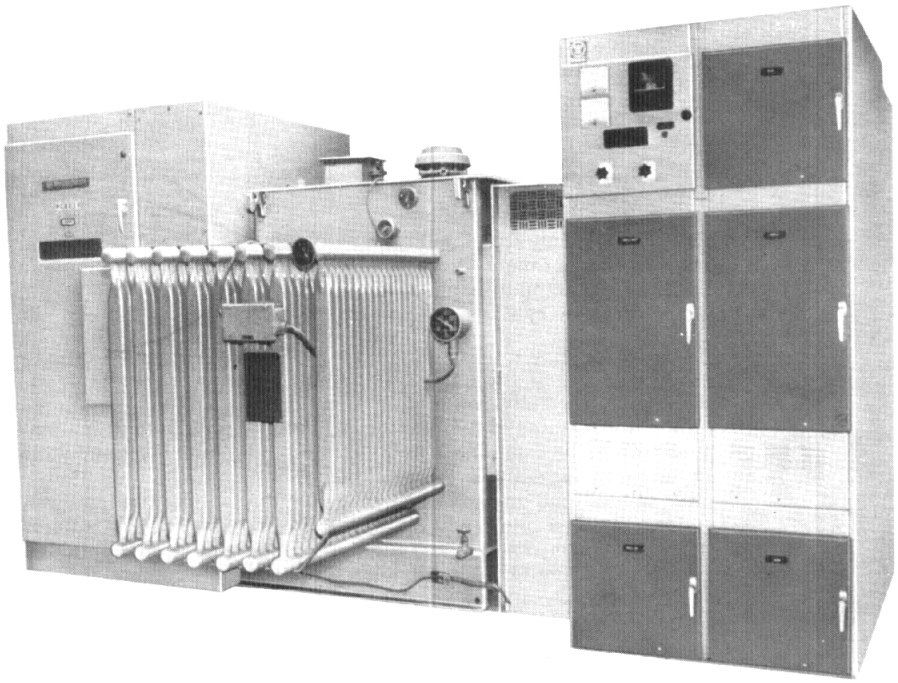
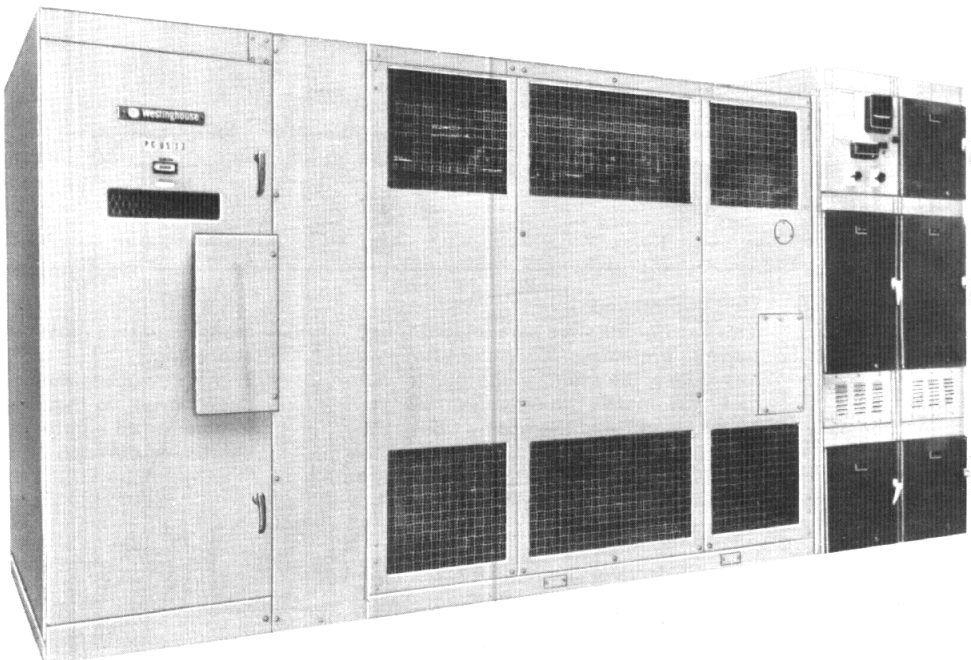
Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, Pa. 15112 U.SA.

November, 1978
Supersedes DB 32-850
dated February 1978
E,D,C/1941, 1961/DB

112.5 to 2500 Kva
Primary—2400-13800 Volts Ac
Secondary—208Y/120-600 Volts Ac

Power Centers Including Type DS Switchgear.





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Definition

A Power Center is defined as a coordinated assembly consisting of 3 phase transformers with high voltage incoming line sections and an assembly of Type DS Low Voltage Switchgear, with the following parameters:

Transformer Kva—112.5 thru 2500
High Voltage—2400 V thru 13,800 V
Low Voltage—208, 240, 480 or 600 V

Power centers may be indoor or outdoor, with a selection of high voltage incoming sections and a choice of transformer types as shown under "components," and an arrangement of Type DS Switchgear to suit the application.

Power centers as defined herein come within the category of "Secondary Unit Substations" as defined in NEMA Standards.

Why Power Centers?

Power centers follow the modern system concept of locating transformers as close as practicable to areas of load concentration at utilization voltages, thus minimizing the lengths of secondary distribution cables and buses. This concept provides several basic advantages over older methods, such as:

- Reduced power losses.
- Improved voltage regulation.
- Improved service continuity.
- Reduced likelihood of faults.
- Increased flexibility.
- Minimized installation expense.
- Availability of non-flammable types of transformers eliminates necessity of vaults.
- Efficient space utilization.

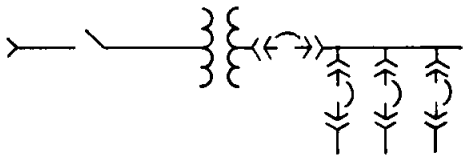
Advantages of Westinghouse Power Centers

- Single responsibility.
- Complete coordination, both mechanical and electrical.
- Extreme flexibility, with wide choice of components and ratings to meet exact application requirements.
- Optimum safety to operators.
- Modern design.
- Meets all ANSI, IEEE and NEMA Standards.

Types of Systems

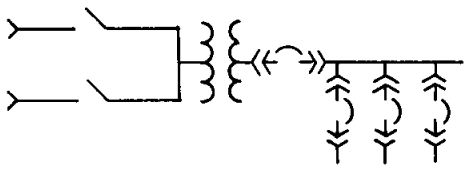
A. Simple Radial

- Simplest and least costly.
- Easy to coordinate.
- No idle parts.



B. Primary Selective Radial

Similar to simple radial, with added advantage of spare primary incoming cable circuit. By switching to spare circuit, duration of outage from cable failure is limited.



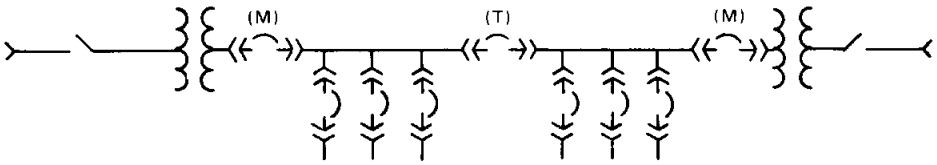
C. Secondary Selective

Normally operates as two electrically independent unit substations, with bus tie breaker(T) open, and with approximately half of total load on each bus. In case of failure of either primary incoming circuit, only one bus is affected, and service can be promptly restored by opening main breaker (M) on dead bus and closing tie breaker(T). This operation can be made automatic, with duration of outage on either bus limited to a few seconds.

Since the transformers are not continuously paralleled, secondary fault currents and breaker application are similar to those on radial unit substations.

Either transformer can be removed from service and isolated with no interruption of service on either bus, by first closing the tie breaker and then opening the associated main breaker.

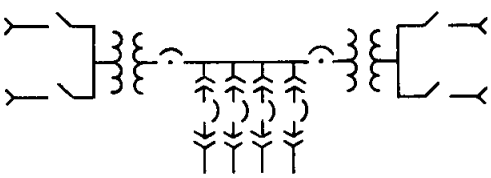
Service continuity and substation capacity can be further improved by substituting selector type primary switches, as in B.

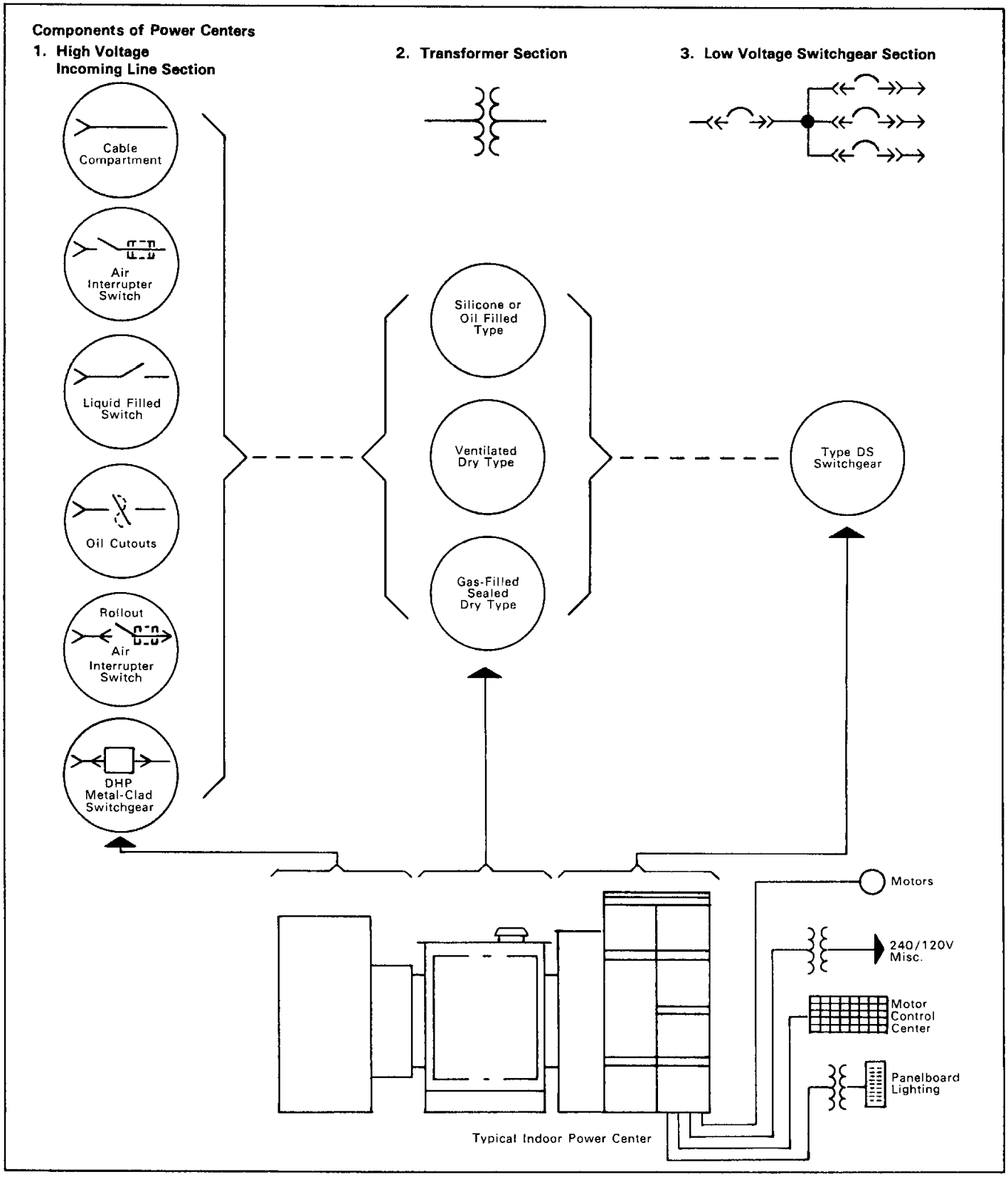


D. Spot Network

The transformers are paralleled through network protectors. In case of primary voltage failure, the associated protector automatically opens. The other protector remains closed, and there is no "dead time" on the bus, even momentarily. When primary voltage is restored, the protector automatically checks for synchronism and recloses.

- Secondary voltage regulation is improved by paralleled transformers.
- Secondary fault capability is increased by paralleled transformers, and the feeder breakers must be selected accordingly.
- Primary switches are usually selector or duplex type, so that transformers can be transferred to alternate live sources, thus shortening duration of overloads.




Components of Power Centers
1. High Voltage Incoming Line Section
2. Transformer Section
3. Low Voltage Switchgear Section
Cable Compartment
Air Interrupter Switch
Liquid Filled Switch
Oil Cutouts
Rollout Air Interrupter Switch
DHP Metal-Clad Switchgear
Silicone or Oil Filled Type
Ventilated Dry Type
Gas-Filled Sealed Dry Type
Type DS Switchgear
Motors
240/120V Misc.
Motor Control Center
Panelboard Lighting
Typical Indoor Power Center

Incoming Line Section

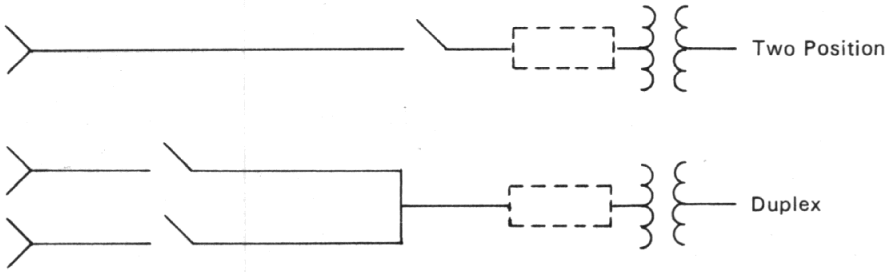
A. Air Interrupter Switch

Primary Power Switch, Type PPS
(for liquid transformers only)

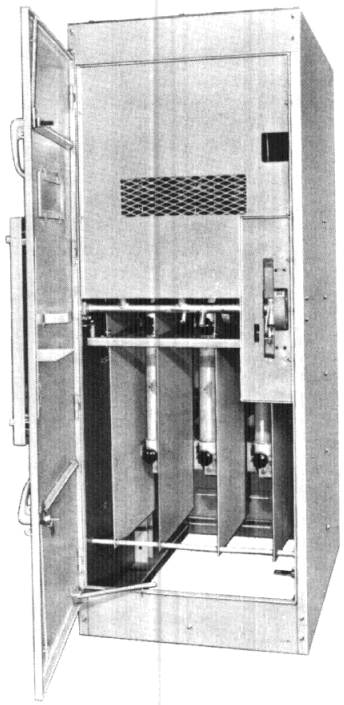
Features

- Quick-make, quick-break stored energy spring mechanism.
- De-ion arc interruption.
- Switch parts molded in tough cast resin, with transparent blade housings.
- Safety interlock between access door and switch mechanism.
- Adequate insulated cable connections to transformer bushings.
- Furnished fused or unfused; fuses either CLE current limiting or RBA non-current limiting type.
- Proven reliability.

Configurations Available



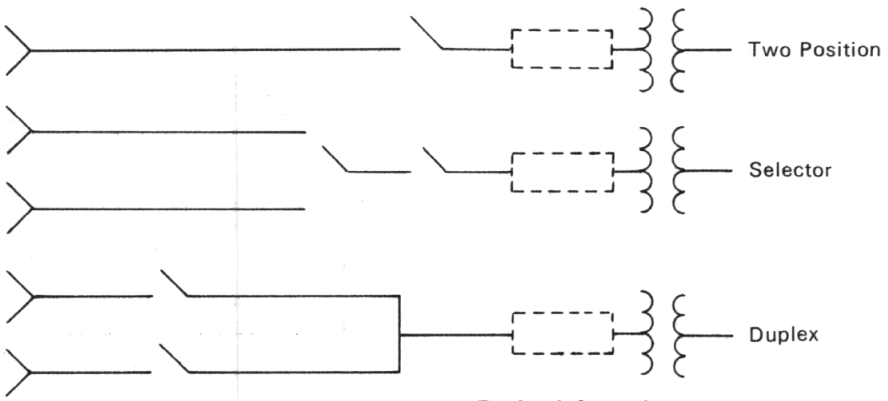
Load Interrupter Switch, Type WLI
(standard for Ventilated Dry and Gas Filled transformers; optional for liquid transformers)



Features

- Quick-make, quick break stored energy spring mechanism.
- De-ion arc interruption.
- Positive switch position indication by operating mechanism.
- Safety interlock between access door and mechanism.
- Adequate insulated cable connections to transformer terminals; bare or insulated bus connections optional.
- Furnished fused or unfused; all CLE, CLT and RBA fuses available.
- Proven reliability.

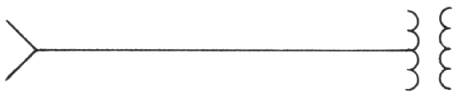
Configurations Available

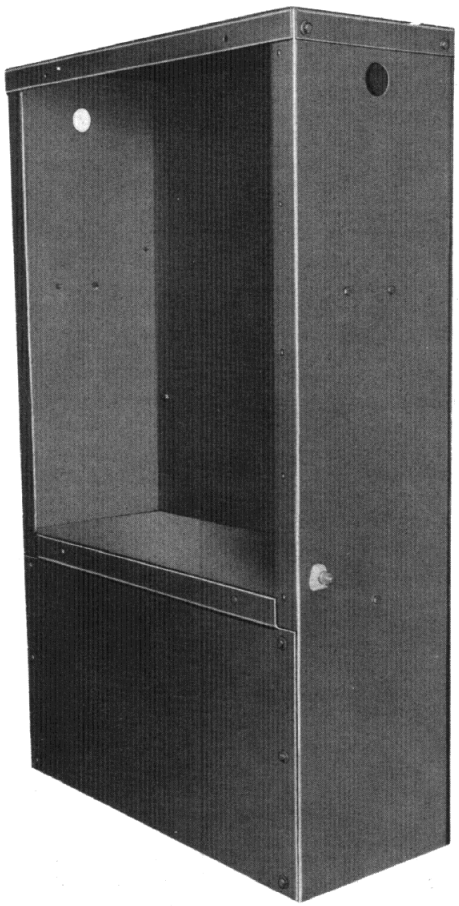


Further Information
DB 31-935

B. Cable terminal compartment only, air filled.

Available with all transformer types. Extends to floor and completely encloses cables and terminals. Arranged for either bottom or top cable entrance.

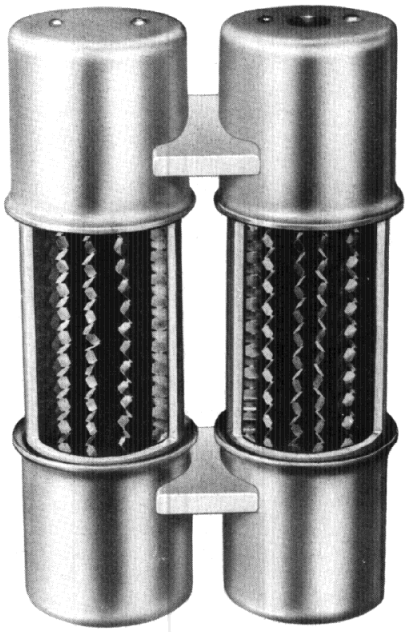




C. Miscellaneous Types of High Voltage Incoming Equipment

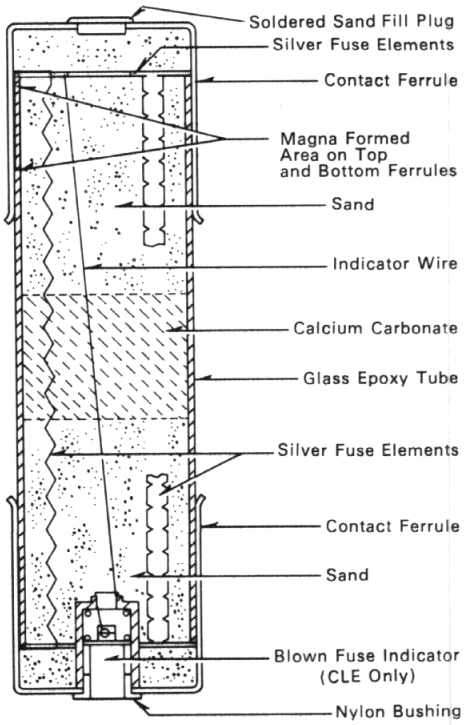
1. Type FSP load-interrupter switchgear units, metal-clad switchgear construction, with "rollout" air switch elements, fused or unfused, 15 Kv, indoor or outdoor. Fuses are Type CLE current limiting only, voltage to suit application.
2. Type DH-P "Porcel-Line" metal-clad switchgear, 5 Kv to 15 Kv, 75 to 1000 Mva interrupting rating, indoor or outdoor.
3. Liquid Filled Switch.
4. Oil Fused Cutouts.

Type CLE and CLT current limiting non-expulsion, non-refillable fuses.



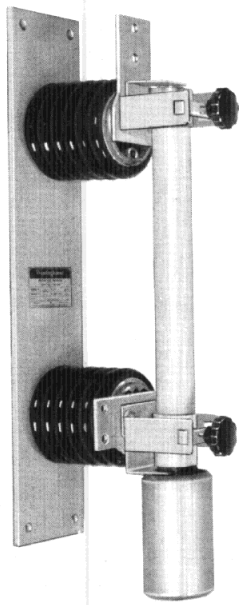
Cutaway view of type CLE-2 fuse showing pure silver elements.

Type CLE and CLT power fuses are basically of inorganic construction, the only organic material used being the glass-resin outer casing and the plastic indicator. The fuse elements are pure silver designed to combine maximum load carrying ability with the most favorable short circuit interruption characteristics, plus being "fatigue proof." This added feature is made possible by bending or spiralling the element prior to assembly, making the element structurally stronger and distributing expansion uniformly to withstand the most severe type of duty cycling without failure. These fuses are filled with a high purity silica sand of controlled grain size, and sandwiched between the sand filling is an additional layer of pulverant arc quenching material. The addition of this band of filler to the fuse changes its melting characteristics and facilitates low current interruption making it more suitable for transformer protection.



Cross-section drawing showing component parts of a type CLE-1 fuse unit.

Type RBA non-current limiting, refillable, expulsion type fuses.

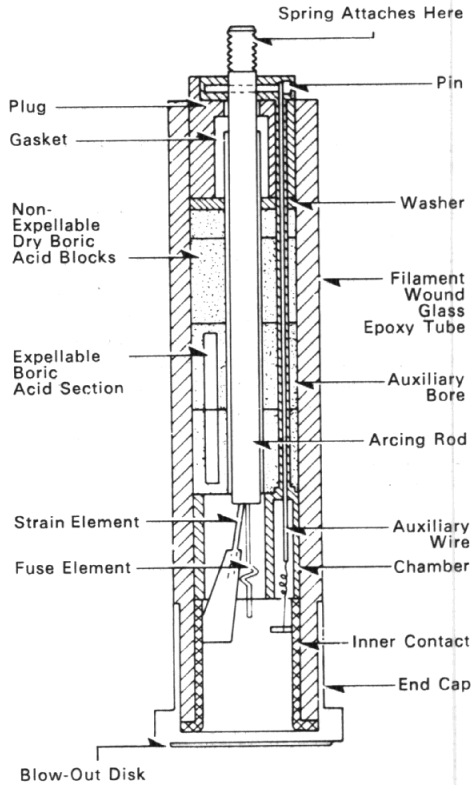


RBA-400 Non-Disconnect Mounting with Fuseholder and Discharge Filter.

Fuse Refill

The boric acid refill is probably the most important component of the RBA fuse. It is designed to interrupt currents of short circuit magnitude within ½ cycle, and through its two de-ionizing chambers in parallel, have selective operation and interruption for both low-current and high current faults. This is achieved by movement of the arc through the boric acid cylinder by a helical spring and rod. Intense heat from the arc, as it strikes, decomposes the dry boric acid. On decomposition the boric acid forms water vapor and inert boric oxide. The electrical interruption is caused by the steam de-ionizing the arc as it is drawn through the cylinder by the action of the spring and rod. The high particle turbulence of boric acid causes the rate of de-ionization in the cylinder to exceed the ionization rate of the electrical arc. This action prevents the arc from restriking.

Upon operation of the fuse under fault condition, the fuse holder is disconnected, the fuse refill removed, and replaced with a new refill.



Transformer Section

Liquid Filled Transformers

Advantages
Standardized bushing height of 55 inches for all ratings allows subsequent uprating at minimum cost.

A proven rectangular core and coil design, pioneered by Westinghouse in 1954, is used in conjunction with a computer program to provide rugged, dependable service and an optimized design.

Insuldur system of thermally stabilized insulating material—allows user 12% additional Kva capacity of 55/65°C rated units or maximum 55°C Kva capacity at 40°C average ambient.

An automated plant, designed specifically for the production of rectangular core form transformers, assures uniform quality and shipping expediency.

General Design Features
These transformers are designed for indoor or outdoor use—oil or Silicone immersed—with a standard temperature rise of 65°C. Either a flange or throat can be furnished on the high and low voltage side for connections to primary and secondary equipment.

High and low voltage terminals are located on opposite sides of the unit for a "straight-thru" line-up. Bushing height is standardized at 55 inches to permit ease of coordination with other equipment and later uprating at minimum costs.

Cooling is accomplished through flat, tubular coolers welded to the tank wall. A welded-on tank cover/handhole provides sealed tank oil preservation. Standard tank pressure is 5 psi.

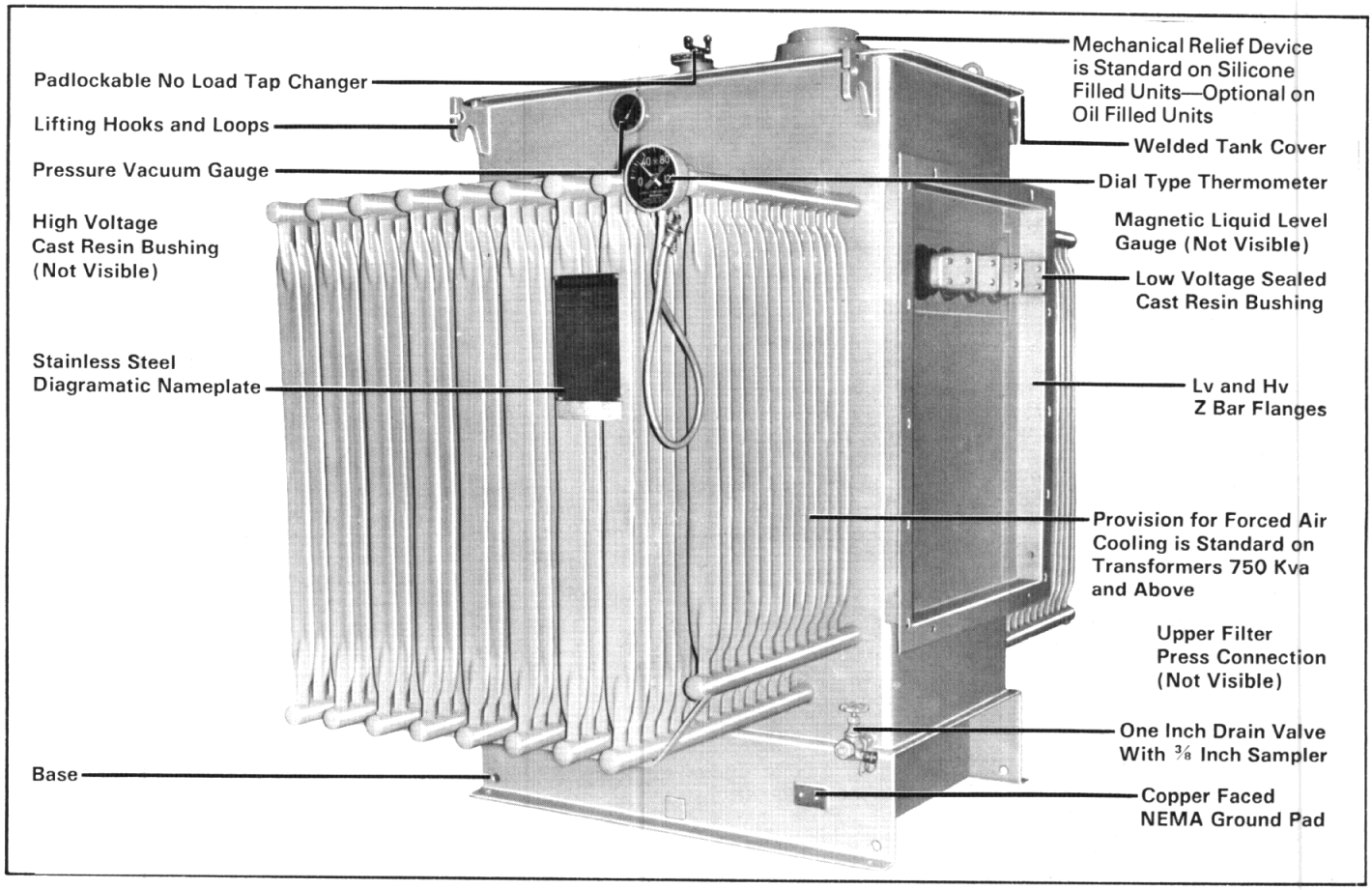
Lifting hooks are provided for lifting the entire unit and lifting loops for lifting the tank cover. The base is designed for skidding in any direction.

Standard Finish
The Westinghouse standard finish is a three-coat system applied as follows:

A. All surfaces are shot blasted or pickled to a semi-white metal to form a completely clean surface.
B. A caustic wash and phosphatized coating to inhibit corrosion and furnish a base for high mechanical strength of paint bonding.
C. An epoxy-melamine primer coat cured in oven at 150° C.
D. A Westinghouse top coat, composed of an alkyd-melamine enamel paint system containing special pigments selected to give long outdoor service in varying climatic exposures and maintain attractive appearance, is applied and given a baked finish at 150° C.
E. An air-dry version of Item D is applied to touch up units prior to shipment.

Standard outdoor tank color is ANSI No. 24. ANSI No. 70 can be supplied but must be specified. Other colors or other paints may be available on special request. Standard indoor color is ANSI No. 61 light grey.

Standard Features and Accessories



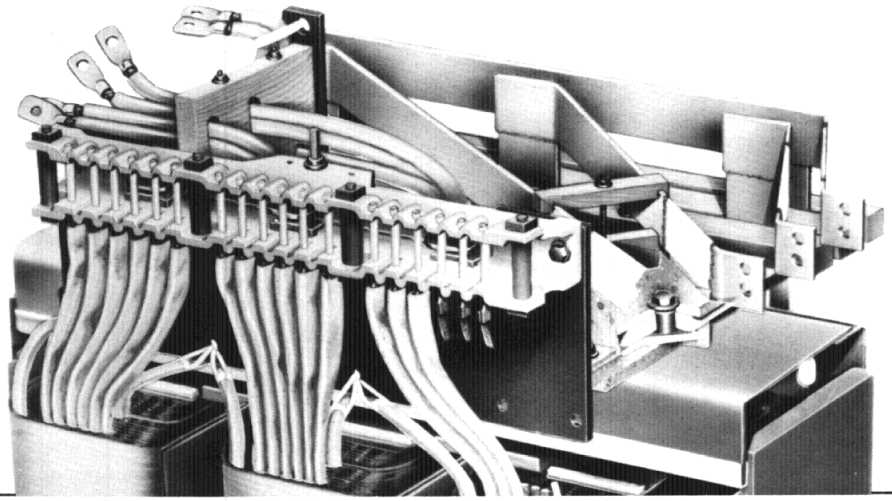
Rectangular Core and Coils

WSS Tap Changer

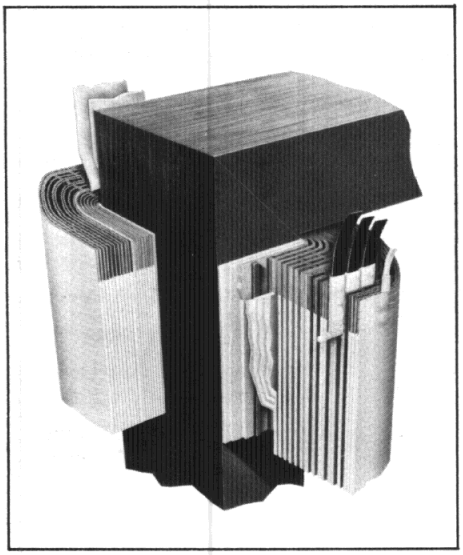
The Westinghouse externally operated WSS tap changer provides positive sequence line voltage changes under de-energized conditions. An in-line assembly, the WSS features through-type stationary contact studs rigidly supported by a molded plastic channel. Moving contacts are spring loaded, silver plated copper which move along the stationary line by means of a rack and pinion.

