PROLEC

Liquid Filled Secondary Substation Transformers

GE Prolec Transformers Meet Latest Applicable Standards of ANSI and NEMA

STANDARD kVA RATINGS

225 kVA	1000kVA
300 kVA	1500 kVA
500 kVA	2000 kVA
750 kVA	2500 kVA
	3000kVA

The standard kVA ratings are based on a 65°C average winding temperature rise by resistance above a 30°C average ambient.

STANDARD SECONDARY VOLTAGE RATINGS

208Y/120*	240*
480	480Y/277

* Not available above 1500 kVA

Secondary voltage ratings are approximately 4.2 percent above the standard motor voltages (460 and 230 volts), allowing for voltage drop in the line between the substation and the motor terminals without operating the motor at subnormal voltage. Motors and control operate satisfactorily on voltages 10 percent above or below rating.

Secondary lighting voltages are standardized at the voltage rating of the lamps (120 volt). Operating voltage is fairly critical to lamp performance. 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 transformers 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.

SPECIFYING TRANSFORMERS

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 designs.

All secondary substation transformers are three-phase, 60 Hz, with high-voltage windings delta-connected. Transformers are also available in 50 Hz designs.

STANDARD PRIMARY VOLTAGE RATINGS

All Delta:

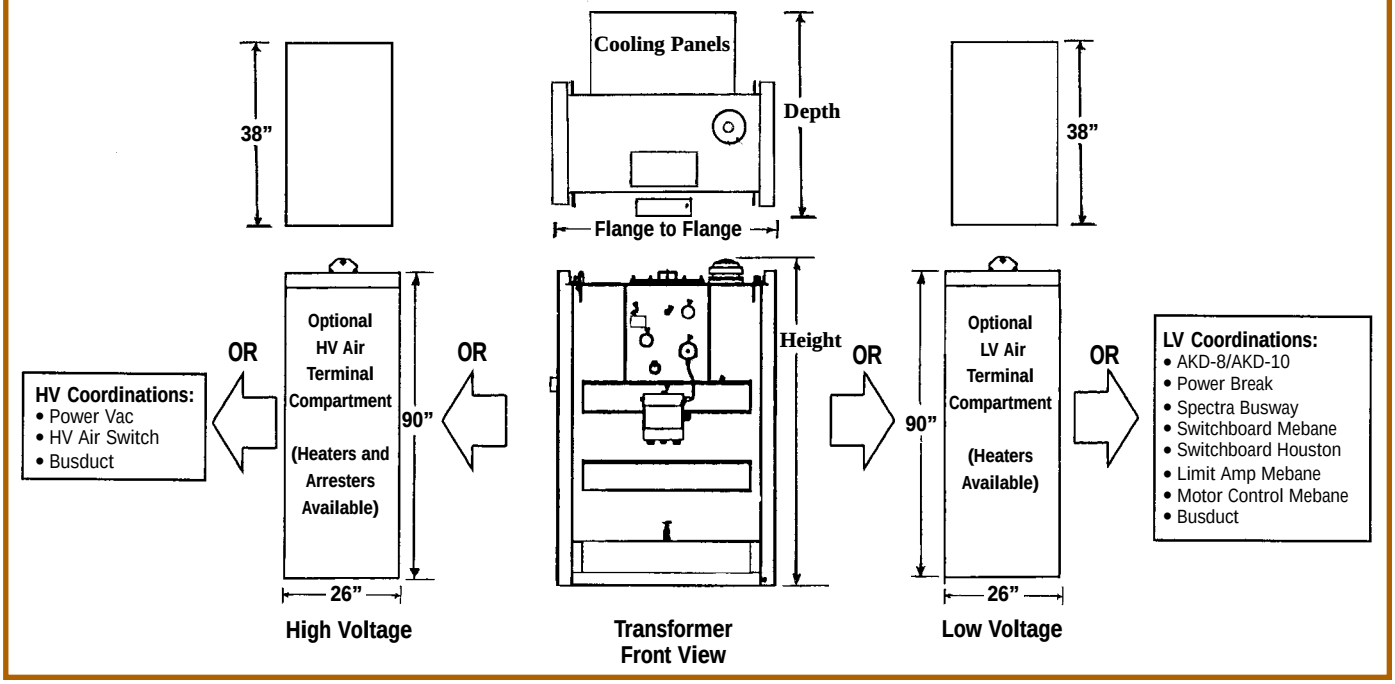
2400 Volts*	12000 Volts
4160 Volts	12470 Volts
4800 Volts	13200 Volts
6900 Volts	13800 Volts
7200 Volts	

