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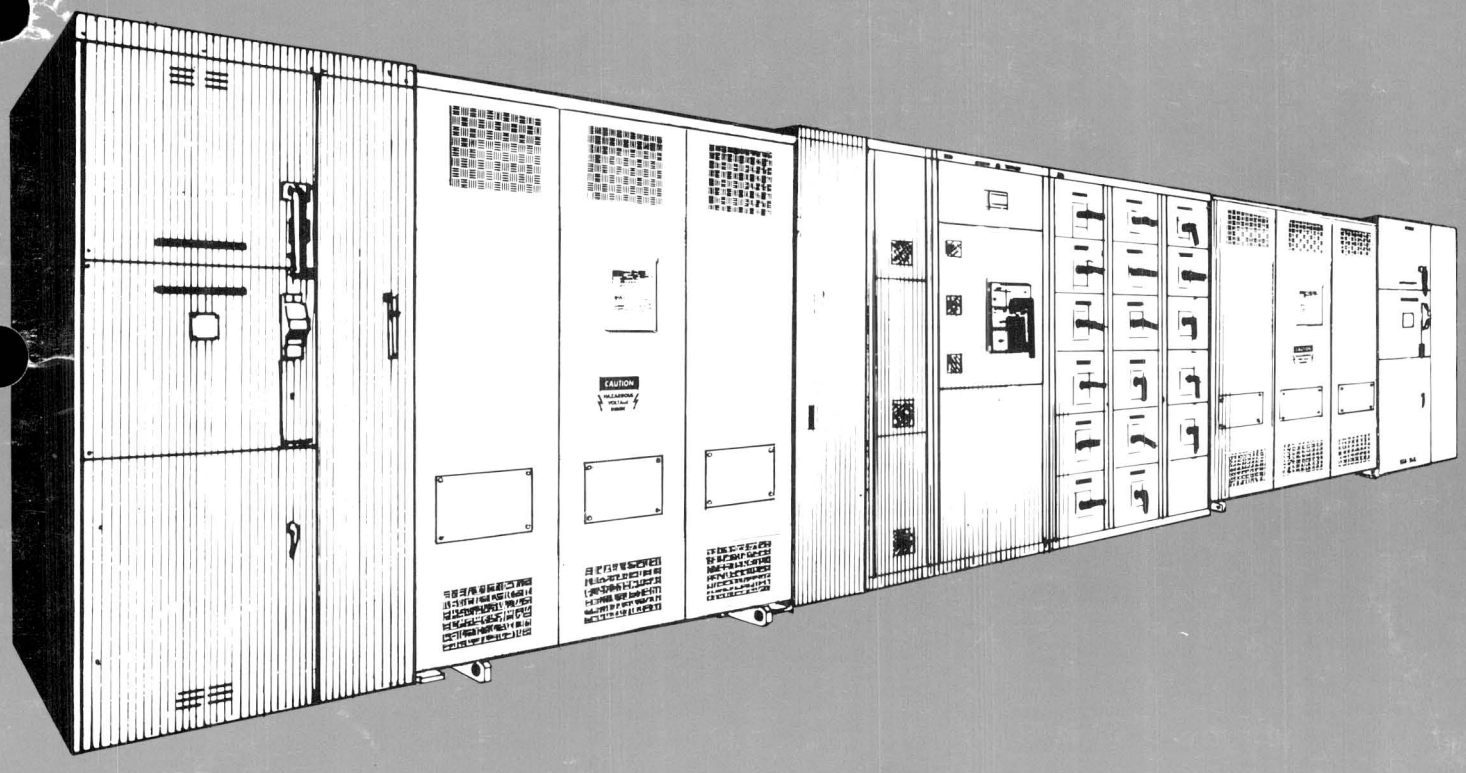


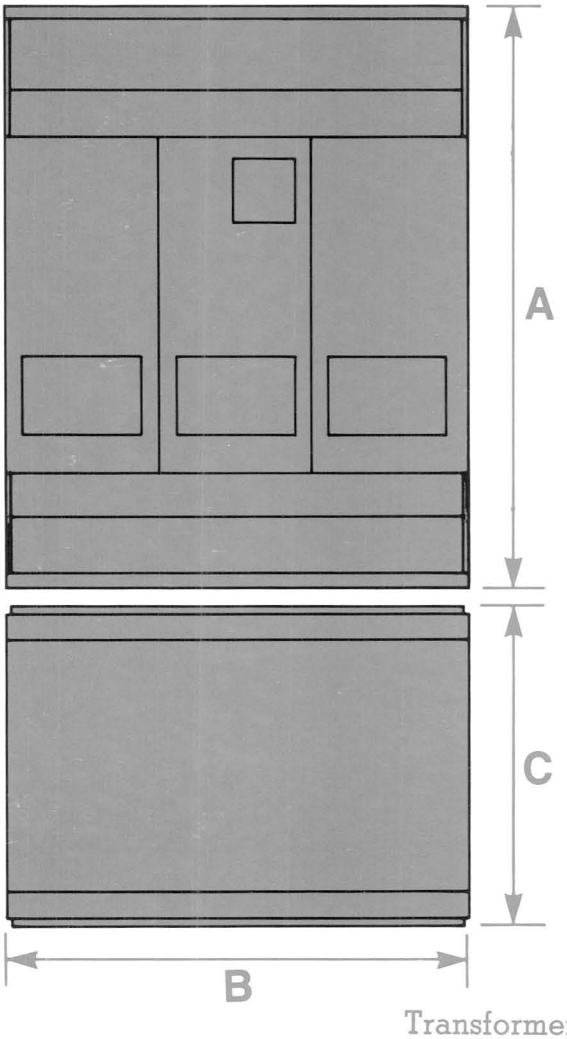
Ventilated Dry-Type Secondary Substation Transformers

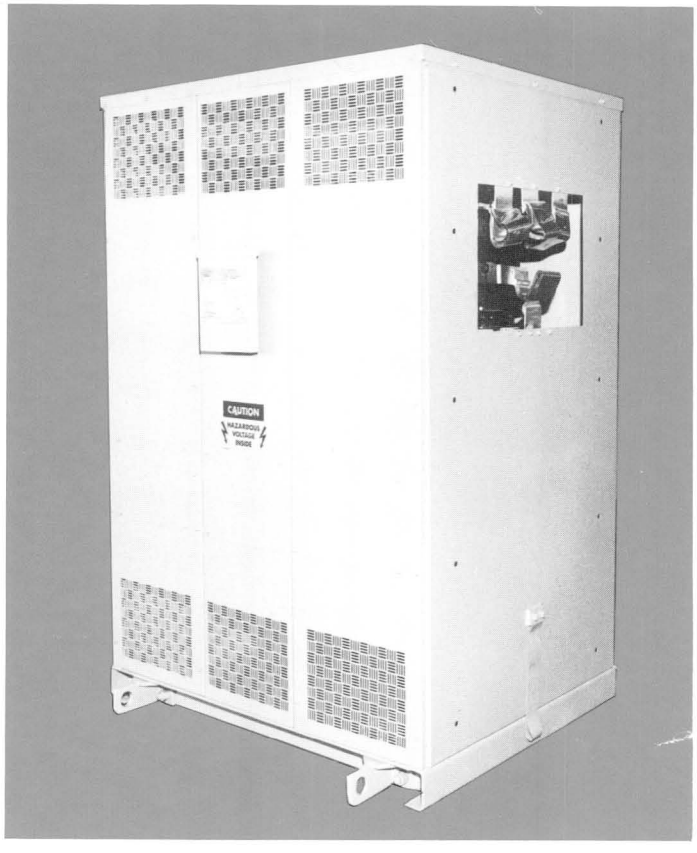
AND TERMINATION EQUIPMENTS FOR INTEGRAL SUBSTATIONS

GENERAL ELECTRIC

GE Transformers Meet Latest Applicable Standards of ANSI and NEMA

Dry-type Secondary
Substation Transformers





General Electric Dry-Type Secondary Substation Transformers are designed, manufactured and tested to meet applicable ANSI and NEMA Standards.

Through the judicious use of materials and methods each dry-type transformer is tailored to meet your specific application requirements.

They can be coupled with a wide variety of termination equipments suitable for almost any light-to-medium power-load application in commercial and industrial distribution systems.

Transformer Weights And Dimensions Based On 150 C Rise*

kVA	"A" Inches		"B" Inches		"C" Inches		Total Weight/Pounds	
	5kV	15kV	5kV	15kV	5kV	15kV	5kV	15kV
750	90	90	60	62	44	49	3600	4150
1000	90	90	62	64	45	50	4300	4700
1500	90	100	72	70	45	51	5850	6350
2000	90	100	76	76	47	53	7300	7800
2500	90	100	80	80	54	54	8650	9300

*All dimensions are subject to change without notice and should not be used for construction purposes unless endorsed.

NEMA TR27

Standard Ratings and Characteristics

Transformer Rating

The available incoming power supply determines the primary voltage and the frequency of the transformer. The voltage that is required by the load determines the secondary voltage. Present load, plus allowance for growth, determines the kVA rating of the transformer. Transformers with specific combinations of voltages and kVA ratings are available as standard units.

All standard open-dry type transformers are three-phase, 60 Hz with high-voltage windings delta-connected. These transformers are also available in 50 Hz designs.

Standard kVA Ratings

750 kVA
1000 kVA
1500 kVA
2000 kVA
2500 kVA

Standard High-Voltage Ratings

All Delta

2400 Volts
4160 Volts
4800 Volts
6900 Volts
7200 Volts
12000 Volts
12470 Volts
13200 Volts
13800 Volts

Primary voltages are supplemented with four approximately 2½ percent full-capacity regulating taps, two above and two below normal. This combination allows compensating for either a higher or a lower than normal sustained primary voltage.

Standard Low-Voltage Ratings

208Y/120*
480Y/277
480

*Not standard above 1000 kVA

Secondary voltage rating is approximately 4.2 percent above the new standard motor voltage (460 volts), allowing for voltage drop in the line between the substation and the motor terminals without operating the motor at subnormal voltage. Motors and controls operate satisfactorily on voltages 10 percent above or below rating.

Secondary lighting voltages are standardized at the voltage rating of the lamps (120 volt). Lamp operating performance is fairly critical to voltage. Overvoltage causes overheating and subsequent short life of lighting equipment, while undervoltage reduces illumination output and may have adverse effects on the operation of fluorescent lamps. The 120 volt rating for lighting substations normally gives the best results. If the regulation is then too great, it is the usual practice to correct it with a small voltage regulator installed on each feeder.

