THE SOUTHERN COMPANY
SPECIFICATION NO. SES-S-PTLP

GENERAL SPECIFICATION

FOR

LARGE POWER TRANSFORMERS

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RECORD OF REVISIONS

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4	03-07-13	General Revision – complete rewrite	RLK	* MEC

* MEC is the Southern Company Major Equipment Committee

SES-S-PTLP

NOTE:
For procurement of large power transformers this general specification is ONLY to be used in conjunction with an appropriate detailed specification.

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THE SOUTHERN COMPANY
SPECIFICATION SES-S-PTLP

GENERAL SPECIFICATION

FOR

LARGE POWER TRANSFORMERS

1.0 GENERAL

1.1 SCOPE

This Specification defines general requirements for the design, manufacture, testing, and delivery of outdoor, single and three phase, 60 Hz, oil-filled, large-power transformers with a maximum MVA rating larger than 100-MVA, 115-kV to 500-kV voltage class for the Southern Company. This general specification is to be used in conjunction with a detailed specification and other order entry documents that provide specific requirements not included in this specification. If there is a conflict between any of these documents, the responsible party ordering the transformer must be contacted for clarification. Equipment shall comply with these requirements.

1.2 CODES AND STANDARDS

Equipment shall be designed, rated, constructed, and tested in accordance with the latest editions of all applicable standards and codes insofar as is consistent with this specification. If there is a conflict between the industry standards and this specification, the manufacturer shall notify the responsible party given in the detailed specification to resolve the conflict before proceeding with work.

ANSI / IEEE

ASTM,

AWS (American Welding Society, Inc)

CGA (Compressed Gas Association)

NEMA,

NESC,

NFPA (National Fire Protection Association)

SSPC (Steel Structures Painting Council)

USEPA (US Environmental Protection Agency Regulations)

1.3 SERVICE CONDITIONS

The transformers will operate in outdoor unsheltered environments when installed in electrical power substations.

1.3.1 The usual service conditions per ANSI/IEEE C57.12.00 will apply.

1.3.2 Any special conditions will be identified in the detailed specification.

1.3.3 The maximum expected wind speed will be 140mph.

1.4 RATINGS

See detailed specification and letter of inquiry for ratings.

1.5 LOSS EVALUATION

The capitalized costs for losses will be provided in the Detail Specification or Letter of Inquiry. Loss evaluation for autotransformers will be made at the self cooled rating to determine evaluated total costs for each transformer. Loss evaluation for GSUs will be made at the maximum rating to determine evaluated total costs for each transformer. If either the tested no-load or load loss of the transformer exceeds its respective guarantee, a loss penalty will be assessed against the transformer's no load and load losses independently. Auxiliary (cooling) losses will be evaluated as load losses at the maximum force-cooled rating (167% of self-cooled).

1.6 DESIGN REVIEWS

Purchaser reserves the right to have a design review meeting prior to release of the transformer design for production. Design reviews will be required on all new and updated designs. Previously purchased duplicates are subject to design review if one was never performed. Design reviews will be conducted in accordance with plans to be furnished prior to the meetings. Design review meetings will usually be held at the manufacturing facility.

Design reviews usually will occur when the transformer electrical, mechanical, and lead layout designs are complete. The outline, nameplate, and preliminary control designs or drawings shall also be available for discussion. No manufacturing is to start until completion of the design review and resolution of any important open items. The manufacturer must assume responsibility for any materials ordered prior to completion of the design review. The manufacturer will be required to supply documentation in the form of historical data, computer analysis, previous calculations, design tests, etc. to support supplied calculated data. Southern Company will require the manufacturer to have experimental and other analytical data for review to demonstrate the accuracy of the design calculations. When a design review is required, the following list identifies some of the issues that will be covered:

1. Shielding and Stray Flux Control

2. Insulation System, Clearances, and Stresses – Recurrent Surge Oscillograph (RSO) tests will be required on new Southern Company designs.

3. Core Design – Core temperatures and hot spot gradients shall be calculated at both 100% and 105% excitation

4. Winding Design including the use of axial crossover supports in the spacer column of disc windings

5. Short Circuit Design – The manufacturers may be asked to support the short circuit capability based on model tests, full sized transformer tests, and experience in service. The calculated forces and stresses shall be based on leakage field calculation methods acceptable to and approved by Southern Company.

6. Design Margins, and Withstand Criteria – The calculated margin and withstand criteria must be acceptable to and approved by Southern Company.

7. Lead routing

8. Mechanical design including a detailed description of the clamping system. Manufactures will be required to provide the deflection in the pressing ring. The mechanical design for shipment shall be approved by Southern Company.

9. Thermal

10. Sound Level

11. Accessories

12. Testing & Test Plan to include test circuit setup, applied voltages, tap position during test, and acceptance criteria.

2.0 DESIGN REQUIREMENTS

2.1 INSULATION SYSTEM

All materials used must meet the highest quality standards. The purchaser reserves the right to examine the specifications for all materials to be applied in Southern Company transformers.

2.1.1 Spacer and barrier pressboard shall be made from high quality pulp. It shall be manufactured using the pre-compressed pressboard method. All materials used in the pressing column shall be high density.

2.1.2 Paper insulation shall be thermally upgraded for 65 K ratings. Paper insulation for Continuous Transposed Conductor shall be elongated papers such as Dennison crepe paper 22HCC. If Dennison is not used, any alternate papers must be approved by the purchaser. Netting tape is also acceptable where applicable.

2.1.3 Lebonite, Lignostone or similar material (laminated wood) shall not be used in high electrical stress areas or in direct contact with any current carrying components.

2.1.4 This transformer shall be designed such that there are no static electrification issues.

2.2 WINDING AND LEAD DESIGN

2.2.1 All windings and leads must be made from copper.

2.2.2 The use of internal metal oxide protection to limit transient voltages in and between windings is not allowed without the written

permission of the purchaser. If internal metal oxide is to be used in a proposed design, it must be clearly noted in the bidder's proposal.

2.2.3 The Purchaser will require the use of the Weidmann curves with acceptable margins as the basis for dielectric clearances.

2.2.4 All layer windings shall be continuously transposed cable and wound with compaction or tension on the conductors so that the windings are tight in both radial and axial directions. Layer windings must be made so that adjustment in the winding length can be evenly distributed about the electrical center.

2.2.5 Disc windings shall have the crossovers supported vertically in the spacer columns

2.2.6 All leads must be well supported for short circuit, handling, and shipping forces. They must be secured using high density pressboard clamps with pressboard sleeves covering the bolts. Each lead must have a pressboard sleeve where it goes through a clamp. The use of cotton tape, string, or plastic ties is not acceptable. For applications 250kV BIL and below, the use of laminated wood or hard maple clamps for supports is acceptable, but pressboard sleeves are still required.

2.2.7 The hot spot temperature of leads must not exceed the maximum hot spot in the windings by more than 2K.

2.2.8 A Recurrent Surge Oscillograph Test (Low Voltage Impulse Test) will be required on all new designs for Southern Company in order to confirm the manufacturer's impulse distribution calculations. Test results on Southern Company transformers shall be provided to Southern Company.

2.3 THERMAL DESIGN

2.3.1 The transformer shall be designed for loading per ANSI/IEEE C57.91 loading guide. Ancillary equipment shall not restrict loading capabilities and conditions described to levels below those permitted by the insulated conductor and other metallic part hot spots per section 9 of C57.91.

2.3.2 The manufacturer shall calculate the oil rise in each individual winding as well as the gradient in the top turn or disc of each individual winding.

