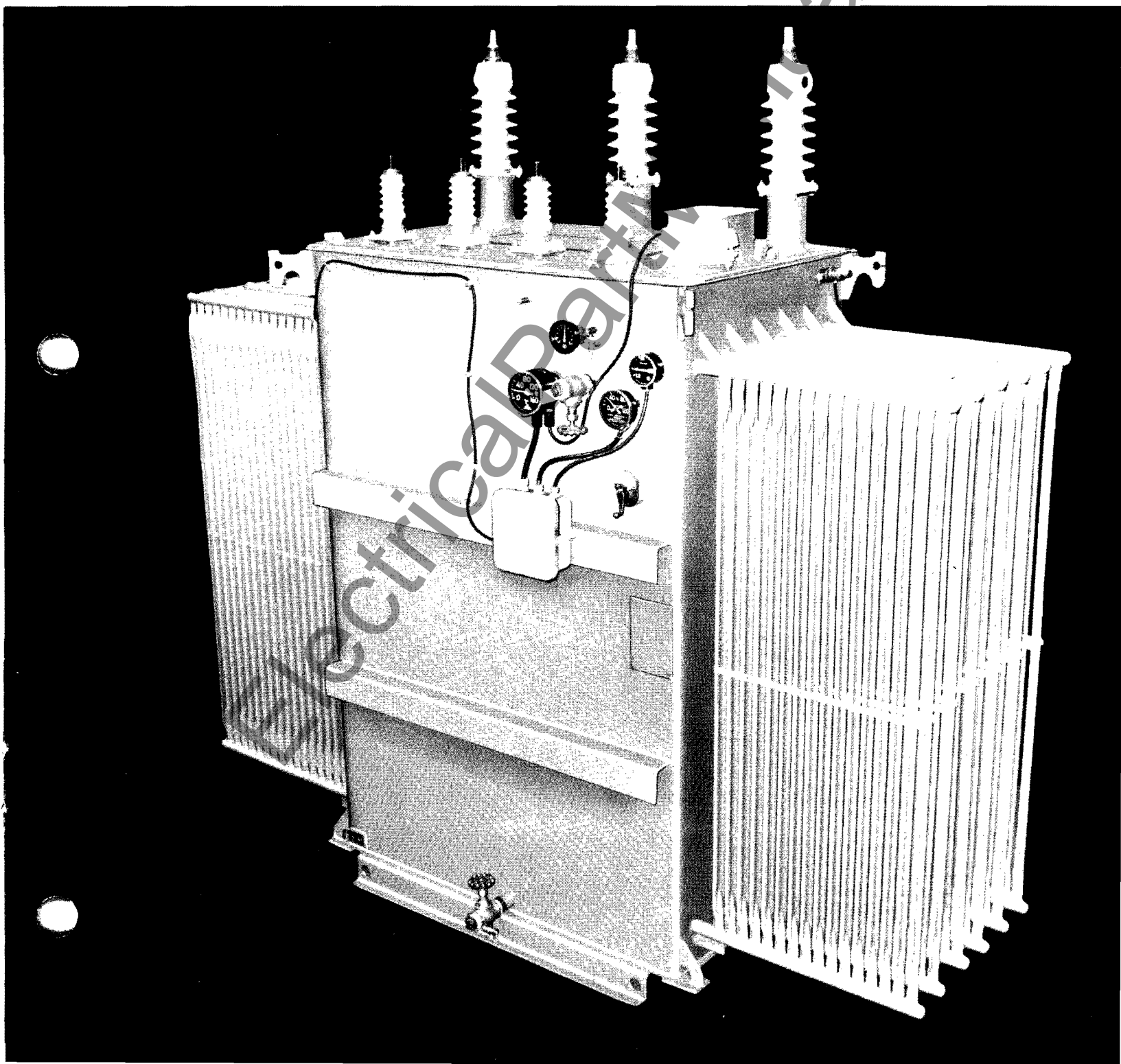
Westinghouse Electric Corporation
Small Power Transformer Division
South Boston, Virginia 24592

January, 1976
Supersedes DB 48-150, Pages 1-8
dated May, 1969
E, D, C/2099/DB

750-5000 KVA OA 3 Phase
833-3333 KVA OA 1 Phase
45-350 KV BIL
2.4-69 KV

Type RSL Liquid Immersed Substation Transformers



Application
South Boston type RSL rectangular core and coil construction transformers are the most reliable and relatively economical substation transformers available to serve the variety of power and lighting needs found in today's diversified utility, industrial and commercial markets. Not only are they designed to meet the latest applicable ANSI, NEMA and IEEE standards and test codes but their less than 1.0% field failure rate and their approximately 99% efficiency provide a standard for the industry. The design and construction of each unit undergo the rigors necessary to assure such continued performance.

Described herein are some of the standards and visible components incorporated into these Westinghouse substation transformers – each scientifically designed and tested and carefully constructed for each project order.

Type RSL transformers are designed in accordance with ANSI standard C57.12.10-1969 to meet the need for an economical and reliable line of quality substation transformers to serve diverse power loads.

Advantages

Specification
Adherence to ANSI standard guidelines results in proven designs with complete accessory equipment and necessary features. Specifications may thereby be more simple and concise while the net cost is reduced up to 40%.

Design and Construction
The use of advanced engineering techniques and optimized design computer programs result in more well proportioned and compact designs. A continuing plant modernization program applies the latest in automated equipment and modern manufacturing processes to assure peak performance plus uniform quality and highest reliability.