Provision For Fan Cooling

Cooling fans on open dry-type transformers will increase the transformers' capacity by 33-1/3 percent. Provision for adding fans is inherent in all units rated 750 kVA and above. It includes:

1. Capacity in all current-carrying parts for the fan-cooled rating.
2. Provision for overload relay to control fans.

Standard Sound Levels

Self-cooled Rating kVA	Sound Level, Decibels	
	Without Fans	With Fans Running
	Open Dry-type	Open Dry-type
750	64	67
1000	64	68
1500	65	69
2000	66	71
2500	68	71

Standard Impedances

kVA	Percentage Impedance
750-2500*	5.75

* 1000 kVA units with 480 V (delta or wye) low voltage will be furnished with 8 percent impedance at standard price if requested.

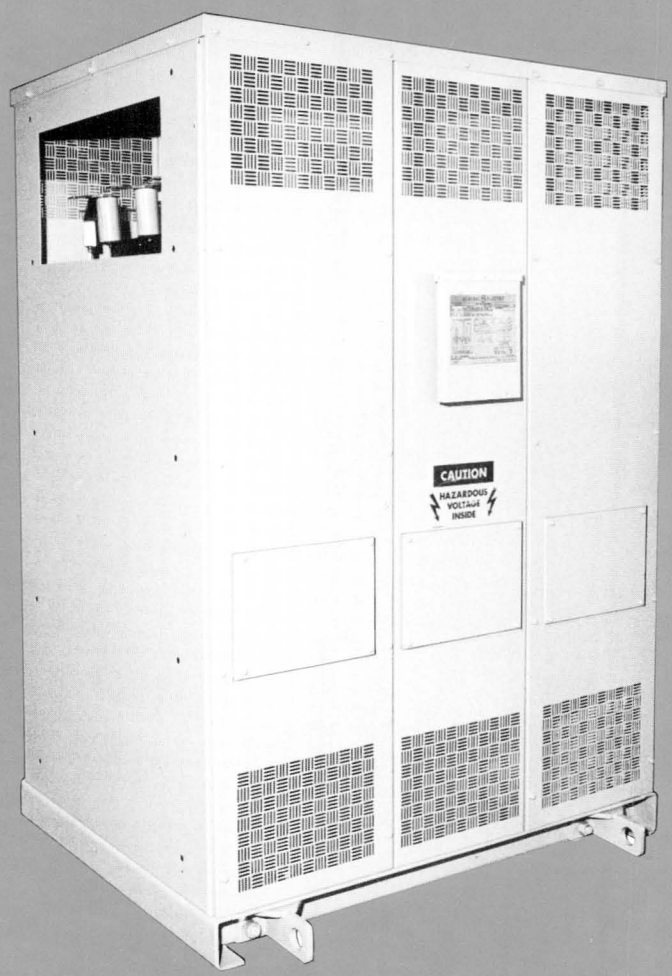
Rated Full-Load Currents Of Transformers

kVA	Primary Line-to-line Volts									Secondary Line-to-line Volts			
	2400	4160	4800	6900	7200	12,000	12,470	13,200	13,800	208	240	480	600
750	180	104	90.2	62.8	60.1	36.1	34.7	32.8	31.4	2082	1804	902	722
1000	241	139	120	83.7	80.2	48.1	46.3	43.7	41.8	2776	2406	1203	962
1500	361	208	180	126	120	72.2	69.4	65.6	62.8	—	—	1804	1443
2000	—	278	241	167	160	96.2	92.5	87.5	83.7	—	—	2406	1925
2500	—	347	301	209	200	120	115.7	109	105	—	—	3007	2405

Standard Ratings and Characteristics

Dielectric Tests Of Winding Insulation (Per ANSI 57-12.01)

Nominal System Voltage	BIL	Low Frequency Test	Impulse Tests		
			Chopped Wave		Full Wave
kV	kV	kV	kV Crest	Min. Time to Flashover, Microseconds	kV Crest
1.2	10	4	10	1.0	10
2.4	20	10	20	1.0	20
4.16	30	12	30	1.0	30
8.32	45	19	45	1.25	45
13.8	60	31	60	1.50	60



Standard kVA Ratings

Designed for 150 C average winding temperature rise by resistance above a 30 C average ambient*

History

Early dry-type transformers employed basically the same types of materials available for most electrical apparatus and were designed for 55 C rise with a total or hot spot capability of 105 C. Later, as higher temperature capability materials became available, dry type transformers were designed to operate at 80 C rise with a hot spot capability of 150 C, in order to reduce their size and cost.

During the 1950's transformers with 80 C rise were standard for dry types, until General Electric introduced dry type transformers designed for 150 C rise with an insulation system hot spot capability of 220 C.

Since the new insulation system had this capability, other temperature rise ratings no longer were necessary to produce the desired life and reliability at minimum size and cost.

Proven System

The materials of the insulation system and indeed the entire system have been thoroughly evaluated by accelerated thermal aging tests to prove their capability to operate successfully. An excellent reference on this subject is an IEEE Conference Paper by General Electric Advanced Development Engineers (Ref. No. 1)†.

The conclusions of this paper confirm the excellent service record of this insulation system during more than 20 years of use.

Life Expectancy

In addition the life expectancy is further extended in most applications such as indutrial plants, commerical buildings, hospitals and schools, where due to several factors the transformer actually operates at an equivalent constant loading of less than 100 percent. These factors are:

1. Transformers are generally over-sized relative to loading.
2. Most applications have load cycles.
3. Some are one-shift operations.

Table below shows the average winding rise and relative life expectancy for various equivalent constant loadings of 150 C rise transformer designs, based on max. 40 C ambient temperature.

Equivalent Constant Loading - %	Average Winding Rise - °C	Relative Life Expectancy (Times Normal Life)
100	150	1
93	133	2
85	115	15
68	80	> 100

While there are certain applications which may require continuous loading at close to 100 percent of nameplate kVA, in general the equivalent constant loading will be between 40-60 percent of nameplate. The value of equivalent constant loading and relative life expectancy can be calculated by reference to the ANSI Guide for Loading Dry-Type Transformers C57.96.

Loading Capabilities and Loss Economics

General Electric ventilated dry-type transformers utilize the same insulation system regardless of temperature rise requirements. All designs have a hot spot capability of 220 C. Although it is possible to design for lower temperature rises, there are several reasons why economic and system effects often make it impractical to operate lower temperature rated units above their nameplate kVA and up to their insulation system temperature capabilities.

Some of these reasons are:

A. Lower temperature rise transformers are higher in initial cost.
B. Lower temperature rise transformers are larger and heavier.
C. If long time overload capability is required above the nameplate kVA rating this can be obtained more economically by the addition of cooling fans; for short time overload capability refer to ANSI Loading Guide C57.96.
D. Overloading a transformer above its designed rating seriously increases the voltage regulation on the low voltage system, which could be detrimental to voltage sensitive equipment.
E. Down stream busway, cable, circuit breakers, etc. must be sized to carry this higher current, otherwise the additional transformer capacity cannot be utilized.
F. The size of the unit dictates a larger core and associated higher core losses. This coupled with increased load losses which increase as the square of the load current generally show that the loss economics are in favor of the design optimized at 150 C rise, when compared to initial cost.
G. The requirements for protection of the transformer are dictated by the National Electrical Code Section 450-3, requiring that primary protective equipment be set at no more than a specific multiple of its rated kVA and the associated currents. Depending on whether there is a main secondary protective device or not, this protective requirement can limit the usable kVA.

Summary

In conclusion, General Electric's dry-type transformer design utilizes high temperature proven and tested insulating materials. Substantiated by over twenty years of field experience, it has the best insulation system (consistent with current industry standards and codes) for applications in industrial plants, commercial buildings, schools, hospitals and other private and public buildings.

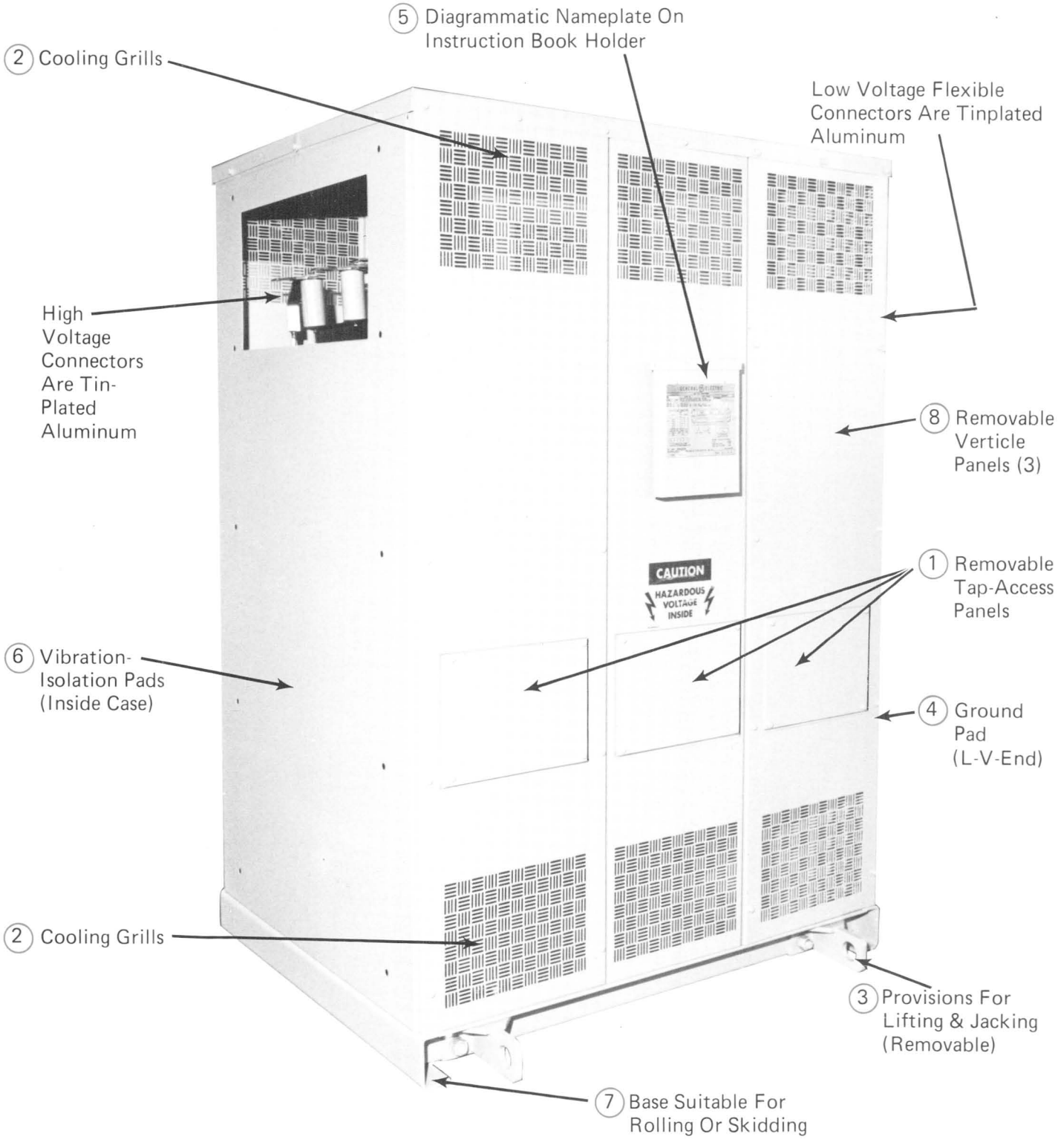
The 150 C rise temperature rating is the best choice for the user who wants low cost, small size, good system characteristics, reasonable losses and overload characteristics consistent with his desired reliability and life expectancy.