2.3.3 The manufacturer shall calculate the hot spot rises in each individual winding based on the calculated oil rises and gradients from 2.3.2, the maximum localized losses, insulation on the conductors, and oil flow patterns. Hot spot allowances will not be accepted.

2.4 SHORT CIRCUIT DESIGN

Short circuit withstand shall be designed per ANSI/IEEE C57.12.00 with fault currents limited by transformer impedance only and for fault duration of five (5) seconds. No system impedance is allowed for the calculations. The calculation of the forces and stresses shall be based on acceptable leakage field calculation methods.

2.4.1 Core Form Short Circuit Design Requirements

1. The inner windings must be designed to withstand “free” or unsupported buckling and “forced” or buckling between axial spacers.

2. The calculated bending between radial spacers and the stress on the radial spacers must be furnished. Calculation of axial forces shall be based on a minimum off set between windings of:

0.50% -	Windings 800mm and below
0.45% -	Windings 800 to 1200mm
0.40% -	Windings 1200 to 1600mm
0.35% -	Windings 1600 to 2000mm
7mm -	Windings greater than 2000mm

2.4.2 Shell Form Short Circuit Design Requirements

1. Beam bending of conductors between supporting spacers shall be calculated.

2. Inner and outer coil edges shall be supported in order to prevent failures due to cantilever forces during short circuit conditions.

2.5 MAGNETIC CIRCUIT

2.5.1 The core induction at 110% voltage shall be limited to 1.93 Tesla with step lap joints and 1.90 Tesla without.

2.5.2 In core form designs, each individual core leg shall be banded or wrapped using a high temperature material for mechanical support. If a total wrap is used it must have a means to allow oil flow between the wrap and the core.

2.5.3 All cooling ducts in the core and between the tie plates and core shall utilize high temperature material capable of withstanding the expected temperatures.

2.5.4 The core hot spot temperature shall be less than 125 C at full rated load, 105% voltage, and 30 C Average ambient temperature (Core Hot Spot Gradient over Top Oil Rise + Top Oil Rise Over Ambient + 30 C Average Ambient Temperature).

2.5.5 The core surface temperature shall be less than 95 C at full rated load, 105% voltage, and 30 C Average ambient temperature (Core Surface Gradient over Top Oil Rise + Top Oil Rise Over Ambient + 30 C Average Ambient Temperature). If the core surface temperature exceeds 95 C, high temperature material (i.e. Nomex, high temperature fiberglass, etc.) shall be used in lieu of pressboard.

2.5.6 The maximum allowed burr on the edges would be .02 mm or .00078 inches.

2.5.7 The core shall be connected to ground through a terminal located on the tank wall. Insulated frames and any other windings (auxiliary transformers, reactors, series transformers, etc.) separate from the main core and coil assembly shall each have separate grounds

connected in the same manner. The terminal bushings shall have a minimum current carrying rating of 200A and be capable of withstanding a 2500V DC insulation resistance test. The terminals shall be located in an oil tight, weatherproof enclosure. The terminal bushings and straps shall be clearly and permanently identified with nameplate adjacent to or on the enclosure. Large enclosures shall be hinged.

2.6 BUSHINGS

See **Drawing PTLP-02**

2.6.1 Bushing arrangement is subject to Purchaser approval.

2.6.2 Minimum external clearance, metal-to-metal:

System Voltage (kV)	BIL (kV)	Phase-Ground Clearance (in)	Phase-Phase Clearance (in)
Below 230	ANSI	ANSI	ANSI
230	900	71	89
500	1550	124	ANSI

2.6.3 The low voltage bushings, low voltage interface design, spacing and flange arrangement for generator step up transformers shall be coordinated with the low voltage interface requirements (isolated phase bus or other means) and shall be subject to approval by the Purchaser. Details of the low voltage interface will be provided in the detail specification.

2.6.4 Low voltage bushings and associated gasketing for generator step up transformers shall be rated for 125 deg C temperatures. Shared oil type bushings are not allowed.

2.7 DE-ENERGIZED TAP CHANGER

2.7.1 A de-energized tap changer (DETC) will be required unless otherwise stated in the detail specification and/or the letter of inquiry. Rated tap positions will be given in the detail specification

and/or letter of inquiry. The taps shall be located in the high voltage winding (series winding for auto transformers).

2.7.2 The tap changer shall be operable from ground level. The height shall not exceed 5 feet from the base of the tank.

2.7.3 A tap position indicator will be located integral with the operating handle and shall be readable from the ground. Operation of the tap changer and visibility of the indicator shall not be impeded or obscured in any way by other components such as radiators, conduit, etc.

2.7.4 The operating mechanism shall be lockable on any tap position with padlock having a 3/8" shackle.

2.7.5 Tap changer contacts shall be silver plated. Tap changers having requirements for periodic movement of the contacts to prevent coking will not be accepted.

2.8 CONSERVATOR OIL PRESERVATION SYSTEM

A conservator oil preservation system is required unless the detail specification or letter of inquiry specifies another system type. It shall be an air cell type of system designed to prevent oil-air contact. The conservator and all associated valves and piping shall be vacuum proof. This capability shall be shown on the nameplate. See Drawing PTLP-05. Provide for the following requirements:

2.8.1 A drain valve to completely drain the conservator tank.

2.8.2 A conservator tank oil level gauge with two sets of form C alarm contacts.

2.8.3 A regenerating desiccant breather for air space located at ground level. Messko and Waukesha are the preferred manufacturers. Any others must be approved by the purchaser.

2.8.4 Gas collector/detector relay system with copper tubing.

2.8.5 Provisions for vacuum processing through the conservator.

2.8.6 Provide isolation valve between the conservator and main tank.

2.8.7 Provide bladder manufactured by Pronal or other customer approved equivalent.

2.8.8 Design oil expansion tank for -30 C to +110 C oil temperature.

The leak rate must be such that the oil will not become saturated in a period of less than 10 years.

2.9 REMOVABLE RADIATORS

2.9.1 Install radiators to permit removal without losing oil from main tank and without affecting use of remaining radiators.

2.9.2 Bolt-on radiator valves are acceptable.

2.9.3 Provide means for venting trapped air from radiators, headers, piping, etc.

2.9.4 Valve position indicators shall be clearly marked to indicate OPEN and CLOSED positions.

2.9.5 Provide means for securely bolting the valves in both OPEN and CLOSED positions.

2.9.6 Transformers supplied with coolers shall have hinged panels that allow the fan motors and shrouds to swing away from the cooler tubes for ease of cleaning.

2.9.7 Radiators shall be painted, galvanized or painted galvanized. The detail specification or letter of inquiry will indicate which coating to use.

2.9.8 The radiator manufacturer must be approved by purchaser. Menk is preferred.

2.10 CONTROL CABINET

2.10.1 Mounting such that height of internal components requiring routine Purchaser access is approximately between 2 ft. and 5 ft. above transformer base and the cabinet bottom is minimum 18 inches above the transformer base.

2.10.2 Doors with non-corrosive hinges.

2.10.3 Double door construction for door openings wider than 42 in.

2.10.4 NEMA 3R rain-tight, ventilated construction.

2.10.5 No penetrations in top of cabinet.

2.10.6 Terminal block spacing such that there is a minimum 4 in. clearance space for Purchaser's cable terminations and between adjacent blocks where Purchaser's terminations are required between blocks.

2.10.7 Removable plate for Purchaser's conduit entrance mounted on inside of cabinet bottom with minimum usable size 8 in. x 18 in.

2.10.8 Provide two or more cabinet heaters for moisture control, mounted in safe and secure location, one half continuously energized and one half controlled by an adjustable means to operate at 120 VAC.

