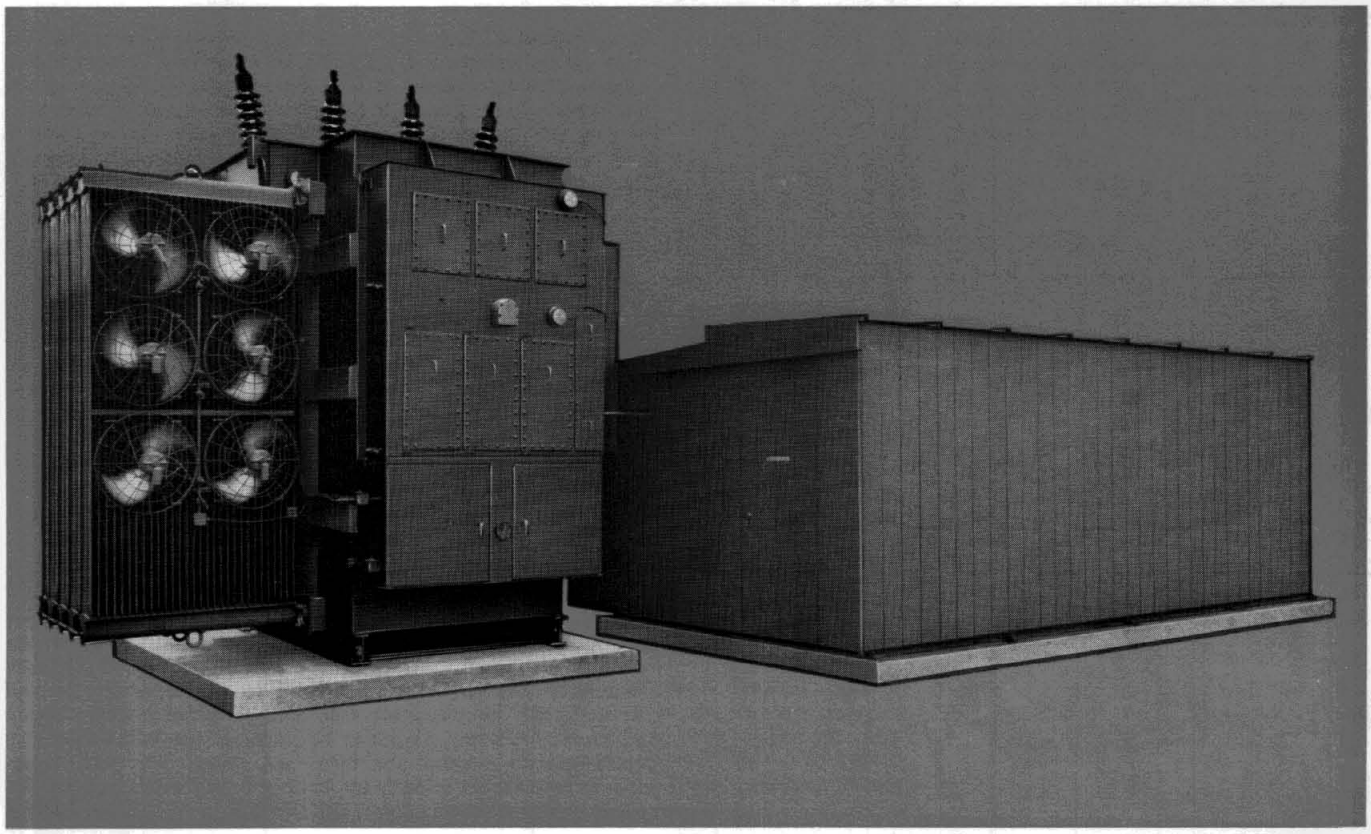
Westinghouse

Primary Unit Substations Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary



Application

Westinghouse primary unit substations with core form transformers and type DH-P Porcel-line metal clad switchgear are designed using the most advanced engineering computer techniques; reliably manufactured with the latest methods, processing and material developments through a continuing research program for trouble free service on any lighting or power distribution circuit.

Porcel-line metal clad switchgear is available in ratings of 4160 and 13,800 volts with maximum interrupting capacities of 250 mva and 750 mva, respectively. Each unit is self-contained with all Westinghouse components. These components include circuit breaker, bus, instrument transformers, relays, instruments, meters, and control devices – all assembled into a compact completely metal enclosed structure.

Westinghouse core form type SL liquid filled transformers are available with ratings of 501 thru 10,000 kva – three phase, 60 cycles – with and without load tap changer, 55°C/65°C or 65°C temperature rise, oil or Inerteen, OA/Fut. FA or OA/FA, 350 kv BIL and below through 67 kv.

Typical Applications: Electric utility systems, industrial plants, municipal pumping stations and transportation systems.

Advantages

Single Responsibility: The order for a complete unit substation is placed with a single manufacturer, minimizing negotiation requirements and centralizing responsibility.

Highest Short Circuit Strength: Research developed, time tested and proved rectangular core and coil design as well as the pre-stressed circular core and coil design.

Highest Thermal Capacity: Insuldur insulation system providing additional capacity, with the same life expectancy, as needed with the increased loading.

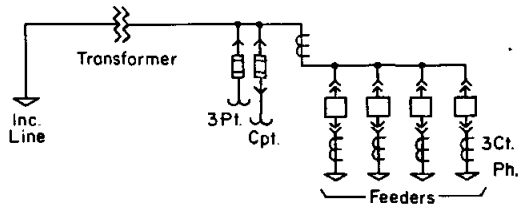
High Strength Porcelain: In the switchgear, porcelain is used to insulate all live parts to ground. The new high strength porcelain is non-tracking, non-combustible, and non-hygroscopic.

DH-P Breakers: Include time-proven Westinghouse features such as horizontal drawout construction, disconnect contact fingers on the breaker, hinged tilting arc chutes, and center coil blowout magnets on the arc chutes.

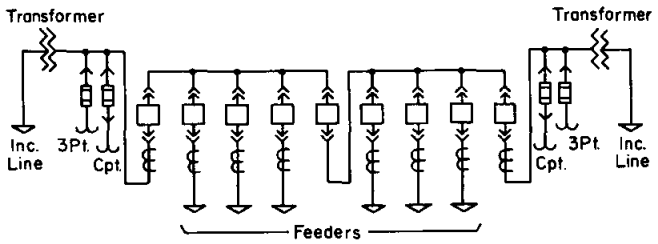
December, 1966
Supersedes DB 34-250, dated September, 1956
E, D, C/1962/DB

Westinghouse

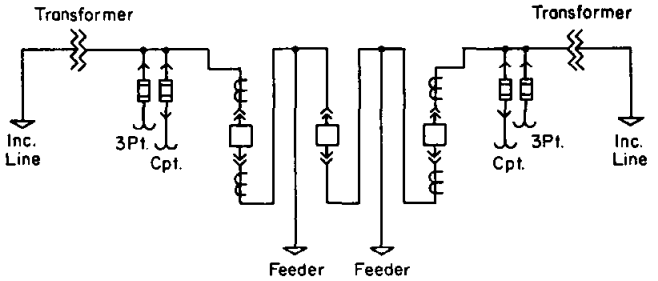
Selector Guide



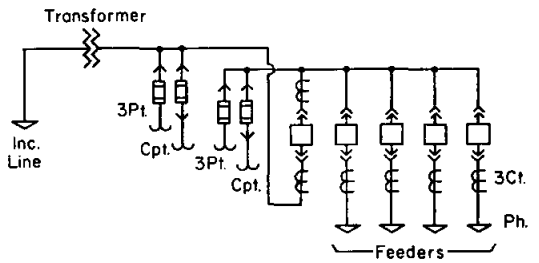
Simple Radial: Consists of the high-voltage supply line, one three-phase transformer, and one or more low-voltage feeder circuits. The high degree of reliability in present-day transformer and switchgear equipment has proved this type of substation entirely satisfactory for many applications even though there is only a single electrical line from the primary supply through to the load.



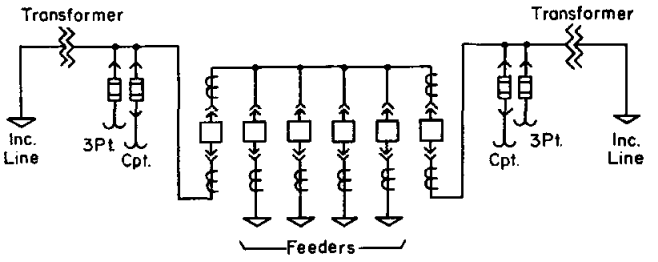
Low-voltage Selective: This arrangement is two simple radial substations double ended, with a normally open tie-breaker in the low-voltage bus. Each side of the low-voltage bus is supplied by an incoming sub-transmission source and a three-phase transformer. In event of failure of the incoming line or of either transformer, undervoltage relays open the affected transformer breaker, close the tie-breaker and maintain substation service. When using this arrangement, the transformer should be selected with ample capacity to carry the total substation load during emergencies.



Duplex: The duplex has two incoming line sources, two three-phase transformers, and the "breaker-and-a-half" arrangement on the low-voltage side. Normal operation consists of each secondary feeder being supplied by its respective transformer and incoming line source. In event of failure of either side, the proper transformer breaker is opened by undervoltage relays, the normally open tie-breaker is automatically closed. The transformers should be selected to carry the load of both feeders without exceeding their ratings.



Primary Network: This system utilizes two or more primary network substations paralleled through the low-voltage sides. This arrangement gives excellent continuity of service to the loads, which are fed from secondary grids and is particularly suitable for high-density, metropolitan loads and for applications where interruption of service cannot be tolerated. Transformer breakers are equipped with network relays which open the breaker on a reverse power flow and disconnect the transformer from the secondary bus, in the event of failure. If failure occurs, there is no interruption of service since the secondary grid is fed by all the substations in the primary network system. Substations should be supplied from two or more primary circuits and arranged so that adjacent substations are never out of service.



Spot Network: For applications where there is a concentrated load area, the spot network system will assure continuity of service. In this arrangement, the low-voltage bus is fed by two transformers operating in parallel. Each transformer breaker is equipped with network relays opening the breaker in the event of failure at the transformer or its high-voltage supply. There is no interruption of service to the secondary bus. Transformers should be selected so that each can carry the total load of the substation temporarily. The feeder circuit breakers should be of sufficient interrupting capacity to open on a fault fed by both transformers.