†Ref. No. 1 (IEEE Conference Paper presented at the "International Symposium on Electrical Insulation—" June 14-16, 1976)

"Thermal evaluation of a largely inorganic insulation system for use in dry-type transformers" by Dr. J.C. Crouse and J.F. Hutcheson, GE Co., Medium Transformer Department, Rome, Ga. Ref. No. 76 CH 1088-4-EI.

***Average** is for any 24-hour period with the maximum ambient not to exceed 40 C during this period.

Standard Features and Accessories



General Electric open dry-type transformers are designed for indoor applications in schools, hospitals, industrial plants, commercial buildings and anywhere that safe and dependable power are important considerations.

Standard Features and Accessories

1 — Removable tap-access panels
2 — Cooling grills at top and bottom of case
3 — Provisions for lifting and jacking
4 — Ground pad
5 — Diagrammatic nameplate
6 — Vibration-isolating pads
7 — Base suitable for rolling or skidding
8 — Removable vertical panels

Maintenance

Special maintenance requirements, inherent in other types of transformers, do not exist for open dry-type units. There is no insulating liquid, so no testing or filtering is necessary. However, periodic cleaning of the windings, leads and terminal boards is recommended. Refer to Instruction Bulletin GEK-5697 for recommended procedures. Since the vertical panels are readily removable, routine maintenance is made easier and quicker.

Tap Terminals

The winding conductor serves as the lead for the tap terminals, thus avoiding brazed joints in the windings. The tap connections, accessible through removable tap-access panels, are made by bridging the proper terminal blades with movable aluminum links. The links are clamped in position with an aluminum bolt, Belleville washer, and a steel nut. The bolt is captive making it possible to change and tighten taps with only one wrench.

Fan Cooling

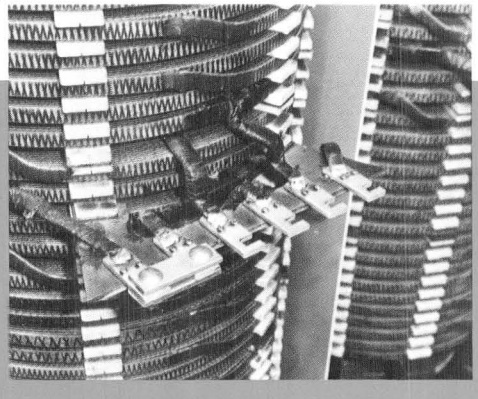
All open-dry type transformers are designed for future forced-air operation as a standard feature. To allow for the addition of fans, all bushings and other current carrying components are designed to handle the increased capacity (33-1/3%). Provisions are also made for the possible future addition of a fan control device. Since the fans are located inside the case the overall dimensions of the transformer are not increased when fans are added.

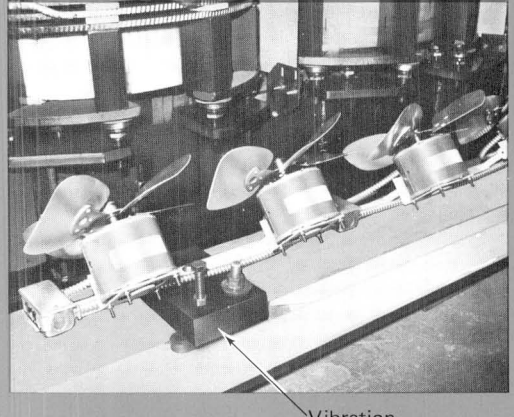
Sound Levels

Indoor usage makes the sound level of open dry-type transformers an extremely important consideration. The sound level of GE open dry-type transformers is at or below applicable industry standards (standard sound levels are listed on Page 4 of this publication).

To control sound, General Electric starts with core steel. The molecular structure of steel and magnetic flux combine to produce magnetostriction —a phenomenon that causes the transformer core to behave much like a tuning fork. The sound emitted is at frequencies that are even multiples of the power frequency. This effect is minimized and controlled by using a special grain-oriented silicon steel, carefully handling it in the factory, and by designing the core for electro-magnetic balance. Equal care is taken with the other components of the transformer to reduce or eliminate sound sources or sound amplifiers. Rubber vibration-isolating pads, put in place during installation, completely isolate the core and coil structure from the enclosure (case) and base structure.

The use of fiberglass lining in critical internal areas helps keep sound levels within specifications.



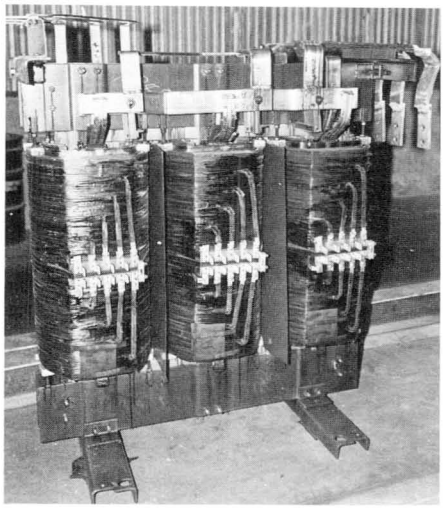


Vibration Isolation Pads

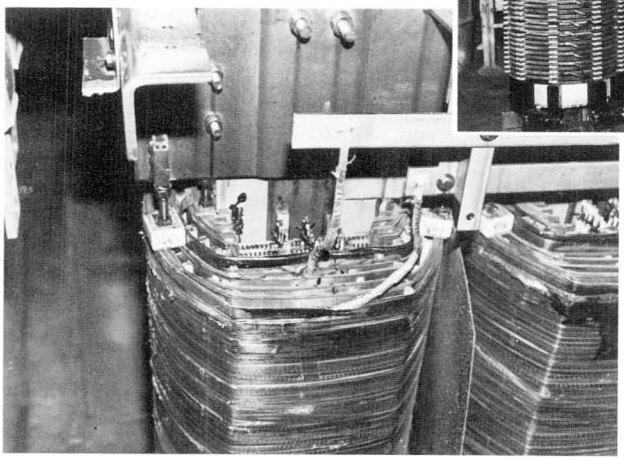
Standard Features and Accessories

Rectangular Coil Design

Standard General Electric open dry-type transformers rated 750-2500 kVA, 15 kV and below, are built with rectangular windings. First, the low-voltage



winding is pressure-wound on a rectangular mandrel. Multiple strands of aluminum conductor are used for each turn. Turn-to-turn insulation consists of a combination of thin inorganic paper, high-temperature fiber winding insulation and high-temperature phenolic varnish. Next, a flexible mica or NOMEX® pad is wrapped over the cooling duct spacers of the low-voltage winding to insulate it from the high-voltage winding. The high-voltage winding is then tension-wound directly over the mica barrier to form a single, rigid unit.

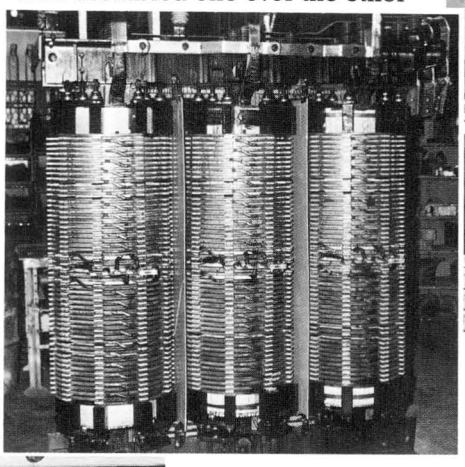


Special inorganic paper and high-temperature molded glass fiber spacers provide layer-to-layer insulation within the high-voltage winding.

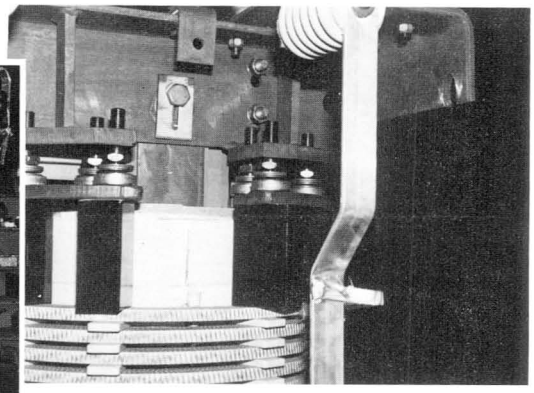
The core legs and yoke consists of stacked steel laminations interleaved to form the main support structure for the windings. The core structure itself is securely clamped in place by top and bottom core clamps that absorb vertical stress on the core. The core clamps are bolted to vertical steel tie plates located on each side of all three core legs to enable transformer to meet the ANSI short-circuit test requirements.

Round Coil Design

Standard General Electric open dry-type transformers rated above 2500 kVA, as well as some 80 C and 115 C rise units, are built with round windings. The high-voltage and low-voltage windings are wound on separate insulating cylinders as "layer" or "continuous-disk" windings and then asembled one over the other (high over low). The insulating cylinders are strong enough to support the many pounds of conductor used in the larger transformers, and are capable of resisting both the crushing short-circuit forces and the jolting that may occur during shipping and handling. The high-temperature life characteristics can withstand exposure to the heat of the core and of the low voltage (inner) winding. Age, usually the most common cause of loss of mechanical strength, does not appreciably affect the cylinder materials used in these transformers.



The core legs and yoke construction utilizes the same steel laminations as the rectangular design, except that air-cooling ducts are formed as an integral part of the core configuration. Core clamps, tie plates and adjustable jack screws, utilized in both designs, combine to hold the windings and core rigidly in place.



Completing The Insulation System

Once the windings have been assembled on the core legs the entire assembly is completely dried in special ovens, vacuum impregnated with silicone varnish, and fully cured to provide a superior 150 C rise (220 C hot-spot) insulation system.*

* For more detailed information on GE dry-type insulation systems refer to IEEE Conference Record #76CH1088-4-EI.

Testing and Finishing

Routine Tests

The following tests will be made on all transformers but not necessarily in the sequence listed. All tests are performed in accordance with the latest revision of ANSI Standard Test Code for Transformers, C57.12.91.

1. Resistance measurement of all windings.
2. Radio 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 on rated connection.
7. Applied potential tests.
8. Induced potential tests.

For more information refer to Company.

In addition to the standard tests there are other classifications of tests.

Design Tests

These are tests made on a sufficient number of representative units to demonstrate conformance with applicable standards, which need not be repeated unless there is a design change. These may be made on prototype equipment, devices, parts or components.