Short Circuit Strength
Core and coil designs have been thoroughly tested and developed through research using ANSI C57.12(10.1.1) and C57.12.90a criteria. The result is a family of designs capable of withstanding the 200,000-1,000,000 lb. short circuit forces thrust upon the transformer component in the modern power system.

Thermal Capacity
The improved Insuldur® and liquid insulation system is the result of an extensive program of research and development. This system allows the highly favored and widely specified Westinghouse 55°C/65°C capability to operate continuously at 100%/112%.

Handling and Maintenance
Compact designs reduce the cost of rigging and hauling and require smaller installation space. The clean design and simplified accessories reduce maintenance costs approximately 10% while liquid filled shipping reduces installation costs by hundreds of dollars.

Standard Characteristics Features and Tests

Standard features

1. Tap changer for de-energized operation with operating handle usually connected through side of tank. Height convenient to transformer design. Provision for padlocking.

2. Magnetic liquid level gauge (LLG)①

3. Dial type thermometer (DTT)①

4. Valve to serve as **drain valve, bottom filter press connection and liquid sampling valve.**③

5. Valve for **top filter press connection.**②

6. Lifting hooks on tank, lifting eyes on cover and provision for jacking.

7. Base of transformer has members forming a rectangle. Permits rolling in the direction of center lines of the ANSI segments. Points of support of members so located that the safe angle of tilt of base will be 15 degrees from the horizontal.
Arrangements for pulling the transformer parallel to centerlines of segments provided in base.

8. Tank grounding provision consists of two copperfaced steel pads, each 2 inches by 3½ inches, with two holes horizontally spaced on 1¾ inch centers and drilled and tapped for ½ inch, 13 NC thread. Minimum thickness of copper facing will be 0.015 inch. Minimum threaded depth of holes will be ½ inch.
Ground pads will be welded on tank wall near the base.
Purchaser to supply ground connectors.

9. Sealedaire® oil preservation is standard on all ratings.

10. Pressure-vacuum gauge (PVG)②

11. Main tank cover will be welded on.

12. Handhole on cover.

13. Cover-mounted mechanical **pressure relief device** (PRD).①②

14. Instruction nameplate.

15. Tank finish.

A. Outdoor units. Standard tank finish is AN Standard sky grey No. 70. AN Standard dark grey No. 24 can be supplied without price addition but must be specified at time order is placed.

B. Indoor units. Standard tank finish for indoor units is AN Standard light grey No. 61 (Munsell 8.3G6.10/0.54).

16. Radiator valves when detachable radiators supplied.

17. When auxiliary cooling equipment is furnished with transformer, auxiliary wiring is terminated at **terminal board** in control cabinet with drill plate provided for conduit entrance.

18. Automatic control for auxiliary cooling equipment from contacts on the liquid temperature indicator (DTT).

19. Cover-mounted bushings including neutral bushing for three-phase transformers standard for both high-voltage and low-voltage winding. Sidewall bushings supplied where possible, necessary, or specified.

①Alarm contacts will be furnished without charge, when specified with the order.
②Standard only above 2499 KVA and/or above 200 Kv BIL.
③Drain and sampling fittings for Inerteen filled units are separate.

Standard Tests
The following tests will be made on all transformers except as specifically stated below. The numbers shown do not necessarily indicate the sequence in which the tests will be made. All tests will be made in accordance with the latest revision of ANSI Standard Test Code C57.12.90.

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.

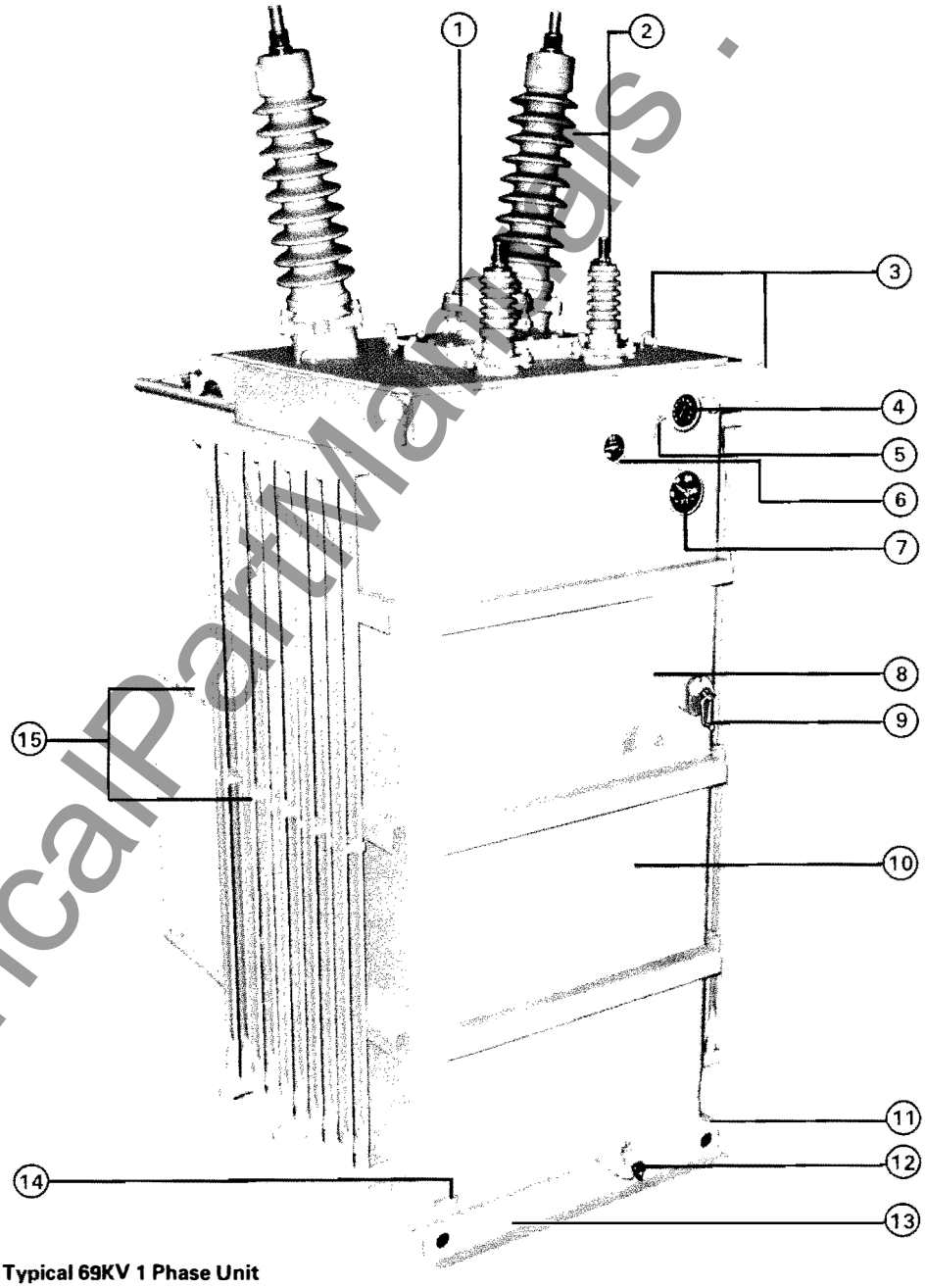
6. **Impedance and load loss** at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on an order.