Primary Unit Substations Multi-feeder Type

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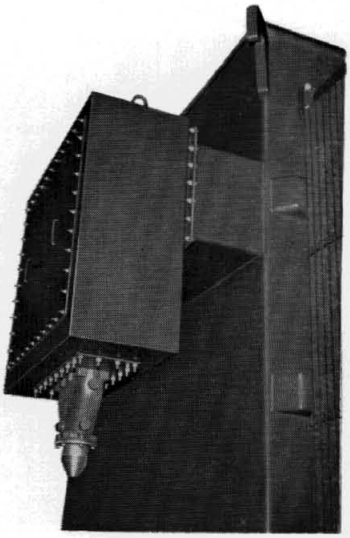
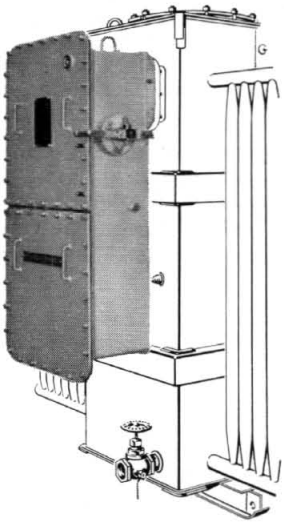
Incoming Line Arrangements

Underground Terminal Chamber



A terminal chamber mounted on the side of the transformer tank encloses horizontal tank wall bushings and provides entrance for incoming cable from underground. For voltages up to 15-kv, the terminal chamber is generally air-filled, with a pothead being included when required. For voltages from 15-kv to 69-kv, oil-filled terminal chambers with potheads are available.

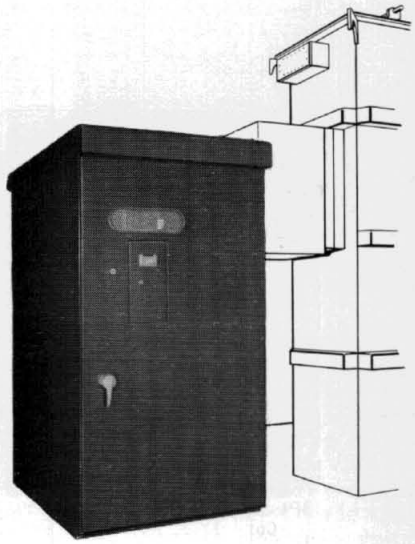
Oil-filled Disconnect Switch



An oil-filled switch complete with terminal chamber provides a means for terminating incoming underground cable and disconnecting transformer without interruption of service on the incoming line.

The oil switch is capable of interrupting the magnetizing current of the transformer, and should be interlocked with the transformer secondary breaker to prevent operation under load. Oil switches are available up to 69-kv.

Primary Air Switch



A load interrupter switch is available for those incoming power circuits rated 15 kv and below. The Westinghouse type LBF interrupter switch has a torsion bar operating mechanism which affords both quick make and quick break on all units as standard. The switch is air insulated, manually gang operated, rated 600 amperes, 3 pole, 95 kv BIL, two position, link type. Westinghouse type CLE or BA fuses can be included on units where interrupting capacities and continuous current ratings are satisfactory. Space is available in the switch case for lightning arresters. The switch has a fault closing ability of 40,000 amperes and a momentary current rating of 61,000 amperes.

A selector switch arrangement is available consisting of a type LBF load interrupter switch in series with a non-load break selector switch. The two switches are interlocked so that the load break switch must be in the open position before the selector switch can be operated.

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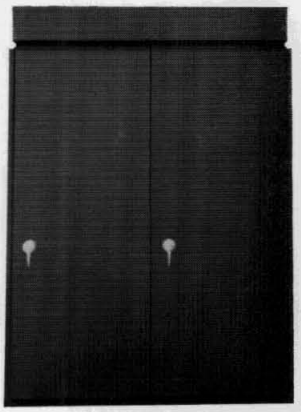
DH-P Air Circuit Breaker



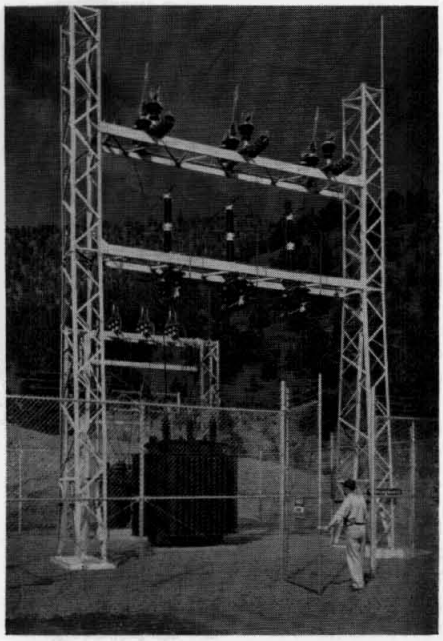
15 Kv Outdoor Metal-clad on primary side of transformer

Westinghouse Porcel-line metal clad switchgear with type DH-P air circuit breakers provides protection to the power transformer and the incoming feeder circuit. Type DH-P breakers are available in ratings of 13,800 volts with maximum interrupting ratings of 500 mva or 750 mva and continuous current ratings of either 1200 or 2000 amperes. The primary switchgear assembly can include lightning arresters, instrument transformers and metering equipment.

Porcel-line switchgear is available in both Shelterfor-M® or Aisle-less construction Shelterfor-M switchgear includes an operating aisle and all equipment is accessible without exposure to the weather. Outdoor Aisle-less switchgear does not include the operating or maintenance aisle.

Overhead

Steel Structure



A steel structure is customarily used for terminating incoming overhead lines and for mounting necessary disconnecting and protective equipment such as air break disconnect switches, lightning arresters and fuses. Westinghouse-designed steel structures are engineered considering all factors of mounting and spacing of equipment, line strain and wind load.

For direct overhead line connection, high-voltage leads are brought out of the transformer through porcelain cover bushings. ASA standard interchangeable bushings are used for ratings of 25-kv through 69-kv.

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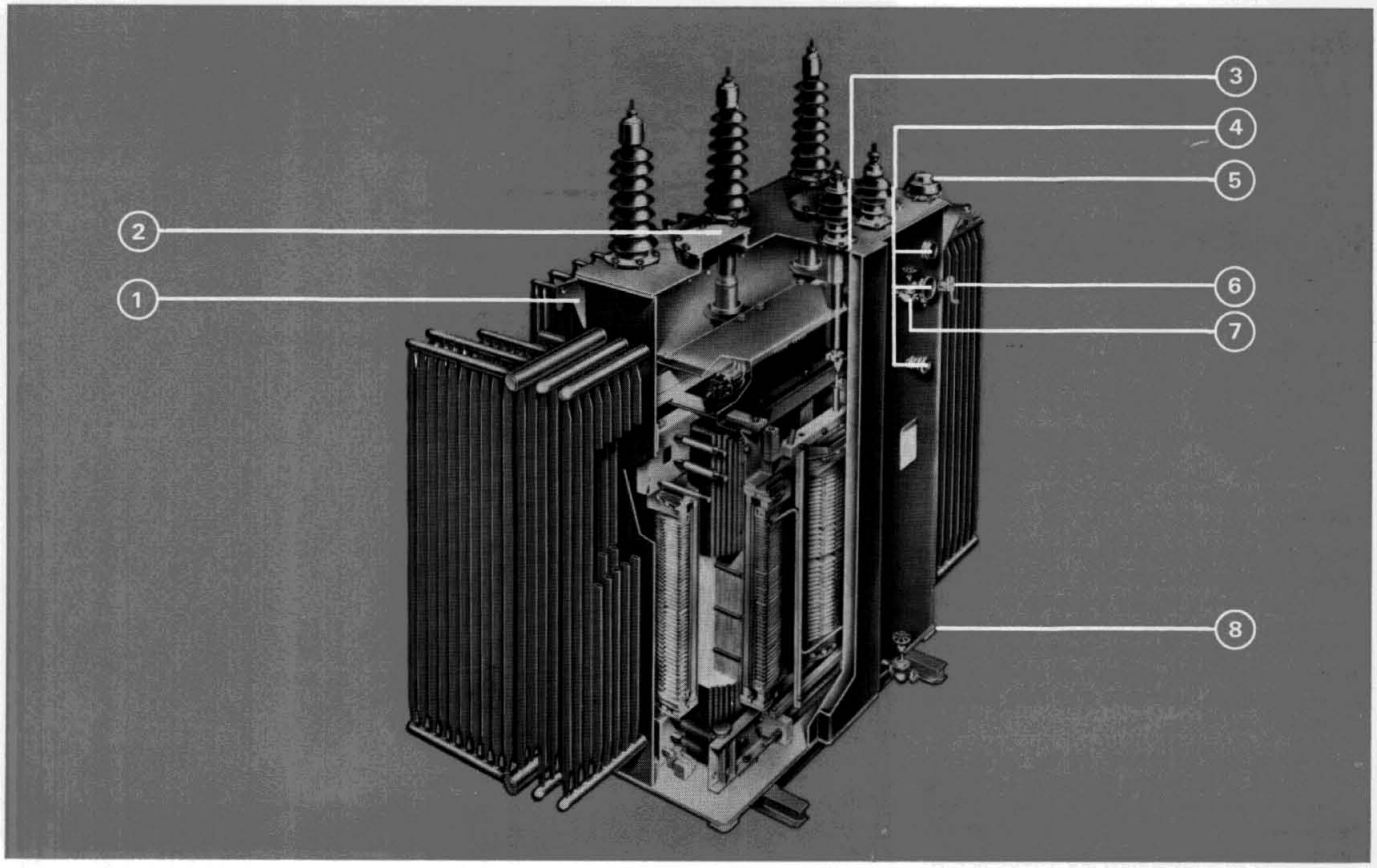
Transformer Design Features



1 Lifting Lug

2 Hand Hole

For interior inspection and maintenance of transformer.