2.10.9 Provide 120-VAC lighting mounted inside the control cabinet.

2.10.10 Provide power outlet, 120-VAC, 20A, duplex, GFCI type, mounted inside the control cabinet.

2.10.11 Internal mounted gauges/monitors shall have a viewing window in the door.

2.10.12 If a 480VAC or 600 VAC auxiliary external power source is used, barriers shall be provided inside the control cabinet separating components of primary power circuit from alternate circuits of 480- or 600-VAC circuits from control and alarm circuits.

2.10.13 All auxiliary equipment contacts shall be wired to terminal blocks in control cabinet and rated for use on 125-VDC ungrounded source.

2.11 CONTROLS

2.11.1 Fan and pump motor power circuits shall be equipped with under voltage relays.

2.11.2 Provide selector switches to alternate sequence of operation of cooling stages, where applicable.

2.11.3 Cooling equipment stages shall be wired and protected so opening a circuit breaker will disable only the affected stage.

2.11.4 Provide ON-OFF-AUTO control switch for each stage of cooling. In AUTO mode, cooling equipment shall be controlled by parallel operation of electronic temperature monitor and oil temperature indicator switches.

2.11.5 Wire the control circuit for the oil pump motor contactor to terminal blocks in order to permit the purchaser to wire a remote lockout auxiliary relay normally-closed contact in series with the power source and the motor contactor.

2.11.6 Fan groups shall be balanced among radiator banks for each cooling stage.

2.11.7 Cooling equipment contactors shall be UL approved definite purpose. The minimum rating shall be 200% of the connected horsepower or 150% of the connected full load current.

2.11.8 All power sources and branch circuits shall be protected by molded case circuit breakers rated 240 VAC with minimum 10,000 Amp RMS symmetrical interrupting current.

2.12 FANS, PUMPS AND MOTORS

2.12.1 Fans and motors must be approved by the Purchaser. Krenz fans are preferred.

2.12.2 OSHA approved fan blade guards and metal blades.

2.12.3 Motors

1. Single phase (preferred), 3 phase if above 1 hp, 60Hz.
2. Thermally protected, automatic reset.
3. Sealed, permanently lubricated ball bearings.
4. Housings grounded by separate grounding conductor from motor to ground connection in control cabinet.
5. Suitable for mounting in any position.
6. Interior protected against rust and corrosion.
7. Equipped with 3/16 in. diameter maximum threaded drain holes; holes temporarily plugged (not taped) for shipment. Temporary plugs shall be highly visible and tagged.
8. UL listed; Class F (or better) insulation material.
9. Centrifugal/mechanical switches not acceptable.

10. Pump motor electrical connectors capable of withstanding full vacuum on main tank.

2.12.4 Pumps shall be Harley/Cardinal with sleeve bearings or Purchaser's approved equivalent.

2.13 AUXILIARY (EXTERNAL) POWER

See detail specification and/or letter of inquiry for 60 Hz external power source provided by the purchaser. If the external voltage furnished is greater than 120/240VAC then the manufacturer must provide an adequately sized dry-type auxiliary power step-down transformer to supply auxiliary power requirements.

2.13.1 The step down voltage determined for the auxiliary power will be subject to Purchaser's review and acceptance.

2.13.2 Separate auxiliary transformers shall be furnished for each external power source. Transformers to be delta connected primary with two above and two below 2-1/2 percent taps and secondary as determined by the manufacturer.

2.13.3 The auxiliary power transformer can be mounted external to the control cabinet. Externally mounted transformers shall be NEMA 3R rain tight, ventilated construction.

2.13.4 A visible break for each power source by a heavy duty safety switch shall be furnished in the control cabinet or separately mounted.

2.14 AUXILIARY STATION SERVICE TRANSFORMER

2.14.1 See Appendix C sheets 2 of 4 and 3 of 4.

2.14.2 See Detail Specification or Letter of Inquiry for station service power source requirements.

2.14.3 Visible break for each power source by a heavy duty safety switch shall be provided.

2.15 VALVES

See Drawing PTLP-05

2.15.1 Provide one (1) drain valve and one (1) fill valve located in the segment opposite the drain valve. Drain valve shall be arranged so that tank can be completely drained of oil.

2.15.2 Bolt on valves will be accepted but will have to meet the specified gasket requirements. There shall be no gasket joints between tank and non-bolted valves.

2.15.3 Provide upper and lower 2” valves (ball is preferred, but gate valves are acceptable) mounted in the same segment for future connection of a Kelman, Serveron, or Hydrocal monitor. The upper (return) valve shall be plumbed internally to the upper portion of the tank and the lower (intake) plumbed straight into the oil. When the monitor is required by the detail specification, isolation valves of the type and quantity recommended by the OEM and approved by the purchaser shall be provided.

2.15.4 For GSU transformers and reactors, provide one (1) rapid-pressure-rise relay with 2” valve installed per drawing PTLP-10 and located to permit removal of the relay with the transformer in service. This is not required for auto transformers unless specified in the detail specification.

2.16 GENERAL

2.16.1 Surge Arresters - Provisions for tank mounted surge arresters along with separate ground pads shall be provided with any arresters supplied by the Purchaser (Per **Drawing PTLP-03)**. The individual arrester pads shall be mounted as close as possible to the respective arrester base.

2.16.2 Current Transformers - See **Drawing PTLP-04** and the Detail Specification or Letter of Inquiry.

2.16.3 Design for Shipment - All transformers must be designed to withstand longitudinal, transverse, and vertical accelerations encountered during shipment by ship, truck, and railroad. The manufacturer is responsible for determining the forces to be encountered during shipment.

2.16.4 Gauges, Thermometers, Relays, and Devices - See **Drawing PTLP-05** and detail specification.

2.16.5 Geomagnetically Induced Current (GIC) - The transformer shall be designed to withstand the following GIC levels:

200 amps in the neutral of the bank (67amps / phase): 1 minute is permissible

150 amps in the neutral of the bank (50 amps / phase): 2 minutes is permissible

100 amps in the neutral of the bank (33.5 amps / phase): 5 minutes is permissible

50 amps in the neutral of the bank (17 amps / phase): 1 hour is permissible

25 amps in the neutral of the bank (8.5 amps / phase): 2 hours is permissible

2.16.6 Audible sound shall meet levels per NEMA-TR-1-1908. The average sound level shall not exceed 85 dB(A). Any special sound requirements will be given in the detailed specification and discussed during design review in order to determine the test procedure and all acceptance criteria.

2.16.7 Auto transformers (system tie) shall be designed for step-up/step-down operation.

2.16.8 This transformer shall be designed such that special procedures and/or restrictions for energization or de-energization are not required.

2.16.9 For auto transformers with tertiary, the tertiary winding shall be designed and name plated for continuous loading of 35% of the main winding rating determined by the product of [Co-Ratio] X [MVA Rating] X 35%. For example, the tertiary winding of a 230/115 kV

autotransformer rated 180 MVA ONAN shall be rated [115kV/230kV X 180 MVA X .35 = 31.5 MVA ONAN.

3.0 MANUFACTURING REQUIREMENTS

3.1 WIRING

3.1.1 Junction boxes shall be rain and dust tight.

3.1.2 Wiring shall be sized in accordance with NFPA-70. Wire shall be type THWN, MTW, FEP, RHH, THHN, XHHW, or approved equivalent, 600V with minimum size number 12 AWG.

3.1.3 Wiring shall be point to point without splices or tee connections and terminated with ring tongue compression connectors fabricated from seamless tube stock.