7. **Temperature test:**
a. Temperature test or tests will be made on one unit only 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 on a duplicate or essentially duplicate unit.

b. Subject to the limitations of the preceding paragraph (a), when a transformer is supplied with auxiliary cooling equipment to provide more than one kva rating, temperature tests will be made only on the following:
55°C OA rating
65°C FA rating

8. **Applied potential tests.**

9. **Induced potential tests.**



Typical 69KV 1 Phase Unit

① **Pressure Relief Device**

② **Bushings**

③ **Cover Lifting Eye and Tank Lifting Lugs**

④ **Pressure Vacuum Gage**

⑤ **Sealedaire**

⑥ **Liquid Level Gage**

⑦ **Dial Type Thermometer**

⑧ **Nameplate**

⑨ **De-energized Tap Changer Handle**

⑩ **Tank**

⑪ **Jack Pad**

⑫ **Drain Valve**

⑬ **Base**

⑭ **Grounding Pad**

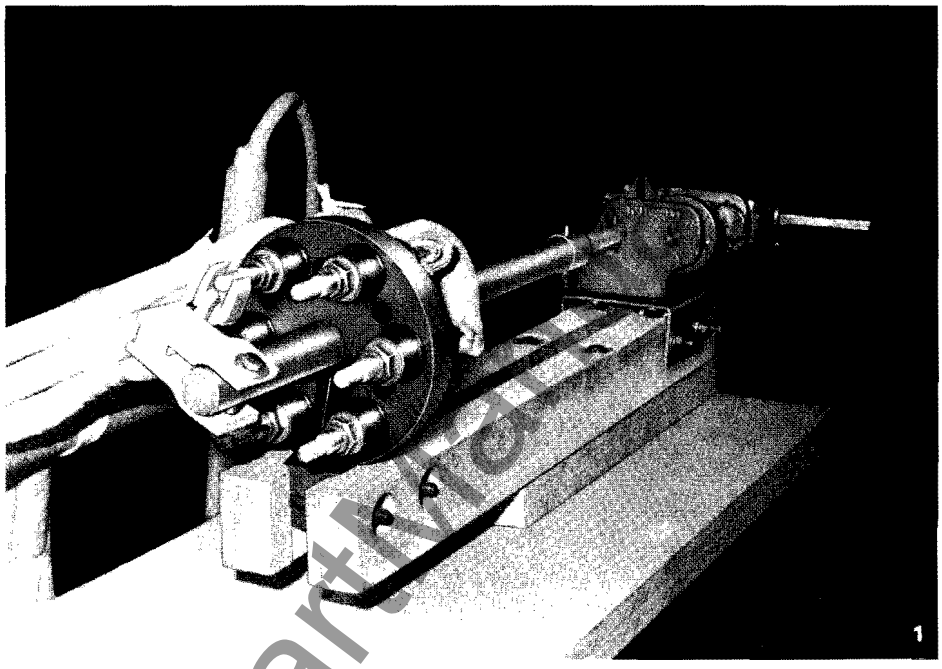
⑮ **Coolers**

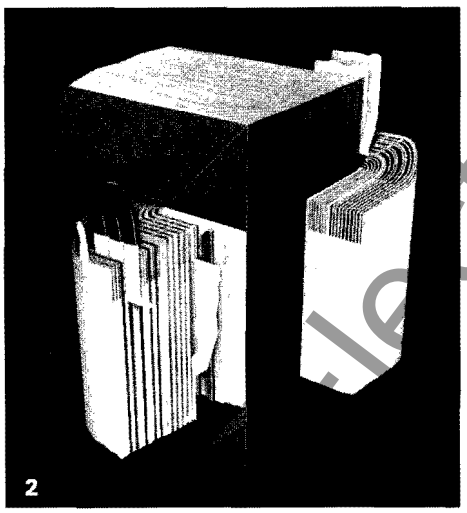
De-energized Tap Changers
Both types available incorporate a molded design that eliminates bolts, rivets and possible misalignment of the stationary contacts.