3 Tank

All tanks are made of high-quality sheet steel with a minimum of electrically welded seams. Tanks are rectangular with rounded corners. For added strength to withstand test and operating pressures, vertical steel reinforcing members are welded to the outside walls. Such bracing also protects the tank against distortion which may occur during shipment or installation.

4 Gauges

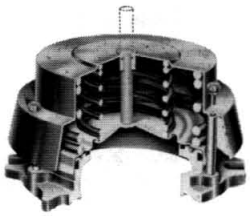
With black faces, brilliant yellow numerals and pointers for easy reading.

Magnetic-Type Oil Level Gauge
Hermetically-sealed, float operated, weatherproof, shockproof. Requires no maintenance. Supplied with alarm contacts, if specified.

Dial-Type Thermometer
Hermetically-sealed. Shows accurate temperature of top liquid. Has resettable red, peak temperature pointer. Supplied with alarm contacts, if specified.

Pressure-Vacuum Gauge
Indicates pressure in gas space.

5 Mechanical Relief Device



Relieves abnormally high internal pressure. Factory calibrated to operate at 10 psi. Easily visible operation pointer. After operation, positively reseals and continues to give protection against the elements.

6 No Load Tap Changer Control Handle

See page 8 for tap changer detail.

7 Upper Valve for Filter Press Connection

8 Jack Pads

Welded pads at bottom corners provide bearing surfaces for jacks.

LV Throat Connection

Unit substations employ a box-type throat for connection of secondary terminals of the transformer to the metal-clad switchgear. The advantages of this type connection include ease of installation with few bolted parts and permits adjustment for minor differences in transformer and switchgear alignment. It also permits replacement of present transformer with a larger unit, if desired.

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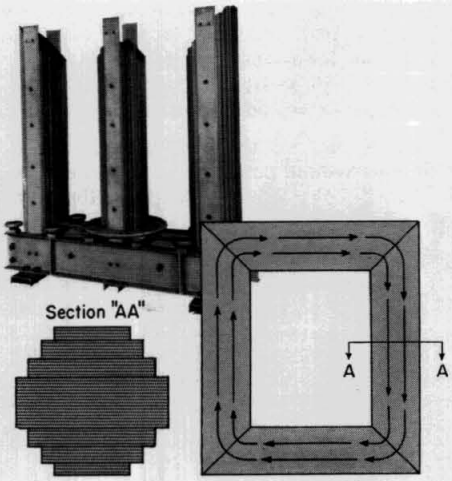
Design Features



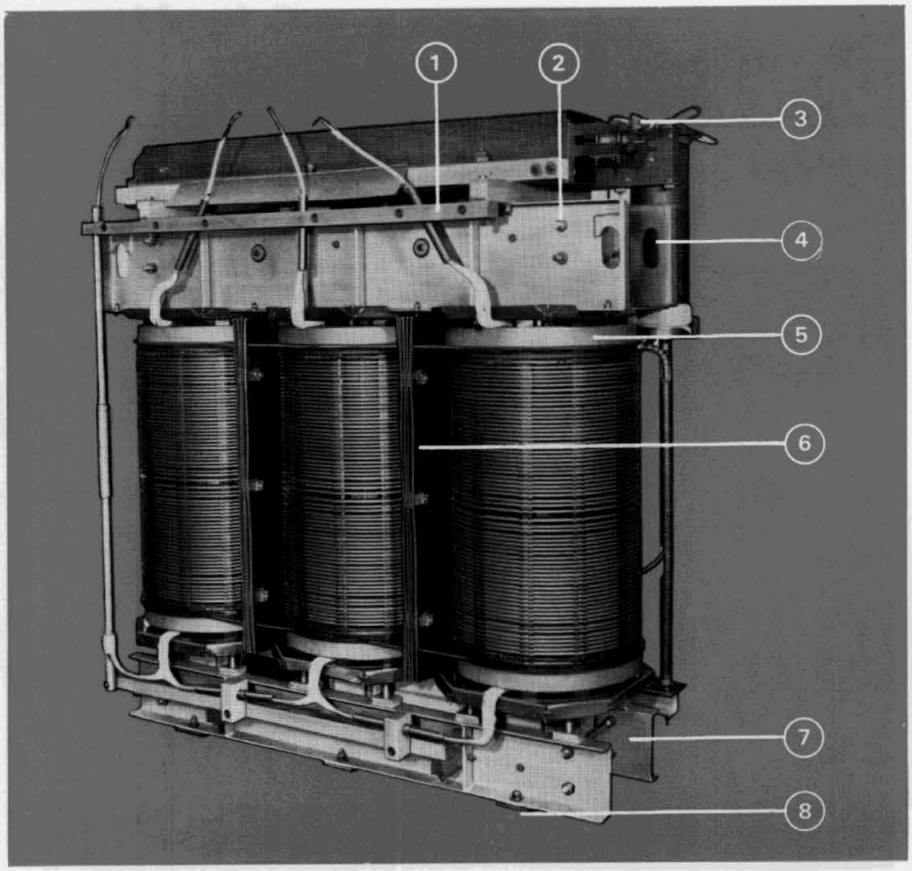
Cores

Hipersil cores of cold-rolled, highly permeable silicon steel laminations carry one-third more flux than ordinary electrical steel per unit area. The grain is oriented for optimum transmittal of flux. Approximate circular section (see A-A) and angled core corners produce optimum magnetic qualities for flux flow.

Flux crowding is minimized by small-diameter bolts, insulated by Micarta® tubes and pressboard washers, which secure the core laminations. These bolts can be small because the core itself is not a part of the coil-bracing system. Core legs are not stressed by clamping.

Non-reacting interlaminar carlite insulation reduces core space nine percent, resulting in more compact cores. This requires less copper in the winding which, in turn, results in lower losses, smaller size and lighter weight, while still maintaining proved performance.

Core and Coil Assembly



Other Mechanical Features

1. L.v. lead assembly
2. End frame bolt
3. No load tap changer
4. Lifting lug
5. Pressure ring insulation
6. Barrier
7. Bottom end frame
8. Foot

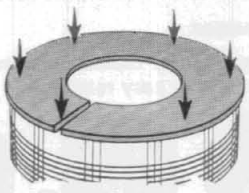
Core and coil assemblies are rigidly braced to withstand the mechanical forces under line fault conditions and to resist vibration and shock forces during shipment.

Lateral Bracing

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

Vertical Bracing

Vertical movement is prevented by three carefully coordinated structural links. The forces originating in the coil are uniformly transmitted through the ring-type pressure plate to the adjustable jack-screws and restrained by the end frames and steel lock plates, the latter being adjacent to the coil and extending its full height.



Ring type pressure plate

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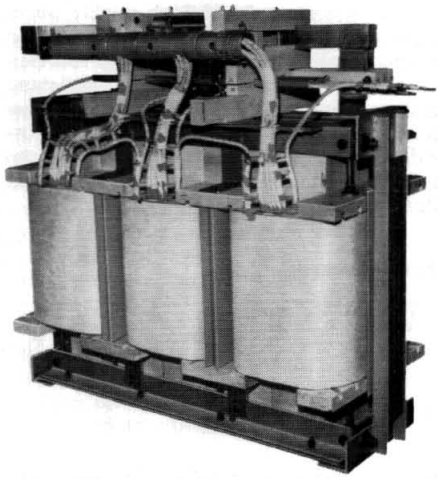
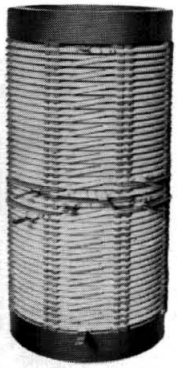
Rectangular Coil Construction



This form of coil construction is used on all three phase transformers rated 501 kva through 2500 kva and with a high voltage through 34.5 kv, 200 kv BIL.

This coil construction consists of a low voltage strip winding, which is the full length of the coil, with pressboard between windings. The high voltage is wound directly over the low for added strength of construction. The resultant layer winding gives a low ground capacitance which improves greatly the surge distribution. The vertical forces are minimized since the electrical centerlines are balanced in this layer winding design. The effect of no load taps (which normally unbalance coil centerlines) is minimized due to their location in these layer wound coils.

This type of construction was developed in 1955 to meet the strenuous short circuit requirements of underground secondary network service and has proven superior with over 5,000 units in service without a single short circuit failure. In network service, repeated short circuits are common operating practices sometimes occuring hundreds of times during the life of an average network transformer. This construction has proven so mechanically strong that it is now also used on rectifier transformers which are also subjected to severe short circuit duty.



Continuous Wound Pancake

Helitran

Cylindrical

Circular Coil Construction

This form of construction is used on three phase units above 2500 kva, 34.5 kv (200 kv BIL). The four (4) basic windings used are form-wound with sliverless conductors insulated with tough, flexible, oil-impregnated Insuldur® paper tape.

The two high voltage windings are the continuous-wound pancake and Hisercap type. The two low voltage windings are the cylindrical and Helitran.

The **continuous-wound pancake** (for voltages to 350 kv BIL), consists of a column or stack of disc sections separated by horizontal oil ducts. The conductor consists of from one to five rectangular straps in parallel, wound continuously over-vertical insulation strips on a pressboard cylinder. Vertical oil ducts separate the conductor from the cylinder.

Helitran windings (coils with only a few turns and currents of 2000 amperes or more) are particularly adapted to withstand the high short circuit stresses encountered in high-current windings.

The **cylindrical-wound coil** (voltages to 95 kv BIL and currents up to 2500 amperes) consists of one or more layers of insulated conductors on a heavy pressboard cylinder with oil impregnated pressboard insulation and vertical cooling ducts between adjacent layers. Additional mechanical strength is provided by winding of three layers of fiberglass tape around the coil.

About 90% of the vertical dimension of cylindrical coils is non-compressible material but to eliminate any possible turn-to-turn slack and to control height of coils accurately, Westinghouse uses a unique system of coil treatment. After these coils are wound; the assembly is securely clamped by means of spring loading and oven dried under spring pressure to insure a tight coil.

These windings are wrapped with epoxy glass tape which becomes a tough jacket after baking. End collars are then accurately sawed to assure a match in height of the adjacent high voltage coil. This construction prevents turn to turn movement under short circuit stress.