*Not available above 1500 kVA.

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

kVA	PRIMARY LINE-TO-LINE VOLTS									SECONDARY LINE-TO-LINE VOLTS			
	2400	4160	4800	6900	7200	12000	12470	13200	13800	208	240	480	600
112.5	27.1	15.6	13.5	9.4	9.0	5.4	5.2	4.98	4.7	312	271	135	108
150	36.1	20.8	18.0	12.6	12.0	7.2	6.9	6.6	6.3	416	361	18.	144
225	54.1	31.2	27.1	18.8	18.0	10.8	10.4	9.8	9.4	625	541	271	217
300	72.2	41.6	36.1	25.1	24.1	14.4	13.9	13.1	12.6	833	722	361	289
500	120	69.4	60.1	41.8	40.1	24.1	23.1	21.9	20.9	1388	1203	601	481
750	180	104.1	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	4164	3608	1804	1443
2000		278	241	167	160	96.2	92.6	87.5	83.7			2406	1925
2500		347	301	209	200	120	116	109	105			3007	2406
3000		416	361	251	241	144	139	131	126			3608	2887

TABLE OF LINE CURRENTS



Dimensions and weights are subject to change without notice and should not be used for construction purposes.

APPROXIMATE WEIGHT (Lbs.), VOLUME (Gallons), AND DIMENSIONS (Inches)

(Oil Filled; 65°C Rise; HV Copper; LV Aluminum)

KVA*	Height	Flange to Flange	Depth	Oil	Weight
750	94	49	66	220	6,800
1,000	94	54	66	300	9,000
1,500	94	58	70	350	9,600
2,000	94	60	72	360	10,500
2,500	95	62	86	400	13,000
3,000	99	65	94	480	15,600

APPROXIMATE WEIGHT (Lbs.), VOLUME (Gallons), AND DIMENSIONS (Inches)

(Silicone Filled; 65°C Rise; HV Copper; LV Aluminum)

KVA*	Height	Flange to Flange	Depth	Oil	Weight
750	98	49	66	220	6,900
1,000	98	54	70	310	8,200
1,500	98	58	74	320	9,700
2,000	98	60	80	360	11,900
2,500	98	62	88	410	13,400
3,000	99	65	104	490	15,900

APPROXIMATE WEIGHT (Lbs.), VOLUME (Gallons), AND DIMENSIONS (Inches)

(Oil Filled; 55/65°C Rise; HV Copper; LV Aluminum)

KVA*	Height	Flange to Flange	Depth	Oil	Weight
750	94	49	66	240	7,000
1,000	94	54	66	310	8,400
1,500	94	58	72	360	10,000
2,000	94	60	88	400	12,100
2,500	96	62	96	420	13,700
3,000	99	65	104	490	16,100

APPROXIMATE WEIGHT (Lbs.), VOLUME (Gallons), AND DIMENSIONS (Inches)

(Silicone Filled; 55/65°C Rise; HV Copper; LV Aluminum)

KVA*	Height	Flange to Flange	Depth	Silicone	Weight
750	98	49	70	230	7,100
1,000	98	54	72	320	8,600
1,500	98	58	91	330	10,100
2,000	98	60	96	370	12,300
2,500	99	62	104	430	14,000
3,000	99	65	110	500	16,400

Dimensions and weights are approximate for kVA, 15kV Class, 95 kV BIL and normal service conditions.
Flange to flange dimensions may decrease slightly for Class units, with LV of 5 kV.
Dimensions may vary with special requirements.