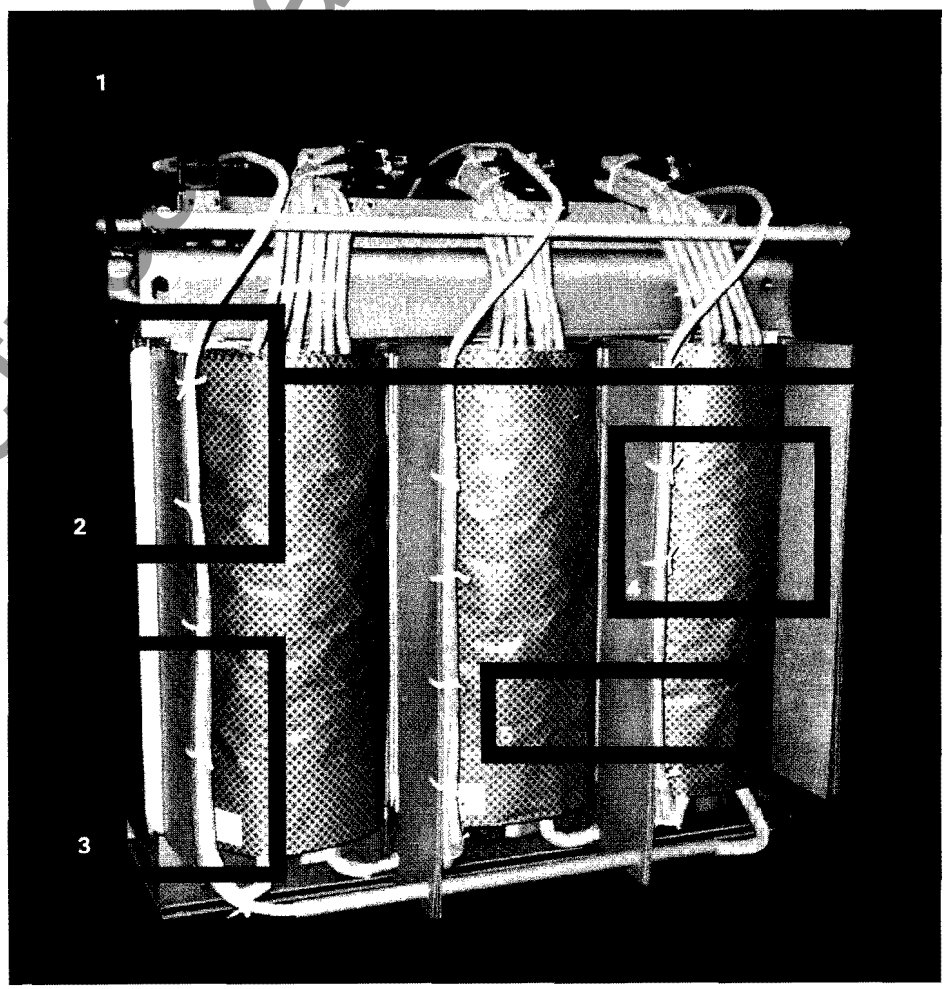
Type WSB
The type WSB tap changer is used for voltages over 34.5 KV, currents over 250 amperes, or for special tap arrangements. Self-cleaning moving contacts are wiped on each tap changer operation. Two parallel moving contacts assure firm positive pressure through the use of mechanical and magnetic forces. The result is positive, trouble free operation which eliminates approximately 20% of costly transformer downtime reportedly due to tap changer failures.

The mechanism employs a Geneva gear-cam assembly which controls the movement of the tap changer and assures positive positioning at the finish of each complete revolution. A padlocking provision is furnished on each handle assembly to allow for increased system safety and reliability. Tap changer positions are clearly marked to complement the positive positioning mechanism. Uncertainty is eliminated for the authorized operator.

Type WSS
This excellent unit is also utilized in substation transformers for standard tap arrangements in applications up to 34.5 KV and 150 amperes. See DB 47-156 for further details.