Westinghouse

Design Features

Bushings

Two types of bushings are furnished: RJ type for voltages 25 kv and below and the condenser type for higher voltages. Both types are cover mounted and comply with all industry standards pertaining to electrical and mechanical characteristics. Usable threaded stud length of at least 2⅛ inches, twelve threads per inch, for terminal connections is supplied. Stud diameter is 1⅛ inches through 400 amperes; 1½ inches from 401 to 1200 amperes.

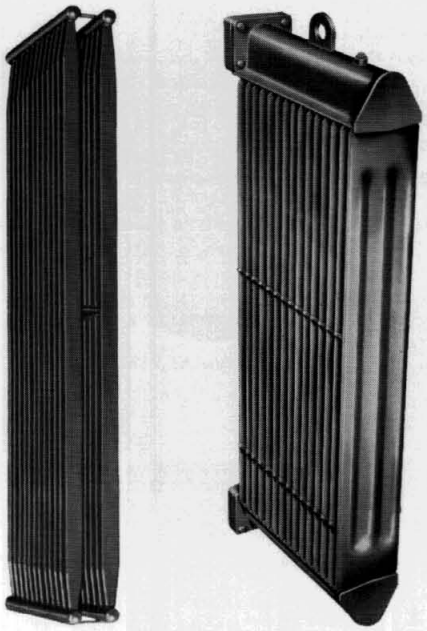
No-Load Tap Changer

Externally operated tap changers make matching of line voltage quick and convenient when the transformer is de-energized. One complete revolution of the readily accessible operating crank is required for each tap changer.

The type WSB tap changer is used where the voltage does not exceed 650 kv BIL and the current is 400 amperes or less. Self-cleaning moving contacts are employed which are wiped clean on each tap changer operation. Two parallel moving contacts provide firm positive pressure, even during faults, because of a magnetic effect during current flow.

The mechanical design employing a geneva gearcam assembly which controls the movement of the tap changer and assures positive positioning at the end of the complete revolution. Provision for padlocking the operating handle is made.

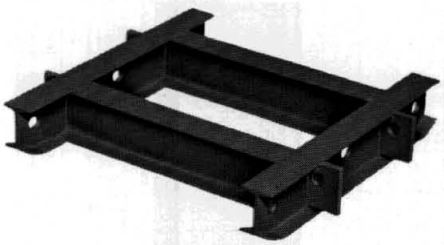
Cooling



Cooling systems for power transformers are designed to fit individual requirements. Self-cooled systems usually consist of external tubes welded into headers that are in turn welded into the tank wall. Large size transformers and those with special shipping clearances are fitted with detachable, all-welded radiators. Top and bottom connections are equipped with valves.

Self-cooled forced air cooled systems employ fans to circulate masses of air. Fans are optional with either tubes or radiator systems.

I-Beam Base

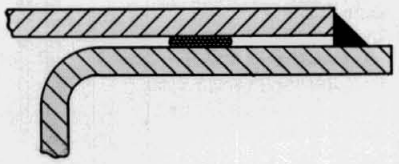


Welded to the base plate of the tank is a rectangular steel I-beam base. The structural members, which strengthen the transformer tank, are designed for ease in skidding or rolling. Holes are provided in the base for pulling, tie-down and ventilation.

Tanks

All tanks are made of high-quality sheet steel with a minimum of electrically welded seams. Tanks are rectangular with rounded corners. For added strength to withstand test and operating pressures, vertical steel reinforcing members are welded to the outside walls. Such bracing also protects the tank against distortion which may occur during shipment or installation.

Tank Cover



The tank walls are flanged outward at the top to form a platform for the cover plate which is welded on.

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Accessories

Standard

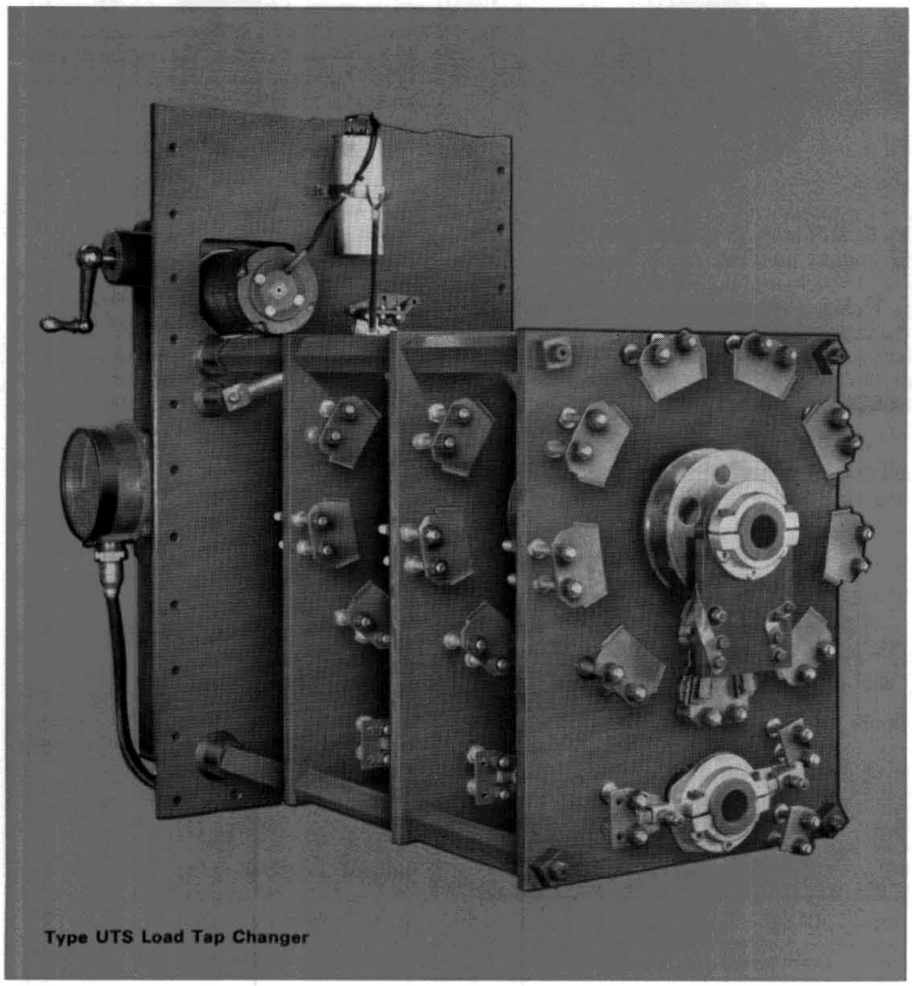
Included with each core-form transformers are:
Cover-mounted bushings without terminal connectors.
Tap changer for de-energized operation.
Liquid-level gauge.
Drain valve, bottom filter press connection and liquid-sampling valve.
Valve for top filter press connection.
Dial-type liquid thermometer.
Lifting hooks on tank.
Lifting eyes on cover.
Provision for jacking.
Sealedaire oil preservation device on oil-immersed transformers.
Vacuum pressure gauge.
Tank pressure-relief device.
Tank grounding provision.
Welded cover on main tank.
Instruction nameplate.

Optional

The following optional accessories can be supplied for use with core-form transformers:

Load Tap Changing

The type UTS load tap changer is rated 15 kv, 400 amperes, which will operate for +10% up to 12,000 kva line capacity. This tap changer is built complete without a case and mounts in a compartment that is integral with the transformer tank giving a structurally stronger unit. Connections between the tap changer and the transformer are made through a cast resin insulating panel utilizing molded connectors. This substantially reduces the possibility of leaks because of a reduction in the number of gaskets.



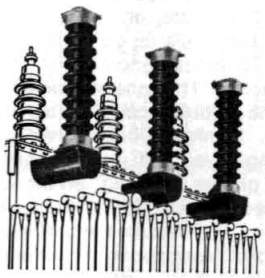
Type UTS Load Tap Changer

The operating mechanism, consisting of the motor, gear train and control cams, is mounted on one end of the tap changer. The tap changer is spring operated to give faster contact parting speed and more reliable service.

The tap changer requires no brake and the cam settings are not critical. A mechanical stop is built into the reversing and selector switches so that it is impossible to go beyond either end position and cause electrical damage.

Fully self-aligning contacts maintain maximum engagement thereby reducing contact heating and improving mechanical wearing of the contacts. The moving and stationary contacts carry a 20 year pro-rated warranty, regardless of the number of operations.

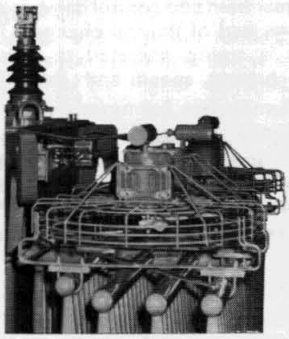
Lightning Arresters



Maximum surge protection is provided by installation of type SV (station type) or LVS (line type) lightning arresters mounted directly on transformer tank brackets.

Westinghouse

Forced-air Cooling



These substation transformers are supplied as standard with provision for future fan cooling. Provision consists of designing the transformer current carrying parts including internal parts for the greater capacity and having space available to receive the required external equipment. When fans are added in the future, an output increase of 15 percent is available on units up to 2500 kva and a 25-percent increase on units 2500 kva and above. The fans are located on the top of the tubular coolers for maximum efficiency. Research has shown that the air moving over the hottest oil coolers provides greater cooling efficiency. This location reduces accidental damage, blows cleaner air, and reduces maintenance, by locating the fans above accumulation of leaves and snow. Automatic control is normally actuated from a top-liquid temperature thermometer.

TRO-1 Relay

The TRO-1 thermal overload relay is available for use on Westinghouse core form transformers as a combination overload protective device and thermal load indicator. It permits loading a transformer to its full thermal capacity under continuous and short-time overload conditions, taking the following factors into consideration:

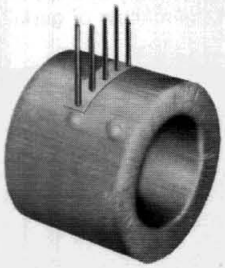
1. Initial load on transformer.
2. Initial ambient temperature.
3. Ambient temperature change during overload.
4. Time constant of transformer in relation to the duration of the overload.
5. The allowable temperature limit of the insulation for the duration of the expected overload.