These might include:

1. Temperature tests to verify design criteria.
2. Impulse tests on all terminals including reduced full-wave, chopped wave, and full wave tests.
3. Short circuit capability tests.
4. Dielectric tests—including applied potential & induced potential.
5. Sound level tests.
6. Tests of mechanical components.

Other Tests

These are tests so identified in individual product standards which may be specified by the purchaser in addition to routine tests.

Examples of these are:

A. Impulse test
B. Insulation power factor test
C. Audible sound test
D. Temperature rise test

Conformance Tests

These are tests which are made by agreement between the manufacturer and the purchaser at the time the order is placed. In some cases, by mutual agreement, certain **Design Tests** may be made as **Conformance Tests.**

Short Circuit Testing Program

The General Electric Company has had an on-going short circuit test program for all types of medium size transformers manufactured at the Medium Transformer Department.

Short circuit tests were conducted at the General Electric High Power Laboratory. The program has included full-size ventilated dry type transformers rated from 1000 through 2500 kVA at various voltage ratings.

Depending on the purpose for which a particular unit was being tested, the test sequence varied (i.e.prototype units vs. actual customer units), enabling the Design Engineer to redesign critical mechanical parts such as coils, clamps, core tie plates, and bus supports.

Short-circuit testing has been performed on prototype units. This type of testing enabled General Electric to incorporate various measuring devices in development units in order to check force calculations, movement of windings, etc. It was also possible to gain knowledge of the transformer movement directly by the use of high-speed motion pictures.

In some cases units were tested to destruction to determine ultimate failure mode, since they were built entirely for development puposes.

Table 1 shows a list of one line ratings of 150 C rise ventilated dry type units tested since 1970.

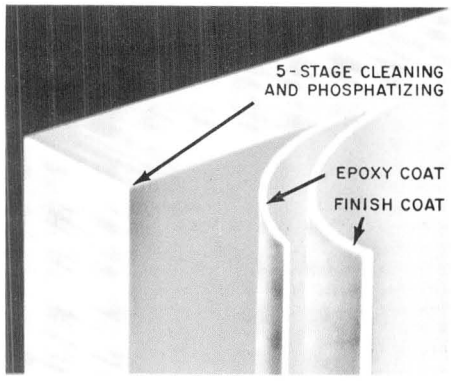
Table 1.

Year	One Line Ratings
1970	AA-T-60 HZ-1000 kVA-13800-480Y/277
1971	AA-T-60 HZ-1500 kVA-2400-480
1972	AA-T-60 HZ-2000 kVA-13800-480Y/277
1973	AA-T-60 HZ-1000 kVA-13800-480Y/277
1974	AA-T-60 HZ-1000 kVA-4800-480Y/277
1975	AA-T-60 HZ-2500 kVA-4160-480Y/277
1976	AA-T-60 HZ-2500 kVA-13800-480Y/277

Paint Finish

Once the pickled and oiled sheets are formed into panels they are processed through a 5-stage washing and phosphatizing line and thoroughly dried. After drying, the panels receive an epoxy coating applied by the powder process, which includes baking the panels at 325 F.

Once the panels have been assembled, a final coat of air-dry enamel is applied. The standard paint color for open dry-type transformers is ANSI-61 Light Gray. Other colors are available as options.



Application Considerations

Surge Protection

It is recommended that proper surge arresters be installed at the primary terminals of the substation, in order to protect the incoming line equipment and transformer from voltage surges.

If it is not possible to locate the surge protection at the transformer incoming line equipment, further investigation should be undertaken to determine if safe surge voltages can still be maintained.

Surge Arresters

To determine the type and rating of the arrester best suited to a particular system it will be necessary to (1) determine the characteristics os the incoming circuit supplying the substation primary terminals, with respect to grounding as defined in the IEEE Standard for surge arresters (IEEE Standard 28-1974), (2) shielding as defined in "USA Standard Guide for Application of Valve Type Lightning Arresters" (C62.2-1969, and (3) location of other equipment in relation to the transformer.

Impulse Strength (BIL)

The impulse strength of the standard open dry-type transformers are shown in Table on Page 4, and vary depending upon the voltage rating. The basic impulse level, commonly referred to as BIL, is defined as the specified crest value (kV) of the surge voltage which can be withstood by the transformer at its terminals.

The insulation structure must be designed to withstand, without flashover or apparent damage, a 1.2 x 50 micro-second wave of the specified crest value. The BIL rating is proven by design tests as defined by the ANSI Test Code C57.12.91.

Although the BIL ratings of dry type transformers are relatively low compared to those of liquid-filled transformers, they can be adequately protected by surge arresters.

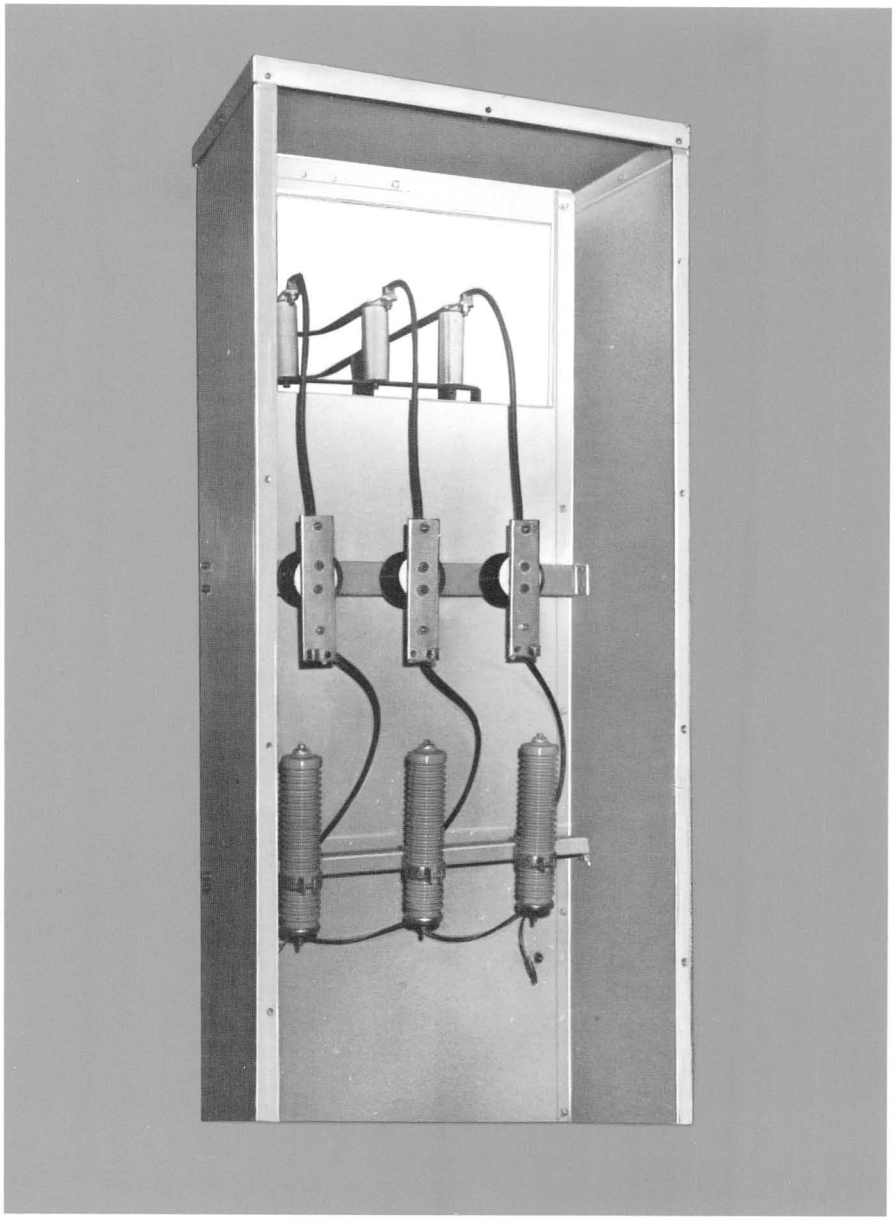
Protective Margin

In order to provide a minimum of ten percent protective margin for dry type transformers distribution type (Form 28) General Electric Surge Arresters may be used at all the listed standard voltage ratings. This is based on ANSI front-of-wave sparkover characteristics and IR discharge voltage at 5000 amps or less.

Greater margin of protection may be obtained at other voltages by the use of intermediate type or TRANQUELL® arresters, since they have better discharge characteristics.

NOTE:

It is important that a good ground path be provided from the ground side of the surge arresters in order to assure that the protective margins are maintained. It is desirable that this ground path be less than one ohm.



Location And Installation

The location and the environmental conditions surrounding the transformer are important factors influencing transformer application.

Environment

Since open dry-type transformers depend on air as their insulating medium and on air circulation for cooling, the environment in which they are placed will affect their operation and reliability. Therefore the atmosphere should be reasonably clean and dry.

If the transformer will be deenergized for some time in a moist atmosphere, space heaters are available as an option. In locations where excessive contamination may be encountered more frequent maintenance may be required. Therefore, if possible, this air movement into the area surrounding the transformer should be filtered. The ventilating openings should also be free of any nearby obstructions to the flow of cooling air.

Location

When located in an equipment room the amount of air delivered and the method of delivery are important factors.

The amount of air delivered to remove transformer losses should be approximately 100 CFM/KW of transformer loss depending on the equipment room thermal design and any additional heat which may be generated in the room from other equipment. It is important that the air flow does not directly impinge on the ventilating openings of the casing since this will disturb the natural flow of air through the transformer. Typically a standard 1500 kVA transformer would generate approximately 1000 BTU/minute at 60-percent load. The ambient temperature must be maintained at an average of 30 degrees C (86 F) with the maximum not to exceed 40 degrees C (104 F) in any 24-hour period. This, of course, may also require modification of the amount of air flow. In general the incoming air should be at least 5 C below the room temperature.

For further information refer to ANSI C57.94 "Guide for Installation and Maintenance of Dry Type Transformers."

The only foundation necessary is a level floor strong enough to support the weight of the transformer. When the unit is mounted on the main factory floor or motor room, the weight has little effect on the foundation costs. However, the unit can be mounted on a balcony or in the roof trusses, because of the minimal maintenance requirements.

Overload Capability

For short-time overloads the open dry-type transformer has approximately the same overload capability as other types. However, if it is necessary to overload the unit for longer than approximately ½ hour, its overload capability decreases.

For longer overload periods consideration should be given to the addition of fan cooling or oversizing of the unit unless some sacrifice in transformer life is an acceptable alternative.

The open dry-type transformer has the advantage of a large fan-cooled capability. The fans are located within the transformer casing and they do not increase the overall dimensions of the transformer. The fan-cooled capability enables an increase of 33-1/3 percent of the rated kVA output of the transformer. The fans are controlled from the winding temperature by simulating the temperature inside the windings at the center phase coil lead.