3.1.4 Wiring shall be bundled and supported using raceways or mechanically (not adhesive) mounted cable ties.

3.1.5 Rigid Metal Conduit, Intermediate Metal Conduit, or Liquid-tight Flexible Metal Conduit shall be provided for external wiring (not including flexible cable). Exposed ferrous conduit threads shall be painted or otherwise protected against future corrosion both before and after assembly. Wiring run in enclosed tank bracing is acceptable.

3.1.6 Auxiliary equipment connected with plug in connectors shall be type SOW #16 AWG flexible cable with maximum 30” length.

3.1.7 Terminal ends shall be clearly and permanently identified.

3.1.8 Spark plug bushings are not acceptable for CT leads.

3.2 TERMINAL BLOCKS

3.2.1 Terminal blocks for Purchaser's connections shall be States Company Type NT or Poweright Type 78S, front connected, sliding link type with white marker strips.

3.2.2 For horizontally mounted terminal blocks, sliding links shall move down to open and up to close.

3.2.3 For vertically mounted terminal blocks, sliding links shall move left to open and right to close.

3.2.4 Door mounting of terminal blocks is acceptable only to facilitate wiring of components located on door. Wiring crossing door hinges shall be terminated on terminal blocks located on cabinet side of hinge.

3.2.5 All CT wiring shall be wired to shorting type terminal blocks in the main control cabinet.

3.3 DEVICE IDENTIFICATION

Identify all controls, relays, power and auxiliary devices, etc., with designation plates adjacent to but not on the device which are clearly legible, etched or engraved on durable, non-corrosive material, permanently attached with mechanical fasteners (adhesive mounting not acceptable). Use the same identification as shown on the elementary diagram.

3.4 GASKETS AND DETAILS

All gaskets shall be in machined grooves.

3.4.1 See Drawing PTLP-06 for sealed tank opening requirements.

3.4.2 See Scarf-splice gaskets per Drawing PTLP-06 for scarf splicing requirements. Butt splicing is not acceptable.

3.4.3 Gasket material shall be fabricated from synthetic rubber (Nitrile-Butadiene, Butyl-N, etc.) highly resistant to oils, aromatic fuels, and

solvents. Materials containing cork are not acceptable. For high temperature applications nitrile or viton gaskets shall be used.

3.4.4 Retain gaskets in rectangular grooves sized for approximately 1/3 compression.

3.4.5 Gasket groove surfaces shall be properly cleaned and protected with two coats minimum rust inhibiting paint and sufficiently dried before gasket installation.

3.4.6 "O-ring" gaskets greater than 6 in. in diameter require Purchaser's approval. The proposal shall list all gaskets required.

3.5 TANK AND FITTINGS

3.5.1 Tank seams subject to leaking shall be welded with continuous bead inside and outside. There shall be no corner seams.

3.5.2 Tank shall be braced for full vacuum.

3.5.3 Cover shall be welded.

3.5.4 Base shall be provided which will allow skidding perpendicular to center lines.

3.5.5 Lugs shall be provided for pulling transformer perpendicular to center lines.

3.5.6 Lifting lugs capable of lifting the transformer completely assembled and oil filled shall be provided.

3.5.7 Lugs shall be provided for lifting cover.

3.5.8 Jack bosses at four corners shall be provided which will accommodate 19" high by 9" diameter hydraulic jacks with minimum 4 in. X 4 in. bearing surface.

3.5.9 All access covers located below the oil level shall be clearly identified in the approval drawings and are subject to purchaser approval.

3.5.10 Round access openings shall have a minimum 18 ½" diameter. Rectangular access openings shall be a minimum 15" by 40".

3.5.11 See drawing PTLP-07 for requirements for safety pole on cover and welded guard cleats.

3.5.12 Pressure relief device shall be mounted on a standpipe with a vent plug. The height of the standpipe shall be same as the top of the conservator tank. The minimum height is 6 inches. The standpipe prevents the conservator from emptying if the pressure relief device operates and does not re-seal.

3.5.13 Cover mounted enclosures for current transformer wiring and cover mounted flanges for isolated phase bus interface shall be provided with seep holes to avoid accumulated liquid.

3.5.14 Provide copper faced or stainless steel grounding pads 1" thick with two (2) ½"x13 threadx3/4" deep tapped holes on 1-3/4" centers as follows:

1. One each welded on diagonally opposite sides of tank near base.

2. One per surge arrester, welded to tank near base of arrester.

3. One near base of the neutral bushing for neutral grounding if the transformer is a three-phase unit.

3.6 FASTENERS (BOLTS, STUDS, WASHERS)

3.6.1 Bolts, studs, and washers exposed to weather: non-magnetic stainless steel; with mild steel or silicone bronze nuts when used on cover access plates; lubricated before installation.

3.6.2 Hand weld studs used to seal gasketed tank openings.

3.6.3 Plated bolts, nuts, and washers shall not be used inside the tank.

3.7 PAINTING

3.7.1 Exterior color shall be ANSI-70 SKY GRAY.

3.7.2 Paint system shall meet or exceed ANSI C57.12.28, 'Enclosure Coating System' or manufacturer paint system approved by the Southern Company.

3.7.3 Interior of the tank shall be painted white.

3.8 INTERNAL COMPONENTS

3.8.1 All electrical connections shall be made with a minimum of two bolts. Any exception to this requirement must be approved by the purchaser.

3.8.2 Lock washers are acceptable only if fully retained by cup washers or other Purchaser-approved method.

3.9 INSULATING OIL

3.9.1 All oil supplied with this transformer shall meet the requirements of ANSI/IEEE C57.106 and SES-S-OS01.

3.9.2 All oil used in the manufacture of this transformer including oil used for factory impregnation and testing shall also meet this requirement.

3.9.3 Certificates shall be supplied verifying that all factory oil used in this transformer meets these requirements.

3.10 SPECIAL PROVISIONS

3.10.1 Radiator cover plates minimum of ¼" steel plate shall be installed on each radiator header. This cover plate shall be furnished with a 3/16" thick nitrile or coreprene gasket to seal the radiator. One plate on each radiator shall have a Schrader valve installed to facilitate pressurizing the radiator and checking the pressure upon receipt. The radiator shall be pressurized to 3 psi @ 25 deg C. The pressure valve and temperatures shall be documented and supplied as part of the shipping documentation.

3.10.2 Bushing cover plates shall be furnished for all bushings removed for shipment. A spark plug type bushing shall be installed in each cover plate for FRA testing before shipment and upon receipt. The respective lead shall be securely connected to the spark plug bushing. The lead shall also be secured as necessary to prevent movement during shipment.

3.11 DRYING AND SIZING

3.11.1 Shell form windings shall be dried under compression. The windings must be compressed and clamped during core assembly so that the windings are under compression after the core is completed and the clamps are released.

3.11.2 The manufacturer is expected to dry, size, and compress the windings such that, after tanking, they are tight to the designed clamping pressure and remain tight during transport and while in service. The Southern Company will require the manufacturer to measure the clamping pressure on the core and coil assembly once it is tanked to ensure that it is equal to the final design clamping pressure. If the clamping pressure of the tanked core and coil assembly is more than 10% less than the applied pressure, the assembly must be repressed to full pressure. In lieu of measuring pressures and repressing once the core and coil assembly is tanked, the manufacturer can perform the hang test as follows:

1. Suspend completed assembly 60 minutes.

2. Lower assembly to floor and re-measure pressure.

3. If 10% or more of the applied pressure is lost, re-pressed windings to full pressure and repeat steps 1 and 2 for 30 minutes hang time.

4. This process may be repeated as necessary until less that 10% of applied pressure is lost.

5. Once pressure loss is less than 10%, re-pressed assembly to full pressure and the tanking process may continue.

3.11.3 The maximum water content of the insulation at time of shipment and when received at the purchaser's site shall not exceed 0.5%. If the insulation moisture content exceeds 0.5%, the manufacturer will be responsible for drying the insulation at the purchaser's site.