Normally, to utilize this inherent overload capacity, these factors must be evaluated, hot-spot temperature carefully watched and loading charts consulted.

The use of a Westinghouse TRO-1 relay enables the transformer to be loaded simply by observing the indicated reserve overload capacity on the dial face. The TRO-1 relay automatically performs the overload calculations.

The relay has additional contacts which may be used to control forced air cooling fans and trip a circuit breaker if the safe overload rating of the unit is exceeded.

Bushing-type Current Transformers



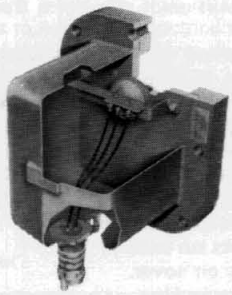
Multi-ratio current transformers are applied for general application involving protective relays and indicating instruments. These can be included in the power transformer case on the bushing flange or provision can be made for future installation by the user. Tap ratios, current ratings and accuracy are according to NEMA standards.

NEMA Standard Ratings for Bushing-Type Current Transformers

	40	50	10	20	600/5		100	300	200	3000/5
	80	100	20	40	1200/5		200	200	400	4000/5
	100	60	160	80	2000/5		200	200	600	5000/5
X5	X4	X3	X2	X1		X4	X3	X2	X1						

Standard Primary Current Amps	BCT Standard Ratios
600	120/100/90/80/60/50/40/30/20/10:1
1200	240/200/180/160/120/100/80/60/40/20:1
2000	400/320/300/240/220/160/100/80/60:1
3000	600/400/300:1
4000	800/600/400:1
5000	1000/800/600:1

Sudden Pressure Relay



Protection against damage due to internal fault can be provided by a sudden pressure relay. This device operates on rate of pressure change; that is, the higher the rate of rise, the faster it operates. It will not operate on pressure changes due to changes in transformer temperature or loading, but it will protect against small arcs which would not cause a relief device to operate. On major troubles causing high rate of rise, it will operate within a half-cycle on a 60-cycle circuit. It is not sensitive to mechanical shock or electrical disturbances which cause no internal damage to the transformer.

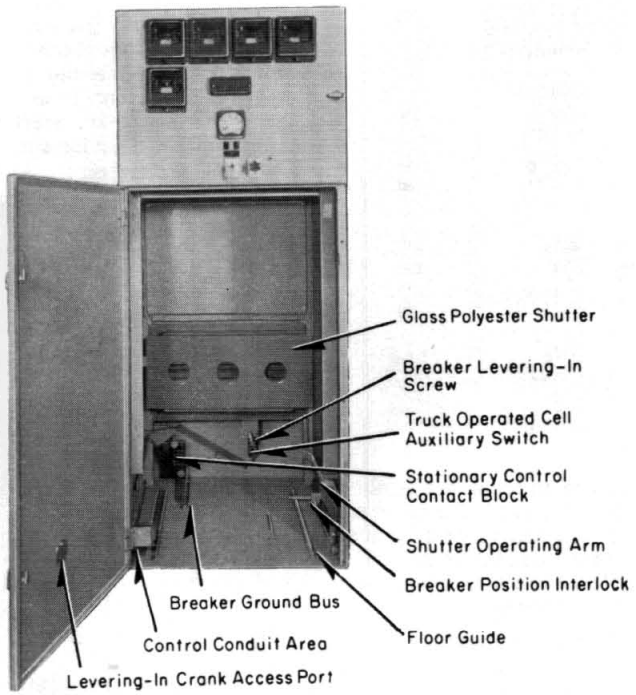
Standard Tests

The following tests are made on all core-form transformers in accordance with American Standard Test Code for Transformers.

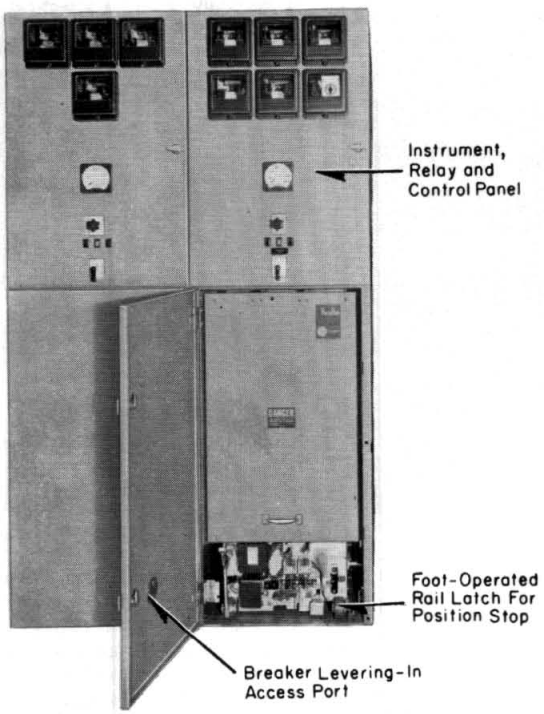
1. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on an order.
2. Ratio tests on the rated voltage connection and on all tap connections.
3. Polarity and phase-relation tests on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on an order.
7. ASA temperature test.
8. Applied potential tests.
9. Induced potential tests.

Primary Unit Substations Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary



13.8 kv DH-P housing with breaker removed.



Typical 4.16 kv DH-P metal-clad housing with one breaker in disconnect position.

Porcel-line™ Metal-Clad Switchgear Design Features

Some of the safety features of DH-P metal-clad:

Complete metal barriers isolate breaker, bus, control, and line compartments.

Steel-front interphase barrier prevents access to live breaker parts. It is bolted to rear of breaker chassis and cannot be removed unless breaker is removed from cell.

Safety interlocks prevent levering when breaker is closed and keep breaker trip free while levering.

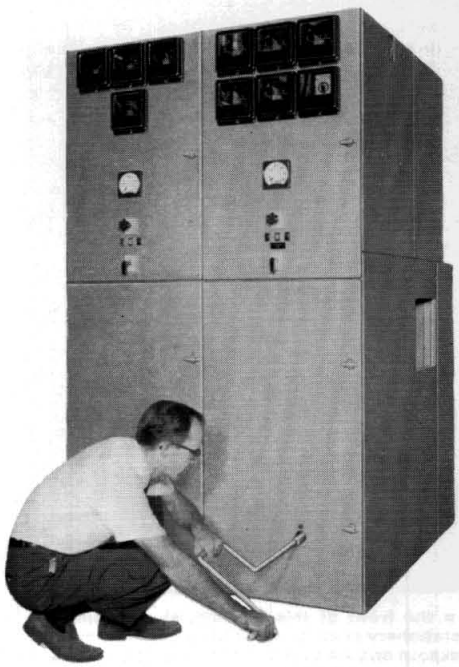
Levering device spins free at end of breaker travel to assure positive engagement of main disconnecting contacts and eliminate danger of over travel.

Glass polyester shutter automatically covers the primary cell contacts when breaker is withdrawn and is at full air clearance from live parts when breaker is withdrawn.

Breaker can be levered in and out with housing door closed, by means of access port in door.

Breaker connected to ground bus in both operating and test position.

Indicator shows position of shutter at all times.



Breaker is levered from connected to disconnected position with front compartment door closed.

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Additional Housing Features

Deep recess of primary contact studs within porcelain contact bottles. These bottles are used at both 4.16 kv and 13.8 kv.

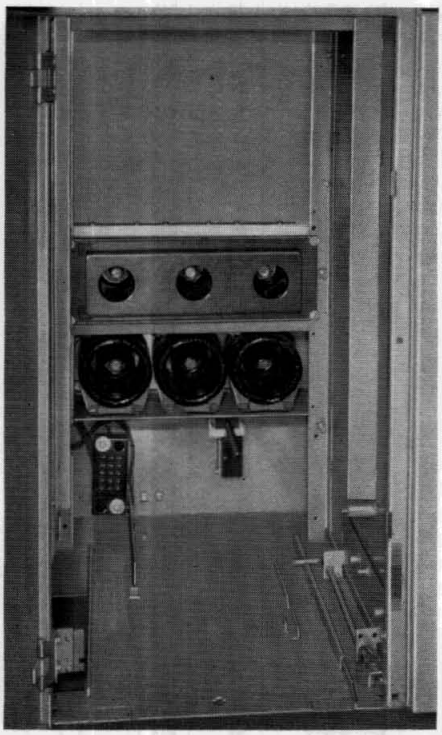
Ring type current transformers are front accessible – up to 6 current transformers can be installed around bottles – 3 on bus side and 3 on line side of breaker.

Bus structure is also front accessible by removing cover just above upper primary contact cover.

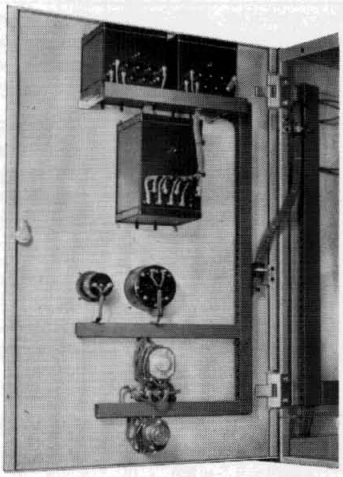
Pin on side of breaker truck must pass through notch in plate at lower left front. This interlock prevents putting wrong continuous or interrupting rating breaker in cell.

Truck operated cell switches just below levering screw indicate physical position of breaker truck (optional).

Breaker position interlock at lower right is shown padlocked in position to prevent levering in a breaker. Key interlock can be used instead of padlock (both features optional).



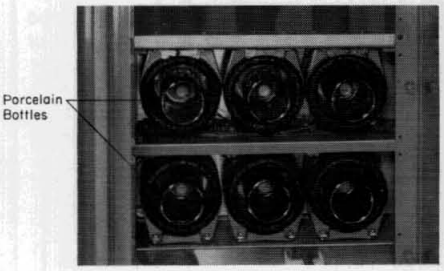
n the front of this housing, shutter and one stationary contact cover have been removed to expose one set of porcelain contact bottles and current transformers.



Wiring – All cell and panel wiring is run in plastic wiring troughs. Leads are taken out of the trough at the approximate location through holes in the side of the trough. This wiring method facilitates field wiring revisions after initial installation.