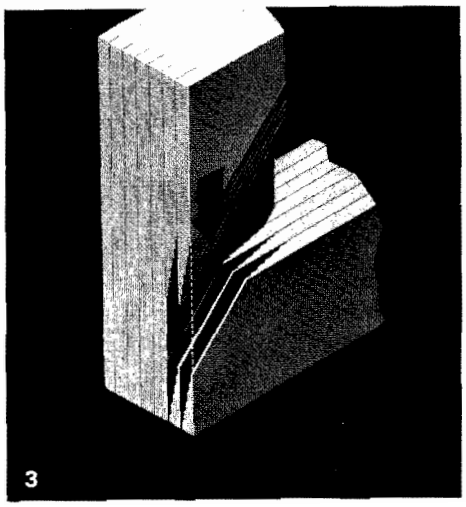






Rectangular Wound Aluminum Coils
The Westinghouse rectangular wound coil features aluminum conductor in both high and low voltage windings. These windings are produced with the control of constant tension machines. Where feasible, the low voltage conductor is a full height sheet assembly providing a 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. The high voltage aluminum strap is wound directly over the low voltage winding. Layer and high-low insulation is diamond epoxy insuldur paper which helps bond the complete coil into a solid configuration when thermo set. The results of the winding procedures are compact and uniform coils which are tightly compressed and bonded. Therefore, the chance of winding shifts under short circuit are further lessened. Failure rate and repair and/or replacement costs are all minimized.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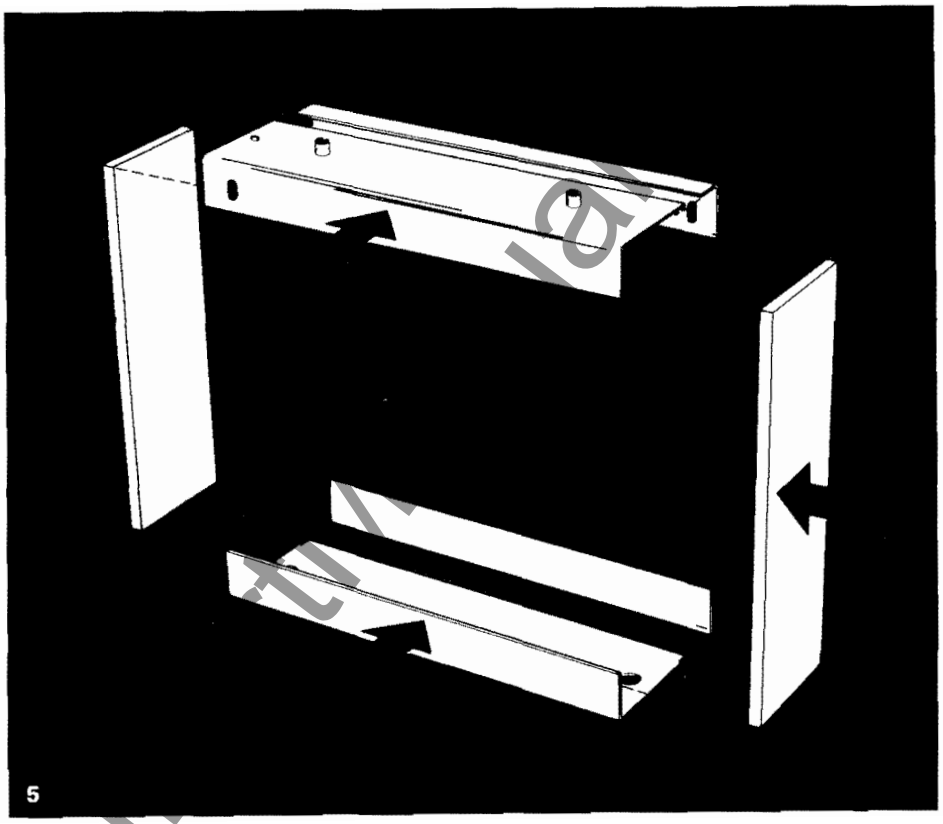
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Step-Lap Core
The Westinghouse exclusive stacked core provides a superior flux path by utilizing the patented step-lap joining of core legs to top and bottom yokes. Hand stacked Hypersil steel punchings with interlocking laminations can be more uniformly and rigidly braced to prevent shifting during service.

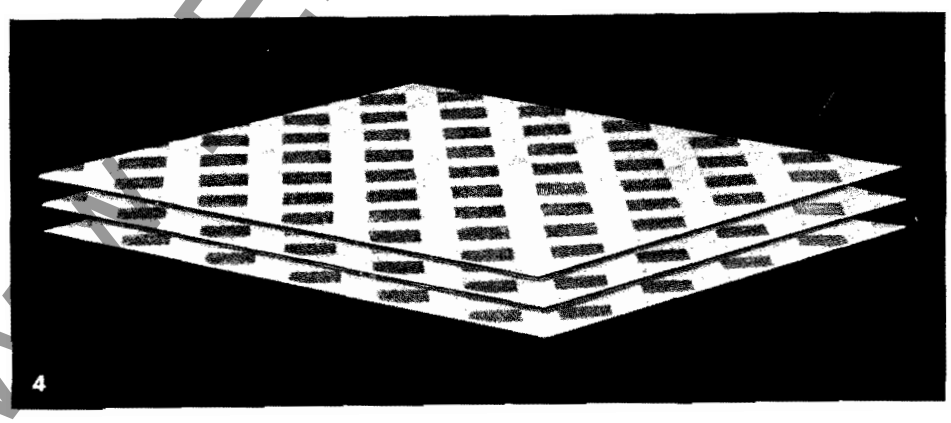
The effective core support method and the efficient step-lap joint have resulted in decreases in exciting current up to 40%, reductions in sound levels up to 3 db and reductions in iron loss up to 10%. Operating costs have been reduced by hundreds of dollars.

Super Insuldur® Insulation
The Westinghouse Super Insuldur insulation effectively upgrades cellulose insulating materials thermally for increased load and overload capability. The result is a coil that better withstands short circuits and allows a 55°C rated unit to operate continuously at 112% capacity without exceeding 65°C.

The chemical stablizers in the Insuldur process retard insulation breakdown under severe temperature conditions and minimize dimensional changes in the insulating materials. This insures a tighter structure and contributes to greater coil strength and integrity throughout the life of the transformer.

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 assembled around the core and coils, in a mechanical pressure fixture and welded to top and bottom plates to form a rigid structure. To determine the members used and the weld design, a computer design calculation is made for each unit including the forces of short circuit and the proper end plate modulus.