For further reference consult ANSI Standard C57.96 "Guide for Loading Ventilated Dry Type Transformers."

Reliability

A transformer, when operated in the environment for which it is designed and loaded in accordance with recognized industry loading guides, will have long life expectancy and good reliability. Each transformer is carefully designed and built with quality materials to insure maximum service and reliability.

Audio Sound Levels

The audio sound level of a transformer for an industrial application is normally not an important factor. If, on the other hand, the transformer is used in an office building or application where the ambient sound level is low, then the sound level of the transformer would be significant.

The NEMA sound levels of the open-dry transformer are shown on Page 3. These are based on NEMA measurement procedures as outlined in NEMA Standard TR-1.

The location of transformers with respect to walls, ceilings, and other transformers will have an affect on the sound level measured. Its method of floor mounting could also be an important factor.

Means are provided to isolate the core and coil assembly from the casing and it is important that the instructions in this regard are followed during installation.

The importance of sound level considerations is relative to the proximity of the equipment to operating personnel. If lower levels are desired they can be obtained by various means, including the design of the equipment room itself.

*Trademark of General Electric Company

Incoming Termination Equipment

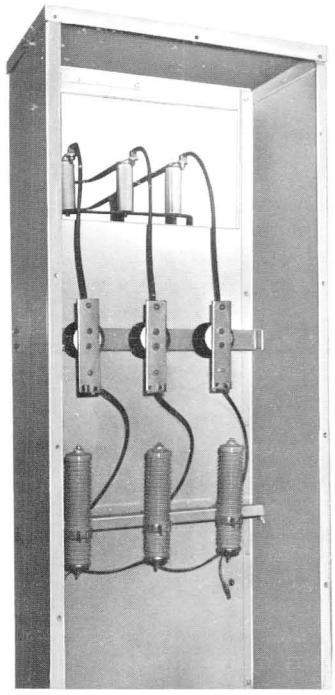
FOR DRY-TYPE SECONDARY SUBSTATION TRANSFORMERS

Air-Filled Terminal Compartment

This is a simple metal enclosure to safeguard personnel when the substation is connected directly to the incoming high-voltage line. It can be supplied with either clamp-type terminals or potheads to terminate the incoming-line cables. The low cost of this section makes it ideal when over-current protection is provided elsewhere.

The compartment is suitable for single or loop feed and for either top or bottom cable entrance. A bolted-on end panel gives easy access to the cable fittings.

Potheads can be supplied with special fittings such as wiping sleeves, stuffing boxes, armor clamps, or conduit couplings for any of the common types of cable.



Air filled compartment with surge arresters and clamp-type terminals mounted for bottom cable entrance.

Oil Cutouts

If fuses are required, oil cutouts are the most economical interrupter switches available. The three-pole, two-position, (OPEN/CLOSED) cutouts are operated simultaneously by a handle accessible through a hinged door on the end of the compartment for 5 kV and on the side for 15 kV. Cables and other live parts are completely metal enclosed. They are not accessible through the operating door, so operators are protected.

Either clamp-type terminals or potheads can be used to terminate cables. The compartment can be specified by the customer for single or loop feed, top or bottom cable entrance.

Switch contacts of the cutouts are completely metal enclosed. The contacts operate under oil, completely submerging the arc flame during circuit interruption. The cutout can be supplied with fuses which will clear fault currents up to 11,000 amps at 4160 volts and 7000 amps at 13,800 volts.

Versatile and Reliable Air-Interrupter Switches

Switches are rated for use with dry type transformers rated 112.5 through 2500 kVA, 2400 through 13,800 volts.

The basic switch, incorporating a stored-energy operating mechanism, has an interrupting rating of 600 amp at all voltages. The stored-energy mechanism provides a positive, controlled closing and opening stroke independent of the operator.

All air switches meet NEMA Standard SG-5 for power switching equipment and ANSI Standard C37.30.

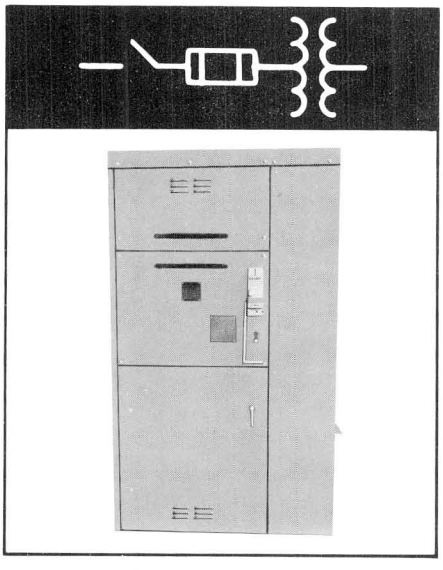
Incoming-line cables can enter the top or bottom of the compartment and can be connected for either single or loop feed. Cables can be terminated with clamp-type terminals or potheads. The terminals are easily accessible to apply test voltage or check the phasing of the unit.

Oil cutouts are operated by a handle accessible through a hinged door.

Two observation windows of shatterproof safety glass are provided in the sheet steel door. The windows are sized and located to give an adequate view of the switch contacts, but are small enough to provide maximum personnel protection during inspection. Current-limiting fuses can be included in the compartment under the interrupter switch. They can provide interrupting capacity sufficient to clear a fault at the low-voltage terminals. When fuses are furnished, the fuse compartment door is mechanically interlocked with the switch so the fuse door cannot be opened unless the interrupter switch is in the OPEN position. Likewise, the interrupter switch cannot be closed unless the fuse door is also closed. Key interlocking with low-voltage circuit-interrupting devices can also be furnished. Lightning arresters can be supplied in the switch compartment for added protection against voltage surges.

Two-Position Air-Interrupter Switch

This switch consists of a two-position (OPEN/CLOSED), three-pole mechanism. All three poles are operated simultaneously by a non-removable handle on the front of the switch compartment. A mechanical position indicator is included.



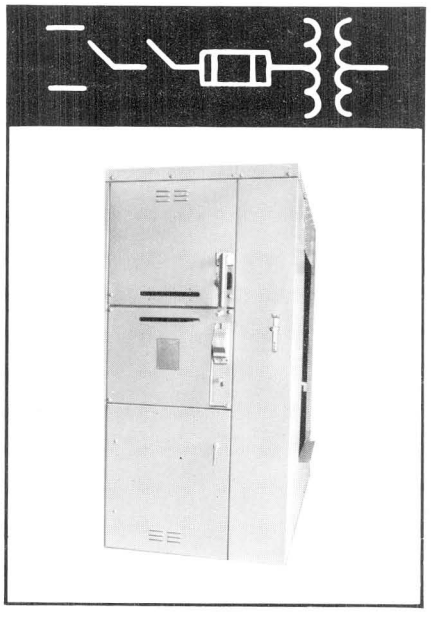
Air Switch Continuous and Short-circuit Current Ratings

kV	BIL	Continuous Rating and Loadbreak	Momentary and Close and Latch Assembly (KA without fuses)
5	60	600	40
5	60	1200	61
15	95	600	40
15	95	1200	61
15	95	1200	80

Air-Interrupter Selector Switch

Where there are two separate incoming lines, the interrupter selector switch gives three positions (LINE 1/OPEN/LINE 2). This gives continuity of service by allowing the operator to switch from one incoming line to the other in case primary feed fails, or to the OPEN position for planned maintenance.

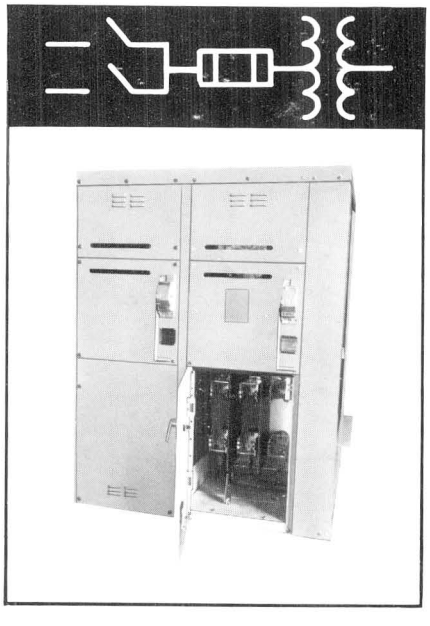
The unit consists of a two-position (OPEN/CLOSED) air-interrupter switch in series with a two-position (LINE 1/LINE 2) selector switch. The selector switch is a dead-break device and is mechanically interlocked so it cannot be operated unless the interrupter switch is open.



Double-Air-Interrupter Switch

This three-position (LINE 1/OPEN/LINE 2) switch is also used where there are two separate incoming lines, and allows the operator to switch from one line to the other, or to OPEN for planned maintenance.

The double switch has the advantage of isolating the two lines, permitting maintenance of one line while the other line is energized and reducing the probability of fault transfer from one cable to the other. This is accomplished by using two two-position (OPEN/CLOSED) air-interrupter switches, key-interlocked so both incoming line switches cannot be closed at the same time (not LOOP FEED through the switches).



Application Information

Surge Protection

There are three types of surge arresters available; Distribution, Intermediate and TRANQUELL®.

Intermediate and TRANQUELL arresters generally provide greater protective margin for the equipment than Distribution type.

Interlocking

To safeguard personnel and reduce switch contact maintenance, the high-voltage switch should be operated while de-energized or while carrying only the magnetizing current of the transformer.

Key interlocking the high-voltage switch with the low-voltage main circuit breaker makes it necessary to remove the low-voltage load before opening the high-voltage switch. When required, this feature is included on GE Substations.

Application Of Unfused Interrupter Switches

High Voltage	2400-4800V		6900-7200V		12000-13800V
Transformer kVA	750	1000-2500	750-1500	2000-2500	750-2500
Air Switch	X	X	X	X	X
Oil Cutouts	X	—	X	—	X

Additional key interlocking can be provided to coordinate with other circuit devices. These include alternate feeds from additional high-voltage sources, low-voltage tie breakers for double-ended substations, and additional low-voltage bus or cable feeds from emergency or other sources.

If such additional interlocking is required, complete information must be provided by the system engineer responsible for the overall substation coordination.

Fusing

Fuses, while available for air switches and cutouts, are not generally required on Integral Distribution Centers. A plain interrupter switch does not involve the expense and coordination problems of fuses and it is adequate for all units that can be protected by remote overcurrent relays.

Sometimes, though, other loads on the circuit are great enough that the National Electrical Code requires fuses on the incoming side of the substation. For example, if the kVA size of the substation is less than about 1/4 to 1/6 of the total load on the feeder, an interrupter switch and fuse combination should be used to protect against short circuits.

Minimum suggested primary fuses are listed in the table on page 15 for the self-cooled rating.

It is essential that the coordination of fuses with other primary and secondary devices be checked before selecting the fuse rating.