The panel wire is carried across the hinge in a bundle without the use of terminal blocks, eliminating a source of poor connections. The bundle is arranged so that the wire twists rather than bends, prolonging wire life.

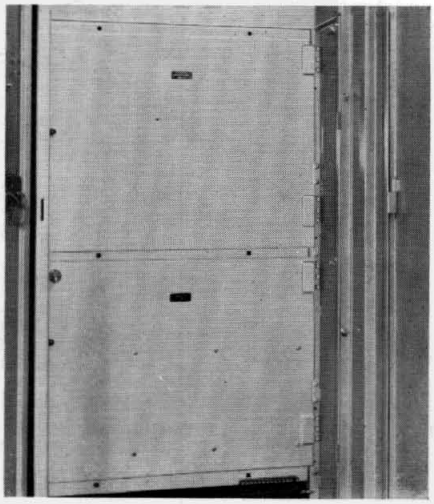
The wire is #14 stranded.

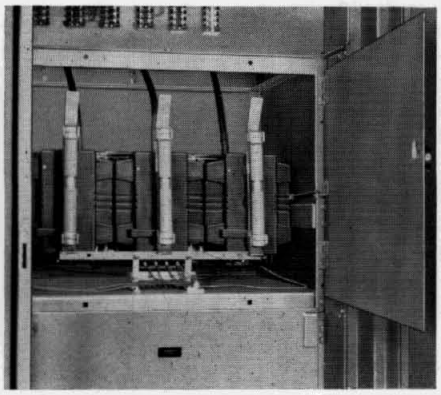


Porcelain bottles enclose the stationary primary contacts in both 4.16 kv and 13.8 kv DH-P housings.

Auxiliary Housings

Auxiliary housings of Porcel-line metal-clad switchgear are arranged for maximum operating flexibility. These housings are available for equipment such as disconnecting potential transformers and fuses, control power transformers, lightning arresters, and motor or generator field equipment.



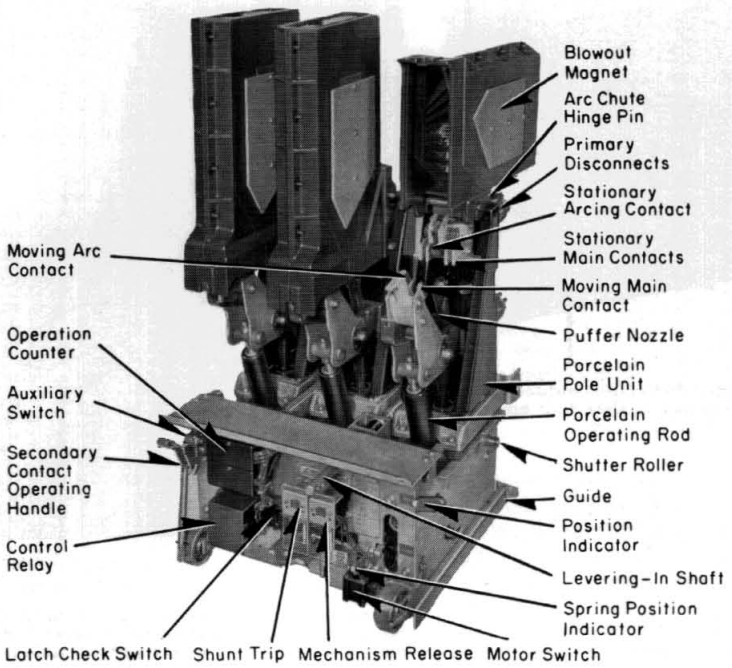


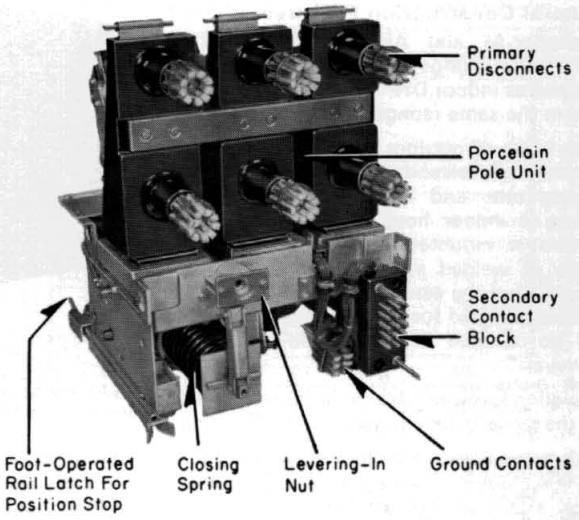
Above illustrations show a typical auxiliary housing arranged for two sets of fused disconnecting potential transformers. With the side hinged doors closed, the potential transformers are in the connected position.

Simply opening either compartment door automatically disconnects the fused potential transformers in that compartment by causing them to rotate to the vertical position for easy and safe replacement of fuses. The primary fuses are grounded at the potential transformer winding end, thus positively grounding the transformer also.

Primary Unit Substations
Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary





▲Rear view of 4.16 kv breaker with barrier assembly and all arc chutes removed.

◀Front view of 4.16 kv breaker with barrier assembly removed and one arc chute tilted back.

Magnetic Air Circuit Breakers Type DH-P

Description

All insulation to ground is high-strength porcelain.

Center coil blowout magnet is at floating potential which decreases voltage stress on arc chute insulation.

Hinged tilting arc chutes provide for ease of maintenance. Tilted chute exposes breaker contacts and inside of chute.

Solenoid or stored energy operating mechanisms are available to meet user requirements.

Contact design reduces impact forces of breaker closing.

Control relays mounted on the breaker permit simplified wiring.

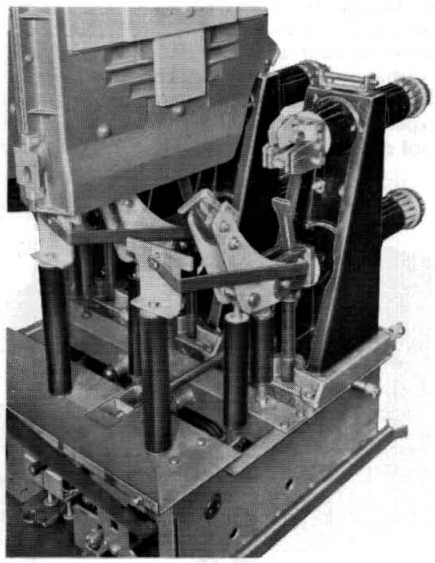
Arc chute enclosure is molded LIMITRAK glass polyester.

Horizontal drawout construction provides easy withdrawal of breaker from housing.

Positive screw type levering-in system provides simple levering of the breaker from disconnected to connected position.

Secondary contacts can be re-engaged without accessories.

Disconnect fingers on removable unit are retained with individual leaf springs to assure positive contact. In addition, mounting on the breaker provides for easy inspection.



13.8 kv DH-P breaker contact assembly: Note similarity to 4.16 kv contacts. Both breakers have wedge-and-finger contact arrangement for low impact and long life. These stationary arcing and main contacts are made of fatigue-resisting cadmium-chromium copper with silver tungsten arcing tips and inserts. Fingers maintain firm contact with wedge-type blades. Tests show no relaxation after twice as many operations as could be expected throughout life of the equipment.

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Outdoor Design Features

General Construction Features

Shelterfor-M and Aisle-less type DH-P Porcel-line outdoor units have the same features as indoor DH-P units and are available in the same ratings.

Both types of outdoor switchgear are constructed by assembling a weatherproof enclosure onto and around the appropriate group of indoor housings. Each shipping section is mounted on an integral base frame of welded steel channels, and pier mounting of the assembly can be employed if desired. A pad for breaker drawout would still be required for the Aisle-less type, however.

Insulation levels and 60 cycle dielectric tests are the same as for equivalent indoor ratings.

Both types have space for two potheads in the line module of the standard unit without a rear extension. The rear of each unit has a bolted cover with lifting handles.

Surface Preparation and Finish

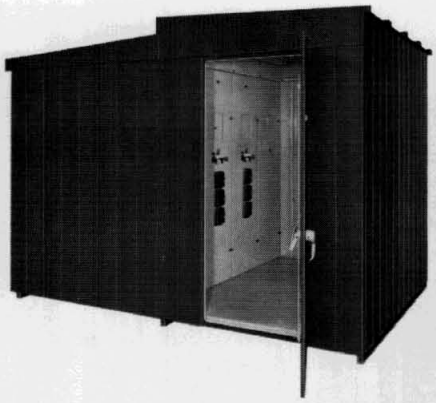
Initial surface preparation and finish of the assemblies, including a coat of light gray paint, is exactly as described for indoor units on page 3. Then a final coat of dark gray enamel, ASA #24, Munsell Notation 10B2.40/1.18, is applied to the exterior surfaces. An undercoating compound is applied to the under side of all bottom surfaces.

Shelterfor-M Design

This type of DH-P Porcel-line outdoor metal-clad switchgear provides an operating or maintenance aisle where equipment is accessible without exposure to the weather. This area is large enough to permit interchanging breakers between cells. Doors are located at each end of the aisle, and are equipped with "crash" latch mechanisms which permit quick release from the inside even when the doors are padlocked from the outside.

Each unit has an upper and lower front hinged panel as described for indoor units on page 11. Where additional panel space is required for relays, instruments, or meters, an eight inch front extension into the aisle is provided to accommodate a full height panel. Aisle lights, switches, and service receptacles are provided.

Ventilating air enters through a screen at the bottom of each line compartment and is expelled through a screen under the rear roof overhang. Air also enters through a screen in the floor of the breaker compartment or in the aisle floor and is expelled through a labyrinth under the peak of the roof.