This design has no rivets, bolts or nuts, thus assuring the proper contact of current carrying parts when taps are changed. The WSS benefits the user through a reduction of repair or replacement costs by eliminating faulty tap changer operation—the cause of failure in 20% of all power transformers.

WSS Tap Changer

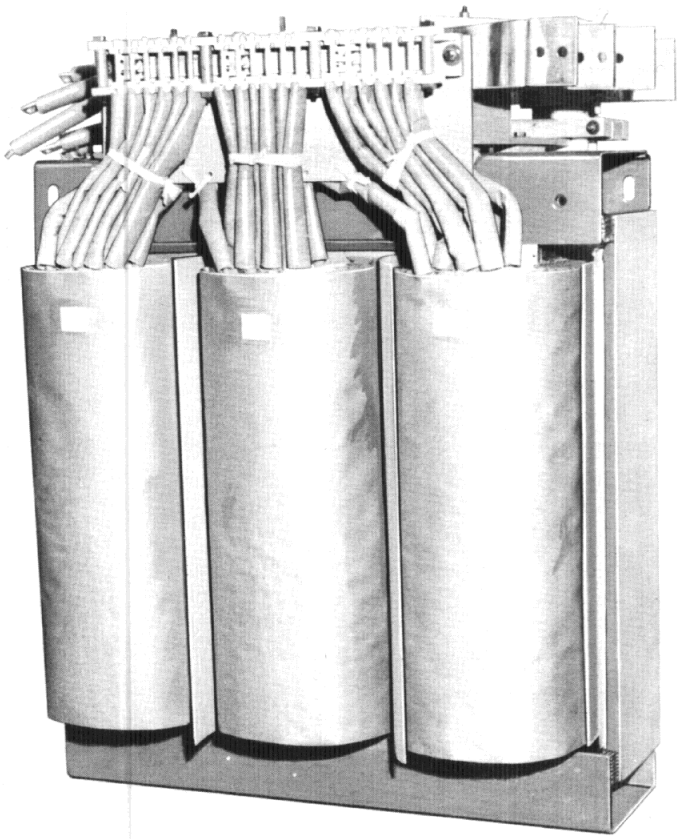


Rectangular Aluminum Wound Coils



The Westinghouse rectangular wound coil features aluminum conductor in both high and low voltage windings. The low voltage winding is accomplished on a constant tension machine and consists of full width sheet aluminum extending the full height of the coil. High voltage strap aluminum is wound directly over the low voltage winding on a constant tension traversing machine. Layer to layer and high to low insulation is diamond epoxy paper which when heat treated bonds the complete coil into a solid configuration.

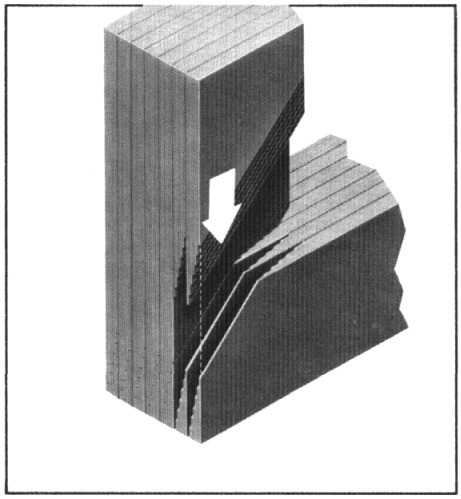
The advantage of low voltage sheet aluminum is a continuous cross section of conductor that allows the electrical centers of high and low voltage windings to easily align themselves, virtually eliminating the vertical component of short circuit force.



Rectangular Core and Coils

The benefit is a coil so uniform and compact, the chance of windings overlapping during short circuit is minimized, reducing failure rate, repair and/or replacement cost.

Step-Lap Core



The Westinghouse exclusive stacked core provides a superior flux path by utilizing the patented step-lap joining of core legs to top and bottom yokes. Hand stacked Hypersil steel punchings with interlocking laminations can be more uniformly and rigidly braced to prevent shifting during service.

The user can benefit through reduced sound levels, lowered iron and total losses, and decreased exciting current to lower total operating cost.

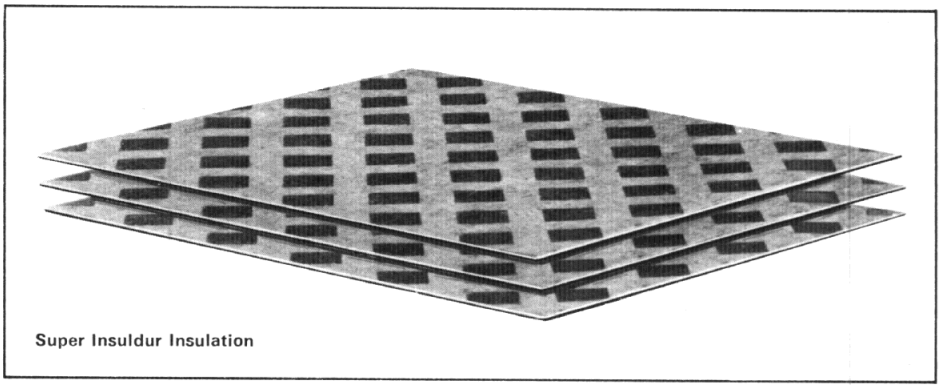
On wye-wye units a fourth leg is added to provide a path for circulating third harmonic flux during unbalance condition.

Welded Frame

The Westinghouse exclusive welded frame provides a superior six piece supporting structure for the core and coils. End plates are thick steel slabs that are assembled in a mechanical and pressure jig around the core and coils, then welded to top and bottom plates to form a rigid structure that will not loosen during assembly, shipment, or in service. To determine the thickness of members used (even the thickness of welds), a short circuit calculation is made for each unit to determine the forces of short circuit.

The result is an assembly that restrains more effectively vertical and horizontal components of force, decreasing the probability of failure during severe short circuits.

This benefits the user by a reduction in repair or replacement costs and a reduction in downtime that means loss of service or lost production.

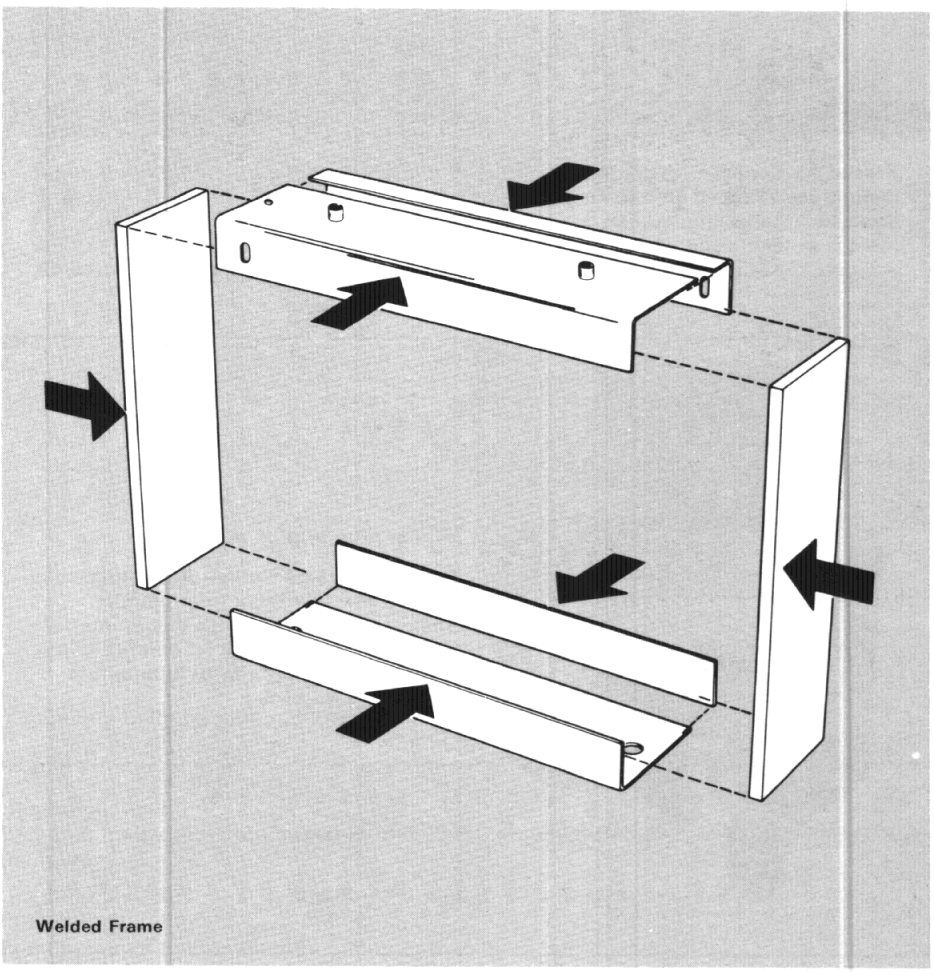


Super Insuldur Insulation

Super Insuldur Insulation

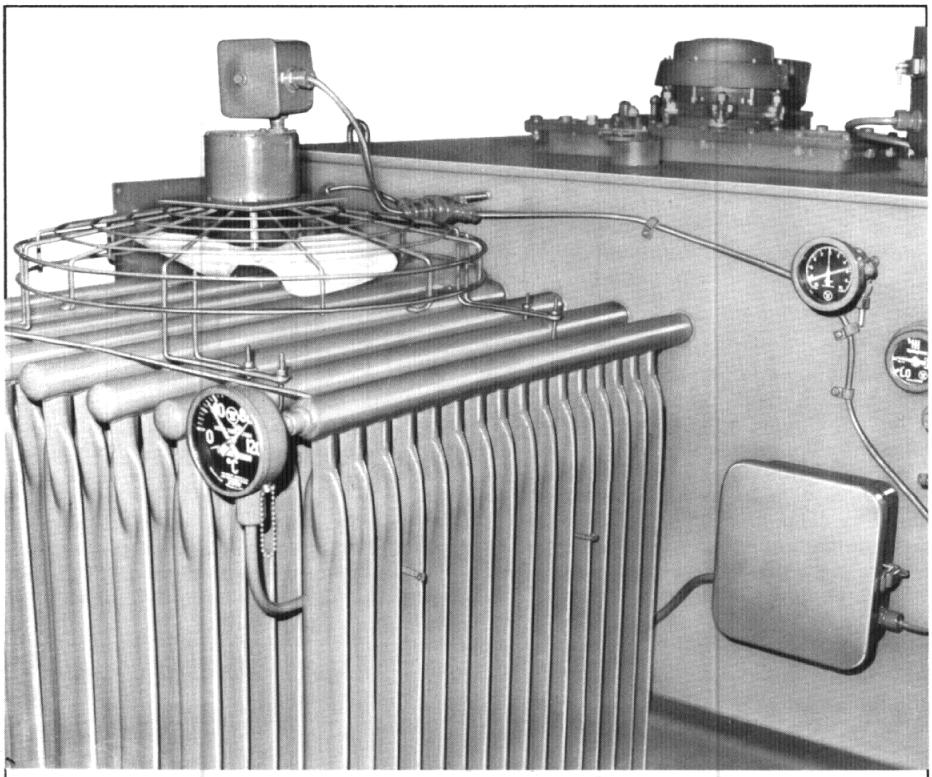
The Westinghouse Super Insuldur Insulation effectively upgrades cellulose insulating materials thermally for increased load and overload capability. The chemical stabilizers in the Insuldur process retard insulation breakdown under severe temperature conditions. Dimensional changes in the insulating materials are minimized, insuring a tighter structure. The result is greater strength and coil integrity throughout the life of the transformer.

The user benefit is a coil that better withstands short circuit and allows an operation at 10°C higher temperature on a 55°C rated unit with a 12% increase in Kva capacity.



Welded Frame

Optional Accessories

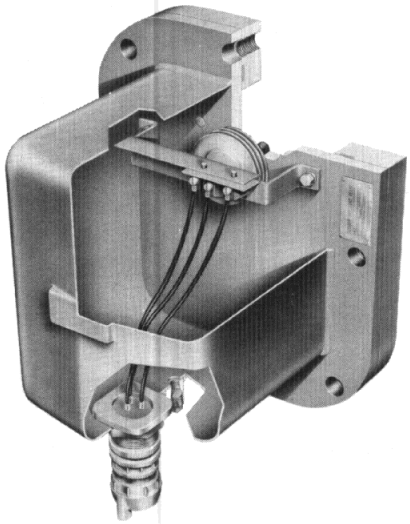


Forced Air Cooling—Provisions for fan cooling are included on transformers 750 Kva and larger. Complete fan cooling equipment is available and when in operation will give the following OA/FA ratings:

750 Kva OA	862 Kva FA
1000 Kva OA	1150 Kva FA
1500 Kva OA	1725 Kva FA
2000 Kva OA	2300 Kva FA
2500 Kva OA	3125 Kva FA

Dial Hot Spot—Dial hot spot winding temperature equipment including a current transformer may be specified.

Alarm Contacts—SPDT Alarm contacts may be added to the thermometer, liquid level gauge and pressure relief device.



Sudden Pressure Relay—A Westinghouse sudden pressure relay for protection against excessive damage due to internal faults may be specified. It operates when a significant rate of rise of internal gas pressure is exceeded.

Further Information
Prices: Price List 47-150

Dimensions: Technical Certification Section 47-159.

Fault Protection and Indication—Reprint 200

Rectangular Coil Core Form Transformers: SA-10099

Bulletin IC/FF—38R Monsanto Askarel Guide

Westinghouse Insuldur: SA-9025B

Why Westinghouse Rectangular Coil Core Form Transformers Withstand Short Circuits: M-7205

The South Boston Value Story: MA-375.

Dry Type Transformers

Application

Ventilated and gas filled sealed dry type transformers are ideally suited for indoor and outdoor applications. Ventilated units may be installed in practically any indoor location not subject to submersion or to a high concentration of destructive fumes, or outdoor with a weather-proof case. Gas filled sealed dry type units offer the ultimate in safety and low maintenance with high impulse levels. They can be installed indoor or outdoor or completely submersed.

Benefits

Reliability and Long Life

- Windings are protected by Nomex® insulation having very high temperature and dielectric characteristics.
- A 220°C fully coordinated insulation system is used.
- Each prototype unit is subjected to a complete set of short circuit calculations which have been verified by full size testing.
- Coil types are coordinated with voltage application, i.e., Barrel type/cylindrical coils on 1.2 and 5 Kv class; Disc coils on 8.6 and 15 Kv class.
- The ventilation system is engineered to assure proper operating temperature in the coils.
- On FA units air is positively directed under pressure through the coil ducts at high speed to assure thermal operation under the 220°C allowable limit.

Low Environmental Cost—Safety and Versatility

- Ventilated dry type transformers are supplied with lightning arresters when specified allowing confident application to any exposed line regardless of line BIL.
- Air insulated and cooled by natural convection, these transformers release no toxic gases and are fire and explosion resistant. Elimination of these principal liquid-filled transformer potential hazards makes them especially desirable for installation in schools, hospitals, hotels, theatres, factories, etc., where large groups of people are present.
- Where space limitations are a consideration ventilated dry type, transformers offer lower weight and absence of liquid allowing their mounting in such places as balconies to save floor space and yet provide safe operation.
- Gas filled sealed dry type transformers are the safest transformers available with a completely hermetically sealed heavy gauge steel tank—they can be installed anywhere.

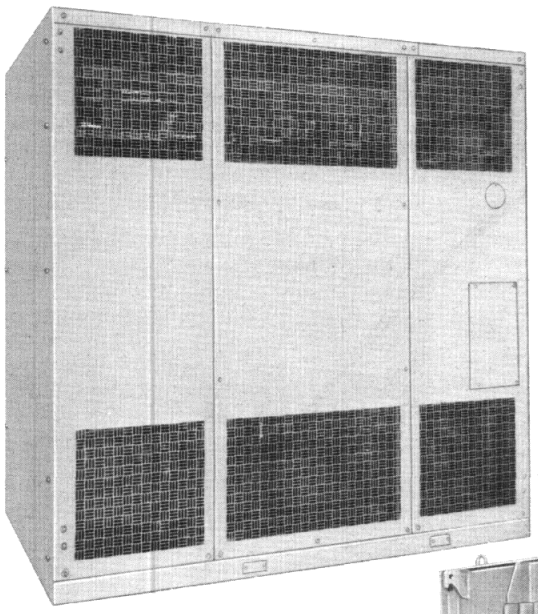
Value

Proven Methods and Materials

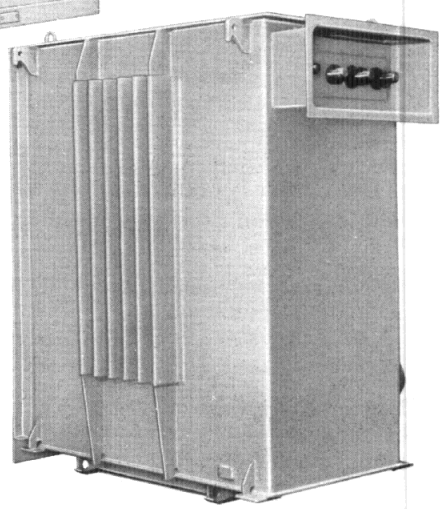
- Westinghouse testing standards are the highest in the industry. New designs are given complete load, short circuit, and insulation tests to prove methods and materials used in manufacture. Verified production line models receive standard quality control inspections and tests by our most experienced personnel. Certified reports on routine tests can be obtained on all units, and special tests or reports can be obtained by special orders.

Further Information

Prices:
PL 47-330
Description:
DB47-351
Ordering Information and Dimensions:
DS 47-370



Ventilated Dry Type



Gas Filled Sealed Dry Type

Insulation Class

Dry type transformers are insulated with 220°C system materials with temperature ratings as follows:

Maximum Ambient	Average Rise	Hottest Spot Winding Temperature Rise
40°C	150°C	180°C
40°C	115°C	145°C
40°C	80°C	110°C

Maintenance
Dry type transformers are practically maintenance free, except for periodic inspection of the connections. On ventilated dry type transformers any accumulation of dust or dirt should be removed by brushing or blowing dry air on the unit. See IL 47-067-1. Gas filled sealed dry type transformers only require periodic checks of pressure and temperature. They require less maintenance than liquid filled or open ventilated dry type transformers.

Design Features

1. Case—Ventilated Dry Type
The case has removable panels for access to the taps and core and coil inspection and the complete case structure can be removed and knocked down to reduce size and weight for rigging into tight locations. The case is constructed of 13 gauge steel and painted ANSI #61 light gray.

Standard case accessories are: jack pads, ground pad, diagrammatic nameplate, provisions for rolling, and protected ventilation grille.

Gas Filled Sealed Dry Type
Sealed Tank
The transformer will be of sealed tank construction to prevent breathing. Tank will be hermetically sealed and will be tested at 15 psi pressure. It will be provided with welded-on ¼" thick Yukon coolers.

Shot Blast
The case and coolers will be cleaned by shot blast and phosphatized before the paint is applied.

Finish
Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or dark gray ANSI No. 24 (outdoor).

The transformer will be insulated and cooled with C_2F_6 fluorocarbon gas.

Bushings
The transformer tank will be fitted with rolled flange, inert arc welded bushings for the high voltage and low voltage connections to insure that the tank is hermetically sealed.

2. Core and Coil Assembly

Core and coil assemblies are rigidly braced to withstand mechanical forces under line fault conditions and to resist vibration and shock forces during shipment.

Coils are concentrically assembled on the core legs and rigidly positioned laterally by spacers between the inner-most insulating cylinder and the core. Horizontal and vertical stresses set up during faults do not exceed the inherent strength of the conductors and support system.

3. Core

Ventilated Dry Type and Gas Filled Sealed Dry Type
Material used to form the core is non-aging, cold rolled, high permeability silicon steel. Bulk material is cut to width and sheared to length by especially hardened and ground cutters to prevent edge damage and burrs that would short between laminations and reduce core efficiency.

Core laminations are firmly clamped by structural steel members for greater strength and lower noise levels. The insulation on the core clamps prevent a metallic short across the stacked laminations. Core clamps and all structural parts are grounded to prevent an induced voltage buildup.

The resulting compact, rigidly clamped structure formed by the core and coil assembly provide a low loss, low sound level design with the strength to withstand repeated short circuit forces.

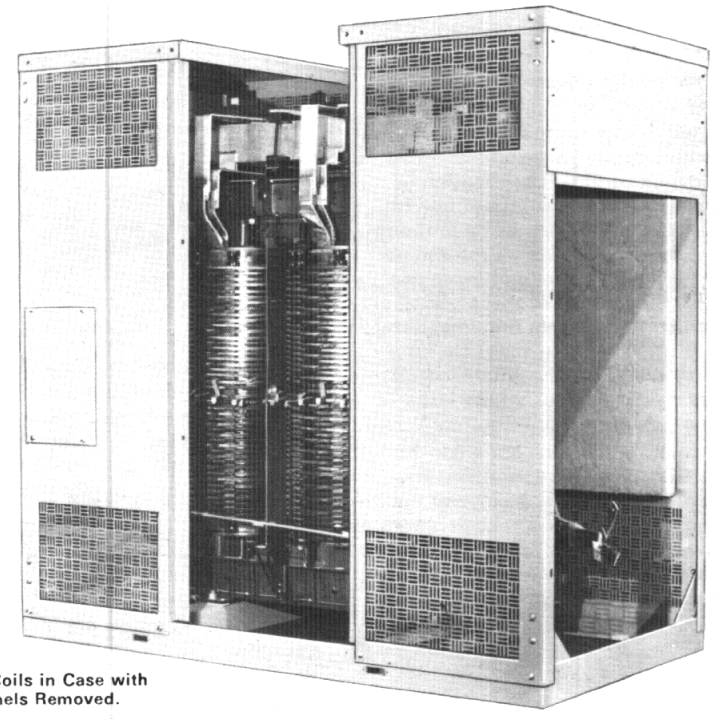
4. Coils

Ventilated Dry Type and Gas Filled Sealed Dry Type

Conductor Material
Aluminum is the standard conductor material. Where design considerations require, copper may be substituted.

Insulation
The insulating structure of the coil is designed for operation at 220 degrees Centigrade hot spot temperature (150°C average rise). High voltage conductor insulation and layer insulation is DuPont Nomex®. This tough, long life high temperature (Class H) Nomex® material is especially resistant to humidity and repeated thermal cycling.

The low voltage coils are usually of cylindrical or strip construction and high voltage coils are usually of the continuous pancake or random wound disc type construction. Large air ducts provide insulation between windings and form vertical cylinders for natural ventilation. The free area in the pancake coils between porcelain spacers further facilitates the flow of cooling air.



Core and Coils in Case with Access Panels Removed.

5. Taps

Ventilated Dry Type
The taps can be reached from the front or back by removing a panel which also protects tampering with the taps.
The taps are rigidly supported by brazing them on the central section of the HV coils. Taps are changed by moving the flexible bolted links from one connecting point to the other. To simplify these changes, the connections are clearly identified.

Gas Filled Sealed Dry Type
De-energized Tap Changer
A tap changer will be supplied to permit changing connections in the high voltage windings from outside the transformer case. The tap changer is designed for operation only when the transformer is de-energized. Provision will be made for padlocking in any position. A packing gland seals the operating shaft at the tank wall. The external housing prevents gas loss due to permeability through the gland packing material. The housing cover may be either gasketed or soldered.

6. Arresters

Ventilated dry type power centers are supplied with RM arresters when specified to provide maximum surge protection for the transformer and associated secondary equipment.

Located in the transformer section, the RM arresters protect against a possible double surge voltage at the transformer terminals even though arresters may be used on the incoming line. The possibility of exceeding BIL level due to reflected voltages is dependent on length and character of cable and steepness of surge.

This protection has added importance when LV apparatus or equipment in use has a lower BIL level than the LV transformer winding. Due to electrostatic coupling, a surge transmitted through a transformer could be as much as 1½ to 2 times as great as would be anticipated on the basis of turns ratio alone and could damage this LV equipment. Therefore, RM arrester at HV terminals are desirable.

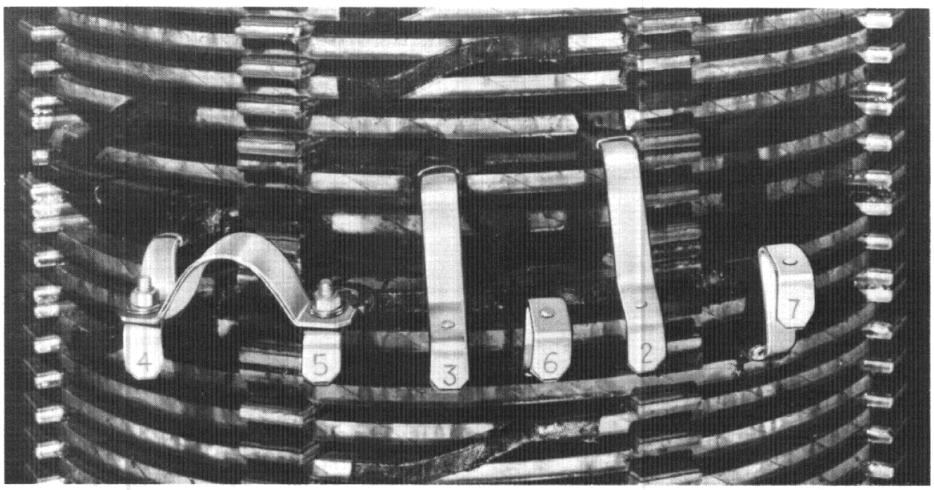
In applying arresters, it should be remembered to use an arrester with a sparkover to operate below the BIL of the apparatus and to install the arresters at the apparatus to be protected.

7. Isomode Pad (Vibration Dampeners) On Ventilated Dry Type Units

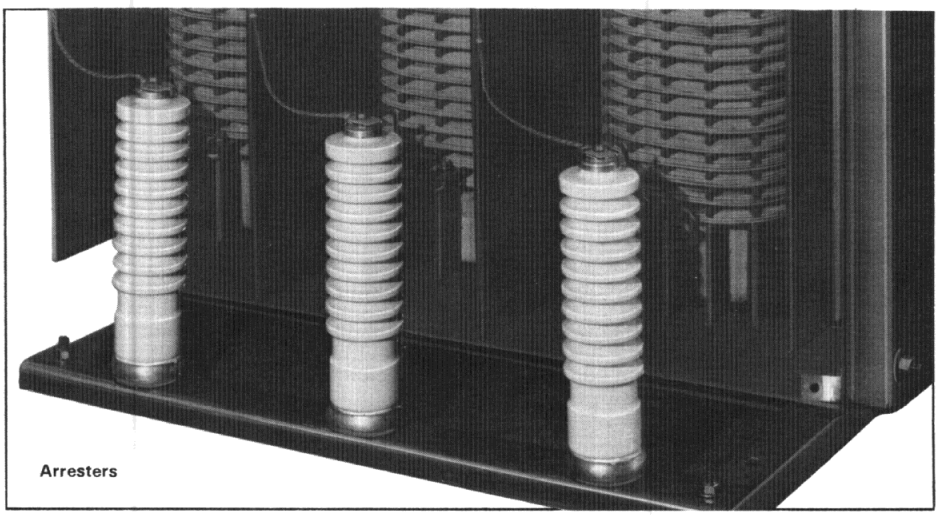
After removal of the shipping braces, the core and coil assembly rests on rubber Isomode pads to isolate normal core vibrations from the case, foundation or any conduit or bus duct connected to the case.

Coil Impregnation
High temperature moisture and chemical resistant varnish maintains superior bond strength, high dielectric strength and good power factor at elevated temperatures associated with 220°C insulation systems. The thermal aging characteristics, thermal stability and physical resistance to common solvents exceeds that of commonly used varnishes. The resistance to alkalis, acids, and moisture is excellent. High and low voltage coils are impregnated with this varnish and baked before assembly.

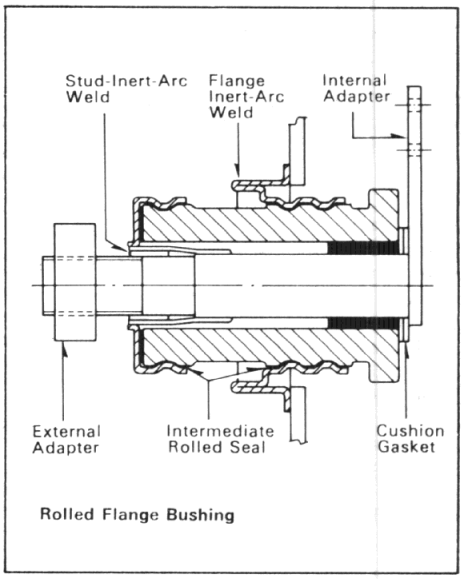
Bushings on Gas Filled Sealed Dry Type Transformers
Gas filled transformers are equipped with rolled flange, inert arc welded bushings, type RFW, for the HV and LV outlets. These bushings insure a hermetically sealed tank while allowing flexibility for conductor expansion and contraction.



Taps



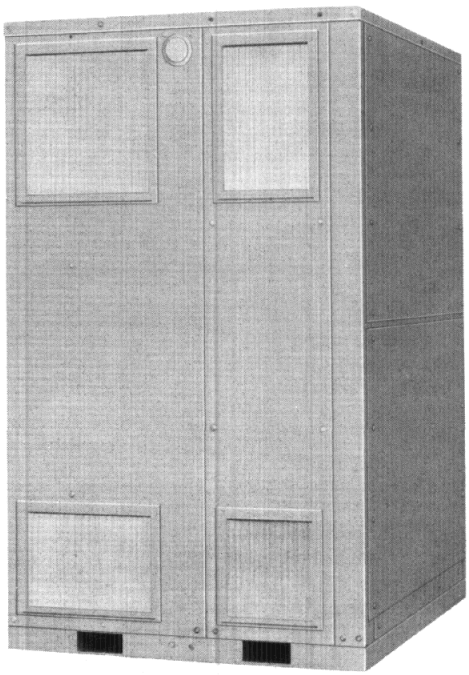
Arresters



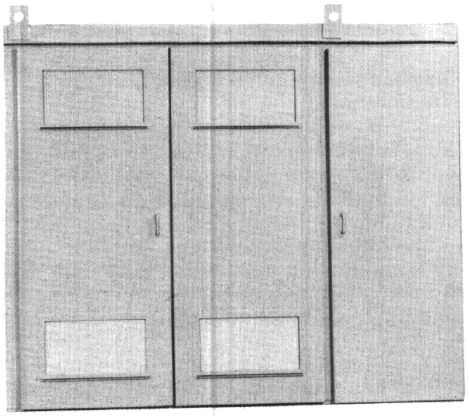
Rolled Flange Bushing

Accessories—Ventilated Dry Type

Outdoor Cases



Standard Outdoor Case



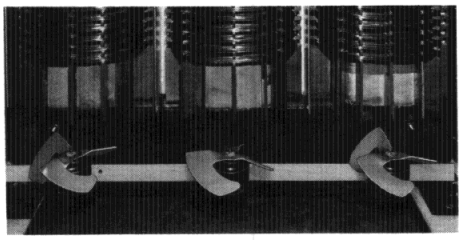
Tamper-Resistant Outdoor Case

Outdoor Cases
Ventilated dry type units are available with outdoor and outdoor tamper-resistant construction.

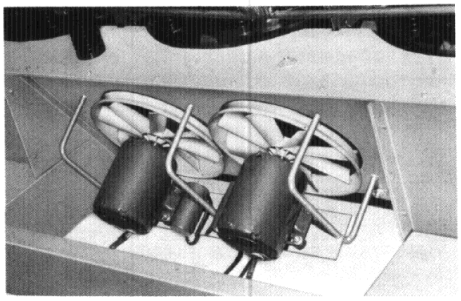
Special ventilating grills allow required cooling air to flow in and out of the case but block the passage of rain, fine spray or wind-driven snow.