Fuse Interrupting Rating RMS Amperes

Operating Voltage	Oil Cutouts With Fuse Link (Asymmetrical)	Air Switch With EJ Fuse (Symmetrical)	Air Switch with Type SM-4S S & C Fuses (Asymmetrical)
2400	11000	50,000	27,500
4160	11000	50,000	27,500
4800	10000	50,000	25,000
6900	5000	50,000	25,000
7200	5000	50,000	20,000
12470	7000	50,000	20,000
13200	7000	50,000	20,000
13800	7000	50,000	20,000

Minimum Suggested Primary Fuses*

3ϕ Self-Cooled Transformer kVA	Rated Primary		GE Type EJ-01 9F62 Series†	S & C Type (Slow Char.)	GE Oil Cutout Fuse Link
	Voltage Volts	Current Amps		SM-4S	
750	2400	180	200E	200E	9F57CAA200
	4160	104	125E	125E	125
	4800	90.2	100E	100E	100
	6900	62.8	65E	65E	065
	7200	60.1	65E	65E	065
	12000	36.1	50E	40E	040
	12470	34.7	50E	40E	040
	13200	32.8	50E	40E	040
	13800	31.4	50E	40E	040
1000	2400	241	250E	—	—
	4160	139	150E	150E	9F57CAA140
	4800	120	125E	125E	125
	6900	83.7	100E	100E	100
	7200	80.2	100E	100E	100
	12000	48.1	50E	50E	050
	12470	46.3	50E	50E	050
	13200	43.7	50E	50E	050
	13800	41.8	50E	50E	050
1500	2400	361	400E	—	—
	4160	208	250E	—	—
	4800	180	200E	200E	9F57CAA200
	6900	126	125E	150E	140
	7200	120	125E	125E	125
	12000	72.2	80E	80E	075
	12470	69.6	80E	80E	075
	13200	65.6	80E	80E	075
	13800	62.8	65E	65E	065
2000	4160	278	300E	—	—
	4800	241	250E	—	—
	6900	167	175E	175E	9F57CAA200
	7200	160	175E	175E	200
	12000	96.2	100E	100E	100
	12470	92.5	100E	100E	100
	13200	87.5	100E	100E	100
	13800	83.7	100E	100E	100
2500	4160	347	400E	—	—
	4800	301	350E	—	—
	6900	209	250E	—	—
	7200	200	250E	200E	—
	12000	120	125E	125E	9F57CAA125
	12470	115.5	125E	125E	125
	13200	109	125E	125E	125
	13800	105	125E	125E	125

*If FA rating required, a larger fuse should be selected in some ratings.
†The minimum fuse rating is the smallest fuse which will withstand transformer inrush.

Outgoing Termination Equipments

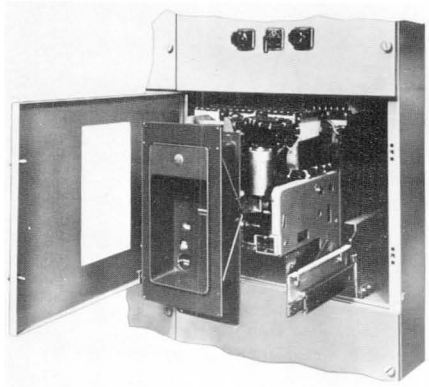
FOR INTEGRAL SUBSTATION APPLICATION

The power-distribution requirements of different loads vary widely. That's why General Electric's building-block approach to building Integral Distribution Centers has particular meaning in the outgoing section. There are five basic building blocks, and some of these have modular construction within themselves, to give even more flexibility.

Air-Filled Terminal Compartment

This is a simple metal enclosure with camp-type terminals identical to the incoming-line compartment described on page 12.

Type AKR Air Circuit Breaker



Your Integral Distrubition Center can be supplied with a single Type AKR low-voltage power circuit breaker, as shown in Table 1. Breakers are available for drawout mounting and for either manual or electrical operation.

A stored energy closing mechanism is standard with either manual or electrical operation. Pre-charged springs in this mechanism provide a powerful, uniform closing force which is independent of the operating force. This quick, positive closing prevents unnecessary arcing between contacts resulting in longer contact and breaker life.

Solid-state trip devices are available with AKR breakers. The Micro VersaTrip® trip device is shown in Table 1.

For more detailed information, refer to GEA-10265.

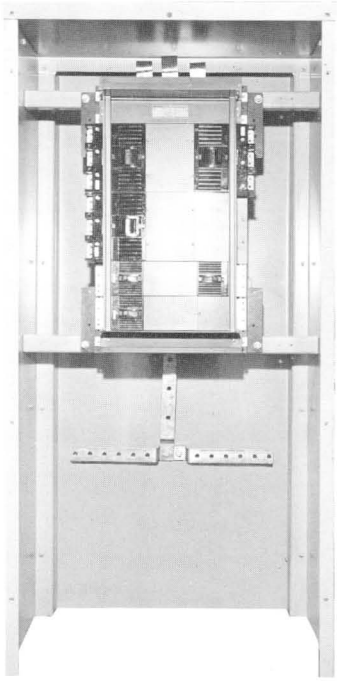
Molded-Case Circuit Breakers

Molded-case circuit breakers can be arranged to provide a main breaker, a main breaker with feeder breakers, or feeder breakers only. Any combination of the breakers shown in Table 2 can be used, as long as the height does not exceed 48 "X" units and the width does not exceed the panel space available.

A typical arrangement for determining the number of "X" units, interrupting rating, trip rating and cable lug sizes is given in Table A.

Main circuit breakers in the compartment panel may be furnished with continuous current ratings up to 1200 amperes and interrupting capacity up to 65,000 amperes symmetrical at 240 volts. Micro VersaTrip breakers are available in J or K frame construction.

Additional separately mounted main circuit breakers can be furnished with continuous current ratings up to 3000 amps and interrupting capacity up to 200,000 amperes symmetrical at 240 volts. Additional compartment width may be required. Refer to Table 3 on page 17 for application guide.



See Table A for typical panel arrangement.

Table A. Typical panel arrangement (maximum space available is 48X)

1200 Amp TKM FRAME 2- or 3-pole		8X
800 Amp TKM FRAME 2- or 3-pole		6X
600 Amp TJK Frame 2- or 3-pole	600 Amp TJK Frame 2- or 3-pole	6X
225 Amp TFK Frame 2- or 3-pole	225 Amp TFK Frame 2- or 3-pole	3X
100 Amp TED Frame 3-pole	100 Amp TED Frame 3-pole	3X
Filler		1X
	TOTAL	27X

ψ For units without metering.

Metering and Control Power Equipment

Simple secondary metering and control equipment can be mounted in the outgoing section of your Integral Distribution Center. Often, though, the compartment must be larger to add this equipment and still provide adequate tolerances and working space. Standard equipments available include:

Metering

Ammeters	Power-factor meters
Voltmeters	Frequency meters
Wattmeters	Watthour meters
Varmeters	kVA meters

Instrument transformers
- Current transformers
- Potential transformers

Control-power transformers

Table 1. Application guide for AKR circuit breakers

Breaker Type	Max Amp	Interrupting Rating* (Sym KA RMS) 240V	480V	600V	Sensor Current Rating (Amperes) Fixed Sensors	Tapped Sensors	Current Setting (Mult. of Sensor Current Rating)
AKR-30†	800	42	30	30	100 150 225 300 400 600 800	100, 150 225, 300 or 300, 400, 600, 800	0.5, 0.6, 0.7, 0.8, 0.85, 0.9, 0.95, 1.0 (x)
AKR-30H	800	50	42	42			
AKR-50†	1600	65	50	42	300 400 600 800 1200 1600	300, 400 600, 800 or 600, 800, 1200, 1600	Same as above
AKR-50H	1600	65	65	65			
AKRT-50	2000	65	65	65	800 1200 1600 2000	(800, 1200, 1600, 2000)	Same as above
AKR-75	3200	85	65	65	1200 1600 2000 3200	(1200, 1600, 2000, 3200)	Same as above
AKR-100	4000	130	85	85	1600 2000 3000 4000	(1600, 2000, 3000, 4000)	Same as above

*With instantaneous trip
†Breakers with extended short-circuit ratings also available.
(x) = Sensor current rating

Table 3. Application guide—Power Break® circuit breakers‡

Max Amp	Interrupting Rating Amperes Symmetrical 240V	480V	600V	Sensor Ampere Ratings	Space Used
800	65,000	50,000	42,000	200, 400, 600, 800	18X
1600	85,000	65,000	50,000	800, 1000, 1200, 1600	18X
2000	85,000	65,000	50,000	1000, 1200, 1600, 2000	18X
3000	100,000	100,000	85,000	400, 600, 800, 1000, 1200, 1600 2000, 2500, 3000	18X
4000	100,000	100,000	85,000	4000	(a)

‡Available with Micro Versa Trip®.
(a) Refer to factory for space requirements.

Table 2. Application guide—Molded-case circuit breakers

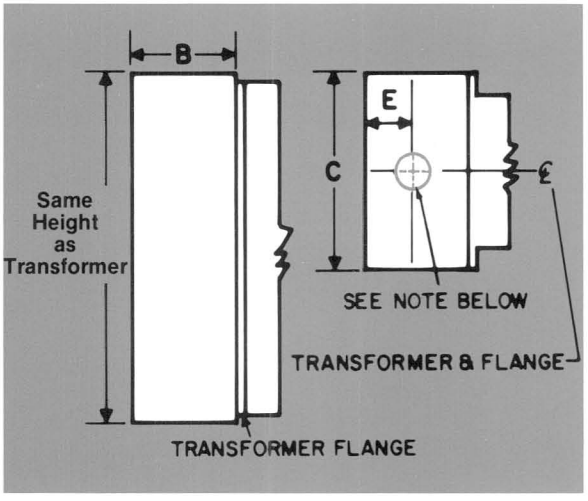
Type Frame	Type Max. Amperes	Interrupting Capacity (Amperes)¶ 240V	480V	600V	Trip Rating (Amperes)	Breaker Space (Max. 48X) △ 2-pole	3-pole
TED-6§	100	18,000	14,000	14,000	15, 20, 30, 40, 50, 60, 70, 90, 100, 110, 125, 150	2 Xθ 2 Xθ	3 Xθ 3 Xθ
THED§	100	65,000	25,000	18,000	15, 20, 30, 40, 50, 60, 70, 90, 100, 110, 125, 150	3 Xθ 3 Xθ	3 Xθ 3 Xθ
TFJ§	225	25,000	22,000	22,000	70, 90, 100, 125, 150, 175, 200, 225	3 Xθ	3 Xθ
TFK	225	25,000	22,000	22,000	70, 90, 100, 125, 150, 175, 200, 225	3 Xθ	3 Xθ
THFK	225	35,000	25,000	22,000	70, 90, 100, 125	3 Xθ	3 Xθ
		42,000	25,000	22,000	150, 175, 200, 225		
TJJ§	400	42,000	30,000	22,000	125, 150, 175, 200, 225, 250, 300, 350, 400	6 Xθ	6 Xθ
TJK-4	400	42,000	30,000	22,000	125, 150, 175, 200, 225, 250, 300, 350, 400	6 Xθ	6 Xθ
THJK-4	400	65,000	35,000	25,000	125, 150, 175, 200, 225, 250, 300, 350, 400	6 Xθ	6 Xθ
TJK-6 TJ4V	600	42,000	30,000	22,000	250, 300, 350, 400 500, 600	6 Xθ	6 Xθ
TKM-8	800	42,000	30,000	22,000	125, 150, 175, 200, 225 300, 350, 400, 500, 600 700, 800	6 X	6 X
THKM-8	800	65,000	35,000	25,000	125, 150, 175, 200, 225 300, 350, 400, 500, 600	6 X	6 X
					700, 800	6 X	6 X
TKM-12 TK4V	1200	42,000	30,000	22,000	700, 800	8 X	8 X
					1000	8 X	8 X
					1200	8 X	8 X
THKM-12	1200	65,000	35,000	25,000	700, 800	8 X	8 X
					1000	8 X	8 X
					1200	8 X	8 X

§ Breaker has fixed trip unit.
¶ U/L listed interrupting ratings—symmetrical.
θ Two breakers of size shown can be mounted side by side in this space.
△ For units without metering. When metering is required, consult factory for maximum breaker space available.