This assembly more effectively restrains the vertical and horizontal components of force thereby decreasing the probability of failure during severe short circuits. The customer realizes savings that sometimes amount to thousands of dollars due to a reduction in repair, replacement and downtime costs.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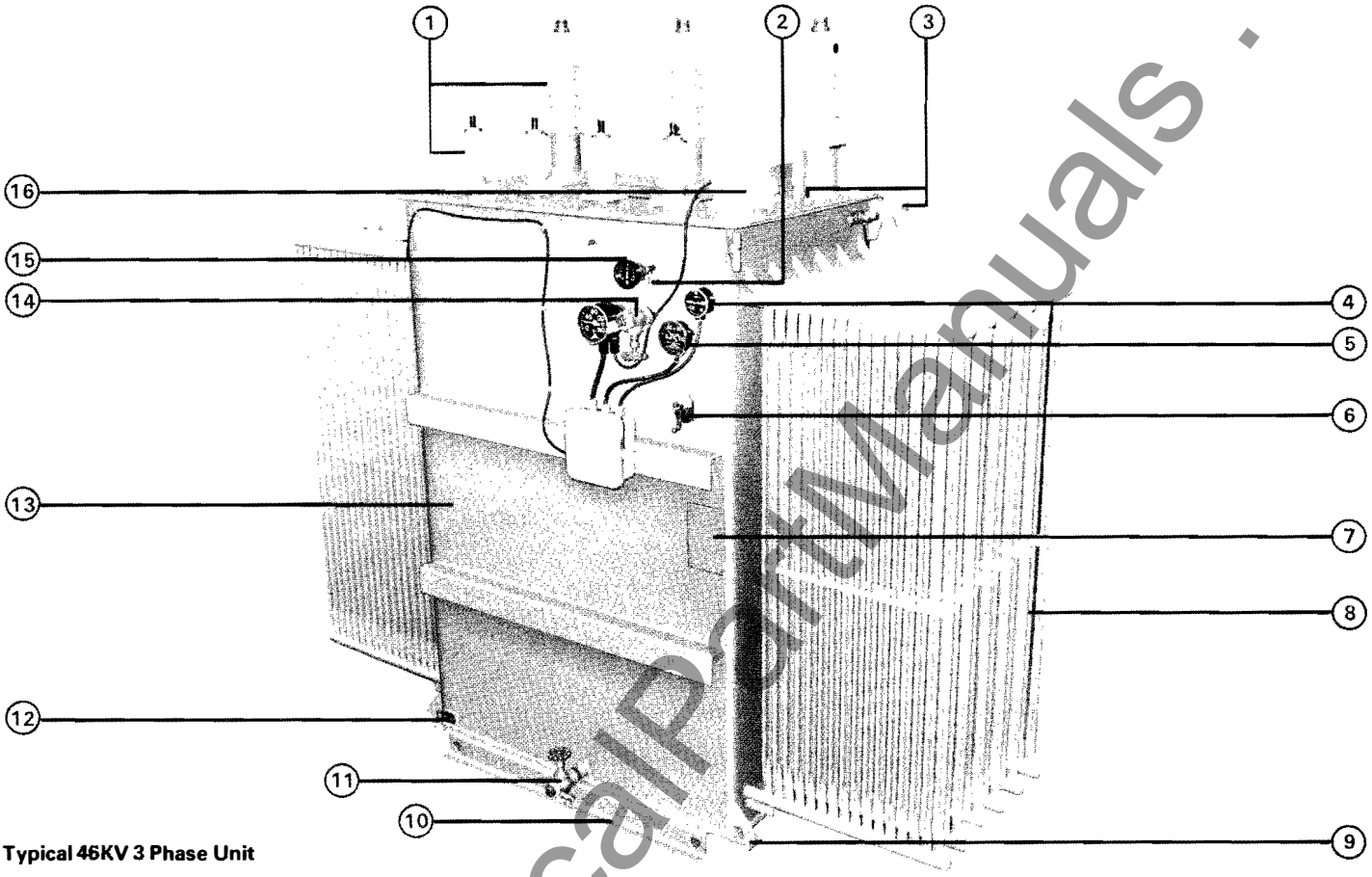


Typical 46KV 3 Phase Unit

① **Bushings** Standard: cover mounted, ANSI 70 Grey, type RJ solid up to 23 KV, type OS condenser 23 KV-46 KV, type O condenser 69 KV. Optional: Sidewall mounted (unit substation) cast resin type CR standard.

② **Sealedaire Oil Preservation System** Westinghouse Sealedaire system of oil preservation excludes oxygen and moisture, preventing deterioration of liquid and insulation. The transformer tank is filled with oil in a vacuum chamber. A relief valve assembly keeps the transformer sealed throughout an oil temperature range of 100°C. Pressure and vacuum-limiting valves are set to open at plus or minus 6.5 pounds per square inch. Gas samples for purging or for analysis may be taken. Not used for Inerteen filled units.

③ **Lifting Lugs and Eyes** Total of four lifting lugs on corners of tank for lifting entire unit. Lifting eyes on tank cover for ease of handling.

④ **Liquid Level Gauge** Float position transmitted magnetically through tank wall to gauge pointer. This preserves tank seal. ②

⑤ **Dial Type Thermometer** Mounted in well on tank wall. Indicates temperature of top liquid. Has magnetically resettable red peak temperature pointer. Provides fan control unless otherwise specified. ②

⑥ **De-Energized Tap Changer Control Handle** Operating handle usually installed through tank wall at a height convenient to the transformer design. Includes provision for padlocking.

⑦ **Instruction Nameplate** Stainless steel nameplate mounted on front tank wall (ANSI, Seg #1) at convenient height.

⑧ **Cooling System** Designed to fit individual requirements. Self-cooled (OA) consists of flattened external tubes welded into headers in turn welded into tank wall.