*** For KVA's not listed, contact the factory.**

Electrical And Mechanical Characteristics

STANDARD IMPEDANCES	
kVA	**Percentage Impedance**
225	2.0*
300-500	4.5*
750-3000	5.75•

*** Minimum impedance**

• 5.5% above 600V LV

AUDIO SOUND LEVELS

All transformers have an inherent sound caused by the alternating magnetic flux in the core. The sound level is proportional to the kVA size of the transformer. There are a variety of options to compensate for sound issues. For example:

1. Strategically locate sites to minimize noise issues.
2. Use flexible conduit connections to prevent sound from being transmitted to other locations. Use auxiliary vibration dampers when appropriate.
3. Design transformer rooms so that they will minimize sound.
4. Install the transformer away from smooth surfaces, hallways, stairways, and enclosures which may reflect, resonate, or echo the sound.

PROVISION FOR FAN COOLING

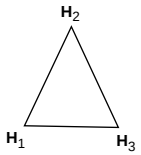
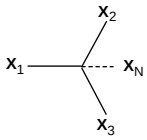
Cooling fans will increase the transformers capacity by 15 percent (750-2499 kVA) and 25 percent (2500-3000 kVA).

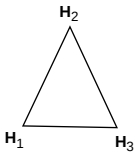
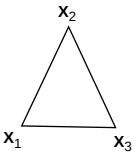
Includes:

1. Capacity in all current-carrying parts for fan-cooling rating.
2. Thermometer relay to control fan from liquid temperature.

STANDARD SOUND LEVELS		
SELF COOLED RATING kVA	WITHOUT FANS	WITH FANS RUNNING
300 & LESS	55	. .
500	56	. .
750	58	67
1000	58	67
1500	60	67
2000	61	67
2500	62	67
3000	63	67

Typical System Voltage	BIL	Insulation Classs	Low-frequency Test	Impulse Test		
				Chopped Wave		Full Wave
kV	kV	kV	kV	Kv Crest	Min. Time to Flashover, Micro-Seconds	kV Crest
1.2	30	1.2	10	36	1.0	30
2.4	45	2.5	15	54	1.5	45
4.8	60	5	19	69	1.5	60
8.32	75	8.7	26	88	1.6	75
14.4	95	15	34	110	1.8	95

Voltage	Delta-Wye connections
2400 4160 4800 6900 7200 12000 12470 13200 13800	Primary  (Three Wire) Secondary  208Y/120 three- or four-wire 480/277 three- or four-wire

Voltage	Delta-Delta connections
2400 4160 4800 6900 7200 12000 12470 13200 13800	Primary  (Three Wire) Secondary  240 three wire 480 three wire

Liquid- Filled Impulse Ratings		
Nominal SYSTEM Voltage, kV	Standard BIL, kV	Optional BIL, kV
1.2	30	45
2.5	45	60
5	60	75
8.7	75	95
15	95	110

Delta-connected primary windings are provided in standard secondary substation transformers. This is the simplest and most satisfactory connection.

Wye-connected secondary windings gain the advantages of neutral grounding in the most practical and economical manner.

DESIGN

Thorough analysis by GE Prolec designers incorporate many new features utilizing state of the art technology. The result: high mechanical and electrical strength necessary to meet the latest ANSI C57.12.90. This is the standard test code and guide for short-circuit testing of transformers.

Liquid-filled transformers are available with three types of dielectric fluid: oil, silicone and R-TEMP or equal. All types are enclosed in sealed tanks to keep the internal elements free from dirt, moisture and corrosive atmospheres.