Dimensions and Weights

INCOMING TERMINATION EQUIPMENTS

AIR FILLED TERMINAL COMPARTMENT AND OIL CUTOUT—FUSED OR UNFUSED WITH ONE POTHEAD 3/C WITH 500 MCM MAXIMUM CONDUCTOR.

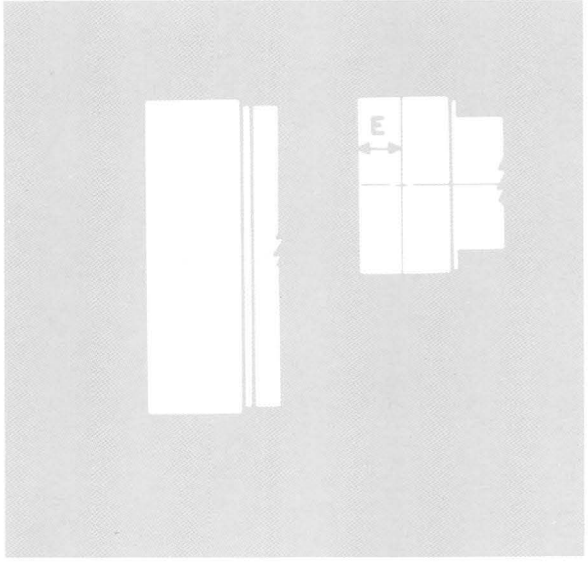


Note: Location of wiping sleeve or stuffing box for cable entrance†

kV	Entrance	Dimensions in Inches			Weight (in pounds)
		B	C	E	
5	Top	14.8 26.3	38.4 38.4	9.8 15.95	350 600
	Bottom	14.8 26.3	38.4 38.4	7.45 15.95	350 600
15	Top	14.8 51.5	38.4 41.25	9.8 8.32	350 1300
	Bottom	21.3 51.5	38.4 41.25	10.95 7.3	350 1300

† for top entrance additional clearance required, 17.3″ max.
Black = Air filled terminal compartment.
Green = Oil cutout.

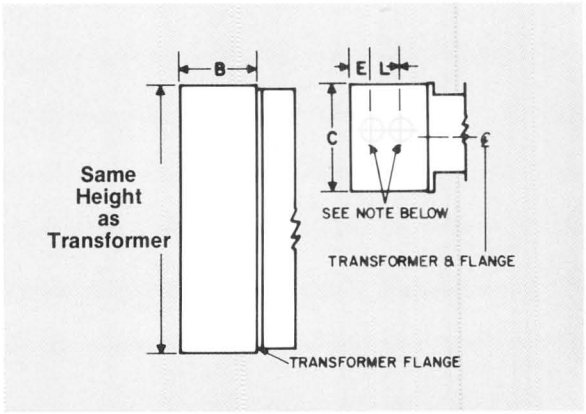
AIR FILLED TERMINAL COMPARTMENT AND OIL CUTOUT—FUSED OR UNFUSED WITH CLAMP TYPE TERMINALS WITH 500 MCM MAXIMUM CONDUCTOR.



kV	Dimensions in Inches			Weight (in pounds)
	B	C	E	
5	14.8 26.3	38.4 38.4	** 14.3	200 500
15	21.3 51.5	38.4 41.25	** 8.0	250 1200

** Entire plan area available for cable entrance
Black = Air filled terminal compartment.
Green = Oil cutout.

AIR FILLED TERMINAL COMPARTMENT AND OIL CUTOUT—FUSED OR UNFUSED WITH TWO POTHEADS 3/C WITH 500 MCM MAXIMUM CONDUCTOR.

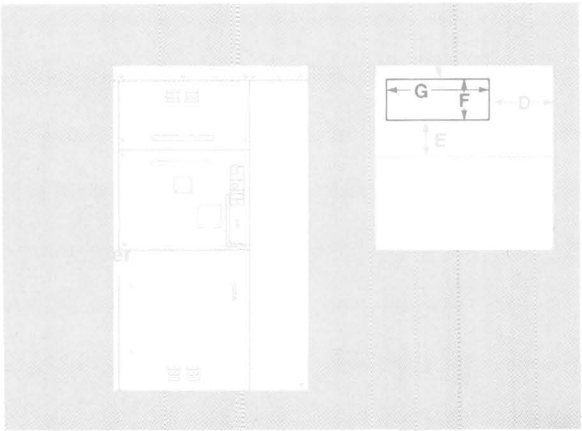


Note: Location of wiping sleeves or stuffing boxes for cable entrance†

kV	Entrance	Dimensions in Inches				Weight (in pounds)
		B	C	E	L	
5	Top	21.3 26.3	38.4 38.4	8.3 8.07	8.0 7.88	500 700
	Bottom	21.3 26.3	38.4 38.4	6.07 8.07	7.88 7.88	500 700
15	Top	21.3 59.5	38.4 41.25	8.3 8.12	8.0 8.0	500 1400
	Bottom	26.3 59.5	38.4 41.25	8.07 7.12	7.88 7.88	500 1400

* = 90″ for 2500 kVA units, 5 & 15 kV.
† for top entrance additional clearance required, 17.3″ max.
Black = Air filled terminal compartment.
Green = Oil cutout.

AIR INTERRUPTER SWITCHES

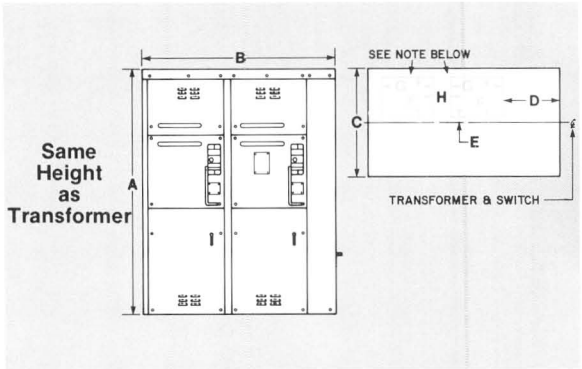


Note: Available space for primary leads at top and bottom

kV Type	Dimensions in Inches					Weight (in pounds)
	B	C	D	E	F & G	
5 Two Position	34.5	50	9.3	9.25	12.5 x 23	†800
15 Two Position	46	53	16.8	10.31	13 x 25	†1100
5 Selector	34.5	69	9.3	6.45	20 x 23	‡1200
15	46	81	19.5	2.4	31.75 x 19.75	‡1500

* A = 90″ for 2500 kVA units, 5 & 15 kV
† (1) for pothead add 100 pounds per 3/C or 3-1C sets
(2) for fuses add 200 pounds
(3) for Lightning Arresters add 100 pounds
‡ (1) for potheads add 200 pounds per 2-3/C or 3-1C sets
(2) for fuses add 200 pounds
(3) for Lightning Arresters add 100 pounds

DOUBLE AIR INTERRUPTER SWITCH



Note: Available space for primary leads at top and bottom

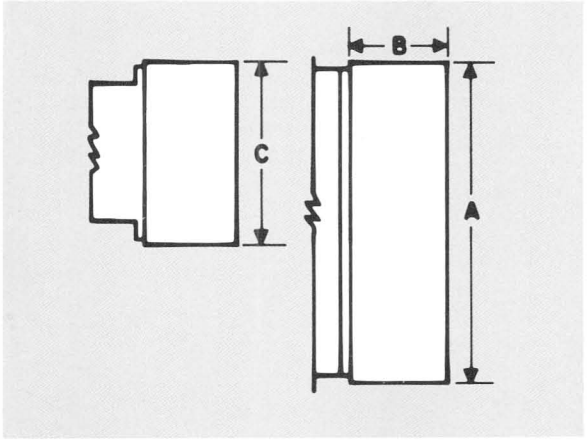
kV	Dimensions in Inches						Weight (in pounds)
	B	C	D	E	F & G	H	
5	61.81	50	9.3	7.75	16 x 23	4.36	‡1500
15	79.3	53	15.85	9.0	12.5 x 27	6.3	‡2100

‡ (1) for potheads add 200 pounds per 2-3/C or 3-1C sets
(2) for fuses add 200 pounds
(3) for Lightning Arresters add 100 pounds

Dimensions and Weights

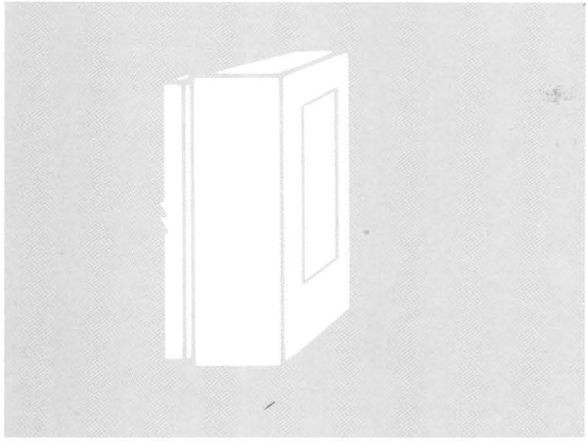
OUTGOING TERMINATION EQUIPMENTS

AIR-FILLED TERMINAL COMPARTMENT



No. of Cables per phase	"A"	"B" (inches)	"C" (inches)	Approximate Weight (pounds)
1 to 4	Same height as transforming section	15	39	250
5 to 8		22	39	400

TYPE AK BREAKER COMPARTMENT‡

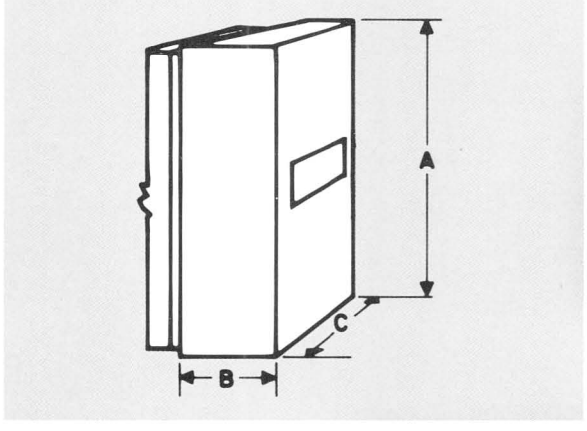


Type Breaker	"B" (inches)		"C" (inches)	Approximate Weight (pounds)	
	Stationary	Drawout		Stationary	Drawout
AKR-30	24	30	39	450	550
AKR-50	29	38	39	700	1000
AK-2-75	34	40	39	1000	1300
AK-2-100	38	44	44	1200	1800

† "A" dimension is same height as transforming section.