Optional forced air (FA) cooling employs fans to circulate masses of air. Purchaser supplies 208-240 volt single phase supply.

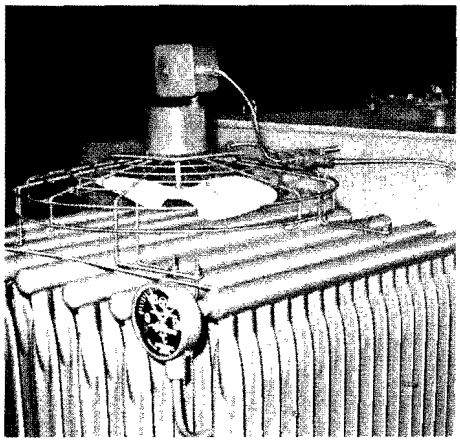
⑨ **Jack Pads** Bearing surfaces for jacks are provided at bottom corners.

⑩ **Base** Designed for ease in skidding or rolling. Holes provided for pulling and for ventilation to eliminate condensation.

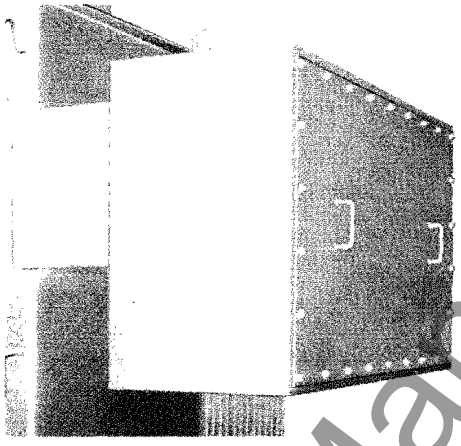
⑪ **Lower Drain Valve, Filter Press Connection and Sampling Valve** Assures complete liquid drainage from tank. Oil sampler at bottom. (If Inerteen®, sampler at top.)

⑫ **Tank Grounding Provision** Two copper faced steel pads with standard tapped holes located on front and rear tank walls near base.

⑬ **Tank** All tanks made of high-quality sheet steel with minimum number of seams. Seams and joints electrically welded. Tanks rectangular with rounded corners. Steel reinforcing members welded to outside walls add strength to withstand test and operating pressures. Bracing protects tank against distortion during shipment or installation. Tank walls flanged outward at top to form platform for welded cover plate. Handhole provided in cover for internal inspection and maintenance.

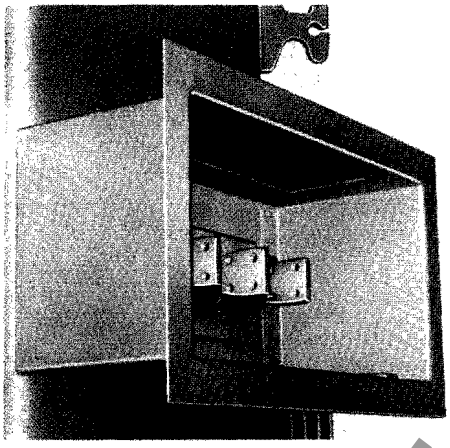


Standard Fan

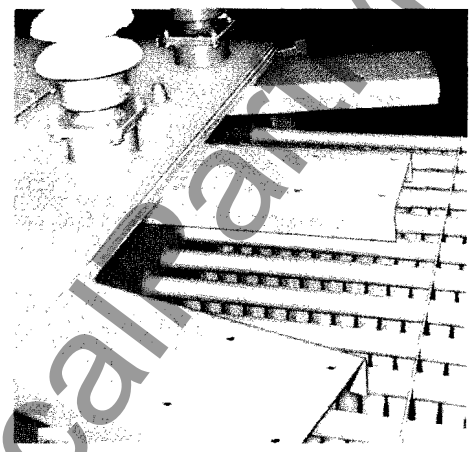


Throat Mounted Air Terminal Chamber

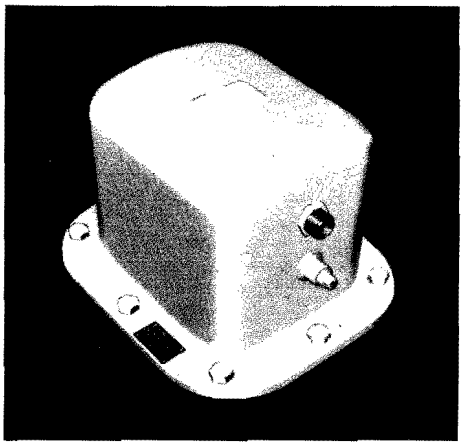
Primary Power Switch



NEMA Standard Bus Duct Throat



Lightning Arrester Mounting Brackets



Sudden Pressure Relay

Standard only above 2499 KVA and/or above 200 Kv.

⑭ **Upper Valve for Filter Press Connection**

⑮ **Pressure-Vacuum Gauge** Indicates pressure status inside tank gas space.

⑯ **Pressure Relief Device** Relieves abnormally high internal pressure. Factory calibrated to operate at 10 psi. Easily visible operation indicator. After operation, positively reseals and continues to give protection against the elements.② Yellow operation indication semaphore available.

① All fittings located on transformer front. ANSI Segment #1.
② Supplied with 1-NO, 1-NC alarm contact when specified.

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 containing zinc chromate 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 finish is ANSI No. 70 (Munsell No. 5.0B67.0/0.4). ANSI No. 24 (Munsell No. 10B2.40/1.18) can be supplied but must be specified at the time order is placed. Other colors or other paints compatible with the paint wash flo-coat machinery may be available through special determination and negotiation.