4.0 TESTS AND SURVEILLANCE

4.1 GENERAL

4.1.1 All tests shall be conducted in accordance with ANSI/IEEE standards and this specification.

4.1.2 When specified by the purchaser, the manufacturer will send preliminary tests results to the purchaser by fax, express mail or electronic mail for review. When such requests are made, the oil shall not be removed from the transformer in preparation for shipment until approved by the purchaser.

4.1.3 The purchaser reserves the right to reject the transformer or negotiate a price settlement if the impedances or losses exceed the ANSI/IEEE tolerances.

4.1.4 If a transformer fails to pass any test or shows abnormal results, the purchaser's technical contact shall be notified **immediately.** The cause for the failure to pass the tests and proposed corrective action shall be reviewed with the purchaser. The purchaser must approve such corrective actions. After corrective action has been completed, tests shall be made consistent with the modification. The purchaser must approve the test program. The repair and testing shall be documented in the Certified Test Report. If a failure occurs during dielectric tests, all dielectric tests shall be repeated after corrective action has been completed.

NOTE: THERE WILL BE NO EXCEPTIONS TO THIS REQUIREMENT.

4.2 TESTS BEFORE SHIPMENT

Perform the following tests in accordance with ANSI/IEEE C57 12.00 and C57 12.90 prior to shipment. The transformer must be completely assembled including the oil expansion tank for temperature tests. The expansion tank must be assembled for dielectric tests.

Report all test results in the test report.

4.2.1 Resistance tests at all tap positions - Provide raw data of all winding resistance measurements (terminal to terminal measurements).

4.2.2 Turns ratio on all tap positions

4.2.3 Polarity and phase relation

4.2.4 No load losses and exciting current at rated frequency and at 90, 100, 105 and 110% rated voltages.

4.2.5 Impedance (positive and zero sequence) and load losses at all tap positions.

4.2.6 ANSI Temperature Tests

NOTE: **Temperature tests must be made before dielectric tests**.

- Temperature tests will be required on all transformers. The temperature tests can only be omitted for multiple order units with written acceptance by the Purchaser.
- Temperature tests will be made at the highest load loss tap position and with an equivalent no load loss at 105% voltage. The tests will be made at the following rates:
  - Self cooled
  - Maximum forced cooled
  - 125% of maximum forced cooled (non-GSUs). The 125% test shall be performed in the same manner as the maximum forced cooled test.
- Provide the following additional temperature data:
  - Measured bottom oil temperature for all ratings

- Calculated hot spot temperature rise for all ratings
- Calculated values for loss of 10%, 25%, or 50% of cooling

- Dissolved gas and moisture content analysis in oil. Obtain samples in syringes for gas in oil and water in oil tests:
  - Before start of temperature tests
  - After each temperature test at the different ratings
  - A minimum of 3 hours after the completion of the last temperature test
  - The maximum allowed increase in the gases is defined per the following table:

GAS MAXIMUM ALLOWED INCREASE		
	Maximum Rating	125% Load
Acetylene C2H2	ND	ND
Methane CH4	2	4
Ethane C2H6	2	4
Ethylene C2H4	1	1
Hydrogen H2	10	20
Carbon Monoxide C0	15	25
Carbon Dioxide C02	150	250

Table 1

NOTE: If any gas exceeds the limits, the purchaser is to be notified before the transformer is drained. Acceptable test results must be received before draining. No further tests shall be performed until the matter is resolved with the Purchaser.

4.2.7 Measured auxiliary (cooling) equipment loss tests

4.2.8 Over-excitation curve from 0% to 110% - Extrapolate the curve to 150%.

4.2.9 Insulation Power Factor, with Doble or Purchaser approved equivalent high voltage power factor test equipment; maximum allowable insulation power factor 0.50%, 20C.

4.2.10 Insulation resistance, core to ground – Test after tanking and just prior to shipment. Include data for both tests with test report; note test voltage and oil temperature (if oil filled) at time of measurement; minimum resistance 1,000 Megaohms, 20C.

4.2.11 Energize open-circuit at 110% voltage on rated HV tap position for six hours.

- Part of the cooling may be in operation.
- Measure exciting current and top oil at the beginning and the end of the test.
- No failure shall occur during the test.

4.2.12 Obtain oil sample(s) using syringes before the beginning of dielectric tests and after three hours minimum from completion of PD tests for dissolved gas and moisture content analysis. The **CHANGE** in any gas level shall not exceed the values listed in Table 1 above.

4.2.13 Applied potential

4.2.14 ANSI impulse including neutrals

4.2.15 ANSI switching impulse

4.2.16 Partial Discharge (PD) and Radio Influence Voltage (RIV) Tests

- Perform after all other electrical tests (except final core ground test).
- Make both PD and RIV measurements at each “hold” period and at five-minute intervals during the one hour test.
- All sudden increases in PD levels, other than momentary rises due to known external causes, will be recorded with respect to time, duration and level.
- The PD levels during the one hour test shall not exhibit any steady rising trend and there shall be no sudden, sustained increase in levels during the last twenty (20) minutes of the test. If the measurements indicate a rising trend or sudden increase, the test shall be extended until the trend or sudden increase levels off.
- Maximum allowable values:
  - Enhancement Test: 200 micro volts

- One Hour Test: 50 micro volts and 150 picocoulombs
- Total increase during the one hour test: 50 picocoulombs
- Increase during last twenty minutes of the test: 20 picocoulombs

4.2.17 Tank pressure and leakage test

4.2.18 Test Current Transformers per ANSI C57.13 for applied potential and polarity/continuity.

4.2.19 FRA TESTING - For transformers shipped by rail, perform a FRA test with Phenix equipment prior to shipment. The transformer shall be in its shipping configuration.

4.2.20 Particle count test to be performed after completion of all tests.

4.2.21 Sound test (if required in detail specification)

4.3 ADDITIONAL TEST REPORT DATA

Include the following information with the test report, in addition to all items listed in Section 4.2; identify measured test data versus calculated values as applicable:

4.3.1 Transformers not tested for temperature rise - If accepted, the manufacturer is to provide temperature rise test results of the exact duplicate design transformer with its serial number, test date, and voltage and KVA ratings.

4.3.2 Results of all dissolved gas and moisture content analyses, identified chronologically. Sequence of testing is as follows:

- Before start of all tests
- Before each temperature rise (if required)
- After all temperature rise (if required)
- Before dielectric
- After dielectrics

4.3.3 Results of all PCB analysis tests; analysis method identified.

4.3.4 Equivalent circuit for the transformer capacitance including bushing capacitance. The circuit should be for each phase (rather than

positive or zero sequence) and should represent the transformer as it will be connected in service. The circuit should include a node for each winding and should include the capacitance to ground of each winding and the capacitance between each pair of windings.

4.3.5 Copy of nameplate drawing filled-in with serial number, weights and test impedance.

4.3.6 Volts per hertz curve

4.3.7 Certification that transformer has completed and successfully passed all specified tests; document details of all test failures and resulting repairs or modifications made.

4.4 SURVEILLANCE

4.4.1 Core and Coil Inspection - The purchaser reserves the right to inspect the core and coil assembly. The manufacturer is to notify the purchaser at least 10 days prior to tanking to be able to inspect the finished core and coil assembly and transformer tank.

4.4.2 Witness Testing - The purchaser reserves the right to witness tests. The manufacturer is to notify the purchaser at least 10 business days prior to the start of tests to be able to witness tests.