An extra dip and bake of varnish and appropriately located space heater protect against damage to the core and coils from condensation during thermal cycling.

Cooling on Ventilated Dry Type Units



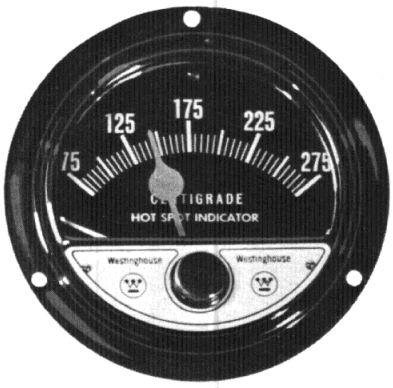
Small Units



Large Units

Forced air cooling is available on all units 300 Kva and above. With air blast equipment in operation the units have forced cooled ratings of 133 percent of the self-cooled rating. Single phase 230 volt fan motors are turned on or off by a Type TRC winding temperature relay.

Hot Spot Relay



Included on all AA/FA units and available as an optional accessory on AA units, the Hot Spot Relay indicates winding hot spot temperature.

The Hot Spot Temperature is an indication of the load being carried by the transformer. Alarm contacts are furnished to signal overload conditions. On fan cooled units, a separate set of contacts turn the fans on when the AA rating is exceeded.

type AA/FA units and available as an optional accessory on ventilated dry type AA self-cooled units.

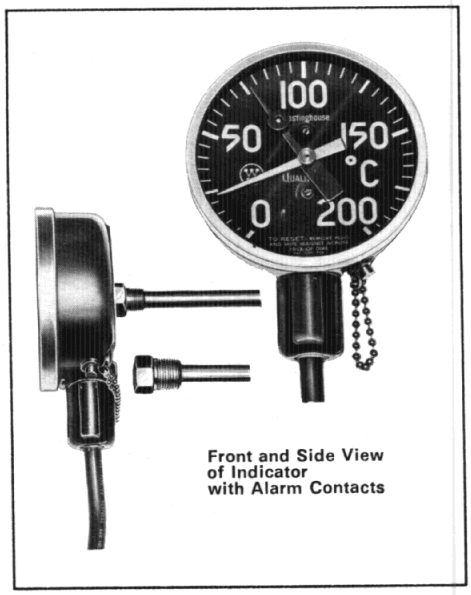
Description
The type TRC Opt-i-Therm is a thermocouple actuated, optically isolated temperature indicator and control. The instrument indicates hottest spot temperature in degrees centigrade and provides contacts for starting and stopping cooling fans, operating alarm signals and lights and actuating breaker trip coils or initiating other shut down or load reduction procedures.

The actuating thermocouple is wound into the transformer low voltage coil at the point of highest temperature. The instrument, therefore, indicates the actual hottest spot temperature of the transformer rather than a simulated hot spot temperature from conventional instruments.

The ability of this type TRC relay to more accurately measure hot spot temperatures offers three benefits: **1.** The ability to safely and reliably carry heavier overloads. **2.** The ability to size a transformer more nearly to the actual load which means lower first cost. **3.** More accurate fan control has the benefit of longer transformer life and fewer failures.

Gas Filled Sealed Dry Type Transformers

Temperature Indicator Hot Gas, Two Switch, Dial Type, Submersible, Direct Mounted



Front and Side View of Indicator with Alarm Contacts

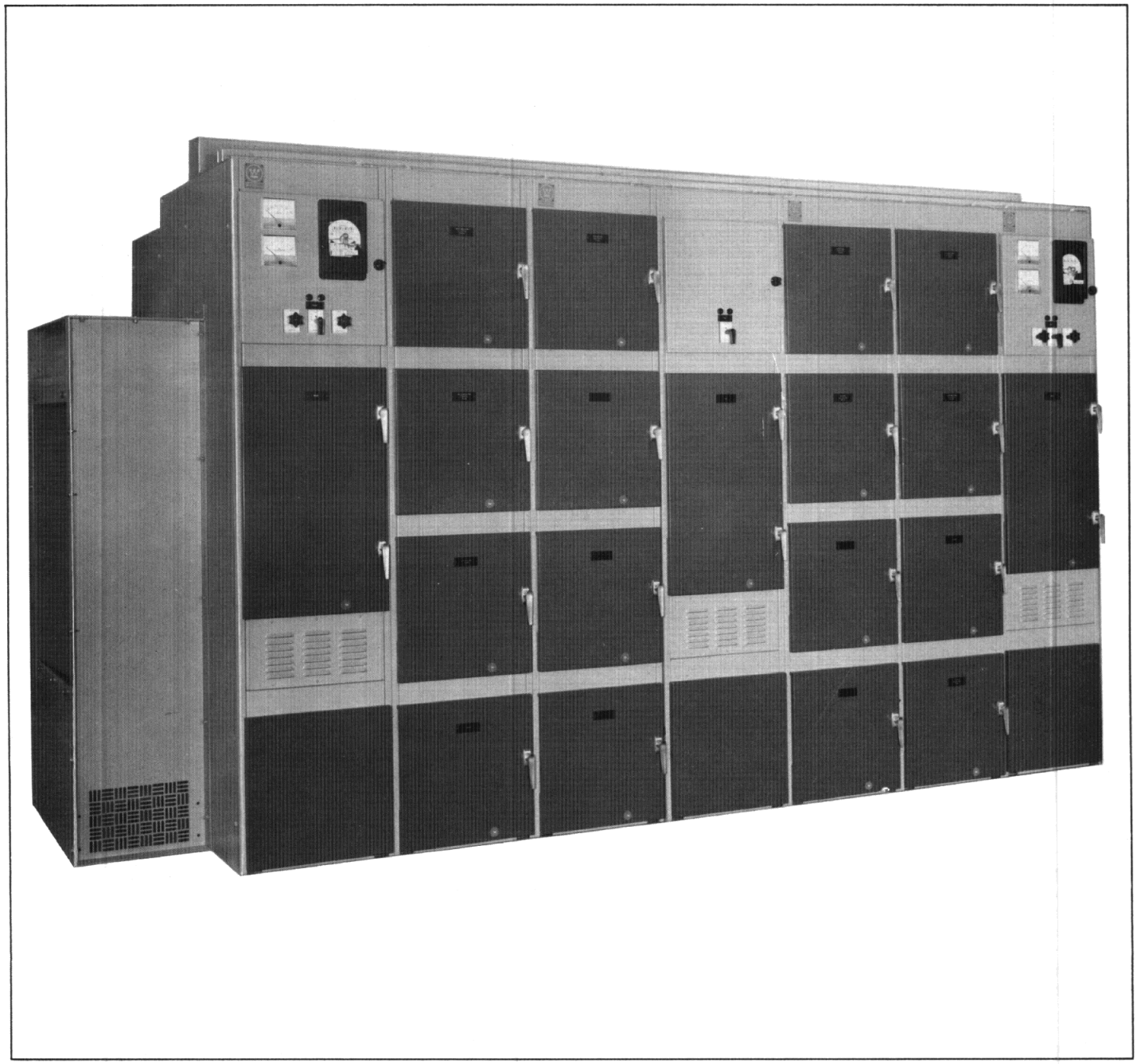
A dial-type thermometer with alarm contacts with maximum resettable indicating hand will be provided. It will indicate the temperature of the gas above the core and coils.

Type DS Low Voltage Switchgear Section

Modern design Type DS Low Voltage Metal Enclosed Switchgear and Circuit Breakers provide

- Integral solid-state type breaker tripping systems
- "Metal-clad" safety features
- Two-step stored-energy breaker closing
- Glass polyester insulation

and many other features for coordinated, safe, convenient, trouble-free and economical control and protection of low-voltage distribution systems.



Ratings
600 volts ac
50 to 4000 Amperes continuous
22,000 to 200,000 amperes interrupting capacity

Features
Two-Tone Standard Indoor Finish—Pearl gray (ANSI No. 61) with contrasting charcoal gray on breaker compartment doors.

Four Position Drawout—Breakers can be in connected, test, disconnected or remove position with compartment doors closed.

Standard Welded Aluminum Main Buses—Reduce maintenance. Purchaser's connections are silver plated copper. (All-copper buses optional).

Wiring Protection—Provided by slotted plastic wiring channels with removable covers, and enclosed steel troughs for interunit cross wiring.

Isolated Incoming Connections—Reduce possibility of fault transmission between incoming source and main bus.

Protection During Levering Operation—When levering the breaker between the connected, test and disconnected positions, the operator is fully protected by a steel barrier (faceplate) from contact with live parts and from arcs and hot gases.

Two-Step Stored Energy Closing Mechanism—Spring charging (1) and spring release to close breaker (2) are independent operations, and always give positive control of the instant of closing.

Motor Operated Stored-Energy Closing Mechanisms are supplied on electrically operated breakers. Standard control voltages are 48, 125 and 250 dc, and 120 and 240 ac.

Remote Closing and Tripping can be accomplished with manually operated breakers, by charging the closing mechanism manually, and closing and tripping it remotely through electric spring release and shunt trip coils; available as optional attachments.

Closing Spring Automatic Discharge—Mechanical interlocking automatically discharges the closing springs when the breaker is removed from its compartment.

Breaker Inspection—When withdrawn on the rails, breaker is completely accessible for visual inspection; tilting is not necessary. The rails are permanent parts of every breaker compartment.

Current Transformers for metering and instrumentation are mounted in the breaker compartments, and are front accessible. Accuracies meet ANSI Standard C37.20, Section 20-4.6.3 for Low Voltage Metal Enclosed Switchgear.

Integral Solid-State Type Breaker Overcurrent Trip Systems—provide maximum reliability and excellent repeatability, and require minimum maintenance. No external control source is required. Continuous stepless current pickup and time delay adjustments are made with sealed potentiometers, with no fixed taps or bands and no contact corrosion. Two types available: Standard Amptector II-A and Optional Amptector I-A.

Ground Fault Tripping is available optionally as an integral part of Amptector I-A.

Change in Trip Rating—The overcurrent trip pickup range is established by the rating of the current sensors on the breaker. A continuous long delay pickup adjustment 50% to 125% of sensor rating is provided. The sensors can be readily changed to provide a different pickup range.

Glass Polyester Insulation—Westinghouse-produced glass polyester, with excellent mechanical, dielectric and thermal properties, is used for the insulation system.

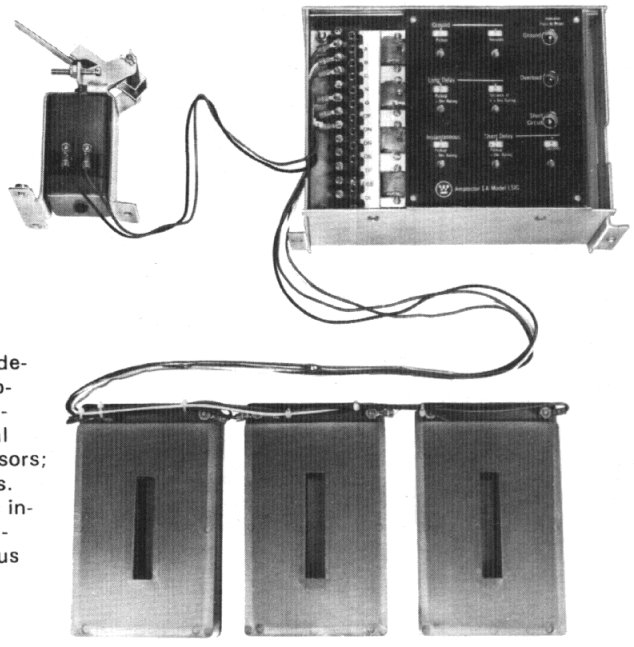
Double Steel Safety Barrier in front of each breaker during normal operation provides maximum safety.

Interphase Barriers—on breakers provide maximum insulation security. The barriers are easily removable for breaker inspection.

Provision for Padlocking—All breakers include provision for padlocking open to prevent electrical or manual closing. This padlocking also secures the breaker in the connected, test or disconnected position by preventing levering.

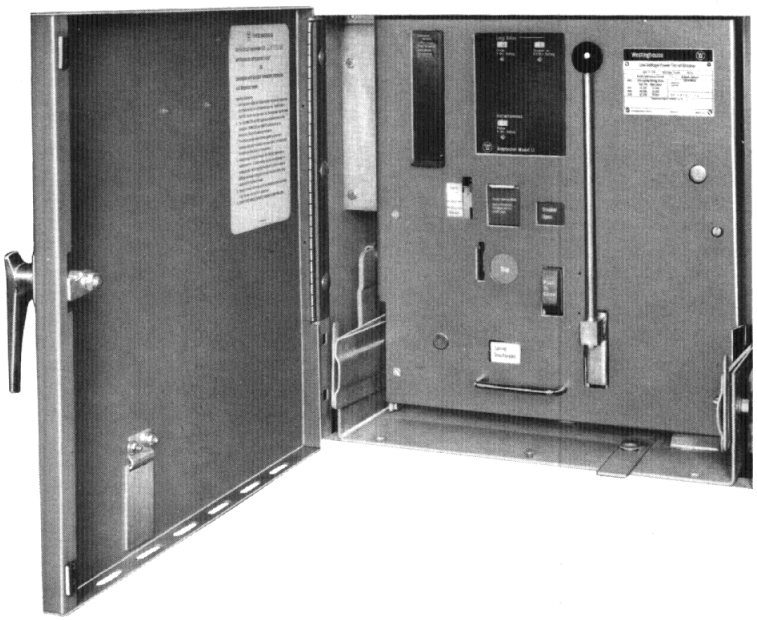
Ease of Inspection and Maintenance—Type DS switchgear and breakers are designed for maximum accessibility and the utmost facility of inspection and maintenance.

Conformity to Standards—Type DS switchgear and breakers conform to the following standards: NEMA SG3 & SG5; ANSI C37.13, C37.16, C37.17 & C37.20 (IEEE No. 27).



Solid-State Trip
Provides continuous wide-range adjustability. Step-type adjustment is eliminated. Energy and signal provided by current sensors; no potential connections. Long delay, short delay, instantaneous and ground-fault protection in various combinations.

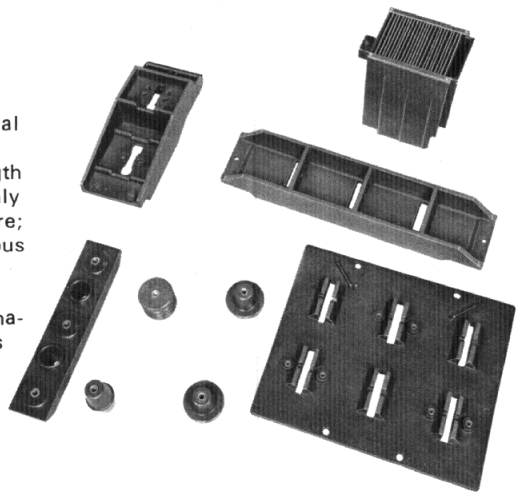
Metal-Clad Safety Features



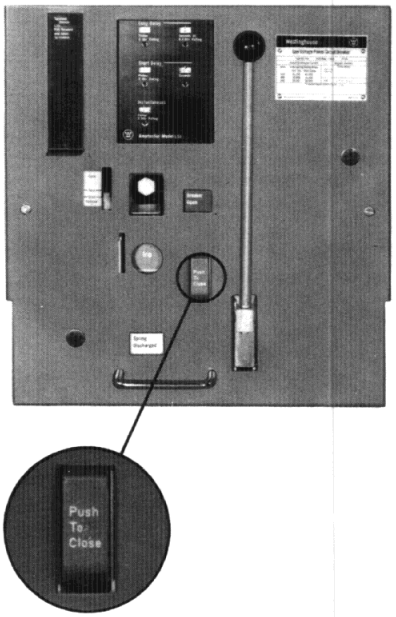
Outer door with quick-opening latches closes compartment completely with breaker in or out. All controls are protected from unauthorized or accidental operation. Full-sized metal shield on breaker face protects operator from live parts, arcs and hot gases while operating, racking or checking Amptector settings. Double interlocked device prevents racking until contacts are open; contacts can't be closed until racking is complete. Separate cable entrance and bus compartments can be provided; removable barriers give access to bus compartment for inspection or cleaning.

Glass Polyester Insulation

Offers far better mechanical, thermal and electrical properties than phenolics. It has the mechanical strength to resist shortcircuit forces; is highly resistant to heat, flame and moisture; and has been designed with generous creepage distances. Often used on 5 Kv and 15 Kv metal-clad switchgear—Westinghouse gives these materials to you on all insulating parts in Type DS 600 volt switchgear.



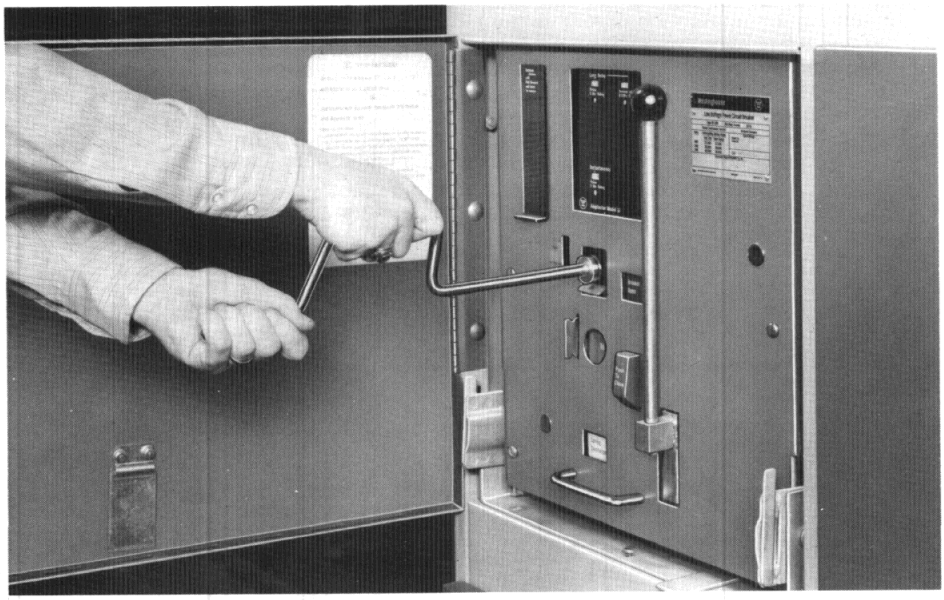
Two-step Stored-energy Closing



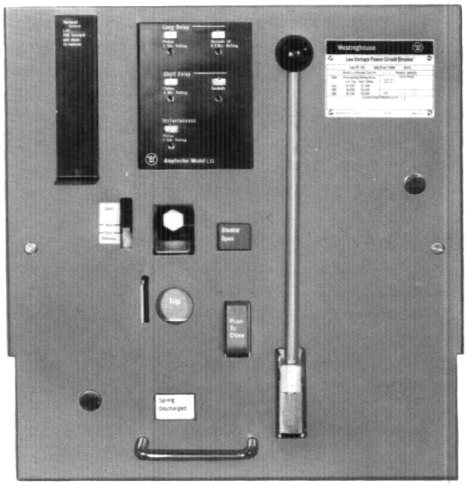
Gives operator positive control of closing after spring mechanism is charged. Breaker can't close while you're still charging. Operation is optional-full manual, full electric, or manual charge and remote electric release.

On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually by pumping an accessory lever 10 to 12 times and released mechanically.

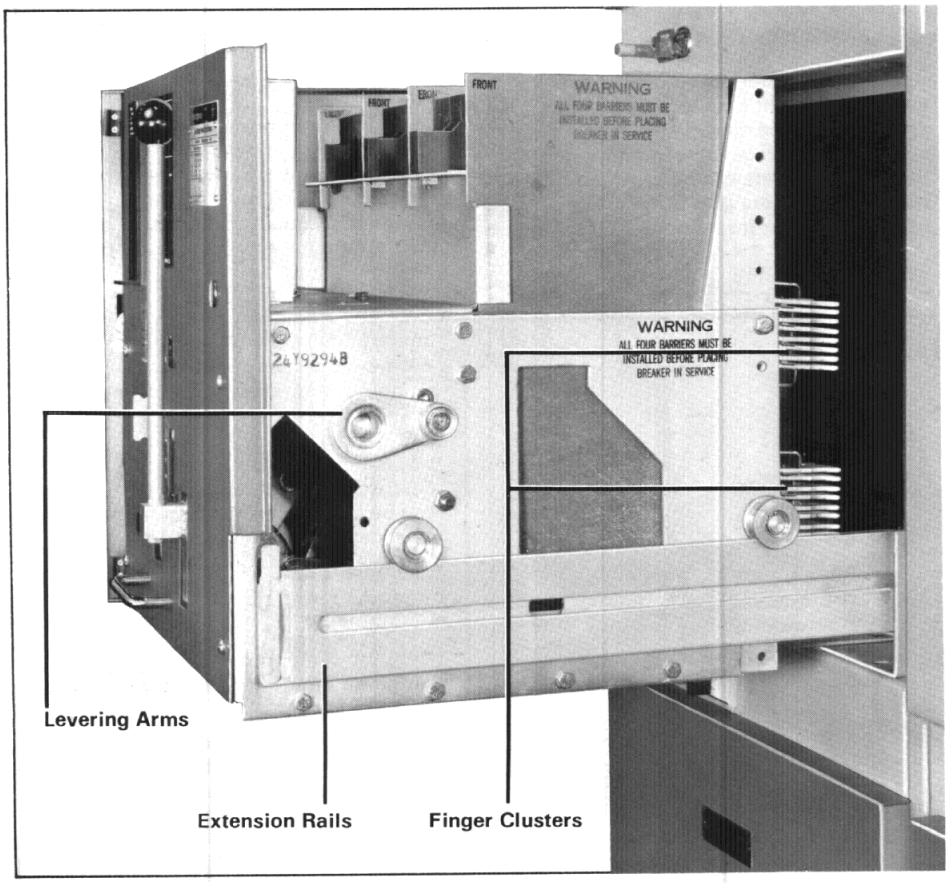
An interlock discharges the closing springs as the breaker is removed from the compartment. The system is patterned after 5 Kv and 15 Kv metal-clad switchgear.



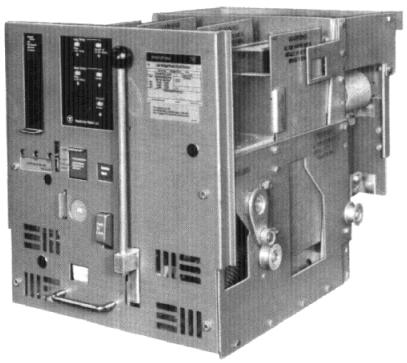
DS Breaker Levering Operation



DS Breaker Faceplate



DSL Breakers and Combinations



Type DSL Breakers are coordinated combinations of Type DS breakers and series connected current limiting fuses. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand and interrupting ratings of "downstream" circuit components.

Arc Chute

There are three basic means of extinguishing an arc: lengthening the arc path; cooling by gas blast or contraction; deionizing or physically removing the conduction particles from the arc path. It was the discovery by Westinghouse of this last method which made the first large power air circuit breaker possible.

The De-ion® principle is incorporated in all of these circuit breakers. This makes possible faster arc extinction for given contact travel; assures positive interruption and minimum contact burning.

Levering Mechanism

The worm gear levering mechanism is self-contained on the breaker drawout element and engages slots in the breaker compartment. A removable crank is used to lever the breaker between the Connected-Test-Disconnected positions.

Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the tripped position.

Stored Energy Mechanism

A cam-type closing mechanism closes the breaker. It receives its energy from a spring which can be charged by a manual handle on the front of the breaker or by a universal electric motor.

Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

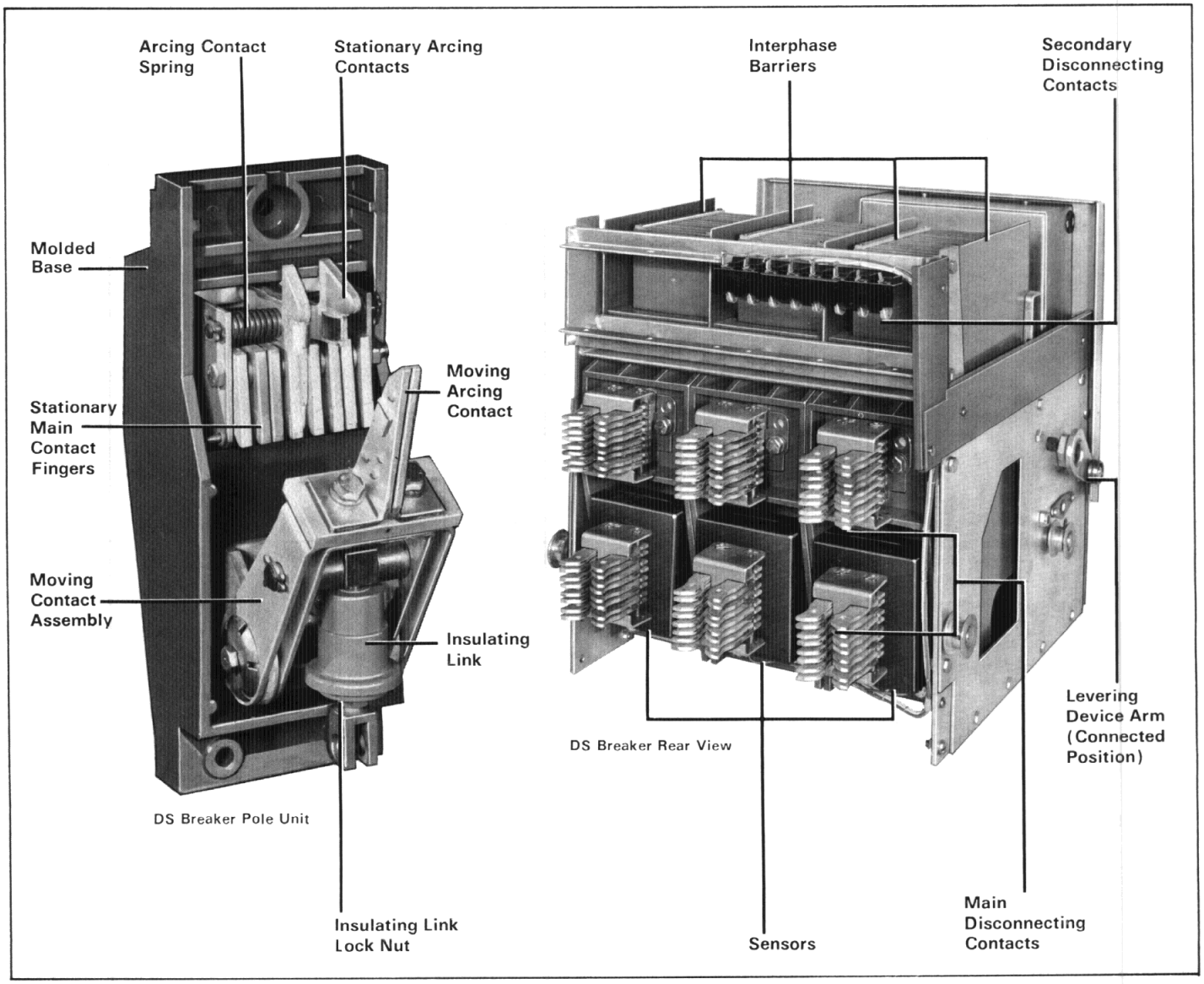
Contacts

All air circuit breakers have solid block, silver tungsten, inlaid main contacts. This construction insures lasting current-carrying ability, which is not seriously impaired even after repeated fault interruptions or repeated momentary overload.

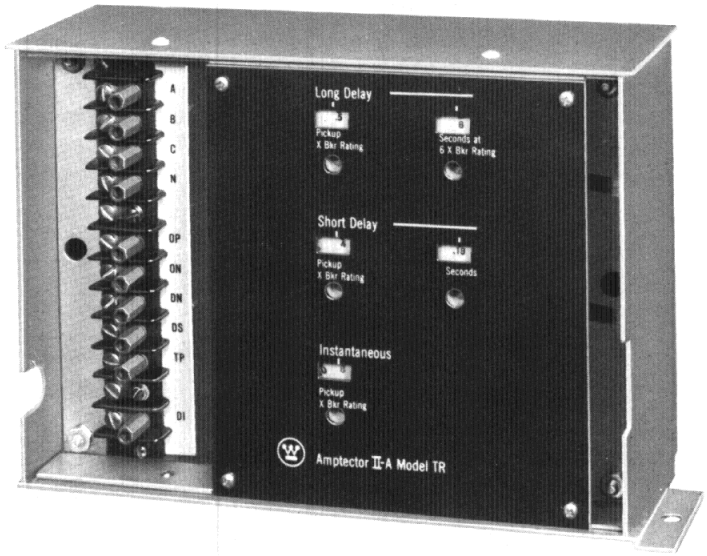
It is not necessary to provide a substantial margin of safety above the actual circuit load current to prevent contact deterioration.

The main contacts are of the butt type and are composed of a multiplicity of fingers to give many points of contact without alignment being critical.

All Type DS breakers are available as either manually or electrically operated.



Standard Amptector II-A Solid-State Trip



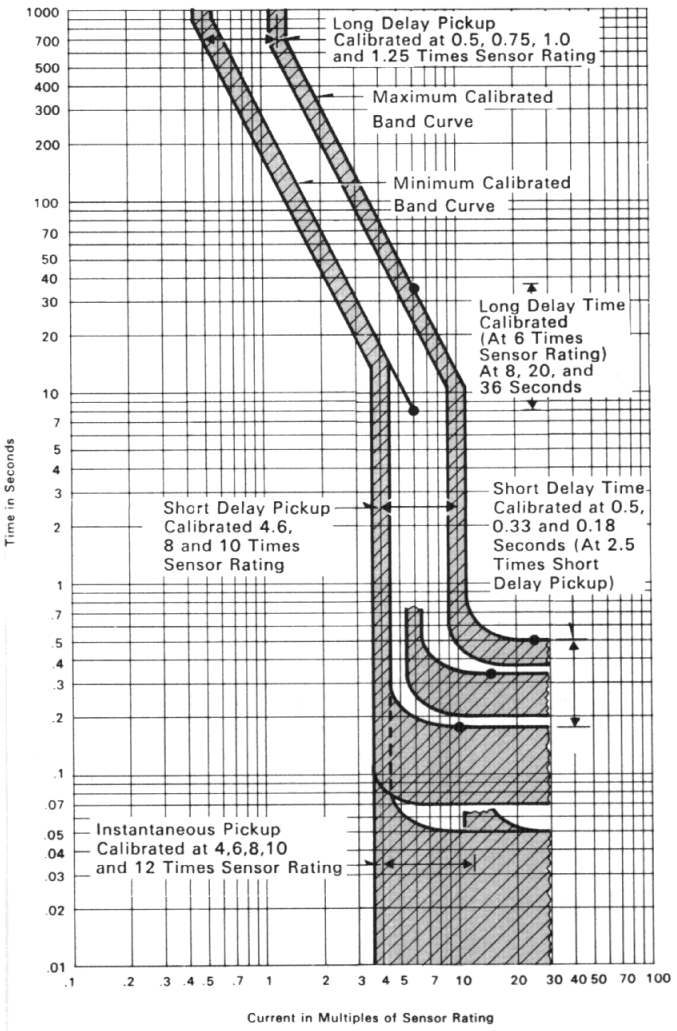
The Westinghouse Amptector II-A is a solid-state device that provides adjustable overcurrent tripping for Westinghouse Type DS low-voltage a-c power circuit breakers. Only one Amptector II-A is required per breaker, and it receives all its energy from a set of sensors—one mounted on each pole of the breaker. It develops an output for an associated trip actuator when preselected conditions of current magnitude and duration are exceeded.

The device can be supplied in three models or combinations of three independent continuously adjustable overcurrent tripping functions: long delay, short delay and instantaneous. These models are:

DU (Dual)—Long delay and instantaneous
SE (Selective)—Long delay and short delay
TR (Triple)—Long delay, short delay and instantaneous

Model DU is the basic standard, and will be supplied when not otherwise indicated or required.

Amptector II-A Characteristics



Amptector I-A and II-A

Each Amptector includes terminal receptacles to permit easy field checking of operation and calibration with an external power supply. A specially designed portable test device with a plug to match the Amptector receptacle is available to provide the utmost in simplicity for checking Amptector operation.