Wemco "C" Oil
Wemco "C" insulating oil is a refined mineral oil obtained from the fractional distillation of crude petroleum. It contains no moisture, inorganic acid, alkali, free sulfur, asphalt, tar, vegetable, or animal oils. It is used as an insulating and heat transfer medium and is intended principally for use in tanks of oil insulated circuit breakers, switches and transformers.

Inerteen®
Inerteen is an ASKAREL especially prepared by Monsanto Company to rigid Westinghouse specifications. Inerteen contains a hydrogen chloride scavenging agent specified by Westinghouse for maximum transformer life. Inerteen is non-corrosive and possesses the high dielectric strength required for an insulating and heat transfer liquid. Where specified it is used for indoor or outdoor designs up through 34.5 Kv Class. For simple field conversion either way between WEMCO "C" Oil and Inerteen refer to Westinghouse.

Standard Inerteen pour point is approximately −19°F; special −39°F.

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 2499 kva and a 25-percent increase on units 2500 kva and above. The fans are normally located on the top of the tubular coolers for maximum efficiency. Research has shown that the air moving over the hottest part of the 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. The power supply by others should be based on 360 V.A. per fan and 208-240 V 1 phase only.

Lightning Arresters
Maximum surge protection is provided by installation of lightning arresters mounted directly on transformer tank brackets.

Westinghouse intermediate or station type arresters may be specified and furnished with the transformer or the transformer furnished with arrester brackets only for mounting customers' arresters. Arresters ship separately boxed (detailed).

Throat Connections
Bushing groups may be enclosed in a flanged throat (ANSI Standard C57.12.10 par. 10.2.4).

Terminal Chambers
Cable entrance compartments are available for primary and/or secondary terminations on units requiring up to 150 KV BIL. Cable entry/exit can be specified either top or bottom. Air insulated chambers are usually used for 15 KV and below services – oil filled terminal chambers for all voltages above 15 KV.

Further Information:
IB 45-063-99 Inerteen-54201CM
IB 45-063-100 Wemco "C" Oil
47-156 D WE A Power Centers
47-220 P WE A
47-229 F WE A, Dimensions
Reprint 200 Fault Protection and Indication
MA 375 Value Story
M-7205 Short Circuit Withstand
SA 9025 B Insuldur
SA 10099 Rectangular Coil Core Form Transformers
Askarel Guide – Bulletin IC/FF-38R

Westinghouse Electric Corporation
Small Power Transformer Division
South Boston, Virginia 24592

Sudden Pressure Relay
Protection against damage due to internal faults 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.

Dial Hot Spot
Dial hot spot winding temperature equipment including a current transformer may be specified. Energy from a current transformer added to the temperature of the top oil in the tank operates a bimetallic element to indicate the simulated hot spot temperature of one phase of the transformer winding. A pointer on the large weatherproof indicator dial gives visual indication. Switches are provided to actuate cooling equipment and to control alarm circuits from a junction box.

Standard Ratings
All 55°C units have a supplementary Insuldur® rating of 112% with 65°C rise and 80°C hotspot rise as follows:

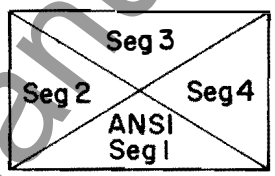
55°C OA Rating	65°C OA Rating	55°C FA Rating	65°C FA Rating
Single Phase Kva Ratings			
833	933	958	1073
1250	1400	1437	1610
1667	1867	1917	2147
2500	2800	3125	3500
3333	3733	4167	4666
Three Phase Kva Ratings			
750	840	862	966
1000	1120	1150	1288
1500	1680	1725	1932
2000	2240	2300	2576
2500	2800	3125	3500
3750	4200	4687	5250
5000	5600	6250	7000

Cable Terminals
Although not normally included, one clamp type terminal per phase can be furnished when specified at the time of order entry. Special terminals require specific negotiation due to their effect on the price and shipment of the transformer.

Current Transformers
Multi-ratio current transformers are applied for general application involving protective relays and indicating instruments. CT's 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 ANSI standards.

Transformer Description – ANSI Segments
Below is a facsimile of the ANSI drawing which serves as a guide in specifying transformers. Use of the ANSI segments more clearly and accurately locates components on the transformer quadrants. The segment applies to the sidewall as well as the cover portion shown. Segment #1 is the "front" by definition.

Transformer Plan View



"Front"
N.P., Fittings etc.

NEMA Audible Sound Levels

Equivalent Two Winding KVA Self Cooled (OA)	Average Level in Decibels
501-700	57 DB
701-1000	58 DB
1001-1500	60 DB
1501-2000	61 DB
2001-2500	62 DB
2501-3000	63 DB
3001-4000	64 DB
4001-5000	65 DB
Max. With Fans	67 DB

Temperature Guarantees
(Altitude not to exceed 1000 meters or 3300 feet)

	Ambient ①	Rise ②	Hotspot Rise
Standard	30°C	55°C	65°C
Optional	30°C	65°C	80°C

① 30°C average ambient temperature of cooling air not to exceed 40°C max. over any 24 hour period.
② Degree rise is the average winding temperature rise by resistance.

Special Applications
Certain applications such as pulse loading, special duty cycles, seismic criteria and captive motor loadings require special design considerations. These differ from the general duty transformers as defined by industry standards which fill the majority of customer needs. Specific guidelines for special applications have been established. Refer all such special cases to Westinghouse.

Printed in U.S.A.