

Power Service Engineering is based at the manufacturing facility in Severn, Maryland, only 6 miles from the Baltimore-Washington International Airport.

Our Service Engineering group is in close liaison with other Powercon engineers who create the application, and the mechanical and electrical design of each switchgear equipment. Powercon also maintains detailed records of every part and component manufactured and/or purchased for each project. They have immediate access to the purchasing staff for suppliers service.

Responsibility

Powercon is responsible for the complete product and all services that it provides.

Powercon purchases, assembles, and provides components from other suppliers. In those rare instances when supplier component problems occur Powercon will handle and solve these problems. All warranties on such components will be handled by Powercon direct with the original supplier. Any and all repairs are the responsibility of Powercon.

POWERCON'S POWER LAB & QUALITY ASSURANCE PROGRAMS PROVIDE OUTSTANDING PERFORMANCE



Documented Quality Assurance

The control of quality is a top management function and responsibility. Power has established a high quality tradition over many years. Constant vigilance and careful workmanship combine to create rigid requirements for quality.

The Quality Control Procedures used by Powercon have been in use since its inception- There have been additions during the intervening years as more information and data was collected and the need arose to be more inclusive. The Quality Control Procedures are fully documented and emanate with the initial engineering designs.

Because final quality must be assured, every complete equipment is tested at the factory for conformity to rigid standards verifying the mechanical and electrical specifications.

Powercon Corporation
P.O. Box 477
1551 Florida Ave.
Severn, Maryland 21144
410-551-6500 (Balt)

The following are some of the tests made on Powercon metal-clad switchgear.

- final master-breaker fixture alignment of all mating and matching points, including drawout mechanism; bushing matching; auxiliary contact mating; grounding shoe contact to assure correct operation to accommodate interchangeability of breaker units.
- .auxiliary wiring check to assure correctness and continuity. This includes primary current injection - primary voltage application - control power to actually operate and synthesize the entire control and protective system.
- all relays and devices given complete secondary power check by test consoles.
- high potential tests of primary and secondary circuitry in accordance with ANSI standards.
- final inspection.