Available Sensor Ratings

Breaker	Frame Size, Amperes	Sensor Ratings, Amperes
DS-206, DSL-206 or DS-206S	800	50, 100, 150, 200, 300, 400, 600, 800
DS-416, DSL-416 or DS-416S	1600	100, 150, 200, 300, 400, 600, 800, 1200, 1600
DS-420	2000	2000
DS-632	3200	2400, 3200
DS-840	4000	4000

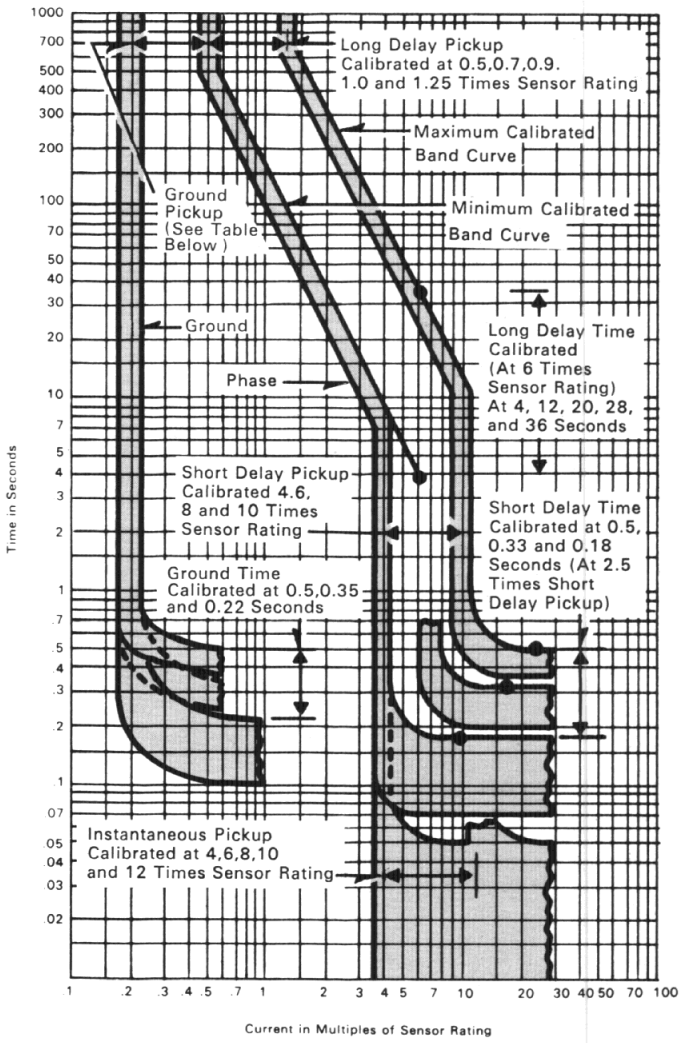
The narrow-band characteristic curves graphically illustrate the close coordination obtainable in breaker systems with Amptector tripping devices. Repeatability within 2%.

The particular breaker current rating for any breaker frame size is determined by the rating of the sensor used.

The breaker current rating for any frame size can be changed by simply changing the sensors, which are easily removed from the breaker drawout element. The wide range of long-delay pickup makes one set of sensors suitable for a number of current ratings. The Amptector itself need not be changed when the associated sensors are changed.

Optional Amptector I-A Solid-State Trip

Amptector I-A Characteristics



Offers all of the features of Standard Amptector II-A, plus:

- Integral ground fault protection (optional), with adjustable pickup and delay.
- Resettable operation indicators for Ground, Overload and Short circuit.

Amptector I-A can be supplied in various combinations of four independent continuously adjustable overcurrent tripping functions:

Long delay (L)
Short delay (S)
Instantaneous (I)
Ground (G)

The following combinations are available:

LI	LIG
LS	LSG
LSI	LSIG

Model LI is the basic standard and will be supplied when not otherwise indicated.

Amptector I-A

Ground Pick-Up Value—Amperes

Dial Setting	Sensor Rating 50	100	150	200	300	400	600	800	1200	1600	2000	2400	3200	4000	Secondary Current ①
A	13	57	60	65	80	110	145	180	260	330	400	530	640	800	1.0
B	18	67	75	85	110	150	205	260	385	505	600	770	1000	1200	1.5
C	22	75	85	100	130	185	250	325	480	625	760	960	1200	N.A.	1.9
D	33	100	120	145	200	270	385	500	730	970	1200	N.A.	N.A.	N.A.	3.0

All pick up values may vary ± 10%

① Current of this value from the secondary of an external ground transformer will cause the ground element to function. Ground element pick-up can also be tested using this value. All sensors must be disconnected during test.

Optional Breaker Attachments and Accessories

(a) Shunt trip on manually operated breakers, for any standard control voltage. An auxiliary switch is also required.

(b) Auxiliary contacts on manually operated breakers, usually consisting of one 4 contact auxiliary switch. Maximum of three 4 contact auxiliary switches available on any breaker, manually or electrically operated. The contact rating is 10 amperes. (Two 4 contact switches are standard on each electrically operated breaker.)

(c) Compartment position switch ("TOC"), 6 or 12 contact, actuated by movement of drawout breaker between the connected and test positions. Most common uses are for disconnecting remote control circuits of electrically operated breaker, and for bypassing "b" interlocking auxiliary contacts, when breaker is withdrawn to test position.

(d) Undervoltage trip (ac and dc available). Acts to trip the breaker when the Voltage on its solenoid coil is insufficient to restrain a spring-loaded core. The dropout point is within 30 to 60 percent of the nominal coil voltage and is not adjustable. Available as either instantaneous or time delay type. The time delay is within 2 to 7 seconds after zero voltage occurs, and is not adjustable. The device automatically resets when the breaker opens; approximately one minute is required for resetting of the time delay type.

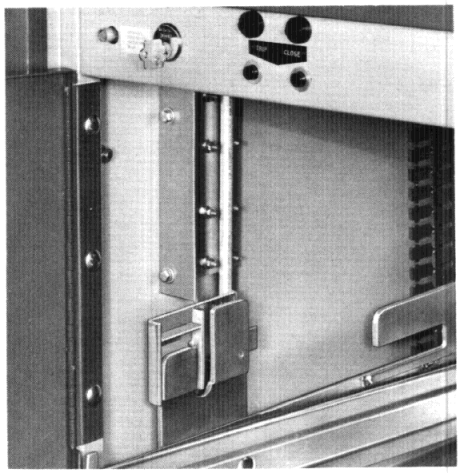
(e) Overcurrent trip switch (OTS). A latching type switch with two independent contacts either normally open or normally closed. Operates only when the breaker is tripped automatically on an overload or fault condition (including Amptector I-A integral ground fault tripping). It may be used for alarm and/or interlocking circuits. Resetting is done by a pushbutton on the breaker face plate, or by a remote switch through an optional reset coil.

(f) High load switch (HLS—available with Amptector I-A only). A self resetting relay which picks up on an overload condition at a lower value than the long delay pickup setting of the tripping device, thus, giving advance warning of an overload condition. The device is completely independent of the overcurrent tripping system, does not trip the breaker, and does not replace any protection in any phase. Adjustment is from 60 to 100 percent of the long delay pickup setting. The time delay is fixed and is approximately one minute. One normally open contact is provided.

(g) Electric Lockout (Manual Breakers). In order to close the breaker after manually charging the closing mechanism, it is necessary to operate an electrical pushbutton on the breaker faceplate. This pushbutton is in series with any required external interlocking. The mechanical "push-to-close" bar is made inoperative when the breaker is in the connected position. An electric spring release attachment (operated by the electrical pushbutton), a charged-spring limit switch, and an auxiliary switch are required.

(h) Electric close release on manually operated breakers, for any standard control voltage. Breaker can be closed by remote control switch or pushbutton after spring is manually charged. A charged-spring limit switch and an auxiliary switch are also required.

(i) Key interlock. Operative only after breaker has been withdrawn beyond disconnected position. Blocks any breaker from being levered into compartment. Breaker can be stored in compartment, and can be completely removed for maintenance or for use as a spare without disturbing interlock. No modification of breaker required.



Key Interlock—Blocking Position

(j) Operation counter.

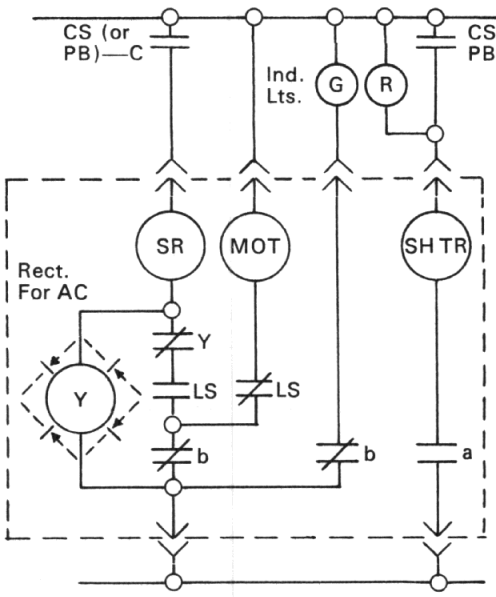
(k) Ac capacitor trip.

(l) Latch check switch.

(m) Mechanical interlock.

Standard Control Diagram

Standard control diagram for Type DS electrically operated breaker, for ac or dc control source.

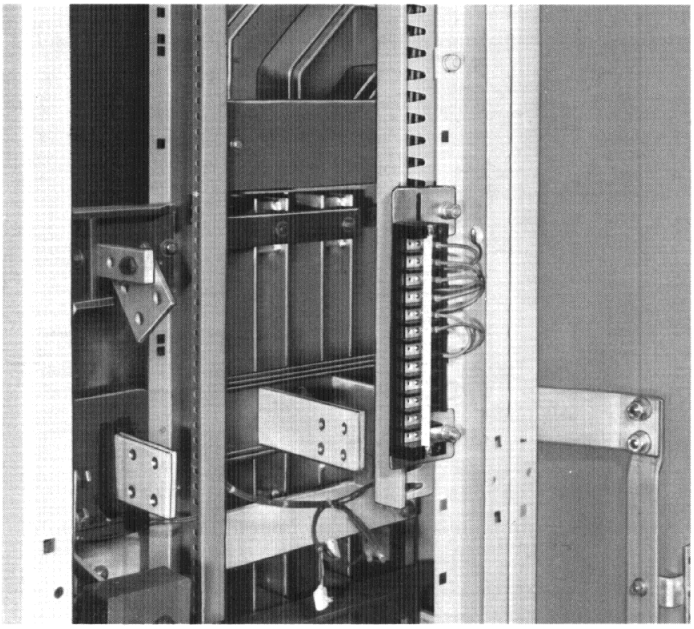


Legend

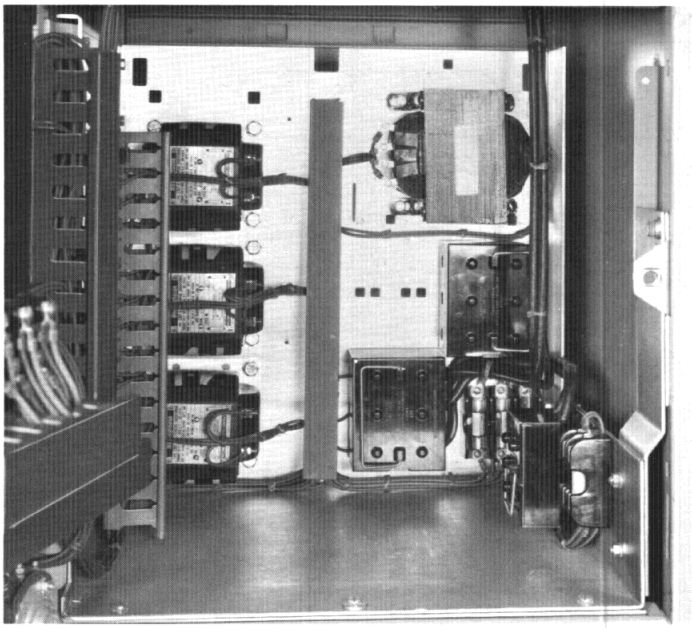
LS —Limit Sw. for Closing Spring
MOT —Motor for Spring Charging
SH TR—Shunt Trip
SR —Spring Release
Y —Anti-Pump Relay

Description of Operation

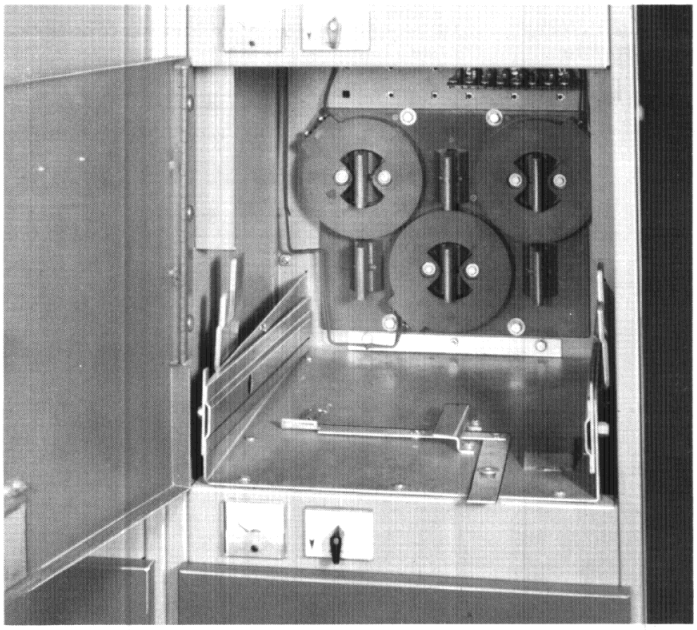
1-When Bkr opens, motor is energized through LS & "b" contact.
2-Motor runs and charges Closing Spring.
3-When Closing Spring fully charged, LS contacts reverse.
4-Closing CS-C contact energizes SR Coil through Y, LS & "b" contacts.
5-When Breaker closes, "b" opens and Y Coil is energized in series with SR Coil.
6-Y contact opens to open SR Coil circuit & prevent pumping should breaker open while CS-C is held closed, Y Coil has very low drop-out voltage.



Terminal Blocks



Potential Transformer and Control Power Transformer with Primary and Secondary Fuses



Current Transformers

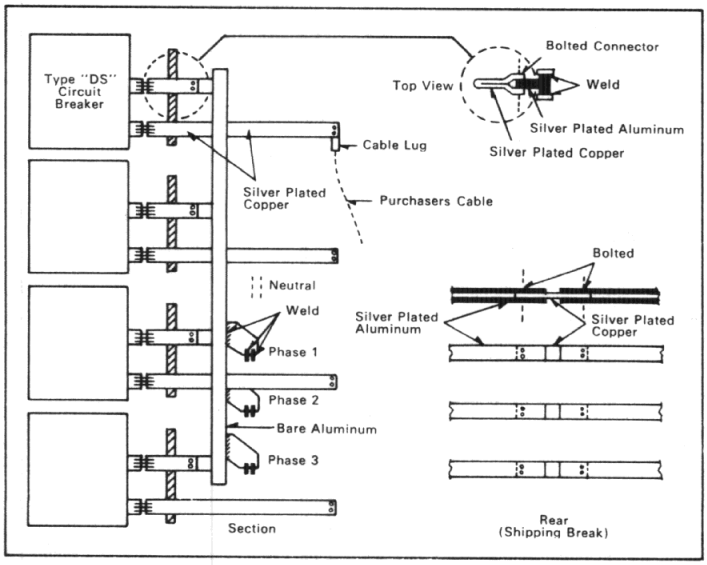
Insulating Boots

Insulation
All insulation is Westinghouse glass polyester, which has been compounded to include the dielectric and mechanical strength necessary for the application. It is highly resistant to heat, flame and moisture, and has been designed with generous creepage distances.

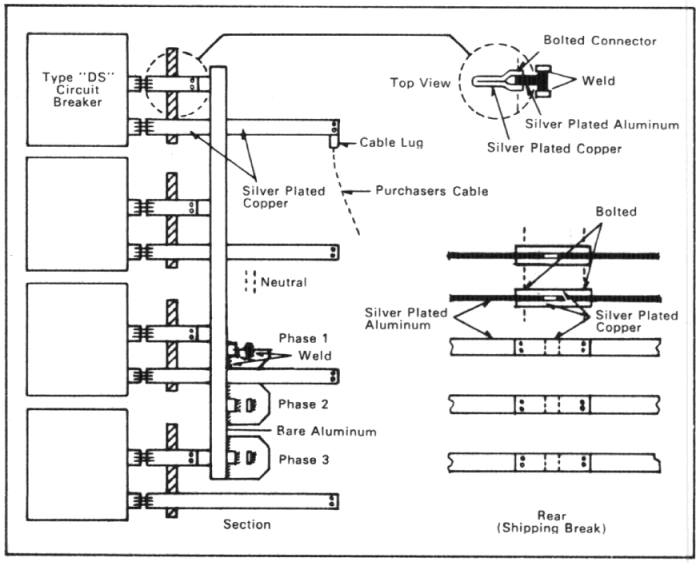
Bus Isolation
The incoming line is isolated from the main bus to reduce the possibility of fault transmission between them. Bus sections are also isolated at a bus tie breaker.

Wiring
Enclosed plastic wiring troughs are used throughout the switchgear. Control circuit terminal blocks are mounted on the rear frame where they are readily accessible for purchaser's connections and inspection. Main circuit terminals may be oriented to suit cable entrance.

Buses and Connections



1600 and 2000 Ampere Bus and Risers

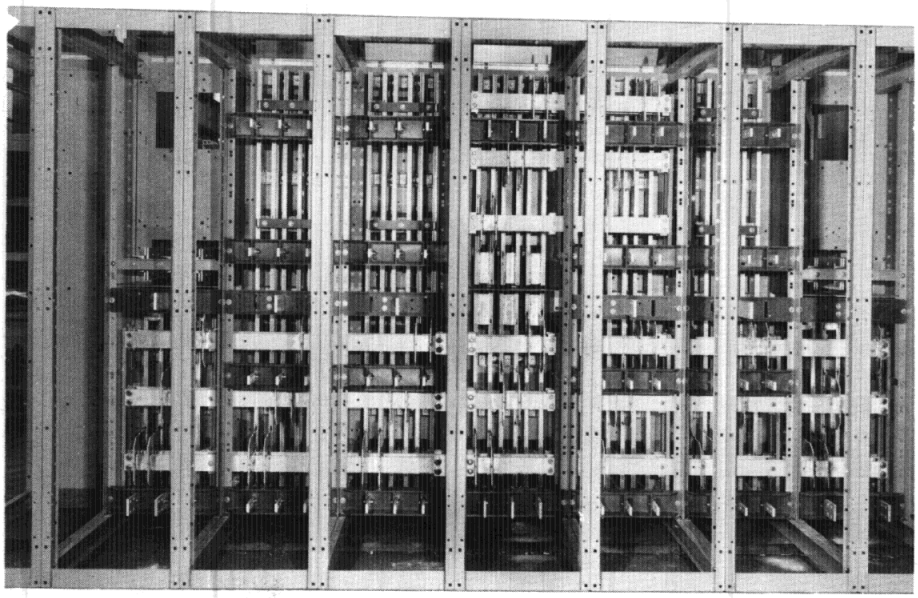


3200, 4000 and 5000 Ampere Bus and Risers

Available main bus ratings in Type DS switchgear are 1600, 2000, 3200, 4000 and 5000 amperes. All ratings are based on a standard temperature rise of 65°C above a maximum ambient air temperature of 40°C outside of the switchgear enclosure.

Details of standard bare welded aluminum main buses, in conjunction with silver plated copper for shipping breaks and for field connections, are shown above.

Optional bare copper main buses with silver plated bolted joints are available.



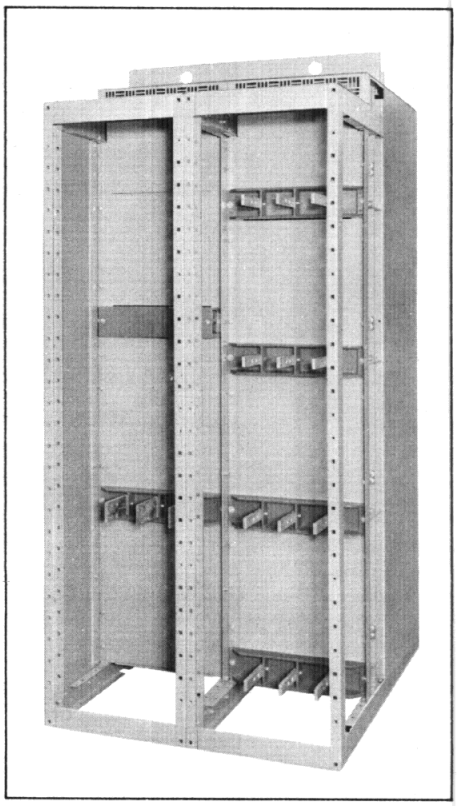
Bus and Cable Compartment with Barriers Removed

The rear portion of the switchgear assembly houses the main bus, connections, and terminals.

A ground bus is furnished the full length of the switchgear assembly and is fitted with terminals for purchaser's connections.

Rear covers are the bolt-on type. They are split into two horizontal sections to facilitate handling during removal and installation.

If the purchaser desires, steel barriers will be furnished to separate the main bus and connections from the purchaser's connection compartment.



Cable Connection Compartment with Barriers in Place

Type RCT Meter Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type*					ANSI Meter Accuracy Classification		
DS-206	DS-416	DS-420	DS-632	DS-840	Ratio	B-0.1	B-0.2
↓	↓				100/5	1.2	—
					150/5	1.2	—
					200/5	1.2	1.2
					300/5	0.6	0.6
					400/5	0.6	0.6
					600/5	0.6	0.6
					800/5	0.3	0.3
	↓	↓			1200/5	0.3	0.3
					1500/5	0.3	0.3
					1600/5	0.3	0.3
					2000/5	0.3	0.3
		↓	↓		2500/5	0.3	0.3
					3000/5	0.3	0.3
			↓	↓	4000/5	0.3	0.3
					5000/5	0.3	0.3
					6000/5	0.3	0.3

*Also for Types DSL-206, DSL-416, DSL-632 and DSL-840 limiter type equipments.

Current transformers with meter accuracy classifications at higher burdens and/or suitable for relaying are also available. They will be mounted in the rear cable connection compartment.

Control Voltages and Currents

Standard control voltages, rated control currents and standard ranges are as follows:

Control Voltage	48 Dc	125 Dc	250 Dc	120 Ac	240 Ac
Close current (SR), amp.	5.0	2.0	1.0	3.0	2.0
Shunt trip current, amp.	5.0	2.0	1.0	2.0	1.0
Spring charge motor amp.	7.5	3.0	1.5	3.0	1.5
Control voltage range:					
Close—	38-56	100-140	200-280	104-127	208-254
Trip —	28-56	70-140	140-280	60-127	208-254

Motor currents are running currents; inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.

Potential Transformers
Potential transformers are rated 10 Kv BIL, and are protected by both primary and secondary fuses. The primary fuses are dead front safety pullout type, NEMA Class J.

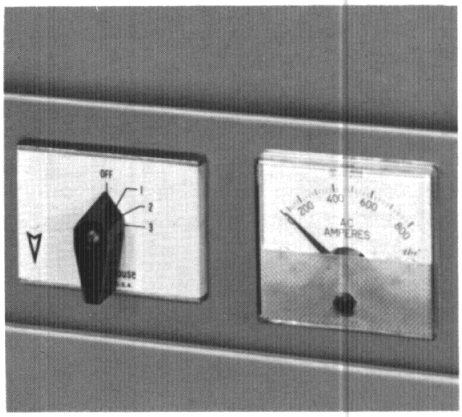
Control Power Transformers
Control transformers are provided when required for Ac control of circuit breakers, space heaters, and/or transformer fans. Like potential transformers, they are protected by pullout type primary fuses and also secondary fuses.

Switchgear Accessories
Standard accessories furnished with each Type DS switchgear assembly include:

- One breaker levering crank.
- One manual spring charging lever, if electrically operated breakers are included.
- Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers. One additional set is provided for each size breaker furnished.

Test plugs are furnished when "Flexitest" relays, Flexitest watthour meters or Flexitest Type FT-1 test switches are mounted on the switchgear.

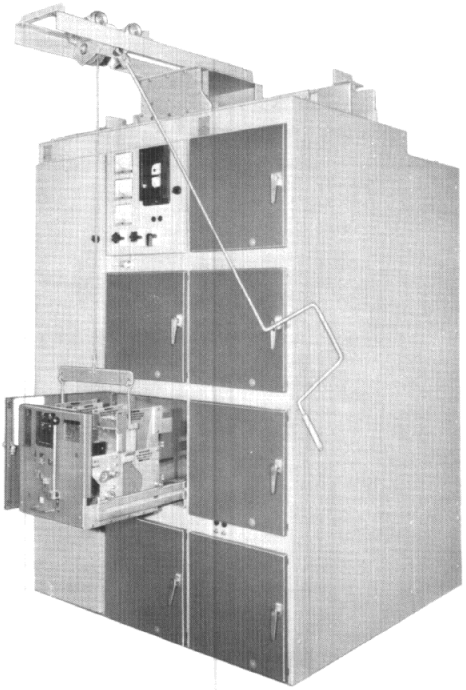
Miscellaneous
For feeder circuit instrumentation, small 2 inch 2% accuracy class ammeters and Type W-2 ammeter switches can be mounted on the horizontal stationary panels adjacent to the breaker compartment doors. The ammeters and switches are immediately associated with definite breaker circuits. Other devices, such as control pushbuttons, indicating lights and test switches can be mounted on these panels, within space limits. Removable covers provide access to wiring.



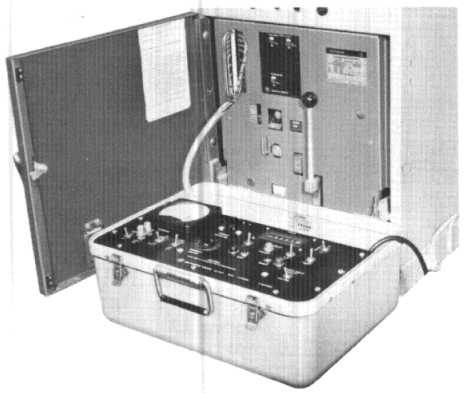
Interference interlocks are supplied on breakers and in compartments where the compartments are of the same physical size, to insure that a Type DS-206 breaker cannot be inserted into a compartment intended for a Type DS-416 or DS-420 breaker, and a Type DS-416 or DS-420 breaker cannot be inserted into a compartment for a Type DS-206 breaker.

Standard wire is Type SIS, stranded copper, polyethylene insulated, No. 14 AWG minimum, with crimped insulation grip ring tongue terminals.

Optional Accessories



- Traveling type circuit breaker lifter, rail mounted on top of switchgear.
- Floor running portable circuit breaker transfer truck with manual lifting mechanism. Requires approximate 60" deep front aisle space.
- Test cabinet for electrically operated breakers, with pushbuttons, control cable and receptacle, for separate mounting.



- Portable test kit for testing and calibration of Amptector trip devices. Utilizes standard 120 volt, 20 ampere single phase 60 Hz supply, available from any outlet.

Outdoor Type DSO Switchgear

Type DSO outdoor switchgear consists of standard Type DS indoor structures assembled in a heavy gauge completely weatherproof enclosure, with a generous internal "walk-in" front operating aisle extending through all units of the assembly. A reinforced access door with holder, provision for padlocking and "panic" hardware is provided at each end of the aisle.

Standard features also include:

- Bolted hinged rear doors for access to cable and bus compartments.
- Labyrinth door openings.
- Filtered ventilation openings.
- Traveling type geared breaker lifter.
- Space heaters.
- Lighting outlets and convenience receptacles.
- Rigid base structure; no channels required.
- Walk-in aisle within shipping group shipped completely asembled.

The interior finish is similar to indoor switchgear. The standard exterior finish is ANSI No. 24 dark blue-gray. An asphalt coating is provided on the underside and base.

Metal Enclosed Bus Runs

For connecting outdoor transformers through building walls to indoor switchgear, low voltage metal enclosed buses in ratings from 600 amperes to 5000 amperes are available. These buses can also be used for bus tie circuits between separate low voltage switchgear assemblies.

Design and construction follow Low Voltage Switchgear Standards, with bare aluminum or copper conductors with silver plated bolted joints and glass polyester supports. Momentary ratings (minimum 50,000 amperes) are as required. Standard finish colors are ANSI No. 61 pearl gray indoor and No. 24 dark blue-gray outdoor.

Application Data, Dimensions and Weights

Air Interrupter Switch Ratings

Primary Power Switch, Type PPS
(for liquid transformers only)

- 15 Kv, 95 Kv BIL (fuse voltage to suit application).
- 600 A continuous and load interrupting.
- 61,000 A asymmetrical momentary, 40,000 A asymmetrical fault close rating.

Load Interrupter Switch, Type WLI
(standard for Ventilated Dry and Gas Filled transformers; optional for liquid transformers)

- 5 Kv, 60 Kv BIL, and 15 Kv, 95 Kv BIL.
- 600 A and 1200 A continuous and load interrupting.
- Momentary ratings 40,000 A and 80,000 A asymmetrical.
- Fault close in ratings 20,000 A, 40,000 A and 61,000 A asymmetrical

Transformer Primary Fuse Application

System Circuit Volts	Fuse Data Identification			Interrupting Rating		Max. Transf. Kva Rating ①	
	Type	Kv	Maximum Amperes	Amperes Symm.	Equiv. 3 Ph. Mva	Self Cooled	Forced Air
2400	CLE-1	2.4	225X	50,000	205	670	780
	CLE-2	2.4	450X	40,000	165	1335	1560
	RBA-200	8.3	200E	19,000	80	600	695
	RBA-400	8.3	400E	37,500	150	1190	1385
	RBA-800	8.3	720E	37,500	150	2140	2500
4160	CLE-1	5.5	225X	50,000	360	1155	1350
	CLE-2	5.5	450X	50,000	360	2315	2700
	RBA-200	8.3	200E	19,000	137	1030	1200
	RBA-400	8.3	400E	37,500	270	2055	2400
	RBA-800	8.3	720E	37,500	270	3700	4320
4800	CLE-1	5.5	225X	50,000	415	1335	1560
	CLE-2	5.5	450X	50,000	415	2675	3120
	RBA-200	8.3	200E	19,000	158	1190	1385
	RBA-400	8.3	400E	37,500	310	2375	2775
	RBA-800	8.3	720E	37,500	310	4280	5000
6900	CLE-1	8.3	125E	50,000	600	1065	1245
	CLE-2	8.3	200E	40,000	480	1705	2000
	RBA-200	8.3	200E	16,600	200	1705	2000
	RBA-400	8.3	400E	29,400	350	3415	3985
	RBA-800	8.3	720E	29,400	350	6150	7170
	CLT	8.3	300C	50,000	600	2560	2985
7200	CLE-1	8.3	125E	50,000	625	1115	1300
	CLE-2	8.3	200E	40,000	500	1785	2080
	RBA-200	8.3	200E	16,600	205	1785	2080
	RBA-400	8.3	400E	29,400	365	3565	4160
	RBA-800	8.3	720E	29,400	365	6420	7500
	CLT	8.3	300C	50,000	625	2670	3110
12,000	CLE-1	15.5	65E	85,000	1770	905	1030
	CLE-2	15.5	125X	85,000	1770	1745	1985
	CLE-3	15.5	200X	50,000	1040	2790	3175
	RBA-200	15.5	200E	14,400	300	2970	3465
	RBA-400	15.5	400E	29,400	610	5945	6930
	CLT	15.5	175C	50,000	1040	2595	3025
12,470	CLE-1	15.5	65E	85,000	1835	940	1070
	CLE-2	15.5	125X	85,000	1835	1810	2060
	CLE-3	15.5	200X	50,000	1080	2900	3300
	RBA-200	15.5	200E	14,400	310	3085	3600
	RBA-400	15.5	400E	29,400	635	6170	7200
	CLT	15.5	175C	50,000	1080	2695	3140
13,200	CLE-1	15.5	65E	85,000	1945	1000	1135
	CLE-2	15.5	125X	85,000	1945	1920	2180
	CLE-3	15.5	200X	50,000	1145	3070	3490
	RBA-200	15.5	200E	14,400	330	3265	3810
	RBA-400	15.5	400E	29,400	670	6530	7620
	CLT	15.5	175C	50,000	1145	2855	3330
13,800	CLE-1	15.5	65E	85,000	2030	1045	1185
	CLE-2	15.5	125X	85,000	2030	2000	2280
	CLE-3	15.5	200X	50,000	1195	3200	3650
	RBA-200	15.5	200E	14,400	330	3415	3985
	RBA-400	15.5	400E	29,400	670	6830	7970
	CLT	15.5	175C	50,000	1195	2985	3480

	For Self Cooled Transformers	For Forced Air Transformers
Type CLE Current Limiting Fuses: Through 7.2 Kv Fuse Rating—	1.4	1.2
14.4 Kv Fuse Rating—	1.49	1.31
Type RBA Expulsion Type Non-Current Limiting Fuses, all Ratings—	1.4	1.2
Type CLT Current Limiting Fuses, all Ratings	1.4	1.2

① Maximum Transformer Kva Ratings are based on Ratios of Maximum Fuse Current Rating to Transformer Full Load Current (I_F/I_T) as listed at left. For a 55°C Rise Liquid Filled Transformer, use the Kva Rating for 65°C rise (55°C rating x 1.12).