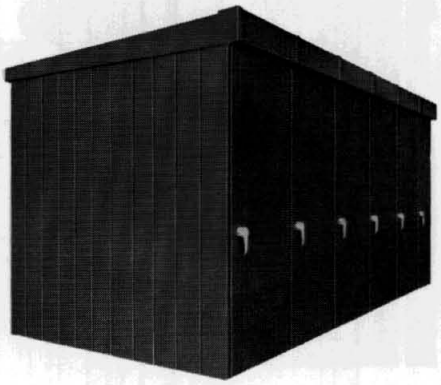


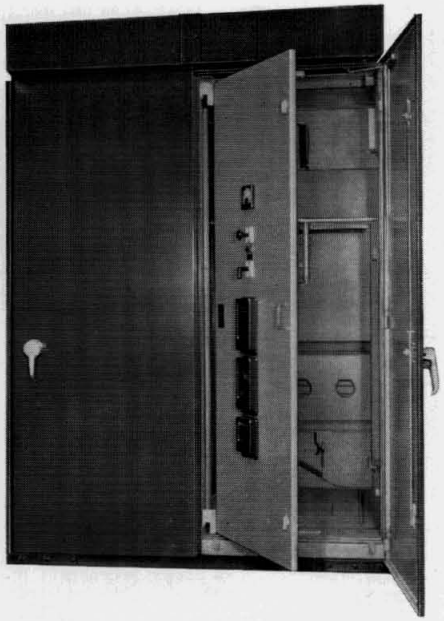
Shelterfor-M DH-P Porcel-line outdoor metal-clad switchgear with one aisle door open.

Aisle-less Design

The Aisle-less type of DH-P Porcel-line outdoor metal-clad switchgear does not include an operating-maintenance sheltered area. A weatherproof door is located on the breaker drawout side (front) of each cell. A full height instrument and relay panel is located behind the outer weatherproof door. A light and service receptacle is provided inside the front of each unit.

Ventilating air enters through a screen at the bottom of the line compartment and is expelled through a screen under the rear roof overhang. Air also enters through a screen in the floor of the breaker compartment and is expelled through a screen under the front roof overhang.



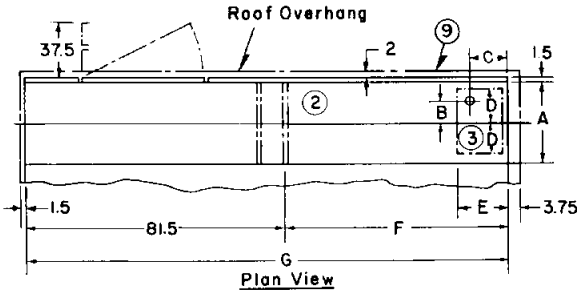


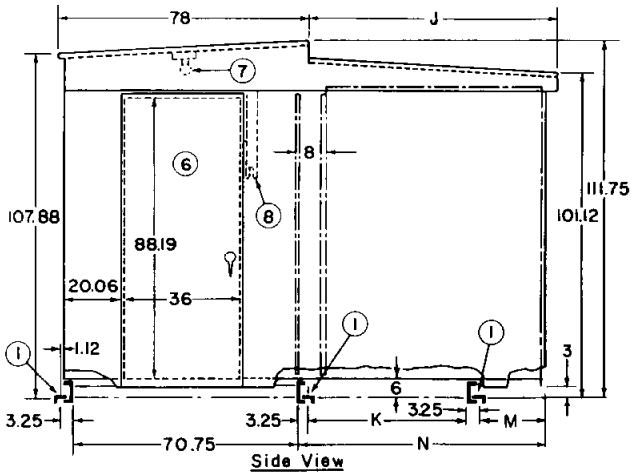
Aisle-less DH-P Porcel-line outdoor metal-clad switchgear with one front weatherproof door open and instrument panel partly open. Breaker is inserted into cell from portable transport truck which attaches to front of cell.

Primary Unit Substations
Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary

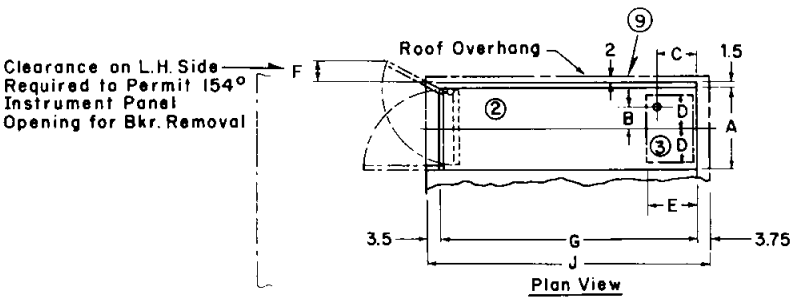
Outline Dimensions
Shelterfor-M (Single Row)

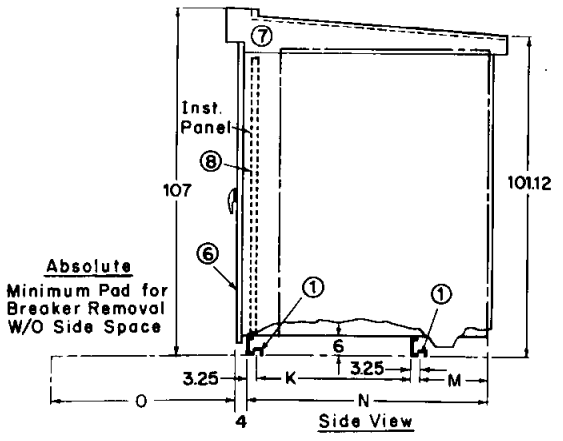




Type of Housing	Amps	Shelterfor-M (Single Row) Dimensions: Inches A	B	C	D	E	F	G	J	K	M	N	Approximate Weight (Lbs.) ④ Housing Only ⑤
5 kv-bkr	1200 2000	26	7.38	14.5	10.5	15.75	70	151.5	78.75	49.12	23	78.62	2150 2350
5 kv-aux	....	26	7.38	14.5	10.5	15.75	70	151.5	78.75	49.12	23	78.62	2750
15 kv-bkr	1200 2000	36	10.62	17.5	15.5	18.88	88	169.5	96.75	64	26.12	96.62	2700 2900
15 kv-aux	....	36	10.62	17.5	15.5	18.88	88	169.5	96.75	64	26.12	96.62	3500

Outline Dimensions
Aisle-less





Type of Housing	Amps	Aisle-less Dimensions: Inches A	B	C	D	E	F	G	J	K	M	N	O	Approximate Weight (Lbs.) ④ Housing Only ⑤
5 kv-bkr	1200 2000	26	7.38	14.5	10.5	15.75	16.5	82.62	89.88	49.12	23	78.62	59	1950 2150
5 kv-aux	....	26	7.38	14.5	10.5	15.75	16.5	82.62	89.88	49.12	23	78.62	59	2550
15 kv-bkr	1200 2000	36	10.62	17.5	15.5	18.88	23.5	100.62	107.88	64	26.12	96.62	80	2400 2600
15 kv-aux	....	36	10.62	17.5	15.5	18.88	23.5	100.62	107.88	64	26.12	96.62	80	3200

① Tie down clips for foundation bolts.
② Space for secondary conduits.
③ Space for primary conduits and ground connection.
④ See page 17 for type DH-P circuit breaker weights.
⑤ Includes one indoor housing plus weather-proofing.
⑥ Weatherproof door on each housing.
⑦ Light in each unit.
⑧ Receptacle on each instrument panel.
⑨ Add 4" to switchgear assembly width for each throat connection required.

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Application Data Transformer Ratings

Available Voltage

High-Voltage (Delta) BIL-Kv	6900 95	7200 95	12,000 95	13,200 95	13,800 95	22,900 150	26,400 200	34,400 200	43,800 250	67,000 350
High-Voltage No Load Taps	7245 7070	7560 7380	12,600 12,300	13,860 13,530	14,400 14,100	24,100 23,500	27,800 27,100	36,200 35,300	46,200 45,000	70,600 68,800
	6730 6555	7020 6840	11,700 11,400	12,870 12,540	13,500 13,200	22,300 21,700	25,700 25,000	33,500 32,600	42,600 41,400	65,200 63,400
Low Voltage	2400 Δ 2520 Δ	2400 Δ 2520 Δ	2400 Δ 2520 Δ	2400 Δ 2520 Δ	2400 Δ 2520 Δ	2400 Δ, 4800 Δ, 7560 Δ, 12,600 Δ, 13,090 Y 2520 Δ, 5040 Δ, 8320 Y, 13,200 Δ, 13,200 Y				
	4160 Y 4360 Y	4160 Y 4360 Y	4160 Y 4360 Y	4160 Y 4360 Y	4160 Y 4360 Y	4160 Y, 6900 Δ, 8720 Y, 14,400 Δ, 13,800 Y 4360 Y, 7200 Δ, 12,000 Δ, 12,470 Y				

Full-load Current Ratings, Amperes – three phase

Voltage	Kva, Self-cooled/Forced-air Cooled							
	1000/1150	1500/1725	2000/2300	2500/3125	3750/4687	5000/6250	7500/9375	10,000/12,500
2400	240/276	360/415	480/552	601/751	902/1126	1202/1502	1800/2250	.....
2520	230/264	344/396	460/528	572/715	857/1040	1140/1430	1720/2150	.....
4160	139/160	208/240	278/320	346/432	520/650	693/865	1040/1300	.....
4360	132/152	199/229	264/304	331/415	495/620	662/830	990/1240	.....
4800	120/138	180/207	.....	300/375	450/563	600/750	900/1126	1201/1502
6900	84/96	125/144	.....	209/212	313/372	418/522	627/785	837/1043
7200	80/92	120/138	.....	200/250	300/375	400/500	600/750	802/1002
8320	70/80	104/120	.....	174/217	260/326	347/434	521/652	695/868
12,000	48/55	72/83	.....	120/150	181/226	241/301	362/452	482/602
12,470	46/53	70/80	.....	116/140	173/216	231/288	347/434	463/577
13,200	44/51	66/76	.....	109/136	164/205	218/272	328/410	437/545
13,800	42/48	63/73	.....	104/130	157/196	209/261	313/390	419/523
14,000	40/46	60/69	.....	100/125	151/188	201/251	301/376	402/502