4.4.3 The Purchaser or its representative shall be provided free access to manufacturer's or sub manufacturer's facilities for inspections/surveillance and to observe/witness tests. This access must be provided at no additional cost to Purchaser. These activities shall not change or delay the schedule. The Purchaser shall have access to all relevant procedures, checklists, records, etc. The Purchaser reserves the right to photograph the purchased equipment during times of inspection/surveillance.

4.5 TESTS AFTER SHIPMENT

4.5.1 Southern Company may perform a low frequency (320 Hz) induced test on each transformer upon receipt at the installation site and prior to commissioning. The test procedure is per the following:

- 230-kV TRANSFORMERS

Percent of Maximum Operating Voltage	Voltage (kV)	Test Time (min.)	Pumps (if furnished)

150	363	4	Off
125	302	55	Off
150	363	1	Off

Table 2

- 500-kV TRANSFORMERS

Percent of Maximum Operating Voltage	Voltage (kV)	Test Time (min.)	Pumps (if furnished)
150	788	4	Off
125	656	55	Off
150	788	1	Off

Table 3

4.5.2 The manufacturer may be present to witness the field tests. Any special requirements must be submitted with the proposal.

5.0 DOCUMENT SUBMITTAL

Documents for all equipment including accessories shall be equipment specific; not "typical". All documents shall be identified with the purchaser's name, purchase order number, equipment number, and destination/substation or plant name. All dimensions and weights shall be given in English units (volume in gallons) with metric units (volume in liters) in parenthesis. All drawings shall be provided in both .dwg and .pdf formats. All other documents shall be provided in .pdf format.

5.1 APPROVAL DOCUMENTS DELIVERED TO ENGINEERING OFFICE

Manufacturer shall furnish one (1) set of each drawing for approval and electronic files. Approval documentation shall include outline drawings, assembly drawings, CT and excitation curves, nameplate drawing, schematic diagrams, wiring connection drawings, and spare parts list.

5.1.1 Outline Drawings

- Assembled and shipping dimensions
- Weights, volumes, etc including radiators and conservator.

- Valves, relays, air cell, and other external devices clearly identified as to use and purpose with catalog part numbers including third part OEM.

- Bushings with ratings and catalog numbers.

- Shipping and assembled unit center of gravity shall be shown including explanation of abbreviations C.G. (S) and C. G. (A).

5.1.2 Current Transformer Drawings

- Polarity markings,

- Thermal rating factor,

- Mechanical/thermal short-time ratings,

- Resistance of secondary winding,

- Secondary excitation curves,

- Ratio correction factors,

- Phase angle curves.

5.2 FINAL DOCUMENTS DELIVERED TO ENGINEERING OFFICE

Manufacturer shall deliver electronic and hard copies of all final documentation to the responsible engineering department identified in the detail specification and purchase order. Include all the documents identified in 5.1 (Approval Documents) plus the following additional documentation:

5.2.1 Core ground connection diagram, showing dimensioned location.

5.2.2 Bushing drawings, showing stud dimensions.

5.2.3 Instruction book including information on all devices furnished and information on storage and handling, installation, operation, maintenance, and all setting files for items such as the electronic temperature monitor.

5.2.4 Test report.

5.2.5 Photographs of core and coil assembly showing full views of top and sides prior to tanking and of top after tanking but without cover.

5.2.6 Spare parts list that identifies original manufacturer and original manufacturer's part number.

5.3 DOCUMENTATION DELIVERED WITH EQUIPMENT

Two (2) complete sets of documentation as described in 5.1 and 5.2 shall be supplied in the control cabinet of the transformer when it is delivered.

6.0 BIDDER'S PROPOSAL

Proposal shall be in strict conformance with these specifications. Any alternates (not exceptions) to the proposed equipment shall be clearly designated as alternates and shall be completely described, defined, and priced. Failure to supply required documentation listed below will cause the bid to be rejected. The Purchaser has the right to reject any proposal that takes any exception to the requirements herein. Proposal shall include:

6.1 Pricing and other requested information per the Detail Specification or Letter of Inquiry.

6.2 Technical information supplied per attached APPENDIX A for each item or type of transformer.

6.3 Outline drawings including dimensions and weights (+/- 10%).

6.4 List of recommended spare parts (including lists of gaskets) and pricing.

6.5 Any exceptions to the specifications must be clearly identified in the proposal.

6.6 All required information will be supplied on the attached forms. Filling in information on the form with reference to other documents is not acceptable.

6.7 Manufacturer must clearly identify in the proposal if the transformer requires special handling or transportation means (such as Schnabel car). The use of a Schnabel car or other special transport means is not acceptable unless specifically approved by the purchaser.

6.8 The manufacturer shall indicate the location of the internal tap changer and external mechanism in the proposal. The manufacturer and ratings of the DETC shall be provided in the proposal.

6.9 If internal metal oxide is to be used in a proposed design, it must be clearly noted in the bidder's proposal. The use of internal metal oxide arresters in the winding design is strongly discouraged and will be considered in the evaluation of proposals.

7.0 EQUIPMENT IDENTIFICATION

Nameplates/designation plates shall be stainless steel or brass and permanently mechanically attached with non-corrosive screws, nuts and bolts or rivets (adhesive attachment not acceptable).

7.1 Nameplate shall be mounted adjacent to HV tap changer operating handle per ANSI C57.12.00. Nameplate shall include type and percent inhibitor in oil, current transformer ratios, description and location of internal metal oxide if allowed and used, and vacuum ratings of tank and conservator

7.2 Equipment number nameplate shall be provided on the main nameplate or a separate plate adjacent to the main nameplate. A six (6) digit equipment number will be provided in the detail specification and purchase order.

7.3 PCB Content

The following statement shall be provided on the main nameplate or a separate plate adjacent to the main nameplate:

"At time of shipment, this transformer contained less than 2ppm PCB's (polychlorinated biphenyls) per ASTM Method D4059."

7.4 Center of Gravity

Two adjacent segments shall be marked with weld beads labeled C.G. (S) for center of gravity for shipping unit and C.G. (A) for center of gravity for assembled unit.

8.0 SHIPPING AND DELIVERY REQUIREMENTS/ INSPECTION

8.1 Impact Recorders: Include two (2) electronic three-axis impact recorders with all shipments.

8.2 Transformer manufacturer's and carrier's representatives shall be present when the Purchaser opens and inspects impact recorders and the transformers.

8.3 If the impact recorders indicate rough handling or possible damage, the manufacturer shall make a thorough and detailed inspection of the transformer at no cost to the Purchaser. A written report on the findings of the inspection including recommendations shall be given to the Purchaser.

8.4 A FRA test using Phenix equipment shall be made in the shipping condition. The results of the FRA will be reviewed before transfer of ownership to the purchaser.

8.5 An inspection (internal and external) by the purchaser will be performed before transfer of ownership.

8.6 All rail and ocean shipments shall have GPS tracking capability.

8.7 Transformers shall be shipped dry air filled with maximum -60F dew point, 0.5% impurities by volume, and 0.03% moisture by weight. At time of shipment record and post the ambient temperature, dew point of air in transformer, and tank pressure.