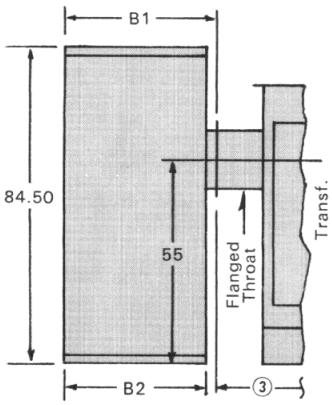
These applications are subject to modification when specific factors such as Transformer Characteristics, other Protective Devices, Coordination Requirements and Load Variations may indicate a different I_F/I_T Ratio.

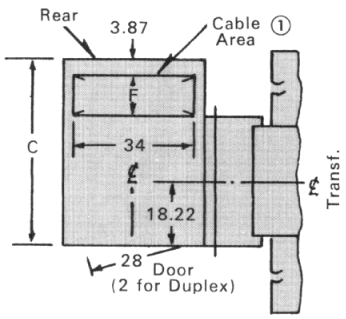
Caution: Primary Fuses must not be relied upon for clearing Secondary Ground Faults

Note: The type RBA interrupting ratings shown are those of the discharge filter type, in which the noise is minimized and deionization of expulsion gases is assured.

Dimensions of High Voltage Incoming Line Sections—Inches (Approximate)

Type PPS Air Interrupter Switch (For Liquid Filled Transformer Only)





Switch Arrangement	Single Unit, 2 Position	Duplex (2 Units)
B1 (Total)	40.99	79.23
B2 (Over Base)	39.74	77.98
Depth C Over Base	Cable Space ① F	
49.86	11	
59.86 ②	21 ②	

③ Transf. Flange-to-flange Dimension plus approx. 9".

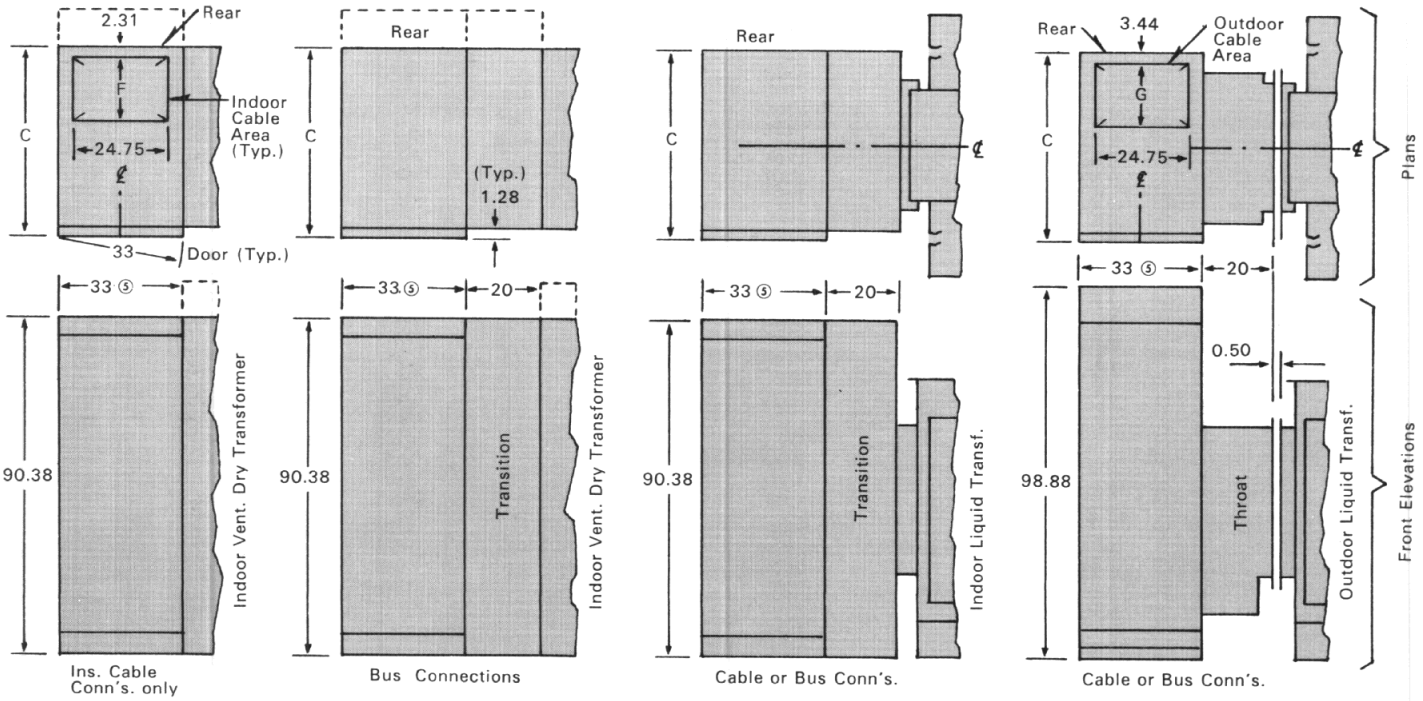
Approx. Weights: Pounds	Single Unit, Unfused	Duplex, Unfused	Fuses, set of three
	— 1500	— 3000	— 200

① 2 Cable areas for Duplex arrangement.

② Required for Loop Feed Potheads.

Dimensions approx. same for both indoor and outdoor.

Type WLI Air Interrupter Switch (Single Units as Shown; See Note for Duplex)



Note: Two (2) units each 33 (or 36) wide, with two (2) cable areas, required for duplex arrangements.

Unit Depth C	Cable Sp. F(I.D.)	Cable Sp. G(O.D.)
① 49.28	16.97	15.84
② 55.28	22.97	21.84
③ 60	27.69	26.56
④ 62	29.69	28.56
70	37.69	36.56
80	47.69	46.56

① Provides 18" max. stress cone space for top entrance.

② Required for add'l stress cone space for top entrance, or for 54" deep dry type transformer case.

③ Min. for single unit selector type, 5 Kv, with bottom entrance; top entrance 70".

④ Min. for single unit selector type, 15 Kv, with bottom entrance; top entrance 80".

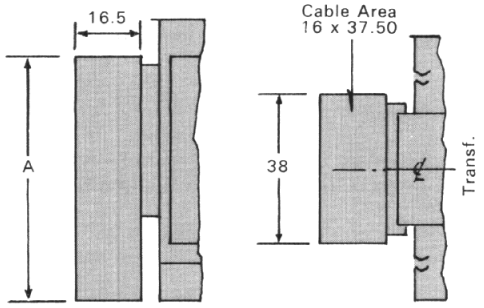
⑤ Except 15 Kv with 61,000 A (fault close) rating 36" wide.

Min. depth with pothead: 5 Kv 49.28; 15 Kv 55.28

For gas filled sealed dry type transformer, refer to Westinghouse.

Approximate Weights—Lb.
Single unit, 2 pos., unfused: indoor 1500; outdoor 1800. (Use two for Duplex.)
Single unit selector, unfused: indoor 1800; outdoor 2100.
Indoor transition—300.
Outdoor throat—200.
Fuses, set of 3—200.

Cable Entrance Compartment



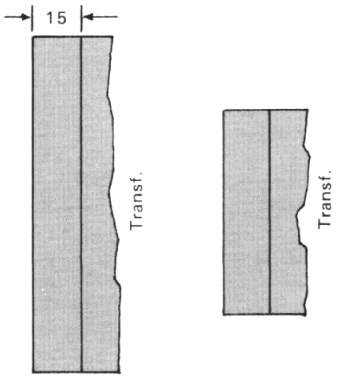
Front Elevation Plan

Height A
Bottom Entr. – 65.25
Top Entrance – 87

Approx. Weight
300 Lb.

Compt. for Gas Filled Sealed Dry Transf. similar except height "A" as required.

For Liquid Filled Transformer, Indoor or Outdoor



Front Elevation Plan

Height and Depth of Compartment same as Transformer case

Approx. Weight — 300 Lb.

For Ventilated Dry Transformer

3 Phase Transformer Secondary Ampere Ratings

		Liquid Filled 55/65°C Rise			Liquid Filled 65°C Rise		Ventilated Dry 150°C Rise		Sealed Dry 150°C Rise
Base Kva	Sec. Volts	OA 55°	OA 65°	FA 65°	OA	FA	AA	FA	AA
300	208	833	933	—	833	—	833	1111	833
	240	722	808	—	722	—	722	962	722
	480	361	404	—	361	—	361	481	361
	600	289	323	—	289	—	289	385	289
500	208	1389	1556	—	1389	—	1389	1852	1389
	240	1203	1347	—	1203	—	1203	1604	1203
	480	601	674	—	601	—	601	802	601
	600	481	539	—	481	—	481	641	481
750	208	2083	2333	2683	2083	2396	2083	2778	2083
	240	1804	2021	2324	1804	2075	1804	2406	1804
	480	902	1011	1162	902	1038	902	1203	902
	600	722	808	929	722	830	722	962	722
1000	208	2778	3111	3578	2778	3194	2778	3704	2778
	240	2406	2695	3099	2406	2767	2406	3208	2406
	480	1203	1347	1549	1203	1383	1203	1604	1203
	600	962	1077	1239	962	1106	962	1283	962
1500	480	1804	2021	2324	1804	2075	1804	2406	1804
	600	1443	1616	1859	1443	1659	1443	1924	1443
2000	480	2406	2695	3099	2406	2767	2406	3208	2406
	600	1924	2155	2478	1924	2213	1924	2565	1924
2500	480	3008	3368	4211	3008	3759	3008	4010	3008
	600	2406	2694	3367	2406	3008	2406	3208	2406

Transformer Standards

Dimensions and Weights as listed in the Tables are based on the following:

1. Standard Base Kva Ratings: 300-500-750-1000-1500-2000-2500.
2. 3 Phase, 60 Hertz, Two Windings.
3. Standard Temperature Rise (See Tables) above ambient air temperature of 40°C (104°F) maximum and 30°C (86°F) average in any 24-hour period.
4. Maximum Altitude of 1000 meters above sea level for full rating (3300 feet).
5. Standard High Voltages: 2400-4160-4800-6900-7200-12000-12470-13200-13800, delta connected only.
6. Standard High Voltage Taps: two approximately 2½% full capacity above and two below rated voltage.
7. Standard Low Voltages (no taps):① 208y/120 (1000 Kva max.) 240 delta (1000 Kva max.) 480 delta (all ratings) 480y/277 (all ratings)
8. Aluminum Winding Conductors.
9. No Series-Parallel or Delta-Wye Terminal Boards.
10. Standard Accessories.
11. Standard Surface Preparation, Finish Processes, Materials and Colors.
12. Standard Tests in accordance with ANSI Standard Test Code (see below).
13. HV and LV Basic Impulse Levels, Impedance and Sound Levels in line with the following Tables.

① 600 Y and 600 △ also available.

Standard Insulation Levels—Kv BIL

High Voltage Rating	Liquid Filled Transformer HV	Liquid Filled Transformer LV (600 Max.)	Vent. Dry Transformer HV	Vent. Dry Transformer LV (600 Max.)	Gas Filled Transformer HV	Gas Filled Transformer LV (600 Max.)
2400	45	30	25	10	45	30
4160	60	30	25	10	60	30
4800	60	30	25	10	60	30
6900	75	30	35	10	75	30
7200	75	30	35	10	75	30
12000	95	30	50	10	95	30
12470	95	30	50	10	95	30
13200	95	30	50	10	95	30
13800	95	30	50	10	95	30

Standard Guaranteed Sound Levels—Decibels

Max. Base Kva (Self Cooled)	Liquid Filled Transformer OA	Liquid Filled Transformer FA	Vent. Dry Transformer AA	Vent. Dry Transformer FA	Gas Filled Transformer AA
300	55	—	58	67	57
500	56	—	60	67	59
750	58	67	64	67	63
1000	58	67	64	68	63
1500	60	67	65	69	64
2000	61	67	66	71	65
2500	62	67	68	71	66

Transformer Kva Ratings, 3 Phase

In addition to their basic self-cooled (AA or OA, 100%) Kva ratings, modern Westinghouse standard Secondary Unit Substation Transformers of the liquid filled and ventilated dry types are designed for continuous operation at the following supplementary self-cooled and fan-cooled (FA) Kva ratings:

Liquid Filled

55/65°C Rise				65°C Rise		**Ventilated Dry Type** 150°C AA Rating	150°C FA Rating
OA 55°C	OA 65°C	FA 55°C	FA 65°C	OA	FA		
300	336	—	—	300	—	300	400
500	560	—	—	500	—	500	667
750	840	862	966	750	862	750	1000
1000	1120	1150	1288	1000	1150	1000	1333
1500	1680	1725	1932	1500	1725	1500	2000
2000	2240	2300	2576	2000	2300	2000	2667
2500	2800	3125	3500	2500	3125	2500	3333

Gas filled sealed Dry Type Transformers are available as AA self cooled (100%) only.

Impedances (±7½% Tolerance):

Kva	Vent-Dry Transformer	Gas Filled Transformer	Liquid Filled Transformer
300	②	5.0%	5.0%
500	5.75%	5.0%	5.0%
750	5.75%	5.75%	5.75%
1000①	5.75%	5.75%	5.75%
1500	5.75%	5.75%	5.75%
2000	5.75%	5.75%	5.75%
2500	5.75%	5.75%	5.75%

① 8.0% impedance standard as alternate, if requested, at 480 volts low voltage

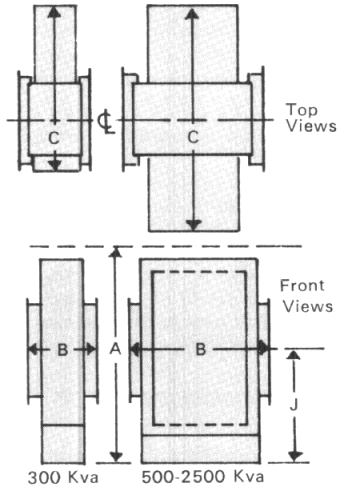
② 6.3% for 5 Kv; 5.0% for 8.6 and 15 Kv

ANSI Standard Tests

1. Resistance measurements.
2. Ratio tests.
3. Polarity and phase relation.
4. No-load loss.
5. Exciting current.
6. Impedance and load loss.
7. Applied potential test.
8. Induced potential test.
9. Temperature test or tests will be made on one unit of an order, covering one or more units of a given rating. Tests will be made only when there is no available record of a temperature test per ANSI Standards on a duplicate or essentially duplicate unit.

Transformer Dimensions and Weights—Inches (Approximate)

Liquid Filled—High Voltage 13800 Maximum, Low Voltage 600 Maximum Indoor or Outdoor



Kva Self Cooled (OA)	65°C Temp. Rise, 80°C Hot Spot B①	C	Weight Lb.	55°C Temp. Rise, 65°C Hot Spot B①	C	Weight Lb.
300	②	②	②	②	②	②
500	47	51	4565	47	63	4840
750	47	70	5340	47	84	5800
1000	50	78	6675	51	92	7180
1500	53	92	7965	53	112	8635
2000	57	101	9540	59	114	10840
2500	61	110	11730	65	120	12730

② Refer to Westinghouse

Standard Fixed Dimensions

A—Oil 86, 88 with optional relief device.
Silicone 88.

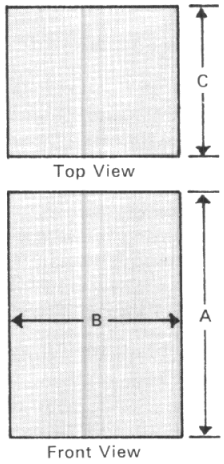
J—Height to centerline of HV & LV bushings 55

Shipping Dimensions

- For Z-bar on HV and LV, add approximately 13 inches.
- For LV bus duct, add approximately 19 inches.

① B Dimension is between Z-bar flanges on HV and LV ends not including bushing projection. Add approximately 9 inches to B Dimension for HV or LV bus duct throat.

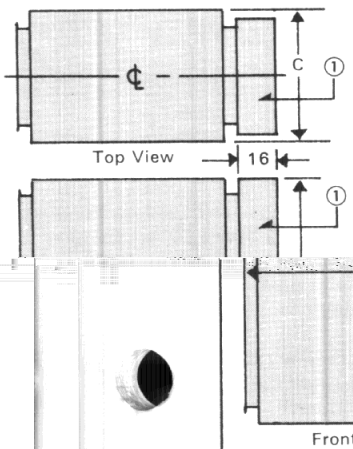
Ventilated Dry Type, 150°C Temperature Rise, Low Voltage 600 Maximum, Indoor①



Kva Self Cooled (AA)	Hv 2400, 4160 or 4800△ 25 Kv BIL Dimensions A	B	C	Weight Lb.	Hv 6900 or 7200△ 35 Kv BIL or Hv 12000, 12470, 13200 or 13800△ 50 Kv BIL Dimensions A	B	C	Weight Lb.
300	90⅜	60	54	2500	90⅜	60	54	3350
500	90⅜	60	54	3150	90⅜	60	54	4100
750	90⅜	60	54	4050	90⅜	60	54	4700
1000	90⅜	60	54	5200	90⅜	90	48	6600
1500	100	90	48	8100	100	90	48	8600
2000	100	90	48	9500	100	100	54	10000
2500	100	100	54	11100	105	100	54	11700

① Refer to Westinghouse for outdoor applications.

Gas Filled Dry Type, 150°C Temperature Rise, Low Voltage 600 Maximum, Indoor or Outdoor



Kva (AA)	Hv 2400△, 45 Kv BIL, or 4160 or 4800△, 60 Kv BIL Dimensions A	B①	C	Weight Lb.	Hv 6900 or 7200△, 75 Kv BIL, or 12000, 12470, 13200 or 13800△ 95 Kv BIL Dimensions A	B①	C	Weight Lb.
300	83	95	47	6800				
500	86	98	50	7000	86	98	50	7000
750	91	103	54	8500	91	103	54	8500
1000	96	108	57	10000	96	108	57	10000
1500	102	114	63	13000	102	114	63	13000
2000	108	120	66	17000	108	120	66	17000
2500	112	122	70	21000	112	122	70	21000

① For indoor only. For outdoor, omit Lv transition unit and Z-bar flanges, and substitute flanged throat; reduce B 6 in. for 15 Kv class and 9 in. for 5 Kv class Hv.

Application—Type DS Air Circuit Breakers

Standards
Type DS circuit breakers meet or exceed all applicable requirements of the latest ANSI Standards C37.13 and C37.16

System Voltage and Frequency
Type DS breakers are designed for operation on Ac systems only, 60 Hz or 50 Hz, 600 volts maximum.

Continuous Current Ratings
Unlike transformers, generators and motors, circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application take into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Type DS breaker is limited to 125% of the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a Type DS-416 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 times 1.25 or 1000 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F) outside of the switchgear enclosure.

Altitude
The breakers are applicable at their full voltage and current ratings up to a maximum altitude of 6600 feet (2000 meters) above sea level. When installed at higher altitudes, the ratings are subject to correction factors in accordance with IEEE and NEMA Standards.

Repetitive Duty
Repetitive breaker opening and closing, such as in frequent motor starting and stopping, are covered by ANSI Standards C37.13 and C37.16. These Standards list the number of operations between servicing (adjusting, cleaning, lubrication, tightening, etc.) and the total numbers of operations under various conditions without requiring replacement of parts, for the various breaker frame sizes.

For motor starting duty, when closing starting currents up to 600% and opening running currents up to 100% of the breaker frame size, at 80% power factor or higher, the endurance or total operations (not requiring parts replacement) will be as follows:

Type DS-206—1400
Type DS-416— 400

The frequency of operation should not exceed 20 starts in 10 minutes or 30 in one hour.

Unusual Environmental and Operating Conditions

Special attention should be given to applications subject to the following conditions:

1. Damaging or hazardous fumes, vapors, etc.

2. Excessive or abrasive dust.

   For such conditions, it is generally recommended that the switchgear be installed in a clean, dry room, with filtered and/or pressurized clean air. This method permits the use of standard indoor switchgear, and avoids the derating effect of non-ventilated enclosures.

3. Salt spray, excessive moisture, dripping, etc.

   Optional drip-proof top covers and space heaters in indoor switchgear, or outdoor weatherproof enclosures, may be indicated, depending upon the severity of the conditions.

4. Excessively high or low ambient temperatures.

   For ambient temperatures exceeding 40°C, and based on a standard temperature rise of 65°C, the continuous current ratings of breaker frame sizes, and also buses, current transformers, etc., will be subject to a derating factor calculated from the following formula:

$$\sqrt{\frac{105°C\ \text{Total}—\text{Special Ambient, °C}}{105°C\ \text{Total}—40°C\ \text{Standard Ambient}}}$$

Interrupting ratings of Type DS breakers at system voltages are given in the following table.

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes With Instantaneous Trip 208-240V	480V	600V	With Short Delay Trip ①② 208-240V	480V	600V
DS-206	800	42,000	30,000	30,000	30,000	30,000	30,000
DS-206S	800	50,000	42,000	42,000	42,000	42,000	42,000
DS-416	1600	65,000	50,000	42,000	50,000	50,000	42,000
DS-416S	1600	65,000	65,000	50,000	65,000	65,000	50,000
DS-420	2000	65,000	65,000	50,000	65,000	65,000	50,000
DS-632	3200	85,000	65,000	65,000	65,000	65,000	65,000
DS-840	4000	130,000	85,000	85,000	85,000	85,000	85,000

① Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DS-840 which is 65,000.

Maximum voltages at which the interrupting ratings apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

Interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15 second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of ½ second each, with a 15-second interval of zero current between the two periods.

The circuit breakers are not adversely affected by very low outdoor ambient temperatures, particularly when energized and carrying load currents. The standard space heaters in weatherproof switchgear will raise the temperature slightly and prevent condensation.

5. Abnormal vibration or shock.

   Applications involving such conditions should be referred to Westinghouse with complete data.

6. Abnormally high repetitive and frequency of operation.

   In line with "Repetitive Duty" above, a lesser number of operations between servicing, and more frequent replacement of parts, may be indicated.

System Application
Tables 3A through 3D on Pages 37 and 38 list the calculated secondary short circuit currents and applicable main secondary and feeder breakers for secondary unit substation switchgear.

The short circuit currents are calculated by dividing the transformer basic (100%) rated amperes by the sum of the transformer and primary system impedances, expressed in "per unit." The transformer impedance percentages are standard for most secondary unit substation transformers. The primary impedance is obtained by dividing the transformer base (100%) Kva by the primary short-circuit Kva. The motor contributions to the short circuit currents are estimated as approximately 4 times the motor load amperes, which in turn are based upon 50% of the total load for 208 volts and 100% for all other voltages.

Higher transformer impedances and/or lower percentages of motor loads will reduce the short circuit currents correspondingly. Supplementary transformer ratings (see Tables on Page 40) will not increase the short circuit currents, provided the motor loads are not increased.

The Tables do not apply for 3 phase banks of single phase distribution transformers, which usually have impedances of 2% to 3% or even lower. The short circuit currents must be recalculated for all such applications and the breakers selected accordingly.

Main Transformer Secondary Breakers
Transformer secondary breakers are required or recommended for one or more of the following purposes:

1. To provide a one-step means of removing all load from the transformer. The NEC limits the maximum number of feeder breakers on a transformer bus without a main breaker to six (6).

2. To provide transformer overload protection in the absence of an individual primary breaker, and/or when primary fuses are used.

3. To provide the fastest clearing of a short circuit in the secondary main bus.

4. To provide a local disconnecting means, in the absence of a local primary switch or breaker, for maintenance purposes.

5. For automatic or manual transfer of loads to alternate sources, as in double ended secondary selective unit substations.

6. For simplifying key interlocking with primary interrupter switches.

Main secondary breakers as selected in Tables 3A thru 3D have adequate interrupting ratings, but not necessarily adequate continuous current ratings. They should be able to carry continuously not only the anticipated maximum continuous output of the transformer, but also any temporary overloads.

Maximum capabilities of transformers of various types, in terms of Kva and secondary current, are given on Pages 40 and 42. It will be noted that the maximum ratings will often require the substitution of larger frame main breakers than those listed in Tables. Even if a self-cooled transformer only is considered, it should be remembered that with ratings of 750 Kva and higher (except for gas-filled transformers), provision for the future addition of cooling fans is automatically included. It is recommended that the main breaker have sufficient capacity for the future fan-cooled rating, plus an allowance for overloads if possible, particularly since load growth cannot always be predicted.

The same considerations should be given to the main bus capacities and main current transformer ratios.

Bus Sectionalizing (Tie) Breakers
The minimum recommended continuous current rating of bus sectionalizing or tie breakers, as used in double ended secondary selective unit substations or for connecting two single ended substations, is one-half that of the associated main breakers. The interrupting rating should be at least equal to that of the feeder breakers. It is common practice to select the tie breaker of the next frame size below that of the main breakers. However, many users and engineers prefer that the tie breaker be identical to and interchangeable with the main breakers, so that under normal conditions it will be available as a spare main breaker.

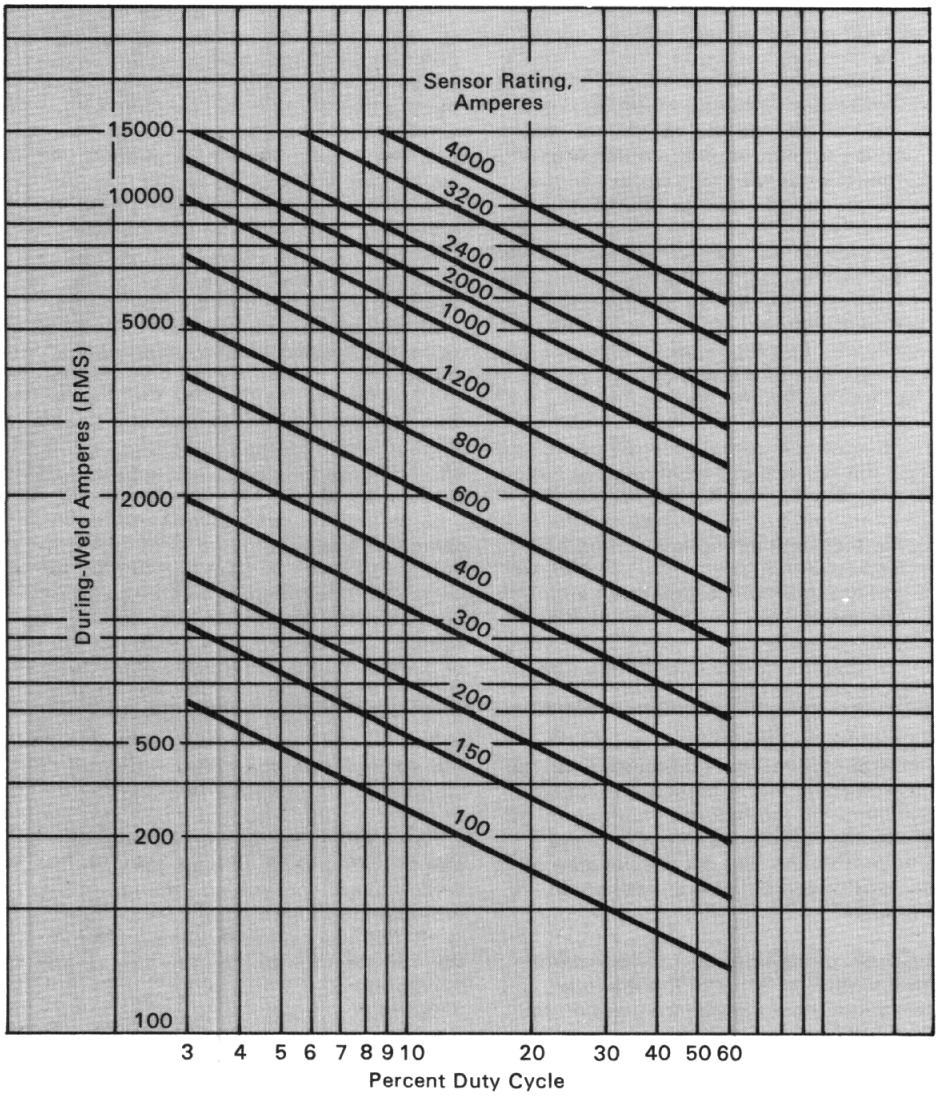
The tie breaker should be equipped with the same type of tripping devices (long and short delay or long delay and instantaneous) as the main breakers.

Generator Breakers
In most applications where generators are connected through breakers to the secondary bus, they are used as emergency standby sources only, and are not synchronized or paralleled with the unit substation transformers. Under these conditions, the interrupting rating of the generator breaker will be based solely on the generator Kva and sub-transient reactance. This reactance varies with the generator type and Rpm, from a minimum of approximately 9% for a 2 pole 3600 Rpm turbine driven generator to 15% or 20% or more for a medium or slow speed engine type generator. Thus the feeder breakers selected for the unit substation will usually be adequate for a standby generator of the same Kva as the transformer.

Most generators have a 2-hour 25% overload rating, and the generator breaker must be adequate for this overload current. Selective type long and short delay trip devices are usually recommended for coordination with the feeder breakers, with the long delay elements set at 125% to 150% of the maximum generator current rating for generator protection.

In the case of two or more paralleled generators, Type CRN-1 antimotoring reverse power relays are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring Type DS-632 or DS-840 breakers, Type COV voltage-restraint type overcurrent relays are recommended.

Type DS Breaker Sensor Selection Guide for Resistance Welding Applications



Resistance Welding Feeder Breakers
The application of Type DS breakers to resistance welding circuits is shown on the Sensor Selection Guide.

Sensor ratings only are given; the breaker frame will also be as required for interrupting ratings.

Type DS breaker solid state tripping devices are well suited for this service, since the chattering, noise, wear and calibration changes experienced in electro-mechanical devices are eliminated.

These applications are based on Amptector II-A or Amptector I-A long delay and instantaneous trip devices with the following settings:

Long delay pickup 1.0 times sensor rating
Long delay time 36 seconds.
Instantaneous trip setting 2 times average weld amperes (during-weld amperes times percent duty cycle) or higher.

Feeder Breakers—General
Circuit breakers for feeder circuit protection may be manually or electrically operated, with long and short delay or long delay and instantaneous type trip devices, and trip settings, as required for the specific circuit and load requirements.

Feeder breakers as selected in Tables 3A thru 3D have adequate interrupting ratings, and are assumed to have adequate continuous current ratings for maximum load demands.

General purpose feeder breakers, such as for lighting circuits, are usually equipped with long delay and instantaneous trip devices, with the long delay pickup set for the maximum load demand in the circuit. Where arcing fault protection is required, the instantaneous trip setting should be as low as practicable consistent with inrush requirements.

Motor Starting Feeder Breakers
These breakers are usually electrically operated, with long delay and instantaneous tripping characteristics for motor running, locked rotor and fault protection. The breaker sensor rating should be chosen so that the long delay pickup can be set at 125% for motors with a 1.15 service factor or at 115% for all other motors.

When system short circuits are less than 40 times the motor full load current, the motor breaker tripping characteristic should include a short delay characteristic for greater fault protection.