Short-circuit Mva Ratings

Primary Voltage Class (Kv)	Short-circuit Mva at Transformer Low-voltage Terminals According to Max. Mva Available from Primary System																							
	1000 Kva			1500 Kva			2000 Kva			2500 Kva			3750 Kva			5000 Kva			7500 Kva			10,000 Kva		
	250	500	Inf.	250	500	Inf.	250	500	Inf.	250	500	Inf.	500	1000	Inf.	500	1000	Inf.	500	1000	Inf.	500	1000	Inf.
Without Load Tap Changer																								
25	16.9	17.5	18.2	24.6	25.9	27.3	21.8	34.0	36.4	38.5	41.7	45.5	60.0	64.0	68.2	77.0	83.5	91.0	117.0	120.0	136.0	133.0	154.0	182.0
34.5	15.6	16.1	16.7	22.8	23.8	25.0	29.4	31.5	33.4	35.7	38.5	41.7	55.5	58.8	62.5	71.5	77.0	83.5	110.0	111.0	136.0	125.0	143.0	167.0
46	14.5	14.9	15.4	21.1	22.1	23.0	27.4	29.0	30.8	33.4	35.7	38.5	51.8	54.5	57.7	66.7	71.5	77.0	94.0	104.0	115.0	118.0	133.0	154.0
69	13.5	13.9	14.3	19.7	20.6	21.4	25.7	27.0	28.6	31.3	33.4	35.7	48.5	51.0	53.5	62.5	66.7	71.5	88.2	97.0	107.0	111.0	125.0	143.0
With Load Tap Changer																								
25	15.6	16.1	16.7	22.8	23.8	25.0	29.4	31.5	33.4	35.7	38.5	41.7	55.5	58.8	62.5	71.5	77.0	83.5	100.0	111.0	125.0	125.0	143.0	16.70
34.5	14.5	14.9	15.4	21.1	21.1	23.0	27.4	29.0	30.8	33.4	35.7	38.5	51.8	54.5	57.7	66.7	71.5	77.0	94.0	104.0	115.0	118.0	133.0	15.40
46	13.5	13.9	14.3	19.7	20.6	21.4	25.7	27.0	28.6	31.3	33.4	35.7	48.5	51.0	53.5	62.5	66.7	71.5	88.2	97.0	107.0	111.0	125.0	143.0
69	12.7	13.0	13.3	18.5	19.3	20.0	24.1	25.4	26.7	29.4	31.3	33.4	45.5	47.5	50.0	58.7	62.5	66.7	83.3	91.0	100.0	105.0	111.0	133.0

To obtain total short circuit duty on low-voltage feeder breakers add rotating machine contribution and contributions from other sources to values tabulated above. (Not necessary for duplex-type unit substations.)

Primary Unit Substations Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary

Transformer Ratings Continued

Transformer Impedance			Sound Level			
High-Voltage Rating	Percent Impedance		Self-Cooled		Forced-air Cooled	
	With LTC	Without LTC	Kva Rating	Decibels	Kva Rating	Decibels
6900 – 22,900	6.0	5.5	1000 □ 1500 2000 ■	58 60 61	1150 □ 1725 2300 ■	67 67 67
26,400 – 34,400	6.5	6.0	2500 3750	62 64	3125 4687	67 67
43,800	7.0	6.5	5000 7500 10,000+	65 67 68	6250 9375 12,500+	67 69 70
67,000	7.5	7.0				

+ Applies only to units with lv ratings of 4800 volts and above.
□ Applies only to units with hv of 34.5 kv or less
■ Applies only to units with lv of 4360 volts and below.

Air Circuit Breaker Ratings

Type DH-P, 60 Cycles

Type	3-Phase Interrupting Rating in Mva	Voltage Ratings in Kilovolts			Current Ratings in Amperes			Interrupting Rating in Amperes		Approximate Weight in Pounds	
		Rated	Max.	Min. for Rated Mva	Continuous at 60 Cycles	Momentary	Four Second	At Rated Voltage	Max.	Dead Only	Impact Only
50DHP75	75 ①	4.16	4.76	3.5	1200	20000	12500	10400	12500	567	283
50DHP250	250 ①	4.16	4.76	3.85	1200	60000	37500	35000	37500	737	363
50DHP250	250 ①	4.16	4.76	3.85	2000	60000	37500	35000	37500	754	376
150DHP500	500 ②③	13.8	15.0	11.5	1200	40000	25000	21000	25000	1400	700
150DHP500	500 ②③	13.8	15.0	11.5	2000	40000	25000	21000	25000	1420	710
150DHP500	500 ③④	13.8	15.0	11.5	1200	60000	25000	21000	25000	1400	700
150DHP500	500 ③④	13.8	15.0	11.5	2000	60000	25000	21000	25000	1420	710
150DHP750	750 ②③	13.8	15.0	11.5	1200	60000	37500	31000	37500	1580	790
150DHP750	750 ②③	13.8	15.0	11.5	2000	60000	37500	31000	37500	1600	800

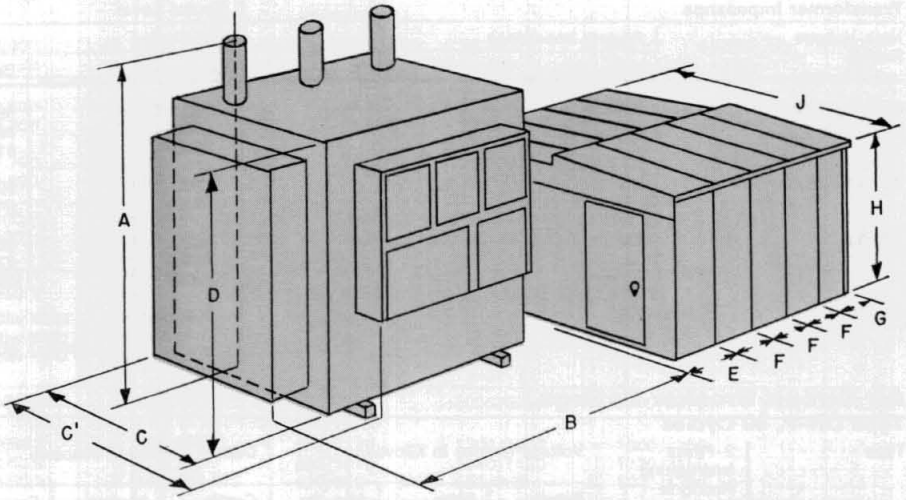
① 2400 volt applications.
50DHP75 will interrupt 50 mva.
50DHP250 will interrupt 150 mva

② 4800 volt applications.
150DHP500 will interrupt 208 mva.
150DHP750 will interrupt 310 mva.

③ 7200 volt applications.
150DHP500 will interrupt 312 mva.
150DHP750 will interrupt 465 mva.

Westinghouse

Dimensions in Inches



Switchgear Compartments

Kv	All Units		Auxiliary Unit		
	Height H	Depth J①	Width E	Width F	Weight Lbs.
5 Kv	112	156.75	31.5	26	2750
15 Kv	112	174.75	41.5	36	3500

Circuit Breaker Unit

Kv	Type	Rating	Width F	Width G	Weight Lbs.
5 Kv	50-DHP-75	1200	26	27.5	567
	50-DHP-250	1200	26	27.5	737
	50-DHP-250	2000	26	27.5	754
15 Kv	150-DHP-500	1200			1420
	150-DHP-750	or 2000	36	37.5	1600

① Depth of Aisle-less switchgear is 89.88 for 5 kv, and 107.88 for 15 kv

Further Information

Application: AD 32-262

Description: DB 32-252
DB 48-150

Prices: PL 32-220
PL 48-120

Primary Unit Substations Multi-feeder Type

501 to 10,000 Kva
6,900 to 67,000 Volts Primary
2,400 to 13,800 Volts Secondary

Transformers: Including Hv Cover, Bushings and Lv Throat

Kva Rating	With Load Tap Changer					Without Load Tap Changer				
	A	B	C	D	Weight Lbs.	A	B	C	D	Weight Lbs.
Hv 6900, 7200, 12,000, 13,200, 13,800 Volts										
1000	120	110	90	90	20,500	97	86	82	83	10,800
1500	121	115	98	100	23,700	107	92	91	93	14,300
2000	125	125	100	110	26,000	114	95	94	100	17,300
2500	133	135	102	120	29,600	131	102	104	117	21,500
3750	145	138	115	130	38,500	146	130	95	132	28,600
5000	153	142	119	134	43,700	153	140	108	139	34,500
7500	164	146	120	150	55,500	159	115	123	145	44,000
Hv 22,900 Volts										
1000	120	110	100	100	23,000	108	89	81	86	12,200
1500	122	120	100	105	25,100	118	94	91	96	15,700
2000	125	130	102	115	28,000	125	97	94	103	18,700
2500	132	140	103	123	32,000	141	104	105	119	22,900
3750	147	142	118	132	42,500	155	132	96	133	30,000
5000	150	145	134	138	48,000	161	142	108	139	35,700
7500	162	152	125	150	61,300	169	117	124	147	45,800
10000	169	158	145	152	73,300	175	125	130	155	52,000
Hv 26,400, 34,400 Volts										
1000	145	115	100	105	25,000	116	93	80	90	14,000
1500	149	123	102	110	27,000	127	98	91	101	17,400
2000	152	135	104	120	30,000	134	100	95	108	20,500
2500	154	146	105	128	33,300	148	107	106	122	24,600
3750	162	147	120	135	45,400	160	135	96	134	32,500
5000	166	150	136	140	52,500	165	144	109	139	37,300
7500	182	160	135	151	65,300	176	120	124	150	48,300
10000	186	165	150	154	77,300	180	130	130	155	56,000
Hv 43,800 Volts										
1500	156	127	105	116	30,800	135	101	90	105	19,500
2000	158	140	107	125	33,600	142	104	96	112	22,400
2500	160	150	108	132	36,400	155	110	107	125	26,500
3750	165	152	125	137	48,600	166	139	97	136	34,000
5000	170	153	138	142	56,300	169	147	110	139	39,100
7500	191	167	150	153	69,500	183	123	125	153	51,000
10000	193	172	160	156	85,600	190	130	130	160	59,000
Hv 67,000 Volts										
1500	160	132	110	123	35,300	135	109	90	116	23,800
2000	163	145	113	130	39,000	160	111	97	123	26,800
2500	166	158	115	135	42,500	168	116	109	131	30,900
3750	178	166	130	142	54,300	176	146	99	139	38,600
5000	180	160	140	145	60,000	176	153	111	139	43,000
7500	196	175	155	155	72,500	196	129	127	159	56,900
10000	198	178	165	158	95,000	200	135	135	163	67,000

A – Height over cover bushings
B – Length
C – Depth
D – Height over cover