OIL-FILLED

The oil-filled unit is the least expensive transformer, and is suitable for mounting outdoors or indoors enclosed in a vault.

The oil used in GE Prolec transformers meets all the requirements of ANSI C57.106 and ASTM D-3487, has high dielectric strength, is free from impurities, is durable and has a high flash point. These features make it an excellent insulating liquid.

SILICONE-FILLED

The silicone fluid selected for use in GE Prolec transformers is a clear, liquid silicone polymer (polydimethylsiloxane) that has been specially processed to meet exacting dielectric specifications. To obtain an optimum combination of heat transfer and fire-resistant properties, the transformer silicone fluid has a viscosity of 50 centistokes at 25°C. This fluid has a minimum fire point of 300°C and oxygen index of 21.

The silicone fluid that we are using meets paragraph 450-23 (Less-Flammable Liquid-Insulated Transformers) of the National Electrical code. OSHA by its Program Directive 100-68 permits the use of silicone transformers as equivalent to askarel transformers in its enforcement of the National Electrical Code.

Transformer silicone fluid has suitable dielectric characteristics, is compatible with other materials used in construction of transformers, and has shown good thermal stability in accelerated aging tests with transformer materials.

LESS-FLAMMABLE DIELECTRIC LIQUID R-TEMP OR EQUIVALENT

A Fire Resistant Hydrocarbon Fluid (FRHF) dielectric coolant formulated for use in distribution transformers is available when its unique electrical, thermal and safety properties are advantageous. It is non-toxic and readily biogradable. It is also referred to as a High Fire Point Fluid, a High Molecular Weight Hydrocarbon or a Less-Flammable Dielectric Liquid.

The dielectric coolant is a listed less-flammable fluid meeting the requirements of National Electrical Code Section 450-23, including a minimum fire point of 300°C and the requirements of the National Electrical Safety Code (IEEE C2-1993), Section 15.

Liquid Filled Transformers Feature Rectangular Coils

CORE-AND-COIL CONSTRUCTION

GE Prolec transformers are built with rectangular windings and core. The rectangular winding construction reduces the size of the tank that results in savings in weight and floor space without compromising performance and quality.

First, the low-voltage coils are wound on a rectangular form that simulates the rectangular core leg and serves as the main support for all the windings. These coils are of sheet winding construction using strip conductors. An extra strong electrical-grade paper is used as the insulation between each low-voltage turn.

The high-voltage coils are wound, under tension, over the low-voltage coils and are of layer-wound construction using film-insulated wire. Film-insulated wire is used because it is less bulky than paper, has higher dielectric strength on a volts-per-mil basis, and does not tend to split or crack when small radius bends are made. To provide insulation between each layer in the high voltage windings, an electrical-grade adhesive-coated paper is used.

After completing the winding process the high and low voltage coils are clamped to the desired dimensions. They are then oven baked at a temperature which allows the adhesive coating on the paper to bond the adjacent conductors and wires together. The result is a winding structure which has high short-circuit strength and high electrical stress withstand capability.

The transformer cores are constructed of non-aging, high grade, grain oriented silicone steel laminations with high magnetic permeability. Magnetic flux densities are kept well below the saturation point. Core laminations are free of burrs and assembled without gaps. The core clamping brackets are designed to provide an even distribution of clamping forces to the core yokes and legs.

LEAK-RESISTANT WELDED TRANSFORMER TANK CONSTRUCTION

The tank design incorporates many desirable features which assure flexibility of location, ease of maintenance and installation, and rodent protection.

The design, in effect, wraps the tank around the core-and-coil assembly. In so doing, the overall weight is reduced by reducing the tank material weight as well as the weight of the dielectric fluid.

The underside of the tank is accessible from the front and back, and allows the free movement of air, which helps to keep the underside of the tank dry and deter the formation of rust.

The high and low voltage bolted flanges have no openings, which eliminates the possibility of rodent access to adjacent high and low voltage terminal equipment.