Group Motor Feeder Breakers
Typical loads for such circuits are motor control centers. The feeder breakers may be either manually or electrically operated as preferred, and are usually equipped with long and short delay trip devices for coordination with the individual motor circuit devices. The minimum long delay pickup setting should be 115% of the running current of the largest motor in the group plus the sum of the running circuits of all other motors.

Ground Fault Protection With Westinghouse Amptector I-A Static Trip

Distribution Systems
The power distribution in three phase low voltage systems can be three or four wire distribution. The three wire distribution can be served from either delta or wye sources, but the four wire distribution is obtained from wye source only. Fig. No. 1 shows three wire distribution with delta source and Fig. No. 2 shows three wire distribution with wye source. It is significant on Fig. No. 2, that the wye connection of a transformer secondary does not necessarily mean four wire distribution in switchgear. This is worthwhile to note because four wire distribution is quite frequently assumed when the transformer secondary is wye connected. The low voltage system is three phase four wire distribution only if a fourth wire is carried through the switchgear and single phase loads are connected to feeder breakers. This fourth wire is the neutral bus. The neutral bus is connected to the neutral of the wye connected transformer secondary as shown on Fig. No. 3. The standard neutral bus capacity is one half of the phase bus current carrying capacity but full capacity neutral busses are also available on request.

Three or four wire systems can be grounded or ungrounded in service. Generally where the source is delta connected it is ungrounded, but in some very rare cases it is grounded at one corner of the delta or at some other point. When the source is wye connected it can be grounded or ungrounded and when grounded the grounding is at the neutral. When low voltage systems are grounded they are generally solidly grounded. However occasionally the grounding is through a resistor. Three and four wire solidly grounded systems are shown on Fig. No. 4 and 5. At present the new installations are mostly solidly grounded or ungrounded low voltage systems with a definite trend toward the increase of the solidly grounded systems. An ungrounded low voltage system is a good operating system if it is equipped with a ground detection device and if the operators and maintenance crew are trained to locate the initial ground and clear it as soon as practical. The grounded neutral system results in a ground current as soon as any ground occurs on a phase conductor and if the current exceeds the setting of the protective device it will operate and isolate the fault.

Need For Ground Fault Protection
If the magnitude of all ground currents would be large enough to operate the short delay or instantaneous elements of the phase overcurrent trip devices there would be no problem in solidly grounded systems. Unfortunately this is not the case, because low magnitude ground currents are quite common. Low level ground currents can exist if the ground is in the winding of a motor or a transformer or if it is a high impedance ground. Low level ground currents may also be due to an arcing type ground. The arcing type grounds are the source of the most severe damages to electrical eqiupment. The lower limit of the arcing ground currents is unpredictable and the magnitude may be considerably below the setting of the breaker phase overcurrent trip devices.

Since the breaker phase overcurrent trip devices cannot provide fast protection against low magnitude ground faults there is a need for an additional protective device. This additional device is not to operate on normal overloads and it is to be sensitive and fast enough to protect against low magnitude grounds. It is also important that this additional ground protecting device be simple and reliable. The Westinghouse Amptector I-A solid-state tripping system including an optional "ground element" will assure good ground fault protection.

The Ground Element
The ground element of the solid-state trip is part of the Amptector I-A and is in addition to the usual phase protection. The ground element has a continuously adjustable pickup with calibrated marks as shown in Table 2 and a continuously adjustable time delay with calibrated marks at 0.22-0.35-0.50 seconds. The input current to the Amptector I-A terminals can be provided by:

(a) Residual connection of phase sensors with residual circuit connected to ground element terminals. This is the Westinghouse East Pittsburgh Low Voltage Switchgear standard ground protection system. This produces pickup values as shown in Table 2.

(b) External ground sensing current transformer directly connected to ground element terminals. This is one of the unique features of the Westinghouse Amptector. This means that this external ground sensor will trip the breaker on grounds without the use of external relay and without the application of a breaker shunt trip and external power source. The lower the CT ratio the more sensitive the ground fault protection.

Ground Fault Protection Application and Coordination

In well designed systems the continuity of service is very important. For reliable service continuity selective tripping is applied between main tie and feeder breakers and the downstream protecting devices for phase to phase faults. Similar selective tripping is desirable when breakers trip on grounds. The application of ground protection on main breakers only may assure good ground protection, however it will not provide good service continually because the main breaker will trip on grounds which should have been cleared by feeder breakers. When the switchgear itself feeds the loads directly the applied ground protection must be such that on a load circuit ground the associated feeder breaker will trip first. Therefore for proper protection and for good service continuity main tie and feeder breakers all should be equipped with ground protection. Ground protection is not required for non-automatic tie breakers having no phase overcurrent protection.

The necessary coordinated tripping is not easily accomplished when the switchgear feeds into downstream sub-distribution panels which do not have ground protection. If full selective tripping is required the downstream protecting devices should also be equipped with ground protection. If not, the system designer will face a coordination problem in obtaining selectivity between the low pickup and fast tripping switchgear breaker ground elements and phase overcurrent protective devices. This is a very difficult problem because of the time-current tripping characteristic of the phase overcurrent protective devices. When such coordination is desired, the ground element pickup must be increased in order to "desensitize" the device. It is obvious that when the ground element is set at its highest setting, valuable protection is lost for low magnitude arcing ground currents. If higher ground element pickup is attempted to achieve coordination with fairly large sized downstream phase devices the ground protection setting approaches the characteristic of a short time phase element and the ground protection will lose its true meaning and not provide the expected protection.

In view of the above it is evident that properly applied ground protection requires ground elements as far down the system to the loads as practical. For best results down stream molded case breakers should have individual ground protection. This would result in excellent ground protection because ground elements of switchgear and downstream breakers having similar tripping characteristic can be coordinated.

Coordination between switchgear breaker ground elements and downstream branch circuit fuses is not practical. This is due to the basic fact that the blowing of one phase fuse will not clear a ground on a three phase system. The other two phase fuses will let the load "single-phase" and also continue to feed the ground through the load as shown in Figure 6.

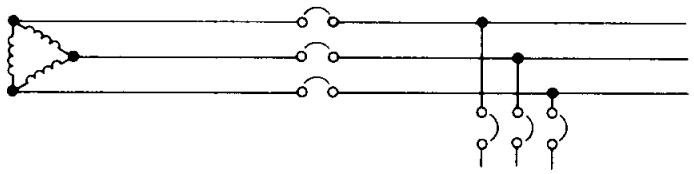


Figure 1. 3 Wire Distribution, Delta Source (Ungrounded)

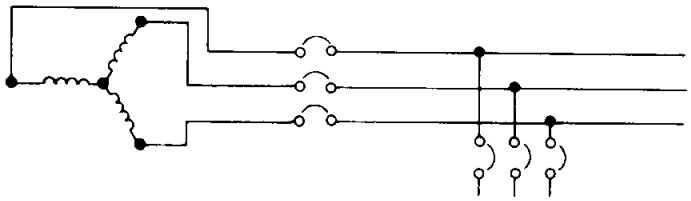


Figure 2. 3 Wire Distribution, Wye Source (Ungrounded)

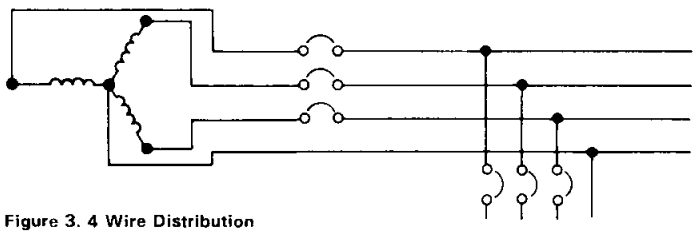


Figure 3. 4 Wire Distribution

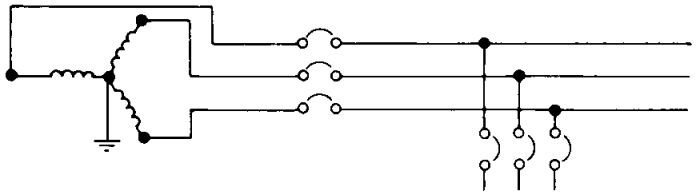


Figure 4. 3 Wire Distribution Solidly Grounded System

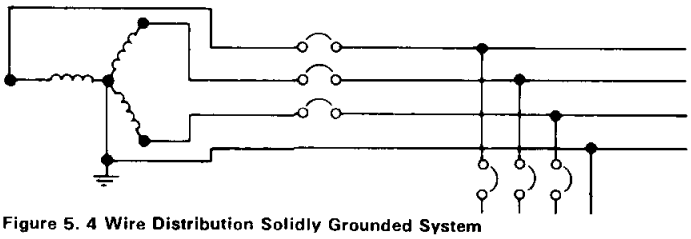


Figure 5. 4 Wire Distribution Solidly Grounded System

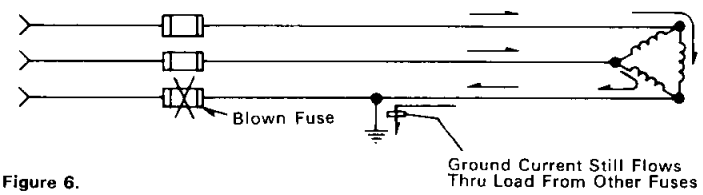


Figure 6.

Table 2

Dial Setting	Ground Pick-Up Value—Amperes Sensor Rating 50	100	150	200	300	400	600	800	1200	1600	2000	2400	3200	4000	Secondary Current ①
A	13	57	60	65	80	110	145	180	260	330	400	530	640	800	1.0
B	18	67	75	85	110	150	205	260	385	505	600	770	1000	1200	1.5
C	22	75	85	100	130	185	250	325	480	625	760	960	1200	N.A.	1.9
D	33	100	120	145	200	270	385	500	730	970	1200	N.A.	N.A.	N.A.	3.0

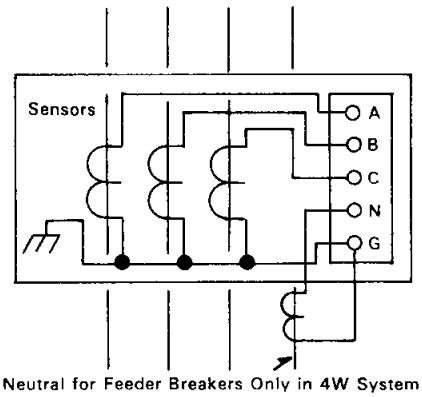
All pick up values subject to ± 10% tolerance.

① Current of this value from the secondary of an external ground transformer will cause the ground element to function.

The Following Provides Guideline for Ground Fault Protection.

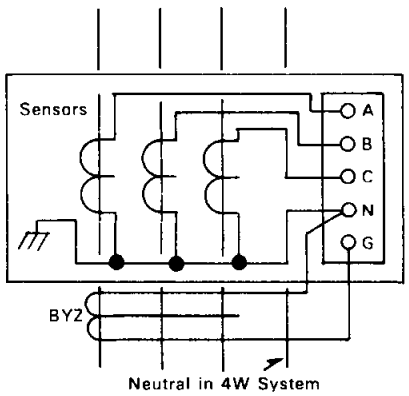
System	Advantages	Disadvantages	Equipment Available for Protection: Main Breaker	Tie Breaker	Fdr. Breaker	Notes
Ungrounded (3 Wire)	Minimum disturbance to service continuity. Currents for the majority of grounds will be limited to capacitance charging current of the system. Can operate with the first ground until it is removed during a regular shutdown.	When ground detector shows that a ground exists corrective action must be taken at the earliest possible shutdown. However, experience indicates that this attention is not always possible. Therefore most ungrounded systems operate with one phase grounded through the first uncleared ground. A ground on another part of the system, due to fault impedance, would probably result in low values of current which would not operate a breaker phase trip, and would produce fire damage.	Lamp type ground detector or ground detecting voltmeters without or with pts. If pts. are used a ground alarm relay can be added for remote or local alarm.			With proper maintenance this system would result in the minimum disturbance to service continuity.
	Ground protection for an ungrounded system		Amptector I-A 'DS' ground 3W protection, minimum pick-up. .50 sec. time delay. See SK No. 1 & No. 6.	Amptector I-A 'DS' ground 3W protection, minimum pick-up. .35 sec. time delay.	Amptector I-A 'DS' ground 3W protection, minimum pick-up. .22 sec. time delay. See SK No. 1 & No. 6.	Ground fault protection on this ungrounded system would trip the breaker when the second ground occurs and current exceeds minimum pick-up setting.
Solid Grounded	Psychologically safer. Practically results in good continuity of service. Isolation of faults automatic through ground protection system; no overvoltages due to ferroresonance or switching.	Probability of very high ground current and extensive damage however, normally these high currents are not obtained. Grounds are automatically isolated and continuity of service is interrupted.	Amptector I-A 'DS' standard residual ground protection in 3W systems and source neutral C.T. feeding into Amptector I in 4 wire systems. Minimum pickup. .50 sec. time delay. See SK No. 1, No. 3 & No. 6.	Amptector I-A 'DS' ground 3W or 4W (as required) fault protection. Minimum pick-up. .35 sec. time delay.	Amptector I-A 'DS' ground 3W or 4W (as required) fault protection. Minimum pick-up. .22 sec. time delay or BYZ current transformer feeding into above Amptector. See SK No. 1, No. 2 & No. 6.	This is the most common system in use today and as long as it is not necessary to coordinate with phase devices down the line it will give very good main bus and feeder protection.
High Resistance Grounded (3 Wire)	Ground fault current is limited. Ungrounding can result in high voltages during switching and this is corrected by high resistance grounding.	Very sensitive detection is required to detect the limited fault current. Since overvoltage due to switching isn't prevalent on ungrounded low voltage systems high resistance grounding is not required.	Same as for ungrounded except if ground alarm relay is used connect relay across grounding resistor.	Same as for ungrounded.	Same as for ungrounded.	This system is very seldom used and is not recommended.

Sketch 1. ②
Residual Main and Feeder Breaker



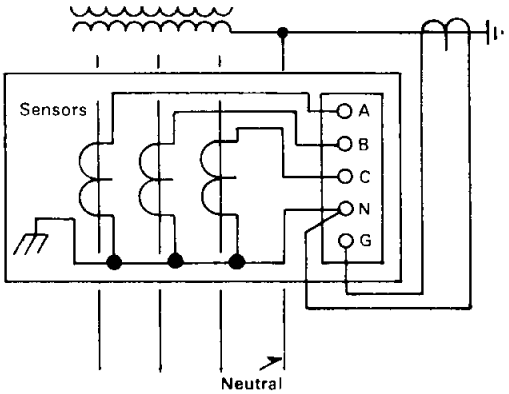
Neutral for Feeder Breakers Only in 4W System

Sketch 2.
Zero Sequence Feeder Breaker



Neutral in 4W System

Sketch 3.
Source Neutral Main Breaker

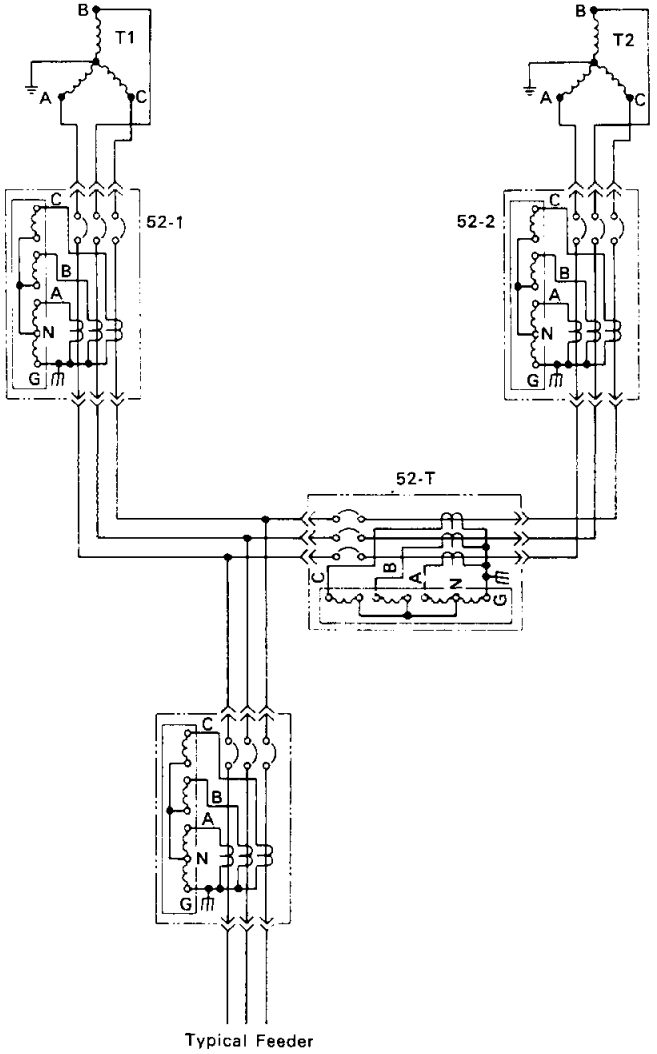


Neutral

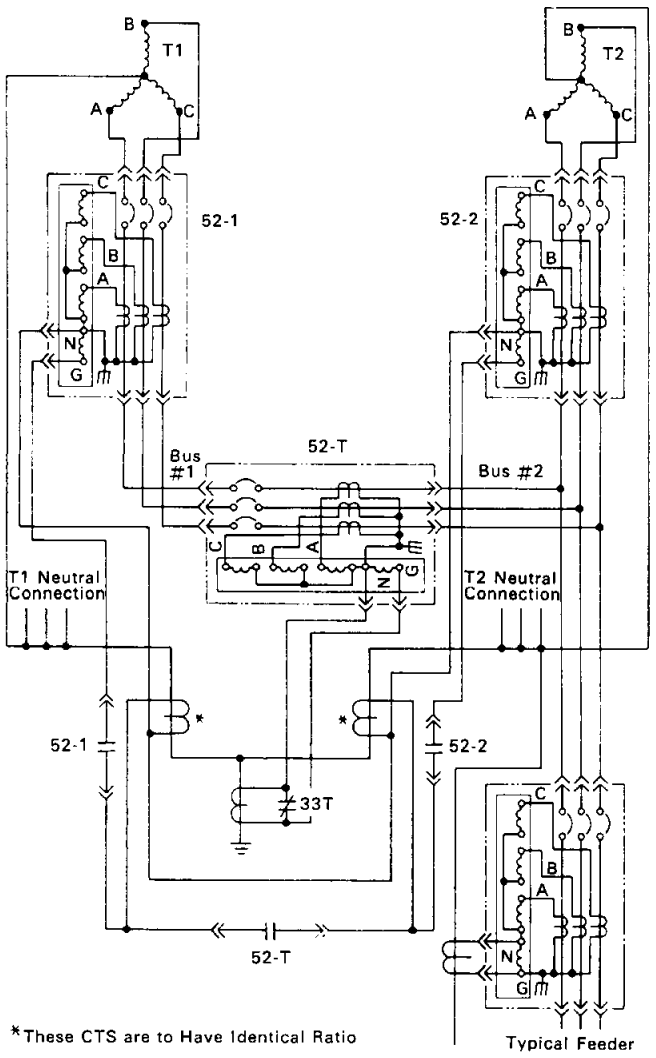
② Apply in 3 Wire Systems for Main Breaker and in 3 or 4 Wire Systems for Feeder Breakers.

Note: For double ended secondary unit substations ground fault protection should be as indicated on sketches No. 4 and No. 5 however for this type application the East Pittsburgh Works Low-Voltage Switchgear Department should be consulted for the actual bill of materials to be used. The application becomes rather complex if single phase to neutral loads are being served.

Sketch 4. 3 Wire Double Ended Unit Substation

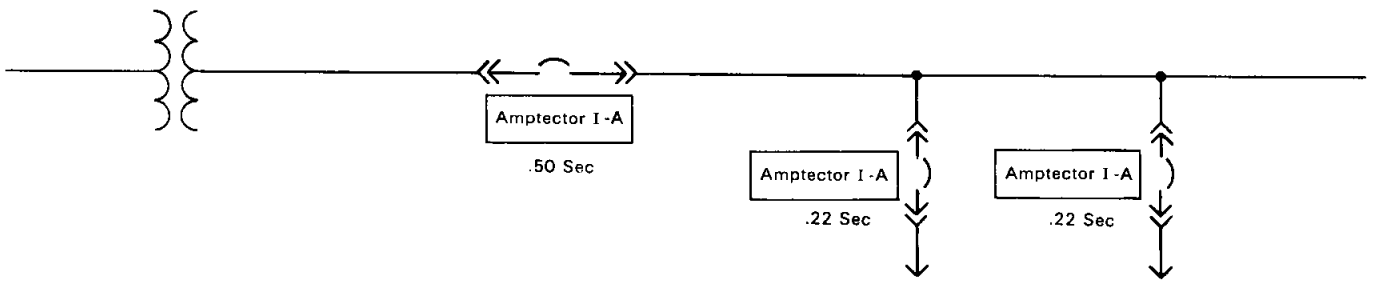


Sketch 5. 4 Wire Double Ended Unit Substation

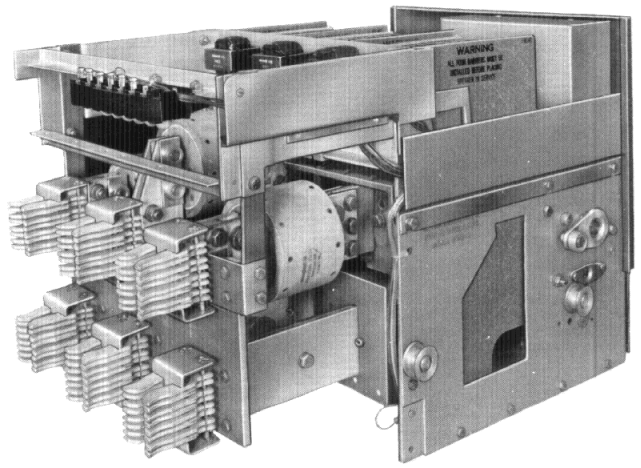


*These CTS are to Have Identical Ratio

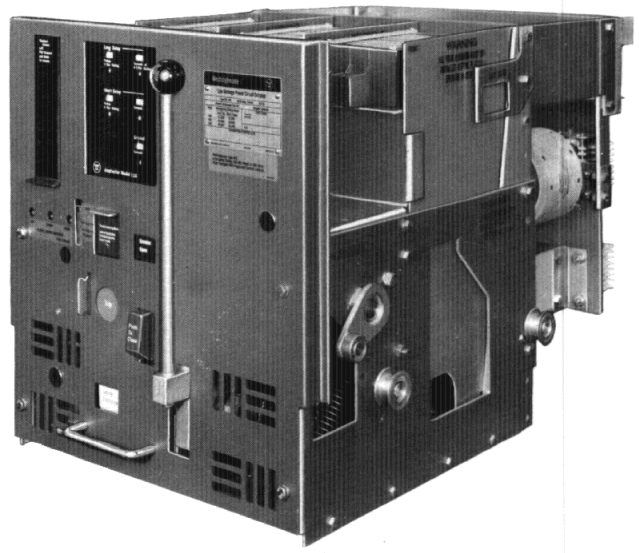
Sketch 6.



Type DSL Limiter Type Air Circuit Breakers



Type DSL-416 Breaker—Rear View



Type DSL-416 Breaker—Front View

Application
Type DSL breakers are coordinated combinations of Type DS breakers and series connected current limiters. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand and interrupting ratings of "downstream" circuit components.

Sizes and Arrangements
Types DSL-206 800 ampere frame and DSL-416 1600 ampere frame breakers include the limiters integrally mounted on the drawout breaker elements, in series with the upper terminals.

Current limiters used in Types DSL-632 and DSL-840 combinations are mounted on separate drawout trucks in additional equal size compartments either directly above the breaker compartment in the same unit or beside it in an adjacent unit.

Scope of Fault Interruption
With properly selected and coordinated limiters, it is expected that the breaker itself will clear overloads and faults within its interrupting rating, leaving the limiters intact and undamaged. The limiters will provide fast interruption of fault currents beyond the breaker rating, up to a maximum of 200,000 amperes symmetrical. Thus, on overloads and faults within the breaker interrupting rating, the breaker protects the limiters; on higher fault currents exceeding the breaker rating the limiters protect the breaker.

Protection Against Single Phasing
Loads are protected against single phase operation by interlock arrangements which trip the circuit breaker whenever any one limiter blows. The breaker cannot be reclosed on a live source until there are three unblown limiters in the circuit.

On the Types DSL-206 and DSL-416 breakers, the primaries of small auxiliary transformers are connected in parallel with the limiters. The voltage between the ends of an unblown limiter is zero, but when any limiter blows, the associated transformer is energized and (1) operates an indicator identifying the fuse and (2) picks up a solenoid which raises the breaker trip bar, holding the breaker trip-free.

The DSL-632 and DSL-840 combinations with separately mounted limiters operate on the same principle except that the solenoid operates a micro-switch which trips the breaker electrically through a shunt trip coil.

Safety Features
The integral fuses on Types DSL-206 and DSL-416 breakers are inaccessible until the breaker is completely withdrawn from its compartment, thereby assuring complete isolation.

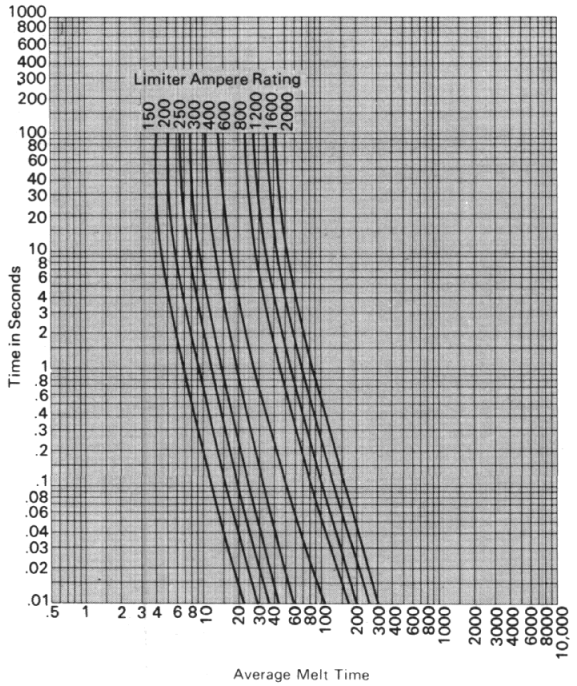
Likewise, the Type DSL-632 and DSL-840 fuses are inaccessible until the separate fuse truck is completely withdrawn and the fuses isolated. The fuse truck is key interlocked with the breaker to prevent withdrawing or insertion unless the breaker is open.

Current Limiting Type Breakers and Combinations

Type	DSL-206	DSL-416	DSL-632	DSL-840
Frame Size, Amperes	800	1600	3200	4000
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000

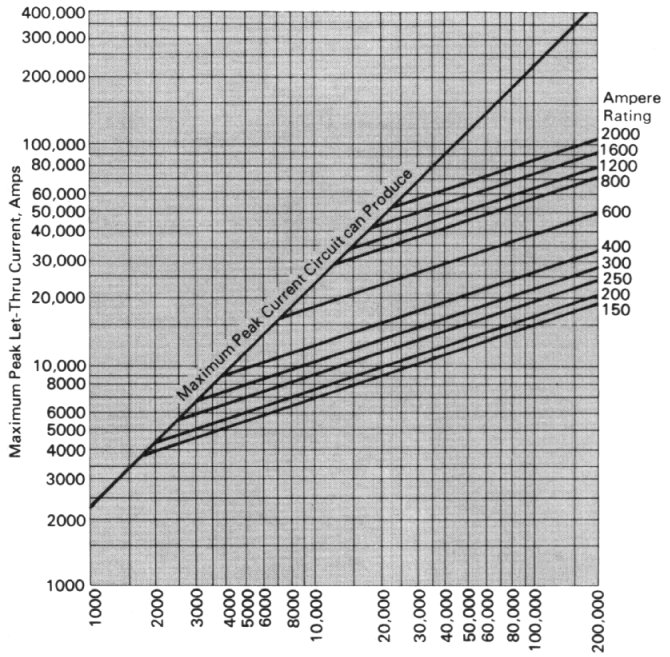
Notes: DSL-206 and DSL-416 include limiters integral with drawout breaker elements. DSL-632 includes DS-632 breaker and DS-3200 drawout fuse truck, in separate interlocked compartments. Maximum continuous rating limited to 3000A when fuse compartment is above breaker compartment in same unit. DSL-840 includes DS-840 breaker and DS-4000 drawout fuse truck, in separate interlocked compartments. Maximum interrupting rating limited to 150,000 amperes when 6000A fuses are used.