‡ In some cases the addition of metering will change the dimensions of the compartment. When metering is required, contact your GE Sales Office for additional information.

MOLDED-CASE BREAKER OR QMR FUSIBLE SWITCH COMPARTMENT‡



Type Panelboard	"A"	"B" (inches)	"C" (inches)	Approximate Weight (pounds)
Molded Case Breakers	Same height as transforming section	22†	39	500

† For main circuit breaker larger than 1200 amps dimension will be increased.

‡ In some cases the addition of metering will change the dimensions of the compartment. When metering is required, contact your GE Sales Office for additional information.

All dimensions are subject to change without notice and should not be used for construction purposes unless endorsed.

Fill in number

Fill in quantity and rating, cross out one

Item No. . . . . Integral Distribution Center
Unit Substation Specifications
. . . . . kVA *(indoor) (outdoor)* Secondary
Unit Substation(s)

General Arrangement

Cross out one

Cross out two

These specifications cover a complete *(outdoor) (indoor)* distribution center unit substation from the incoming line terminals to the outgoing feeder terminals. The unit shall be arranged so that facing the front of the unit, the incoming line section shall be on the *(left) (right)* and the low-voltage outgoing section on the (right (left).

Ratings

Fill in rating

The substation shall have the following self-cooled ratings.

Capacity . . . . . kVA
Frequency . . . . . 60 Hertz
Phases . . . . . three

Fill in rating
Cross out one
and fill in rating

Incoming 3-wire circuit . . . . . volts
Outgoing (3) (4)-wire circuits . . . . . volts

THE UNIT SUBSTATION WILL CONSIST OF THE FOLLOWING COORDINATED COMPONENTS:

1. Incoming Line Section

Select one

Air-filled Terminal Compartment

1—Air-filled low-voltage terminal compartment shall be mounted integrally with the transformer with *(pothead) (set of clamp-type terminals)* for a quantity of . . . . *(single-) (three-)* conductor *(lead-) (rubber-)* covered cable(s), size . . . . *(MCM) (AWG)* entering from *(below) (above)*.

3—TRANQUELL® (distribution type) . . . . . kV surge arresters mounted inside terminal compartment.

Old Cutouts

1—Set of three, gang-operated, oil cutouts rated *(5 kV) (15 kV)* mounted in an air-filled terminal chamber integral with the transformer. *(Key interlocking with the low-voltage secondary circuit breakers is required).*

1—Set of three fuse links mounted in above cutouts. These fuses shall be rated . . . . amperes and will be applied on a circuit having a short-circuit capacity of . . . . kVA symmetrical at . . . . volts.
(Pothead) (set of clamp-type terminals) for a quantity of . . . . *(single-) (three-)* . . . . conductor *(lead-) (rubber-)* covered cable(s), size . . . . *(MCM) (AWG)* entering from *(below) (above)*.

3—*(Station) (Intermediate) (Distribution)* class . . . . . kV surge arresters mounted inside terminal compartment.

Air-interrupter Switch

1—Two-position: open-close, three-pole, gang-operated, air-interrupter switch with stored-energy operating mechanism rated *(5) (15)* kV, *(600 amps continuous, 600 amps load interrupting, 40,000 amps asymmetrical momentary) (1200 amps continuous, 1200 amps load interrupting, 60,000 amps asymmetrical momentary). (Key interlocking with low-voltage main breaker may be required.)*

3—Power fuses *(GE Type EJ) (S&C Type SM4S) (S&C Type SM5S)* are to be mounted in separate compartment within the switch unit accessible through a hinged door mechanically interlocked with interrupter switch. Fuses shall be rated . . . . amperes and applied on circuit having short-circuit capacity of . . . . kVA symmetrical at . . . . volts.
(Pothead) (set of clamp-type terminals) for a quantity of . . . . *(single-) (three-)* conductor *(lead-) (rubber-)* covered cable(s), size . . . . *(MCM) (AWG)* entering from *(below) (above)*.

3—*(Station) (Intermediate) (Distribution)* class . . . . kV surge arresters are to be mounted inside the incoming-line compartment.

Air Selector Switch

1—Air interrupter, three-pole, gang-operated, selector switch rated *(5) (15)* kV, 600 amps continuous and load interrupting rating 40,000 amps asymmetrical momentary. It will consist of a two-position: open-close air switch with stored-energy mechanism in series with a two-position, line 1—line 2, dead-break switch. The two switches are to be mechanically interlocked so that the open-close interrupter switch must be in the open position before the line 1—line 2, dead-break switch can be operated. *(Key interlocking of the interrupter switch with low breakers is required.)*

3—Power fuses *(GE Type EJ) (S&C Type SM4S) (S&C Type SM5S)* are to be mounted in separate compartment within the switch unit accessible through a hinged door mechanically interlocked with interrupter switch. Fuses shall be rated . . . . amperes and applied on a circuit having short-circuit capacity of . . . . kVA symmetrical at . . . . volts.
(Pothead) (set of clamp-type terminals) for a quantity of . . . . *(single-) (three-)* conductor *(lead-) (rubber-)* covered cable(s), size . . . . *(MCM) (AWG)* entering from *(below) (above)*.

3—*(Station) (Intermediate) (Distribution)* class . . . . kV surge arresters are to be mounted inside the compartment and are to be connected to the bus between the two switches.

Double Air-interrupter Switch

1—Double air-interrupter switch rated *(5) (15)* kV, *(600 amps continuous, 600 amps load interrupting, 40,000 amps asymmetrical momentary) (1200 amps continuous, 1200 amps load interrupting, 60,000 amps asymmetrical momentary).* The equipment will consist of 2—two-position: open-close, three-pole, gang-operated, air interrupter switches, equipped with stored-energy mechanisms, which are connected to a common load-side bus. The switches will be key interlocked so that only one switch can be in the closed position.

3—Power fuses *(GE Type EJ) (S&C Type SM4S) (S&C Type SM5S)* will be mounted in a separate compartment within the switch unit accessible through a hinged door that is key interlocked so that both switches must be in the open position before the door can be opened. Fuses shall be rated . . . . amperes and are to be connected to the load-side switch bus. The incoming circuit has a short-circuit capacity of . . . . kVA symmetrical at . . . . volts.
(Potheads) (set of clamp-type terminals) for a quantity of . . . . *(single-) (three-)* conductor *(lead-) (rubber-)* covered cable(s), size . . . . *(MCM) (AWG)* entering from *(below) (above)*.

3—*(Station) (Intermediate) (Distribution)* class . . . . kV surge arresters are to be mounted inside the compartment and are to be connected to the common bus between the switches and power fuses.

GUIDE FORM SPECIFICATIONS (CONTINUED)

Select one

2. Transforming Section

Cross out one
Fill in ratings and cross out one

The transformer section of the unit substation shall be designed and built in accordance with the latest applicable NEMA Standards. It shall be ventilated dry type, self-cooled (with fans) and rated: AA (/FA), 60 Hertz, ... kVA 150 C *(115 C) (80 C)*, ... volts delta primary, ... volts *(wye) (delta)* secondary. Impedance, sound level and voltage connections will be in accordance with NEMA Standards.

The transformer shall have four approximately 2 1/2 percent rated kVA taps, two above and two below rated primary voltage. These taps shall be available by means of an internal terminal board located behind removable plates on the side of the transformer case and are to be changed only when the transformer is de-energized.

Standard Accessories

- Diagrammatic nameplate
- Ventilating louvers
- Removable side sheets
- Vibration-isolating pads
- Provision for lifting
- Provision for jacking
- Base suitable for rolling or skidding
- Ground pad on low-voltage end of enclosure

Optional Accessories

- Fans for auxiliary cooling mounted inside enclosure
- Overload indicator (with alarm contacts)

Test Requirements

The transformer core and coils shall be designed and built to meet the requirements of "Distribution and Power Transformer Short-circuit Test Code" ANSI C57.12.90a—IEEE 262A-1974. Each bidder shall submit to the engineer for his review and approval a complete listing of all full-size transformers of his manufacture within the rating category covered by these specifications.

Each transformer will receive all standard commercial tests in accordance with ANSI C57.12.90. (In addition, the following special tests will be performed on each transformer in accordance with applicable ANSI Standards—[impulse test on high-voltage winding] [sound level test] [temperature test at the self-cooled rate].)

3. Outgoing Line Section

Molded-case Circuit-breaker Panelboard

Consisting of a dead-front panelboard of the convertible circuit-breaker type containing individual molded-case circuit breakers, manually operated, with thermal-magnetic overcurrent protection assembled into a single unit. The panelboard shall be mounted in a metal-enclosed compartment mounted integral with the transformer. The following breakers are included.

Fill in ratings

1—Main air circuit breaker, molded-case, manually operated, stationary-type 3-pole, ... frame, rated . . . . .amp, ...amps interrupting capacity at . . . . .volts, set to trip at . . . . .amps.

Fill in quantity and ratings

. . . . .feeder breakers, molded-case, manually operated, stationary-type interrupting rating at . . . . .volts as follows:

Fill in quantity and ratings

Qty	Frame	Pole	Max Amp	Interrupting Rating (Amp)	Set to Trip at (Amp)
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

AKR Air Circuit Breaker

Consisting of a single Type AKR air circuit breaker of the drawout construction mounted in a metal-enclosed compartment mounted integral with the transformer. The breaker shall be of the stored-energy type and shall be *(manually) (electrically)* operated. The breaker shall be . . . . . amps frame size with . . . . . amps trip rating. Each pole of the breaker shall be equipped with dual magnetic long-time and instantaneous-overcurrent tripping devices.

Air-filled Terminal Compartment

Air-filled, low-voltage terminal compartment shall be mounted integrally with the transformer with *(pothead) (set of clamp-type terminals)* for a quantity of . . . . . *(single-) (three-)* conductor *(lead-) (rubber-)* covered cable(s), size . . . . . *(MCM) (AWG)* entering from *(below) (above)*.

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