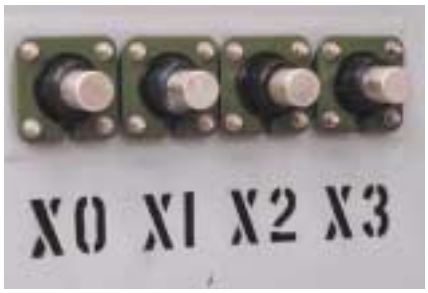
The tank cover is welded-on to eliminate contamination in the atmosphere from entering the tank. Cooling-panels are leak tested during the production cycle.

Sealed tank construction is achieved by seam welding formed and punched steel plates. Additional braces are welded as necessary to the side-walls to provide adequate pressure and vacuum ratings. Cooling panels are welded (removable radiators available) to the front and rear tank walls. Tanks are designed for 12 PSI. The tank is leak tested prior to, as well as after, coil drying and vacuum filling. Secondary substation transformer tanks feature side wall high voltage and low voltage bushings with flanges for connections to HV or LV switchgear or air terminal compartments.

For ease of handling and installation sturdy lifting lugs are welded in place on each corner for lifting by crane.

BUSHING DESIGN

The bushing design utilizes bolted construction using time-tested gasketing techniques and materials which are compatible with the liquid dielectric.



These techniques assure leak-free performance for the full life of the transformer.

Both high and low voltage bushings are externally removable without the necessity of removing the tank cover. This enables easy replacement of the bushings, should such a replacement be required.

The bolted-on porcelain or epoxy bushings are ideally suited for their application.

GE Prolec provides transformers designed for standard arrangements or reverse arrangement whichever is most convient for installation.

Accessories and Testing

The base is designed with bolt holes for easy tie down. It is constructed for rolling, skidding or sliding in the direction of either centerline.

Air Terminal Compartments

1. Terminal boxes can be supplied on the primary or secondary side of the transformer.
2. HV terminal boxes are suitable for single or loop feed.
3. Bolted-on end panel provides easy access to the cable fittings.
4. Incoming line cables can enter the top or bottom of the terminal box and can be connected with up to 8 cables per phase.
5. The standard method for cable connections is with clamp type terminals (#2-4/0 AWG,250-500 MCM or 600-1000 MCM).
6. NEMA two hole lugs are available upon request.
7. GE Tranquell Intermediate, Distribution, and Station type arresters are available when specified.

Standard Liquid and Features

- Type I Insulating mineral oil
- 60 Hertz Operation
- Externally operated de-energized tap changer providing (2) 2½ % Full Capacity taps above and below Nominal
- 65°C Average Winding Rise
- Side-mounted bushings
- HV and LV flange connections
- Pressure-vacuum gauge
- Top filter press connections
- Liquid level gauge
- Liquid temperature gauge
- Pressure test valve
- ANSI Grounding pad
- Drain/filter valve with sampling device
- Tank lifting lugs
- Non-corrosion diagrammatic nameplate
- ANSI 61 paint finish, 5 mils thick

Optional Liquid and Features

- Silicone fluid
- High fire point fluid, such as R-TEMP.
- 55/65°C Average Winding Rise
- Forced Air Cooling
- Future Fan Wiring and Control
- Removable Radiators
- Pressure Relief Device
- Fault Pressure Relay
- Winding Temperature Device
- Devices with alarm contacts
- Top Filter Press Valve
- HV & LV Air Terminal Compartments
- HV lightning arresters in ATC
- Current Transformers
- Neutral Grounding Resistor

Special Design or Application

- Special Impedances
- Low Loss
- Rectifier Transformer
- Isolation Transformer
- Special Ambient
- Special/Low Sound Level
- 50 Hertz
- Seismic Zone III and IV
- Retrofit to Specific Dimensions
- Non-standard loading conditions such as harmonic loading or specified K-factor

The liquid-level gage, dial-type thermometer, and pressure-vacuum gage are grouped with the nameplate so that all are easily readable from one floor-level position.