Limiter Ratings and Characteristics



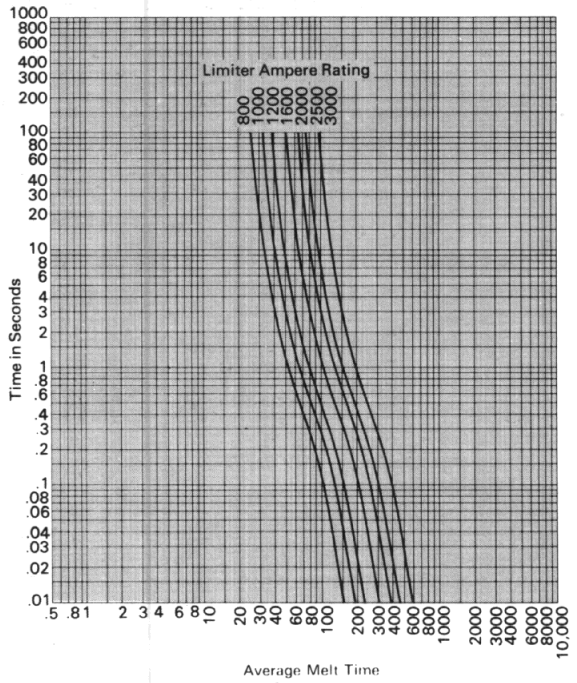
Scale x 100 = Current in Amperes
Limiter Time-Current Characteristic Curves
For DSL-206 Breaker

Curve 1



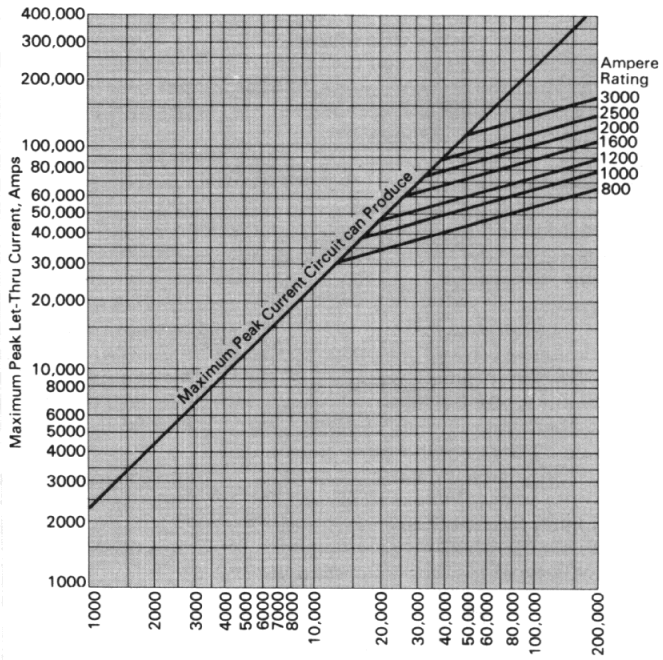
Available Current in RMS Symmetrical Amperes
Maximum Peak Let-Through Current Curves
For DSL-206 Breaker

Curve 2



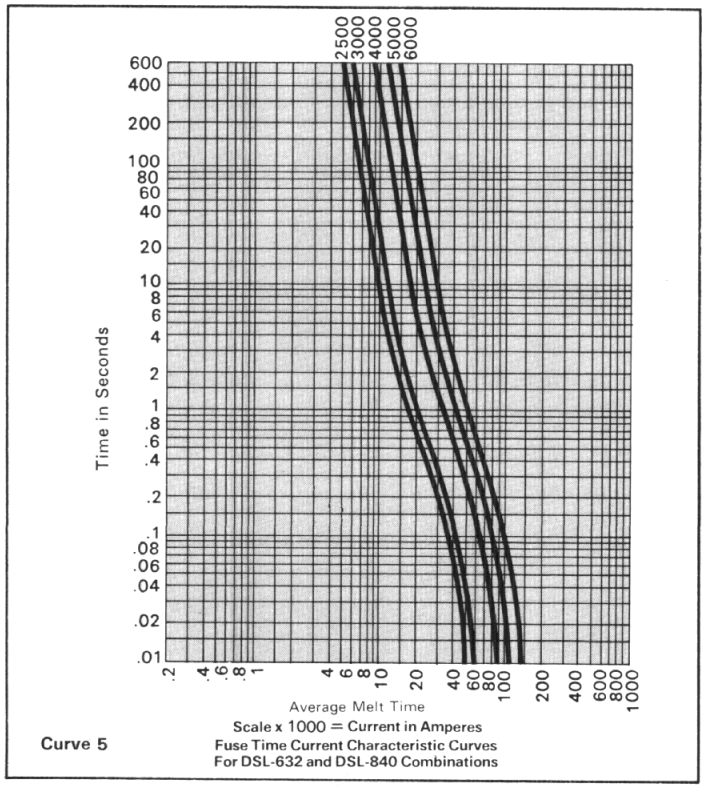
Scale x 100 = Current in Amperes
Limiter Time Current Characteristic Curves
For DSL-416 Breaker

Curve 3

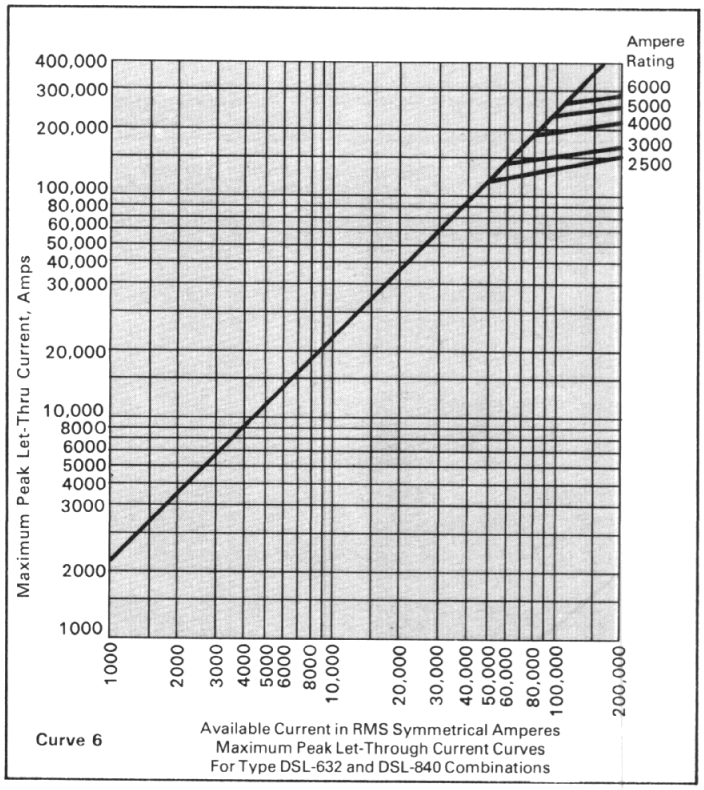


Available Current in RMS Symmetrical Amperes
Maximum Peak Let-Through Current Curves
For DSL-416 Breaker

Curve 4



Curve 5 Fuse Time Current Characteristic Curves For DSL-632 and DSL-840 Combinations



Curve 6 Maximum Peak Let-Through Current Curves For Type DSL-632 and DSL-840 Combinations

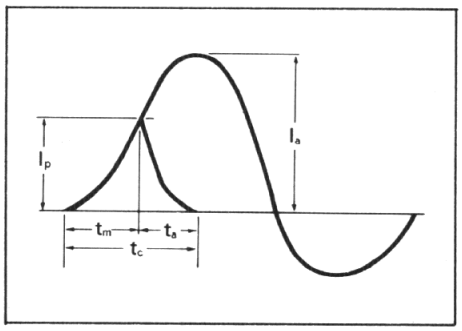
Curves Nos. 1 through 6 illustrate the ratings, melting time-current characteristics and current limiting or let-through characteristics of limiters for Type DSL breakers.

The let-through current for a given limiter application is readily determined from Curve No. 2, No. 4 or No. 6, by extending a vertical line from the applicable maximum available symmetrical fault amperes at the bottom margin to the characteristic line for the particular limiter, and from this intersection extending a horizontal line to the left margin and reading the peak current. The withstand rating of any circuit elements protected by the limiters should be at least equal to this peak current.

It will be noted that the let-through current increases with the limiter size or ampere rating; in other words, the maximum current limiting effect is obtained with the smallest size. This effect is to be expected, since the resistance decreases as the rating increases. If the vertical line from the bottom margin as described in the previous paragraph does not intersect the limiter characteristic line, it is indicated that the available system fault current is below the "threshold" current of that limiter, and it will offer no current limiting effect.

The current limiting principle is illustrated on Curve 7.

Curve 7: Current Limiting Effect of Type DSL Limiters



I_a = The Available Peak Fault Current
t_m = The Melting Time
I_p = The Peak "Let Through" Current
t_a = The Arcing Time
t_c = The Total Interrupting (Clearing) Time

Limiter Selection

The selection of a suitable limiter rating for a given application is generally governed by a choice of the following types of protection:

A. Maximum protection of "downstream" components. Type DSL breakers are often used for this purpose even when the maximum available fault currents are within the interrupting rating of the corresponding Type DS unfused breakers.

B. Protection of the circuit breaker only.

Case A would tend to use the smallest available limiter; Case B the largest. When downstream protection is required, the selection is usually a compromise, since certain small limiters cannot be coordinated with the breaker to avoid nuisance blowing on overloads or small and moderate short circuits.

Minimum, recommended, and maximum limiter sizes for Type DSL-206 and DSL-416 breakers are given in the following table.

Breaker Type	Sensor Rating Amperes	Limiter Rating, Amperes Minimum ①	Recommended ②	Maximum ③
DSL-206	50 or 100	150	1200	2000
DSL-206	150	200	1200	2000
DSL-206	200	250	1200	2000
DSL-206	300	400	1200	2000
DSL-206	400	600	1200	2000
DSL-206	600	800	1200	2000
DSL-206	800	1200	1600	2000
DSL-416	600	800	2000	3000
DSL-416	800	1000	2000	3000
DSL-416	1200	2000	2500	3000
DSL-416	1600	3000	3000	3000

① For use only when protection of downstream equipment is required. Not completely coodinated with breaker to avoid nuisance blowing.
② Lowest rating which can be coordinated with breaker to minimize nuisance blowing.
③ Highest available ratings, for protection of breaker only.

Fuse Time-Current Characteristics Curves are available from the nearest Westinghouse Sales Office or the Switchgear Division.

Application of Type DS Air Circuit Breakers
With Standard 3 Phase Transformers—Liquid Filled, Ventilated Dry, and Gas Filled Sealed Dry Types
Table 3

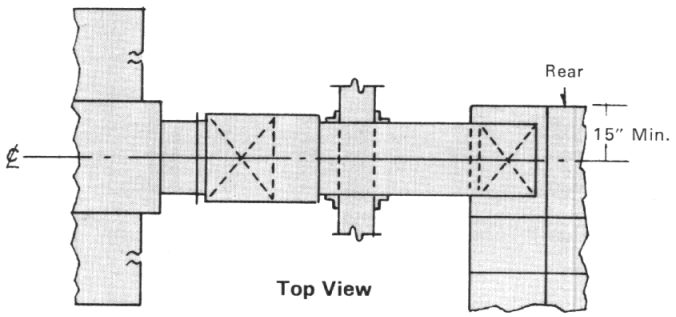
Transformer Base (100%) Rating			Secondary Short-Circuit Currents RMS Symmetrical Amperes			Breakers for Selective Trip Systems			Breakers for Non-Selective Trip Systems	
Kva and Percent Impedance	Amperes	Maximum Short Circuit Kva Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip	Main Breaker Instantaneous Trip	Feeder Breaker Instantaneous Trip
Table 3A: 208 Volts 3 Phase—50% Motor Load										
300 5.0%	833	50000	14900	1700	16600	DS-416	DS-206	DS-206	DS-416	DS-206
		100000	15700		17400		DS-206	DS-206		DS-206
		150000	16000		17700		DS-206	DS-206		DS-206
		250000	16300		18000		DS-206	DS-206		DS-206
		500000	16500		18200		DS-206	DS-206		DS-206
		Unlimited	16700		18400		DS-206	DS-206		DS-206
500 5.0%	1389	50000	23100	2800	25900	DS-416②	DS-206	DS-206	DS-416②	DS-206
		100000	25200		28000		DS-206	DS-206		DS-206
		150000	26000		28800		DS-206	DS-206		DS-206
		250000	26700		29500		DS-206	DS-206		DS-206
		500000	27200		30000		DS-206	DS-206		DS-206
		Unlimited	27800		30600		DS-206S	DS-206		DS-206
750 5.75%	2083	50000	28700	4200	32900	DS-632	DS-206S	DS-206	DS-632	DS-206
		100000	32000		36200		DS-206S	DS-206		DS-206
		150000	33300		37500		DS-206S	DS-206		DS-206
		250000	34400		38600		DS-206S	DS-206		DS-206
		500000	35200		39400		DS-206S	DS-206		DS-206
		Unlimited	36200		40400		DS-206S	DS-206		DS-206
1000 5.75%	2778	50000	35900	5600	41500	DS-632②	DS-206S	DS-206	DS-632②	DS-206
		100000	41200		46800		DS-416	DS-206S		DS-206S
		150000	43300		48900		DS-416	DS-206S		DS-206S
		250000	45200		50800		DS-416S	DS-416		DS-416
		500000	46700		52300		DS-416S	DS-416		DS-416
		Unlimited	48300		53900		DS-416S	DS-416		DS-416
Table 3B: 240 Volts 3 Phase—100% Motor Load										
300 5.0%	722	50000	12900	2900	15800	DS-206②	DS-206	DS-206	DS-206②	DS-206
		100000	13600		16500		DS-206	DS-206		DS-206
		150000	13900		16800		DS-206	DS-206		DS-206
		250000	14100		17000		DS-206	DS-206		DS-206
		500000	14300		17200		DS-206	DS-206		DS-206
		Unlimited	14400		17300		DS-206	DS-206		DS-206
500 5.0%	1203	50000	20000	4800	24800	DS-416②	DS-206	DS-206	DS-416②	DS-206
		100000	21900		26700		DS-206	DS-206		DS-206
		150000	22500		27300		DS-206	DS-206		DS-206
		250000	23100		27900		DS-206	DS-206		DS-206
		500000	23600		28400		DS-206	DS-206		DS-206
		Unlimited	24100		28900		DS-206	DS-206		DS-206
750 5.75%	1804	50000	24900	7200	32100	DS-420②	DS-206S	DS-206	DS-420②	DS-206
		100000	27800		35000		DS-206S	DS-206		DS-206
		150000	28900		36100		DS-206S	DS-206		DS-206
		250000	29800		37000		DS-206S	DS-206		DS-206
		500000	30600		37800		DS-206S	DS-206		DS-206
		Unlimited	31400		38600		DS-206S	DS-206		DS-206
1000 5.75%	2406	50000	31000	9600	40600	DS-632②	DS-206S	DS-206	DS-632②	DS-206
		100000	35600		45200		DS-416	DS-206S		DS-206S
		150000	37500		47100		DS-416	DS-206S		DS-206S
		250000	39100		48700		DS-416	DS-206S		DS-206S
		500000	40400		50000		DS-416	DS-206S		DS-206S
		Unlimited	41800		51400		DS-416S	DS-416		DS-416

Transformer Base (100%) Rating		Secondary Short-Circuit Currents RMS Symmetrical Amperes				Breakers for Selective Trip Systems			Breakers for Non-Selective Trip Systems	
Kva and Percent Impedance	Amperes	Maximum Short Circuit Kva Available from Primary System	Through Transformer Only	Motor Contribution	Combined	Main Breaker Short Delay Trip	Feeder Breaker Short Delay Trip	Feeder Breaker Instantaneous Trip	Main Breaker Instantaneous Trip	Feeder Breaker Instantaneous Trip
Table 3C: 480 Volts 3 Phase—100% Motor Load										
500 5.0%	601	50000	10000	2400	12400	DS-206 ②	DS-206	DS-206	DS-206 ②	DS-206
		100000	10900		13300		DS-206	DS-206		DS-206
		150000	11300		13700		DS-206	DS-206		DS-206
		250000	11600		14000		DS-206	DS-206		DS-206
		500000	11800		14200		DS-206	DS-206		DS-206
		Unlimited	12000		14400		DS-206	DS-206		DS-206
750 5.75%	902	50000	12400	3600	16000	DS-416	DS-206	DS-206	DS-416	DS-206
		100000	13900		17500		DS-206	DS-206		DS-206
		150000	14400		18000		DS-206	DS-206		DS-206
		250000	14900		18500		DS-206	DS-206		DS-206
		500000	15300		18900		DS-206	DS-206		DS-206
		Unlimited	15700		19300		DS-206	DS-206		DS-206
1000 5.75%	1203	50000	15500	4800	20300	DS-416 ②	DS-206	DS-206	DS-416 ②	DS-206
		100000	17800		22600		DS-206	DS-206		DS-206
		150000	18700		23500		DS-206	DS-206		DS-206
		250000	19600		24400		DS-206	DS-206		DS-206
		500000	20200		25000		DS-206	DS-206		DS-206
		Unlimited	20900		25700		DS-206	DS-206		DS-206
1500 5.75%	1804	50000	20600	7200	27800	DS-420 ②	DS-206	DS-206	DS-420 ②	DS-206
		100000	24900		32100		DS-206S	DS-206S		DS-206S
		150000	26700		33900		DS-206S	DS-206S		DS-206S
		250000	28400		35600		DS-206S	DS-206S		DS-206S
		500000	29800		37000		DS-206S	DS-206S		DS-206S
		Unlimited	31400		38600		DS-206S	DS-206S		DS-206S
2000 5.75%	2406	50000	24700	9600	34300	DS-632 ②	DS-206S	DS-206S	DS-632 ②	DS-206S
		100000	31000		40600		DS-206S	DS-206S		DS-206S
		150000	34000		43600		DS-416	DS-416		DS-416
		250000	36700		46300		DS-416	DS-416		DS-416
		500000	39100		48700		DS-416	DS-416		DS-416
		Unlimited	41800		51400		DS-416S	DS-416S		DS-416S
2500 5.75%	3008	50000	28000	12000	40000	DS-632 ②	DS-416	DS-416	DS-632 ②	DS-416
		100000	36500		48500		DS-416	DS-416		DS-416
		150000	40500		52500		DS-416S	DS-416S		DS-416S
		250000	44600		56600		DS-416S	DS-416S		DS-416S
		500000	48100		60100		DS-416S	DS-416S		DS-416S
		Unlimited	52300		64300		DS-416S	DS-416S		DS-416S
Table 3D: 600 Volts 3 Phase—100% Motor Load										
500 5.0%	481	50000	8000	1900	9900	DS-206	DS-206	DS-206	DS-206	DS-206
		100000	8700		10600		DS-206	DS-206		DS-206
		150000	9000		10900		DS-206	DS-206		DS-206
		250000	9300		11200		DS-206	DS-206		DS-206
		500000	9400		11300		DS-206	DS-206		DS-206
		Unlimited	9600		11500		DS-206	DS-206		DS-206
750 5.75%	722	50000	10000	2900	12900	DS-206 ②	DS-206	DS-206	DS-206 ②	DS-206
		100000	11100		14000		DS-206	DS-206		DS-206
		150000	11600		14500		DS-206	DS-206		DS-206
		250000	11900		14800		DS-206	DS-206		DS-206
		500000	12200		15100		DS-206	DS-206		DS-206
		Unlimited	12600		15500		DS-206	DS-206		DS-206
1000 5.75%	962	50000	12400	3900	16300	DS-416	DS-206	DS-206	DS-416	DS-206
		100000	14300		18200		DS-206	DS-206		DS-206
		150000	15000		18900		DS-206	DS-206		DS-206
		250000	15600		19500		DS-206	DS-206		DS-206
		500000	16200		20100		DS-206	DS-206		DS-206
		Unlimited	16700		20600		DS-206	DS-206		DS-206
1500 5.75%	1443	50000	16500	5800	22300	DS-416 ②	DS-206	DS-206	DS-416 ②	DS-206
		100000	20000		25800		DS-206	DS-206		DS-206
		150000	21400		27200		DS-206	DS-206		DS-206
		250000	22700		28500		DS-206	DS-206		DS-206
		500000	23900		29700		DS-206	DS-206		DS-206
		Unlimited	25100		30900		DS-206S	DS-206S		DS-206S
2000 5.75%	1924	50000	19700	7700	27400	DS-420 ②	DS-206	DS-206	DS-420 ②	DS-206
		100000	24800		32500		DS-206S	DS-206S		DS-206S
		150000	27200		34900		DS-206S	DS-206S		DS-206S
		250000	29400		37100		DS-206S	DS-206S		DS-206S
		500000	31300		39000		DS-206S	DS-206S		DS-206S
		Unlimited	33500		41200		DS-206S	DS-206S		DS-206S
2500 5.75%	2406	50000	22400	9600	32000	DS-632 ②	DS-206S	DS-206S	DS-632 ②	DS-206S
		100000	29200		38800		DS-206S	DS-206S		DS-206S
		150000	32400		42000		DS-206S	DS-206S		DS-206S
		250000	35600		45200		DS-416S	DS-416S		DS-416S
		500000	38500		48100		DS-416S	DS-416S		DS-416S
		Unlimited	41800		51400		DS-632 ①	DS-632 ①		DS-632 ①

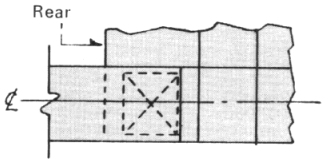
① Type DSL-416 1600 ampere frame or DSL-206 800 ampere frame fused type breakers may be substituted for Type DS-632 feeder breakers, if adequate for load demands.

② Next larger frame size main breaker may be required for 55/65°C rise and/or forced-air cooled (FA) transformer. Check Table of Transformer Secondary Ampere Ratings on Page 29.

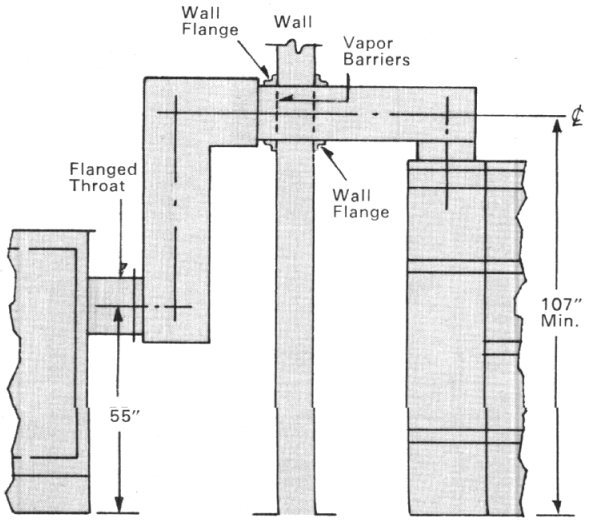
Typical Metal Enclosed Bus Arrangements



Top View



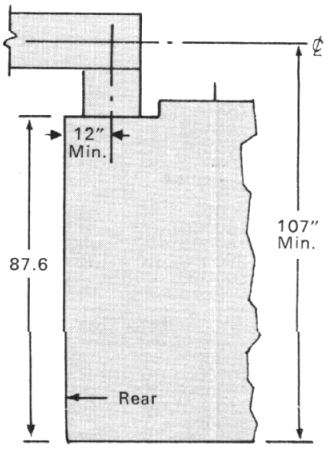
Top View



Outdoor Liquid Transformer

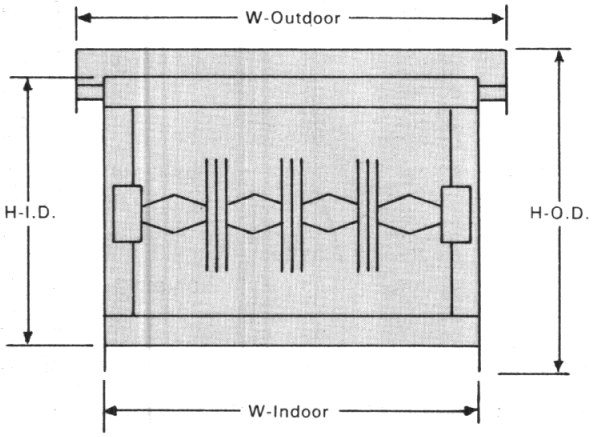
Indoor Switchgear Front View

Elevation



Indoor Switchgear Side View

Elevation



Buses 4000 Amp. and Larger Include Interlaced Conductors

Bus Dimensions, Inches

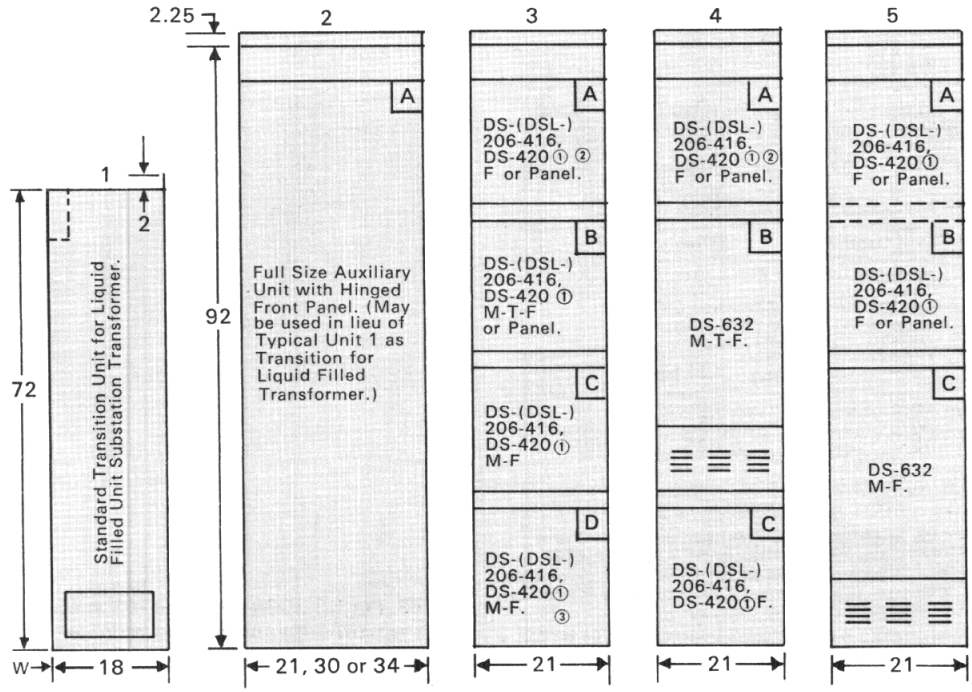
Cont. Rating, Amp. ①	Copper or Aluminum Conductors, Except as Noted						
	Ventilated				Non-Vent.		
	Indoor		Outdoor		Outdoor		Notes
	W	H	W	H	W	H	
600	18.00	10.00	21.25	13.12	21.25	13.12	3 Wire or 4 Wire
1200	20.00	14.38	23.25	17.50	23.25	17.50	
1600	20.00	14.38	23.25	17.50	23.25	17.50	Dimension W
2000	20.00	14.38	23.25	17.50	23.25	17.50	Based on 3 Wire;
2500 ③	20.00	14.38	23.25	17.50	23.25	17.50	Add 4 In.
3000 ②	20.00	14.38	23.25	17.50	N.A.	N.A.	for 4 Wire.
3500 ②	20.00	14.38	23.25	17.50	N.A.	N.A.	
4000 ②	30.00	22.87	33.25	26.00	N.A.	N.A.	3 Wire Only
4000 ③	34.00	22.87	37.25	26.00	37.25	26.00	
4500 ②	34.00	22.87	37.25	26.00	N.A.	N.A.	3 Wire or 4 Wire
5000 ②	34.00	22.87	37.25	26.00	N.A.	N.A.	

① Continuous ratings are based on Standard 65°C Temperature Rise above ambient air temperature of 40°C maximum outside of bus enclosure.

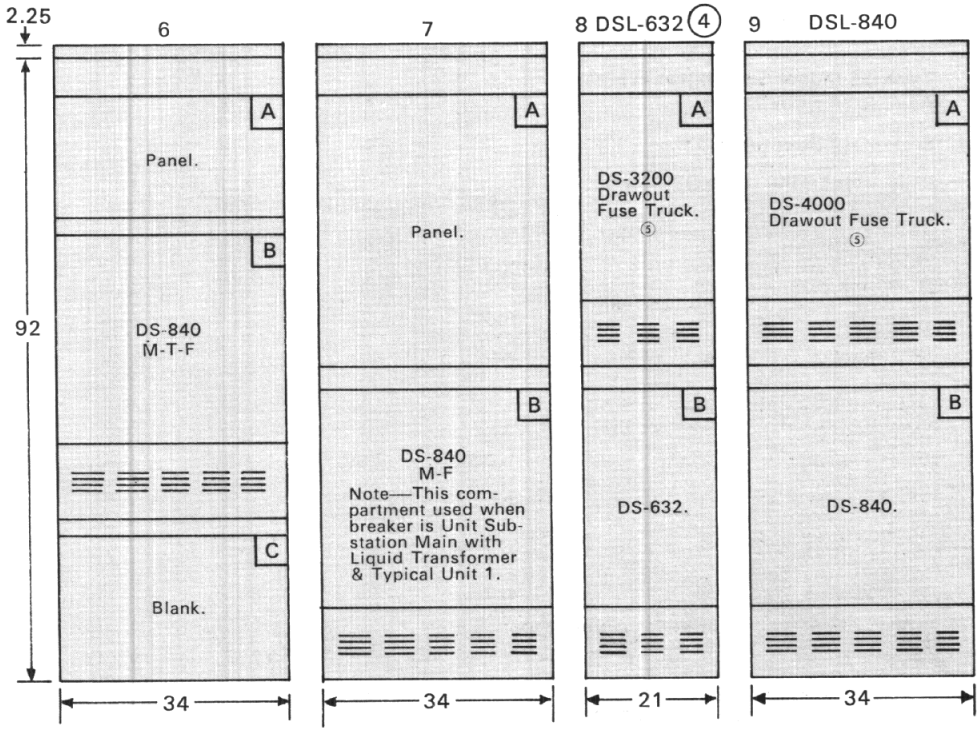
② Copper conductors only. ③ Copper only when non-ventilated.

Type DS Indoor Switchgear Dimensions—Inches

Front Views of Typical Units



M—Main Breaker
T —Tie Breaker
F —Feeder Breaker



NOTE: For DS-206S and DS-416S space requirements, dimensions and weights use those shown for DS-206 and DS-416 respectively.

① Special Notes on DS-420 Breakers:
1. Only one active DS-420 per unit.
2. If DS-420 in Compt. C or D (Typ. Unit 3) is a close coupled transformer secondary main breaker, no other breakers are permitted in same unit.

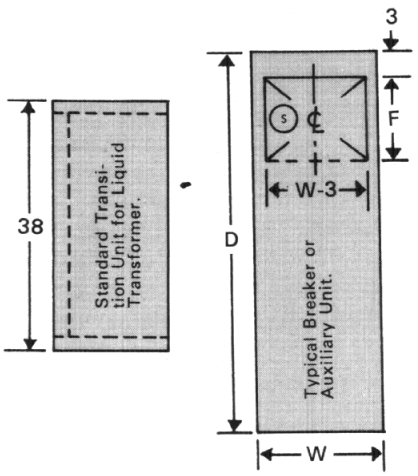
② Must be panel or blank compt. when breaker in Compt. B below is a main breaker.

③ Must be blank compt. when breaker in Compt. C above is a main breaker.

④ Max. continuous rating with this arrangement 3000A.

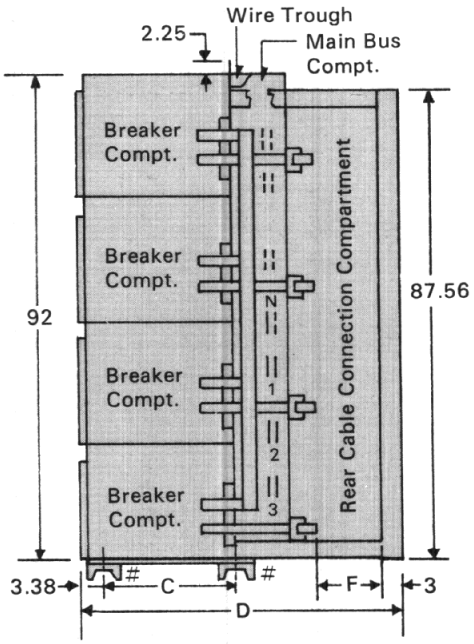
⑤ Fuse truck may also be located in alternate position in compt. beside breaker compt., in adjacent unit. DSL-632 will have 3200A max. cont. rating.

Plans



Ⓢ Space for power and control cables, top and bottom.
Minimum recommended front aisle for breaker removal:
For DS-206-416-420-632—36
For DS-840 or DSL —44
For transfer & lift truck —60
Top-of-gear mounted breaker lifter:
Overall height, approximate—108
Projection front of switchgear—23.5
Maximum height over lift truck—110
Minimum recommended rear aisle—24

Section of Typical Breaker Unit



Depth D	Dim. C	Dim. F
54-60-66-72	23.62	See Table
62-68-74-80	31.62	Above

Floor channels not included.

Main Bus 1600A or 2000A

Unit Depth D ①		Cable Sp. F	
With Bkr. Type DS-206 DS-416 DS-420	With Bkr. Type DSL-206 DSL-416	Bkr. Unit ③	Aux. Unit
54	62	8	14
60 ②	68 ②	14	20
66	74	20	26
72	80	26	32

Main Bus 3200A, 4000A or 5000A

Unit Depth D ①		Cable Sp. F	
With Bkr. Type DS-206 DS-416 DS-420 DS-632	With Bkr. Type DSL-206 DSL-416 DSL-632 DSL-840 DS-840	Bkr. Unit ③	Aux. Unit
60	68	9	15
66 ②	74 ②	15	21
72	80	21	27

① Maximum depth requirement for any unit determines uniform depth of complete assembly.

② Minimum recommended depth with 3 or 4 DS-206 (DSL-206) or DS-416 (DSL-416) feeder breakers, initial or future, in same unit. Also required for metal enclosed bus termination.
Next deeper unit required for Type BYZ zero sequence current transformers, and/or phase current transformers for relaying.

③ Additional 6 in. available for cables thru floor if bottom compartment is blank.

Type DS Indoor Switchgear Weights—Pounds (Approximate)

Stationary Structures

21 in. wide breaker unit less breakers:	
66 in. maximum depth	— 1300
80 in. maximum depth	— 1400
34 in. wide breaker unit less breaker	— 1500
21 in. wide auxiliary unit:	
66 in. maximum depth	— 1000
80 in. maximum depth	— 1100
30 in. or 34 in. wide auxiliary unit	
66 in. maximum depth	— 1100
80 in. maximum depth	— 1200
Std. transition unit (liquid transf.)	— 300

Drawout Elements

DS-206 Breaker #	— 175
DS-416 Breaker #	— 180
DS-420 Breaker #	— 185
DS-632 Breaker #	— 300
DS-840 Breaker #	— 405
DSL-206 Breaker #	— 205
DSL-416 Breaker #	— 255
DS-3200 Fuse Truck	— 325
DS-4000 Fuse Truck	— 430

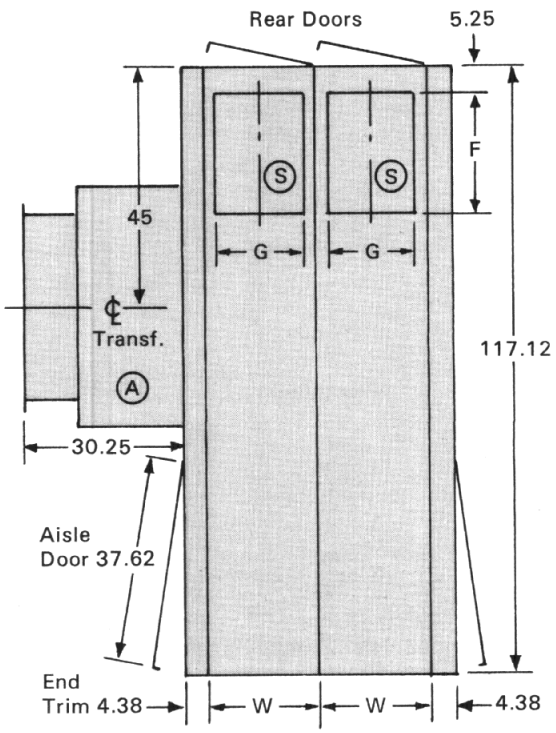
Manually or elec. operated. For approx. impact weight, add 50% of breaker weight.