STANDARD RATINGS AND IMPEDANCES

TEMPERATURE RISE: 65°C average winding rise or as stated in the **Detail Specification** or **Letter of Inquiry**

COOLING CLASS: See **Detail Specification** or **Letter of Inquiry**

MVA RATINGS: See the **Detail Specification** or **Letter of Inquiry**

IMPEDANCE: See the **Detail Specification** or **Letter of Inquiry**

WINDING VOLTAGES AND CONNECTIONS

See the **Detail Specification** or **Letter of Inquiry**

RATINGS, STANDARD	DWG. NO. PTLP-01	SHEET 1 OF 1
THE SOUTHERN COMPANY		

NOMINAL SYSTEM VOLTAGE (kV, L-L)	BIL (kV)	AMPERES (A)	BUSHINGS APPROVED SOURCE
13.2	110	400/1200	ABB PCORE
		2000	ABB PCORE
		3000 & up	ABB PCORE
25	150	400/1200	ABB PCORE
		2000	ABB PCORE
		3000 & up	ABB PCORE
115	550	800/1600	ABB PCORE
		3000	ABB PCORE
161	750	1200	ABB PCORE
		800/1600	ABB PCORE
230	900	800/1600	ABB PCORE
		2000	ABB PCORE
		3000	ABB PCORE
500	1550	2000	ABB PCORE
		3000	ABB PCORE

Notes:
1. Proposed bushings are subject to Purchaser approval. Draw lead bushings will be considered.
2. ABB design must have one piece brass core extension for slip joint design, complete with rain shields.
3. No Trench bushings.
4. Any special bushing installation tools shall be furnished.

Primary Line Bushings - **Terminals: Blade type**

Secondary and Neutral Bushings - **Stud: threaded, copper alloy and terminals**

Terminal connector: NEMA Standard CC 1-1984 4-hole stud to flat,
Copper alloy, Anderson Electric Type HDSF or Purchaser approved equal.

THE SOUTHERN COMPANY

BUSHINGS, STANDARD LARGE POWER TRANSFORMERS	DWG. NO. PTLP-02	SHEET 1 OF 3

NOMINAL SYSTEM VOLTAGE (kV, L-L)	BIL (kV)	AMPERES (A)	BUSHINGS APPROVED SOURCE.
Line Bushings			
13.2	110	400/1200/2000/3000	ABB or PCORE
26.18	150	400/1200/2000/3000	ABB or PCORE
115	550	1600/2000/3000	ABB or PCORE
161	750	1200/1600	ABB or PCORE
230	825	1200	ABB or PCORE
	900	1600/2000/3000	ABB or PCORE
500	1550	2000/3000/4000	ABB or PCORE

Stud: threaded, copper alloy
Terminal connector: NEMA Standard CC 1-1984 4-hole stud to flat,
Copper alloy, Anderson Electric Type HDSF or Purchaser approved equal.

NOMINAL SYSTEM VOLTAGE (kV, L-L)	BIL (kV)	AMPERES (A)	BUSHINGS APPROVED SOURCE/CATALOG NO.
Tertiary Bushings			
* 25kV unit preferred Manufacturer to propose			
Neutral Bushing			
25	150	400/1200/2000	ABB or PCORE

Notes:

1. Proposed bushings are subject to purchaser approval. Draw lead bushings will be considered.
2. ABB design must have one piece brass core extension for slip joint design **complete with rain shields**.
3. No Trench bushings.
4. **Any special bushing installation tools shall be furnished.**

Stud: threaded, copper alloy

Terminal connector: NEMA Standard CC 1-1984 4-hole stud to flat, Copper alloy, Anderson Electric Type HDSF or Purchaser approved equal.

TRANSFORMER RATED VOLTAGE (kV)	DUTY CYCLE (kV)	MCOV (kV)	SURGE ARRESTERS, STATION CLASS APPROVED SOURCE
115	96	76	ABB CPS Hubbell /Ohio Brass Siemens Polymer acceptable 115kV and lower
161	144	115	ABB CPS Hubbell / Ohio Brass Siemens
230	180	144	ABB CPS Hubbell / Ohio Brass Siemens
500	396	318	Furnished by Purchaser

THE SOUTHERN COMPANY		
LARGE POWER TRANSFORMERS		
SURGE ARRESTERS, STANDARD	DWG. NO. PTLP-03	SHEET 1 OF 1

RELAYING

GENERAL:	Bushing Type; standard 5-tap with distributed windings; 2.0 Thermal Rating Factor for all windings; C800 Relaying Accuracy.
HV BUSHINGS:	See the **Detail Specification** or **Letter of Inquiry**.
LV BUSHINGS:	See the **Detail Specification** or **Letter of Inquiry**.
NEUTRAL BUSHINGS:	See the **Detail Specification** or **Letter of Inquiry**.
TERTIARY:	See the **Detail Specification** or **Letter of Inquiry** - One in one phase, if the transformer is a three-phase unit.

LINE BUSHING AND BURIED TERTIARY CURRENT TRANSFORMERS

See the **Detail Specification** or **Letter of Inquiry**.

METERING

General: Single ratio, accuracy of 0.3 with burden B1.8.

HV BUSHINGS: See the **Detail Specification** or **Letter of Inquiry**.

LV BUSHINGS: See the **Detail Specification** or **Letter of Inquiry**.

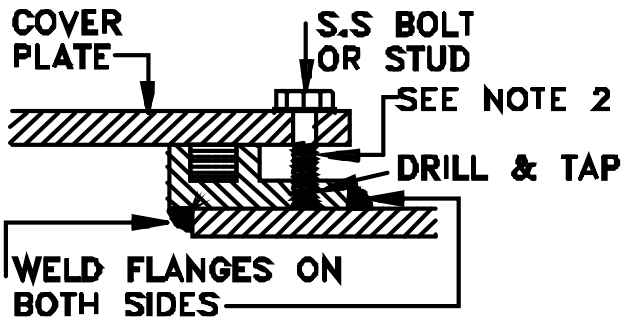
Note: Hot spot current transformer ratio shall be shown on the nameplate.

THE SOUTHERN COMPANY		
BUSHING CURRENT TRANSFORMERS, STANDARD LARGE POWER TRANSFORMERS	DWG. NO. PTLP-04	SHEET 1 OF 1

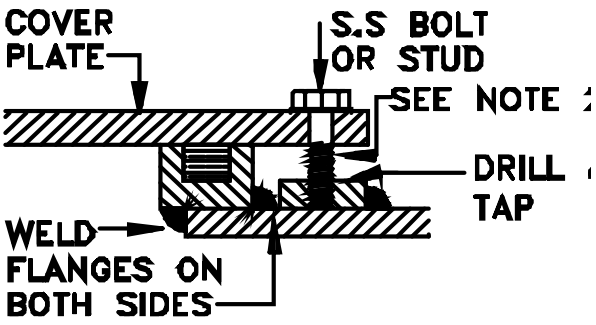
GENERAL

Non-clouding lens on all gauges.
Shield or guard on all capillary tubing

APPLICATION OR DESCRIPTION	TYPE OR MAKE	APPROVED SOURCES/CATALOG NO. OR SPECIFICATION
	VALVES	
Upper fill, lower drain, & conservator drain without sampling device.	2” Globe	Marsh United Milwaukee
Conservator Shut-Off & Rapid-Pressure-Rise Relay Shut-Off	2” Ball	Marsh United Milwaukee
	GAUGES	
P-V bleeder with gauge	Qualitrol	70-35F (-5 to +5 gauge) 070-35C CS-35005 (-15 to +15 gauge)
Oil level gauge with two SPDT switches for low level alarm	Qualitrol / Messko	032 Series / MTO-ST160 with Option 1 for positive pressure and 042 Series / MTO-ST160 with Option 2 or 3 for conservator oil preservation system. Magnetic dial type; 6"diameter; with HIGH, LOW, and 25C levels marked; low level alarmed by two SPDT switches set to alarm at low and low-low levels – 15 deg mechanical difference between low and low-low
Oil flow indicator with alarm switches		One for each oil pump
	TEMPERATURE INDICATORS	
Oil temperature		Dial type; maximum temperature drag hand with manual reset; gauges mounted about 5' above transformer base; with switches for controlling cooling
Electronic Temperature Monitor (See Detail Specification)		
	RELAYS & DEVICES	
Pressure Relief Device	Qualitrol / Messko	Semaphore visible from ground and switch; not mounted on access cover, mounted diagonally opposite and far away as practical from upper oil fill valve.
Rapid-Pressure-Rise Relay	Qualitrol	900-010-02, without seal-in relay, reset switches, & associated circuitry
Gas Collector Relay		**Manufacturer to propose**