OPTIONAL ACCESSORIES

Winding Temperature Indicator

The winding temperature indicator provides a visual reading of the equivalent transformer winding hot-spot temperature. Similar to the top liquid thermometer, the winding temperature indicator is located in the top liquid. The indicator reads the combination temperature of the top liquid and a heater. This heater, when supplied with current proportional to the winding current, is designed to closely approximate the winding hot-spot rise over the top liquid; and thus, the indicator reading indicates winding hot-spot.

The indicator comes equipped with two sets of contacts which can be used for actuating auxiliary devices.

Fault-Pressure Relay

The fault-pressure relay provides a positive and reliable means of detecting an excessive rate of pressure rise within the tank resulting from an internal arc. The relay is normally mounted on the transformer cover. The relay is equipped with one normally open and one normally closed momentary contacts; therefore, the user must provide for a seal-in circuit to operate other devices.

Pressure-Relief Device

The pressure-relief device is self-reclosing and self-resealing. The mechanism is set at the factory to operate within an accuracy of plus or minus 10 percent.

A pressure-relief device will be furnished as a standard accessory on all silicone-insulated transformers.

PAINT FINISH

Metal surfaces are thoroughly cleaned of scale, oil, grease, rust and other foreign matter prior to painting. They are spray painted with one coat of primer.

An intermediate flow coat of enamel is then applied. If the unit is for outdoor application a third flow coat is applied to give a minimum film thickness of five mils.

Final finishes use an air dry enamel which is applied by either the hot air spray or conventional cold spray methods.

The standard paint finish color is ANSI-Number 61, Light Gray, Munsell Notation 8.3G 6.10/0.54.

STANDARD 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 C57.12.90—-1980.

1. Resistance measurements of all windings.
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.
7. Applied potential tests.
8. Induced potential tests.
9. Impulse tests.

GUIDE FORM SPECIFICATIONS

GENERAL ARRANGEMENT This specification covers a complete three phase secondary substation-type transformer. The transformer shall be **(Check One)**

(__) Standard Arrangement; When facing the front (nameplate) of the transformer, the incoming section shall be on the left and the outgoing section on the right.

(__) Reverse Arrangement; When facing the front (nameplate) of the transformer, the incoming section shall be on the right and the outgoing section on the left.

RATING Three-phase substation shall have the following self-cooled ratings:

kVA :_____ 300-3750 kVA with LV rating of <601 volts.
750-5000 kVA with LV rating of >600 volts.

WINDING RISE :
(__) 65 degree Centigrade rise…..(Standard).
(__) 55/65 degree Centigrade rise. Allows for 12% additional capacity when operated at 65 degree Centigrade.

FAN COOLING:
(__) OA, self-cooled; No fans available <750 kVA.
(__) OA/FFA self-cooled/future fan cooling capacity.
(__) OA/FA, self-cooled / fan-cooled increased capacity:
(15% additional capacity….750 kVA-2000 kVA)
(25% additional capacity….2500 kVA-5000 kVA)

FREQUENCY: (__) 60 Hertz (Standard) (__) 50 Hertz

INSULATING FLUIDS: (__) Mineral Oil (__) Silicone (__) High fire point fluid (ex. R-Temp)

HV Rating: (__) _____ Delta or Wye *
LV Rating: (__) _____ Wye * or (__) Delta
* HV Wye-LV Wye available only for 2500 KVA and below.