Shipping Groups
Each shipping group includes a maximum of five (5) breaker and full size auxiliary units, plus one or two standard transition units (Typical Unit 1).

NOTE: For DS-206S and DS-416S space requirements, dimensions and weights use those shown for DS-206 and DS-416 respectively.

Type DSO Outdoor Switchgear Dimensions — Inches

Plan of Typical Units



(A) Standard Transition Throat for connection to Liquid Filled Unit Substation Transformer. Also available for location on right end of Switchgear, facing front, and on both ends for double ended unit substation.

(S) Cutout in base of Switchgear for power and control cables, with removable bolted cover for drilling by purchaser.

Dimensions F and G

Unit Width W	F	G
21	25.25	17.50
30	25.25	25.25
34	25.25	25.25

Minimum recommended front clearance — 24 in.
Minimum recommended rear aisle for 21 in. wide units — 24 in.
Minimum rear aisle for 30 in. wide unit — 30 in.; for 34 in. wide unit — 34 in.

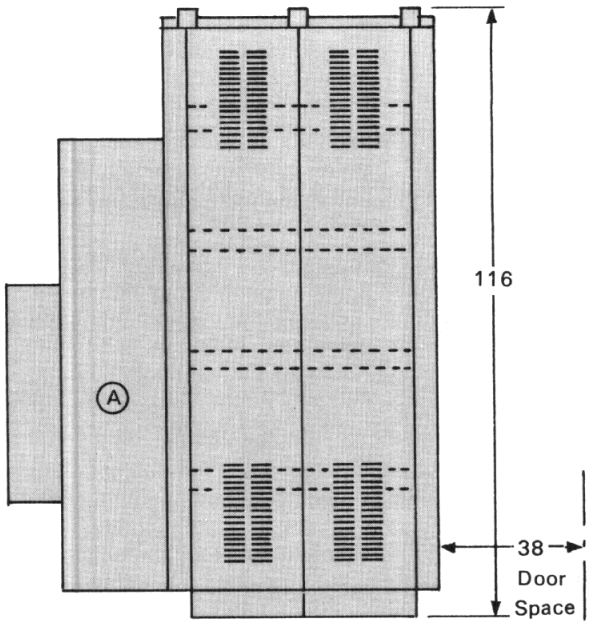
Each shipping group includes a maximum of four (4) breaker and full size auxiliary units, or a maximum combined length of 84 in. exclusive of end trims and transition throats.

Outdoor Switchgear Weights—Pounds (Approximate)
Stationary Structures

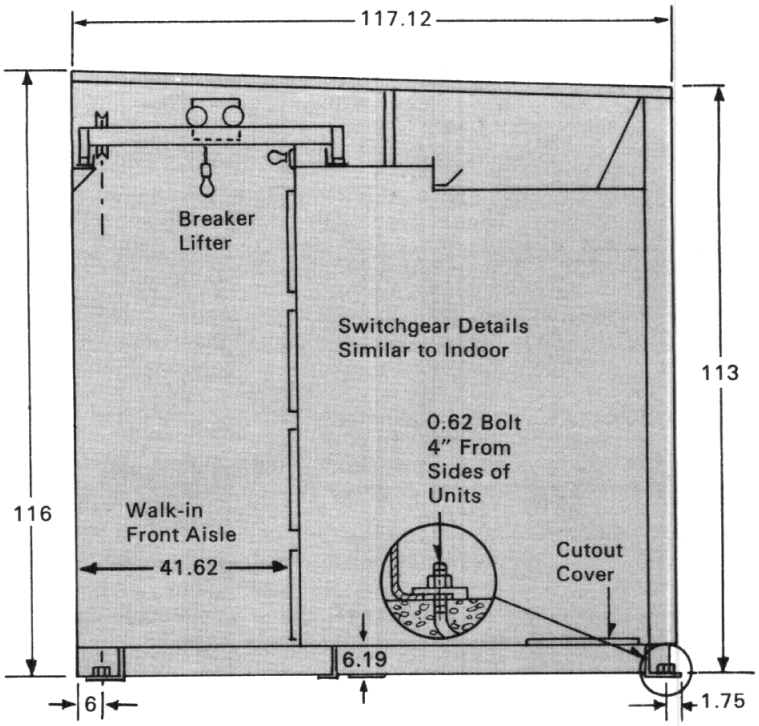
End Trims (One Set per Assembly)	—1500
21 in. wide breaker unit less breakers	—2600
34 in. wide breaker unit less breakers	—2700
21 in. wide auxiliary unit	—2300
30 in. or 34 in. wide auxiliary unit	—2400
Standard transition throat	— 800

Drawout Elements
Same as in Indoor Switchgear

Front Elevation



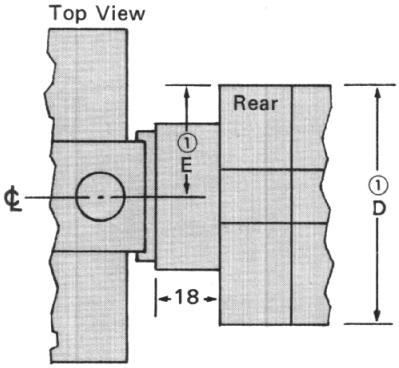
Section of Typical Unit



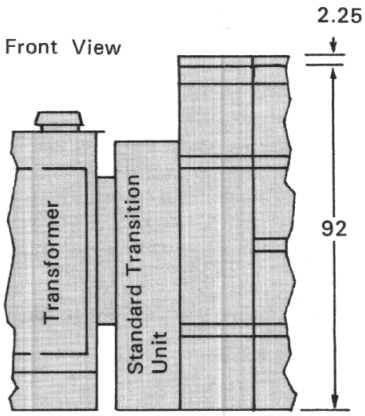
Power Center Coordination—Dimensions in Inches

Indoor Power Center with Liquid Filled Transformer

Top View

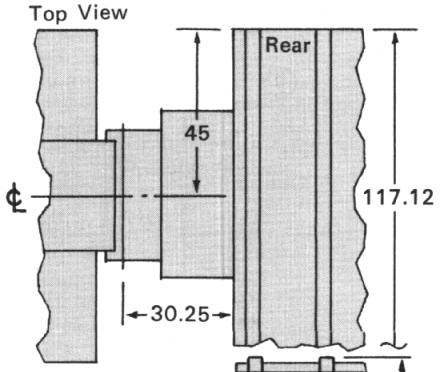


Front View

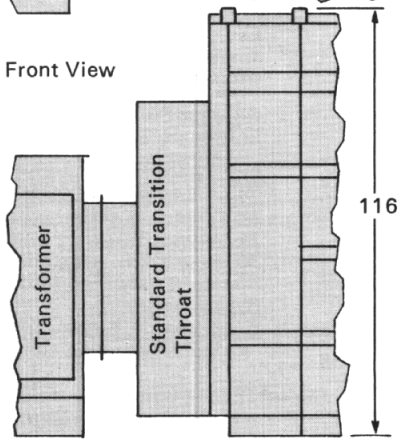


Outdoor Power Center with Liquid Filled Transformer

Top View

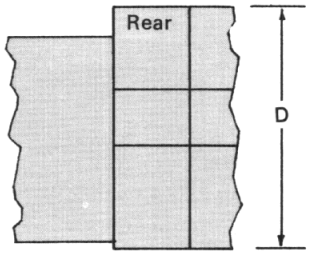


Front View

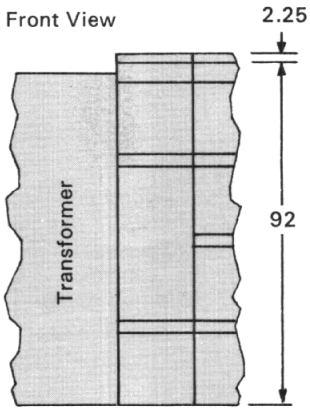


Indoor Power Center with Ventilated Dry Type Transformer

Top View

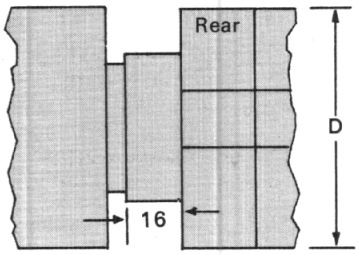


Front View

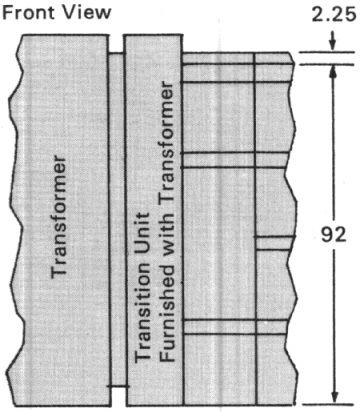


Indoor Power Center with Gas Filled Sealed Dry Type Transformer

Top View

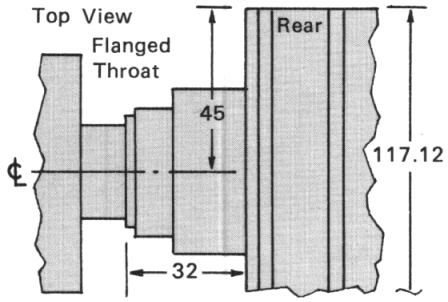


Front View

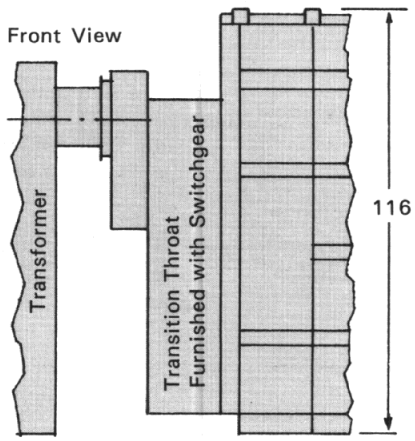


Outdoor Power Center with Gas Filled Sealed Dry Type Transformer

Top View



Front View



Notes

Units are shown with Lv to right, Lv right is standerd and will be supplied unless otherwise specified. Any unit substation may be opposite hand or double ended.

① Depth D	Dim. E
54 or 62	19.25
60 or 68	25.25
66 or 74	31.25
72 or 80	37.25

Specification Guide for Power Centers and Type DS Low Voltage Switchgear

General

This specification includes an (Indoor) (Outdoor) secondary unit substation complete from the incoming line terminals to the feeder terminals.

The secondary unit substation shall be designed, assembled and tested in accordance with applicable standards of NEMA, IEEE and ANSI.

The following sections shall be included and arranged (left-to-right) (right-to-left) when facing the control side of the switchgear and the nameplate side of the transformer:

Incoming Line Section
Transformer Section
Outgoing Low Voltage Switchgear Section.

Incoming Line Section

Air Interrupter Switch—The HV switch shall be manually operated and rated at 600 (1200A) continuous, load break with fault closing rating of _____ amperes asymmetrical and a momentary rating of _____ amperes asymmetrical. The switch mechanism shall provide quick closing and opening, independent of the handle speed. When the switch access door is open, a plexiglass or screen barrier shall exist over the area where energized parts may be readily touched.

Switch shall be cable connected to the transformer terminals to prevent transmission of sound to the switch. The switch case shall be made of a minimum of 13 gauge steel.

3-Pole 2-Position—The HV section shall be provided with a gang operated 3 pole, 2 position air-insulated load interrupter switch. The switch compartment shall have a sight window for visual inspection of switch contacts. The switch handle shall be operable from the front of the unit.

Selector Switch—The HV section shall be provided with a gang operated 3 pole, 3 position (open - feeder 1 - feeder 2) selector switch which will consist of a no load selector switch for switching from one feeder to the other on the line side and in series with an air-insulated load interrupter switch. The load interrupter switch must be open before the selector switch can be changed from one feeder to another. The switch compartment shall have a sight window for visual inspection of switch load contacts. The switch handles shall be operable from the front of the unit. The selector switch handle shall visually indicate line 1 and line 2.

Duplex Switch—The HV section shall be provided with a gang operated 3 pole, 2 position duplex switch which will consist of 2 air insulated load interrupter switches connected together on the load side which shall be used for connecting the transformer to one of 2 available feeders. The two switches shall be interlocked to prevent both feeders from being connected to the transformer simultaneously. Each of the 2 switch compartments shall have a sight window for visual inspection of switch contacts. The switch handles shall be operable from the front of the unit.

Fuses—(Three - current limiting _____ E) (three RBA boric acid _____E) fuses are to be provided on the load side of the HV switch in the HV switch compartment. _____ Kva interrupting capacity required. The hinged access door shall be interlocked with the switch so that the door cannot be opened until the switch is in the open position. Also the switch cannot be closed until the door is closed. The fuses shall have a continuous rating to protect the transformer.

Three spare fusee are to be supplied. (Optional)

Cutouts—The HV section shall consist of 3 - single pole _____ ampere gang operated oil fused cutouts.
Optional equipment available:

1. Provide 3_____ spare fuse links for oil fused cutouts.
2. Provide _____ key interlock(s) to interlock with _____.

Terminal Compartment—The HV section shall consist of a terminal compartment for cable entrance. The terminal connectors shall be located so as to give sufficient space for stress cones.

Lightning Arresters—Provide 3_____ Kv (station type) (intermediate) (distribution) arresters for _____ Kv (grounded) (ungrounded) service.

Interlocks—Provide _____ key interlock(s) to interlock with _____.

Terminals—Provide (potheads(s)) (clamp terminals) for termination of the (single feed) (loop feed) _____ MCM cables, _____ per phase.

Liquid Type Transformer Section

The Indoor (Outdoor) transformer will be rated as follows:

_____ Kva, 3 phase, 60 hertz, OA/FFA, oil (Silicone) insulated, 65°C rise (55°C rise) (Complete with 230V 1ϕ fans, OA/FA, for increased rating to _____ Kva).
HV _____ volts, 3 wire, plus two 2½%, minus two 2½% no load full capacity taps, delta connected.
LV _____ volts, 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities—A flange will be provided on the end wall of the tank for attaching the Incoming Line Compartment. Flange will be located on the left (right) when facing the front of the transformer.

Cable Entrance—The cables shall enter the terminal compartment from the top (bottom).

Low Voltage Lead Facilities—A flange will be provided on the end wall, opposite high voltage flange, for attaching the low-voltage switchgear.

Accessories will include the following:
- Combination drain and filter valve and sampling device.
- De-energized tap changer, externally operated. Cover mounted operating handle.
- Pressure test connection
- 1-inch filling plug and filter press connection in cover
- Thermometer, dial type, without (with) alarm contacts
- Liquid level gauge, without (with) low level alarm contacts
- Provision for lifting
- Provision for jacking
- Pressure relief device, without (with) alarm contacts. (Silicone only.)
- Instruction nameplate
- Ground pad
- Pressure vacuum gauge
- Welded-on main tank cover

Impedance—The impedance of the transformer at normal rating and frequency will be *% ± 7½% tolerance.

(*5.0% for 500 Kva and below, *5.75% for 750 Kva through 2500 Kva.)

Sealed Tank—The transformer will be of sealed tank construction to prevent breathing. Adequate gas space will limit the internal pressure due to normal load cycle operation.

Shot Blast—The case and cooling tubes will be cleaned by shot blast or pickling and phosphatized before the paint is applied.

Finish—Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or dark gray ANSI No. 24 (outdoor).

Future Capacity—Each 750 Kva through 2500 Kva transformer shall be OA/FFA rated, i.e., include all design and construction capacities for future addition of fans.

Ventilated Dry Type Transformer Section

The indoor (outdoor), standard or (tamper-resistant) transformer will be rated as follows:

_____ Kva, 3 phase, 60 hertz, ventilated dry type, 150°C rise, 220°C insulation system. (Complete with fans for increased rating to _____ Kva.)
HV _____volts, 3 wire, with plus two 2½%, and minus two 2½% no load full capacity taps delta connected.
LV _____ volts, 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities
Provisions will be made for connecting the transformer case directly to the high voltage switch housing and the high voltage leads to the high voltage switch.

Low Voltage Lead Facilities
Provisions will be made for connecting the transformer directly to the low voltage switchgear housing and low voltage leads to the switchgear bus.

Accessories will include the following:
- Diagram instruction plate
- Provision for lifting and jacking
- Removable case panel for access to high voltage taps
- Drip proof cover
- Ground pad

High Voltage Taps
Tap leads will be terminated at the coils and equipped with provisions for changing taps.

Insulation
The transformer will be of the non-explosive, fire-resistant, air insulated, dry type construction, cooled by the natural circulation of air through the windings. Solid insulation in the transformer will consist of inorganic materials such as porcelain, glass roving or Nomex in combination with a sufficient quantity of a high temperature binder to impart the necessary mechanical strength to the insulation structure. Such insulation is defined by ANSI Standards as Class H materials.

Case
The knockdown case for ease in fitting through limited openings will be formed of 13 gauge sheet steel construction equipped with removable panels for access to the core and coils on the front and rear with ornamental ventilating grills. A bolted cover section will be supplied for access to the core and coil lifting loops for lifting the complete assembly.

Paint Finish
The case will be phosphatized and finished in manufacturer's standard light gray.

Lightning Arresters (optional)
Three low ratio lightning arresters will be mounted in the transformer case and connected to the high voltage leads. They will be for use on a _____ Kv grounded (ungrounded) system.

Impedance
The impedance of the transformer at normal rating and frequency will be manufacturer's standard ±7½% tolerance.

Gas Filled Sealed Dry Type Transformer Section

The indoor (outdoor) transformer will be rated as follows:
_____ Kva, 3 phase, 60 Hertz, gas filled sealed dry type, 150°C rise, with a 220°C insulation system.
H.V. _____ volts. 3 wire, plus two 2½%, minus two 2½% no load full capacity taps, delta connected.
L.V. _____ volts. 4 wire (3 wire) wye (delta) connected.

High Voltage Lead Facilities
A flange will be provided on the end wall of the tank for attaching the incoming Line Compartment. Flange will be located on the left (right) when facing the front of the transformer.

Cable Entrance
The cables shall enter the terminal compartment from the top (bottom).

Low Voltage Lead Facilities
A flange will be provided on the end wall, opposite high voltage flange, for attaching the low-voltage switchgear.

Accessories will include the following:
- I-beam base for rolling in any direction.
- Cover will be welded to the tank flange.
- Yukon cooler ¼ inch thick.
- Lifting hooks—4 total.
- Jack pads—4 total.
- Vacuum pressure gauge.
- Dial-type gas thermometer with alarm contact.
- ¾ inch filling plug—2 total.
- Diagram nameplate.
- Welded handhole cover for access to high voltage and low voltage bushings.
- De-energized tap changer, externally operated.
- Ground pad.
- Welded-on main tank cover.

Impedance
The impedance of the transformer at normal rating and frequency will be *%±7½% tolerance.

(*5.0% for 500 Kva and below. 5.75% for 750 Kva through 2500 Kva).

Sealed Tank
The transformer will be of sealed tank construction to prevent breathing. Tank will be hermetically sealed with metallic seals throughout and will be tested at 15 psi pressure. It will be provided with welded-on ¼" thick Yukon coolers.

Shot Blast
The case and coolers will be cleaned by shot blast and phosphatized before the paint is applied.

Finish
Paint finish will be manufacturer's standard, applied over a properly prepared surface. The color will be light gray ANSI No. 61 (indoor) or drak gray ANSI No. 24 (outdoor).

Insulation
The transformer will be of the non-explosive, fire-resistant, fluorocarbon insulated, dry type construction, cooled by the natural circulation of fluorocarbon through the windings. Solid insulation in the trans-

former will consist of inorganic materials such as porcelain, glass roving or Nomex in combination with a sufficient quantity of a high temperature binder to impart the necessary mechanical strength to the insulation structure. The transformer will be insulated and cooled with C_2F_6 fluorocarbon gas. It will be shipped filled with this C_2F_6 gas to a gauge pressure of approximately 1½ P.S.I. at 25°C ambient.

Bushings
The transformer will be equipped with rolled flange, inert arc welded bushings for the HV and LV connections to insure that the tank is hermetically sealed.

Outgoing Low-Voltage Switchgear Section

General—Type DS indoor (outdoor) low-voltage metal-enclosed switchgear will consist of a stationary structure assembly and one or more removable "De-ion" air circuit breaker units fitted with disconnecting devices and other necessary equipment. The switchgear will be suitable for 600 volts maximum service and will receive a dielectric test for that voltage class in accordance with NEMA standards. It will be designed, manufactured and tested in accordance with the latest standards of IEEE, NEMA, and ANSI.

Stationary Structure—Each steel unit forming part of the stationary assembly will be a self-contained housing having one or more individual breaker or instrument compartments and a rear compartment for the bare buses, and outgoing cable connections. Each circuit breaker compartment will be equipped with primary and secondary contacts, rails, stationary levering mechanism parts, and required instrument current transformers. A blank formed steel door equipped with ventilation openings in the lower flange, an emergency trip buton, and supported on concealed hinges will be provided for each circuit breaker compartment.

The top of the unit will be enclosed with removable steel sheets which include necessary ventilation openings.

The structure will be so designed that future additions may readily be made at any time. The steel structure will be thoroughly cleaned and phosphatized prior to the application of the priming and finishing coats of paint.

A black, anodized aluminum, engraved circuit designation nameplate 1¼ inches high and 3½ inches wide will be provided on each circuit breaker door.

Buses and Connections—Each circuit will include the necessary 3 phase bus and connections between the bus and one set of circuit breaker studs. Solderless type terminals on silver-plated copper extensions for the outgoing cables will be provided on the other set of circuit breaker studs. The buses and connections will consist of high-conductivity bare aluminum bar mounted on heavy duty glass polyester supports. The main bus joints will be welded. Shipping breaks and provisions for future bus extensions will have silver-plated bolted connections. Moldarta™ terminal blocks with integral-type barriers will be provided for secondary circuits. The terminal blocks will be mounted at the rear of the units, and will be accessible through a removable cover.

Disconnecting Devices—The stationary part of the primary disconnecting devices for each circuit breaker will consist of a set of contacts extending through a glass polyester insulating base. Buses and outgoing cable terminals will be directly connected to them. The corresponding moving contacts will consist of a set of contact fingers suitably spaced on the circuit breaker studs. In the "connected" position, these contact fingers will engage the stationary contacts forming a current-carrying bridge. The assembly will provide a multitude of silver-to-silver high-pressure point contacts. High uniform pressure on each finger will be maintained by springs. The entire assembly will be full floating and will provide ample flexibility between the stationary and moving elements. Contact engagement will be maintained only in the "connected" position.

The secondary disconnecting devices will consist of floating fingers mounted on the removable unit and engaging flat contact segments located at the rear of the compartment. The secondary disconnecting devices will be silver-plated to insure permanence of contact. Contact engagement will be maintained in the "connected" and "test" positions.

Removable Element—The removable element will consist of a type DS De-ion air circuit breaker equipped with the necessary disconnecting contacts, wheels, and interlocks for drawout application. The removable element will have four position features and will permit closing the compartment door with the breaker in the "connected", "test", "disconnected", and "remove" positions.

Air Circuit Breakers—The air circuit breakers will be type DS (DSL) operating on the Westinghouse De-ion arc interruption. These breakers will incorporate specially designed circuit-interrupting devices which provide high interrupting efficiency and minimize the formation of arc flame and gases.

The air circuit breakers will have silver-tungsten butt type contacts which operate under high pressure. The arcing contacts will be of arc-resisting silver-tungsten. The breaker will be equipped with "De-ion" arc chutes which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by short-circuit interruption. Each breaker will be equipped with a position indicator, mechanically connected to the circuit breaker mechanism.

Include when DSL breakers specified above. (Circuit breakers shall include current limiters, integrally, or separately mounted coordinated with the breaker trip device so as to avoid unnecessary blowing of the current limiters. Breaker shall include an anti single phase device that will trip the breaker in the event of a blown limiter, indicate from the front of the breaker which limiter is blown, and prevent the breaker from being reclosed on a single phase condition, due to missing or blown limiters.)

Each breaker will be equipped with an Amptector II-A (Amptector I-A) solid-state trip. The adjustments will be Long delay pick-up between 50% and 125% of the trip rating, Long time delay between 4 and 36 seconds at 6 times trip rating, Short delay pick-up between 4 and 10 times trip rating, Short time delay between 0.18 and 0.5 seconds at 2.5 times Short delay pick-up, instantaneous pick-up between 4 and 12 times trip rating, ground fault (Amptector I-A only) pick-up approximately 20% of trip rating and ground fault time between 0.22and 0.5 seconds. Adjustments will be of the continuous type and each will be independent of all the others. All components will be covered with a sealing compound to prevent deterioration in corrosive atmospheres.

It will be possible to test and calibrate the time and current characteristics and trip circuit by means of a portable plug-in test device.

Note: Only those characteristics as required should be specified.

Both electrically operated, and manually operated breakers will have stored energy operating mechanisms. Only one stroke of the operating handle will be necessary to charge the stored energy spring when operating the manual breaker. The release of the energy to close the breaker manually will be by means of a mechanical pushbutton which insures positive control of the closing operation. Electrical close will be initiated by means of a release solenoid.

Factory Assembly and Tests
The switchgear will be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of the equipment.

The main circuits will be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits will be given a dielectric test of 1500 volts for one minute between live parts and ground.

Detail Specification
1—Indoor (Outdoor) low-voltage metal-enclosed switchgear assembly including the following equipment:

a. 1—Set of necessary provisions for throat connection or close coupling to the transformer secondary.

b. 1—Set of necessary bare main bus and ground bus connections. (Including full neutral) (including 50% neutral).

c. ___Current transformers_____/5 ampere ratio. (2 for 3 wire, and 3 for 4 wire with neutral bus in switchgear.)

d. ___Potential transformers_____/120 volt ratio complete with primary and secondary fuses. (2 for 3 wire, and 3 for 4 wire with neutral bus in switchgear.)

e. 1—Ammeter, 0- _____ ampere range. 2% accuracy class.

f. 1—Ammeter switch for reading each phase current.

g. 1—Voltmeter, 0- _____ volt range, 150 volt coil, 2% accuracy class.

h. 1—Voltmeter switch arranged for reading phase to phase (phase to phase and phase to neutral) voltages.

i. 1—Watthour meter 2 element, 3 wire (2½ element, or 3 element, 4 wire) 5 ampere, 120 volt coils.

j. _____ Main secondary breaker(s), _____ ampere frame, — Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, short delay (and ___ wire ground) characteristics.

k. _____ Tie breaker(s), _____ ampere frame, ___ Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, short delay (and ___ wire ground) characteristics.

l. _____ Feeder breakers, _____ ampere frame, ___ Amps sym. int. cap. (manually) (electrically) operated with Amptector II-A (Amptector I-A) solid state trips with long delay, instantaneous (and ___ wire ground) characteristics (with integrally mounted current limiters for max. 200,000A int. cap.)

m. Control power transformer complete with primary and secondary fuses for space heaters, lights, receptacles and circuit breaker control as required.

n. Sets of clamp type terminals for _____ _____ MCM cables per phase and _____ _____ MCM cables for neutral entering from the bottom (top) of the unit.

o. 1—Set of engraved black anodized aluminum nameplates.

p. 1—Set of necessary small wiring, wiring accessories and terminal blocks.

q. 1—Set of space heaters, light and receptacles as required. (Standard for outdoor).

Caution:

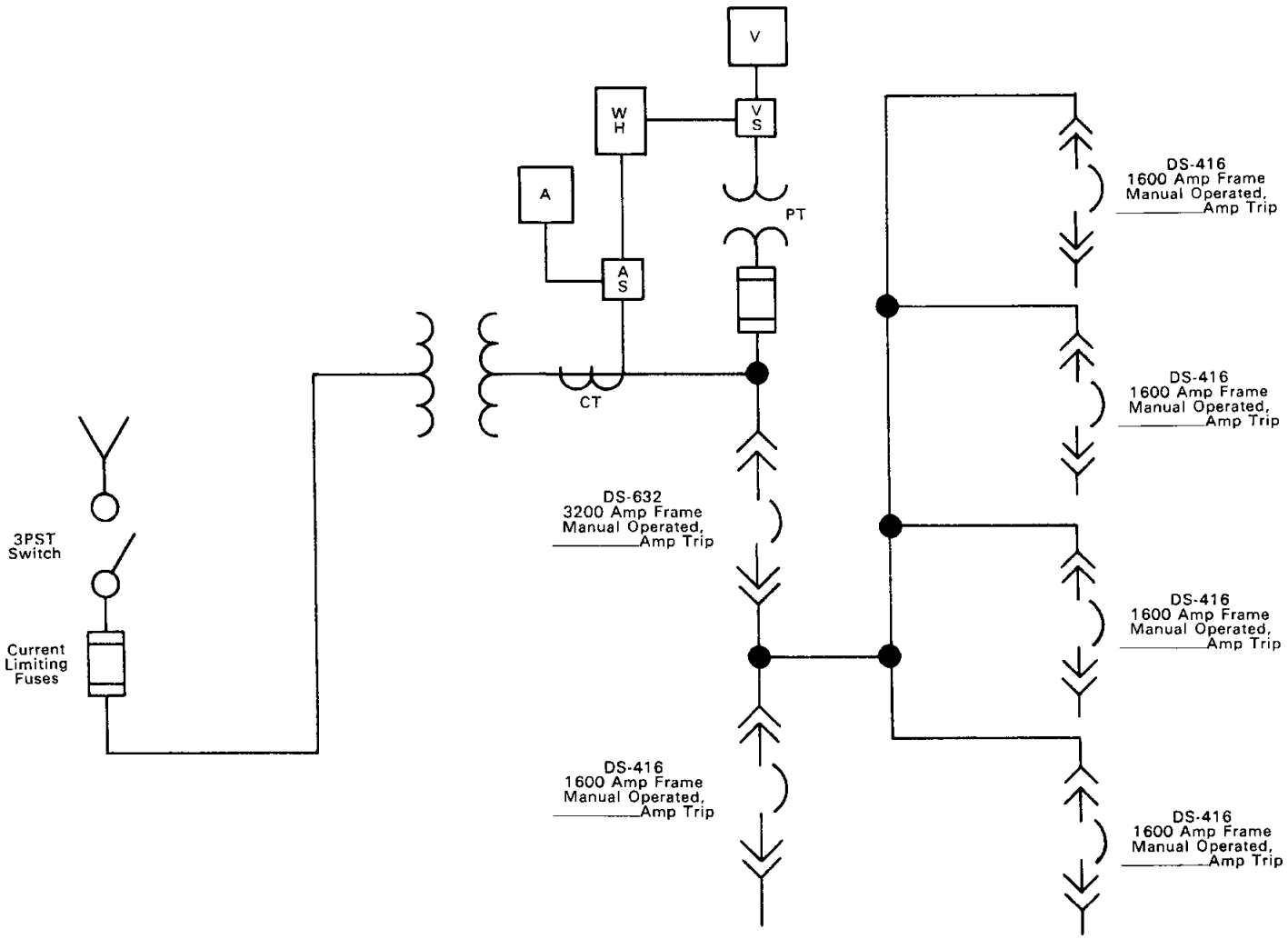
1. (b) Be sure to specify current carrying capacity and arrangement of neutral bus if one is required. Normally 50% capacity will be supplied if full capacity is not specified.
2. (j-k-l) If trip characteristics other than shown are required please be sure to specify them.

Accessories

a-1 Top of assembly mounted circuit breaker lifting device (optional)
b-1 Test plug for watthour meter.
c-1 Levering crank.

Note: Arrangement sketch and single line diagram similar to following samples should accompany the written specification.

Single Line Diagram



Indoor Secondary Unit Substations