HV BIL:
(__) Standard….HV 15 kV Class, 95 kV BIL; 5 kV Class, 60kV BIL
(__) Optional….HV 15 kV Class, 110 kV BIL; 5 kV Class, 75kV BIL

LV BIL:
(__) Standard….LV 480 V Class, 30 kV BIL; 5 kV Class, 60kV BIL
(__) Optional….LV 480 V Class, 45 kV BIL; 5 kV Class, 75kV BIL

Impedance:
(__) Standard….5.75 % for LV < 600 V above 501 kVA; < 501 kVA
4.5 % Min **or** 5.50 % for LV > 600 V and HV BIL ≤ 110kV
(__) Special _____

Note: ANSI allows the tested Impedance to vary 7.5 % above or below the designed Impedance.

GENERAL CONSTRUCTION

The liquid insulated, secondary type substation transformer shall be designed, manufactured and tested in accordance with the latest ANSI Standards. Impedance, sound level and voltage connections shall be in accordance with NEMA Standards. The core shall be constructed of high-grade gain oriented silicone steel laminations to reduce size, sound and losses. The coils shall be of rectangular construction utilizing extra strong, electrical grade, adhesive-coated paper between turns. The core and coil assembly shall be installed in a sealed tank, immersed in insulated liquid to prevent dirt, moisture and corrosive elements from deteriorating the electrical and mechanical integrity of the transformer. Transformer shall have four approximately 2.5 percent rated kVA taps, two above and two below rated primary voltage. These taps shall be available by means of an externally operated manual tap changer for operation only when transformer is de-energized, with provisions for padlocking the tap changer.

STANDARD FEATURES

Windings : HV Cu / LV Al
Cover vent plug
Top filter-press connection
Liquid level gauge
Two tank grounding pads
Anodized aluminum Nameplate
Tank hand hole on transformer cover
Pressure relief device (Silicone units)
ANSI 61 Gray finish coat paint
No load tap changer with handle on front wall of transformer
Provisions for lifting and jacking
Drain and sampling device
12-PSI tank
Pressure test valve
Pressure vacuum gauge
Dial type thermometer (liquid)

OPTIONAL FEATURES

(__) Windings: All Copper
(__) Pressure relief device *
(__) Fault pressure relay *
(__) Winding temperature indicator *
(__) Pressure relief device (Oil Units) *
(__) Liquid level gauge *
(__) Liquid temperature indicator * (liquid)
* Device with electrical contacts

INCOMING SECTION

(__) HV flange, 90” full-height (Standard)
(__) Air filled terminal compartment: 26.4”deep and 38.4” wide.
Compartments are full height. Space heaters standard in outdoor units.
(__) Coordinated to HV Switch (supplier) _____

OUTGOING SECTION

(__) LV flange, 90” full-height (Standard)
(__) Air filled terminal compartment: 26.4” deep and 38.4” wide.
Compartments are full height. Space heaters standard in outdoor units.
(__) Coordinated to GE LV equipment _____
Includes copper flexible connectors.

TEST REQUIREMENTS

Each transformer shall receive all standard commercial tests in accordance with ANSI C57.12.90 (latest revision), with tests report available by serial number of the transformer.
Routine tests include:
-Resistance measurements of all windings
-Ratio tests on the rated voltage connection and all tap connections
-Polarity and phase relation tests on the rated voltage connection
-No load loss at rated voltage
-Exciting current at rated voltage
-Impedance and load loss
-Applied and Induced potential tests

...And Standing Behind Our Product

GE's sales organizations and distributor network will provide technical sales and service for GE Prolec products as they do for all other GEJT&D products and systems. GE's installation and service Engineers group, along with it's network of Apparatus Service Centers strategically located throughout North America, provide the new joint venture with a service network second to none.

All products manufactured under the JV will portray the GE monogram and carry the standard GE warranty.

Standards

ANSI/IEEE
NEMA,
NOM (Mexico)

BRINGING YOU QUALITY, TECHNOLOGY-BASED TRANSFORMER PRODUCTS...

PROLEC

INDUSTRIAL TRANSFORMERS
Phone: 1-800-GEPROLEC
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GE Dial Com 8 292-3384
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(706) 291 3144
8 292-3144

Or contact your local GE Sales Representative for more information.