METHOD–1



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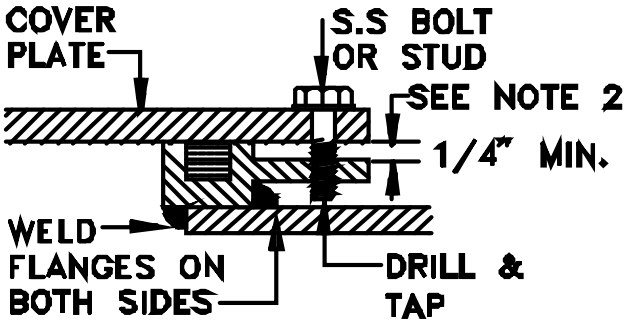

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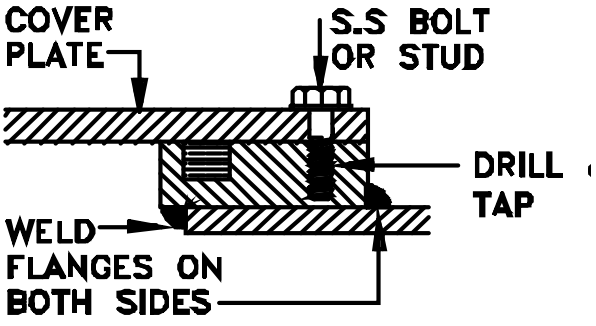

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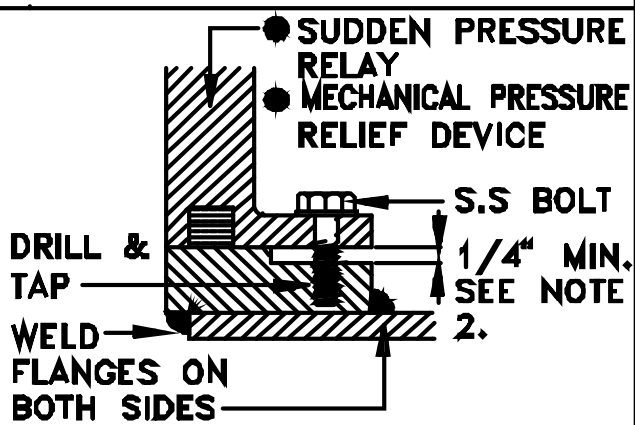

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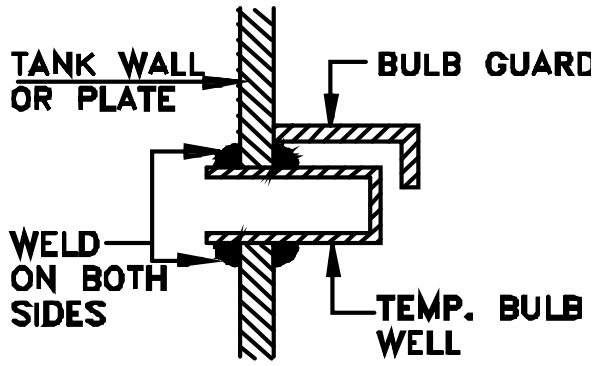
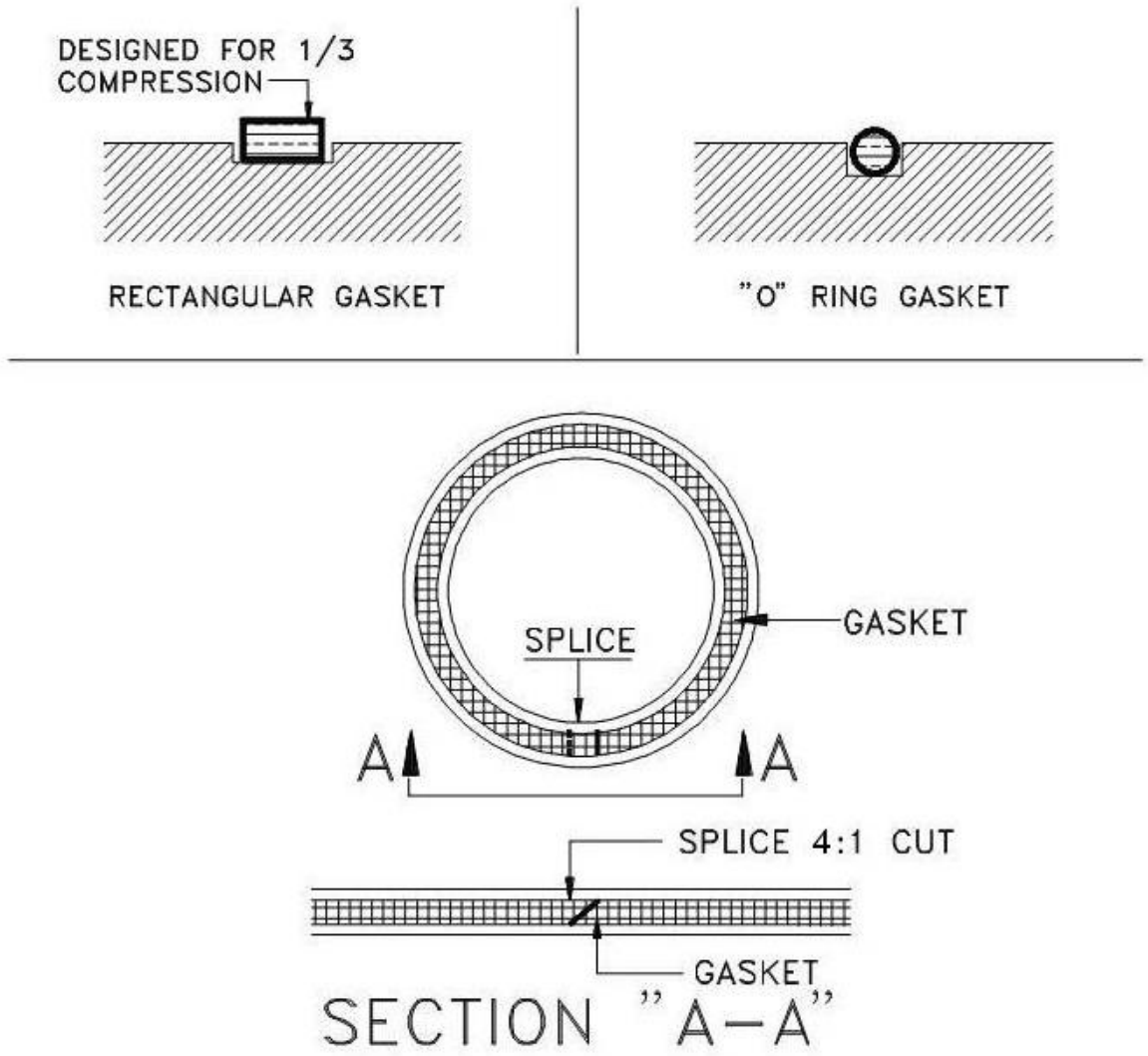


METHOD–6

THE SOUTHERN COMPANY		
GASKETING METHODS LARGE POWER TRANSFORMERS	DRAWING NO. PTLP-06	SHEET 1 OF 2

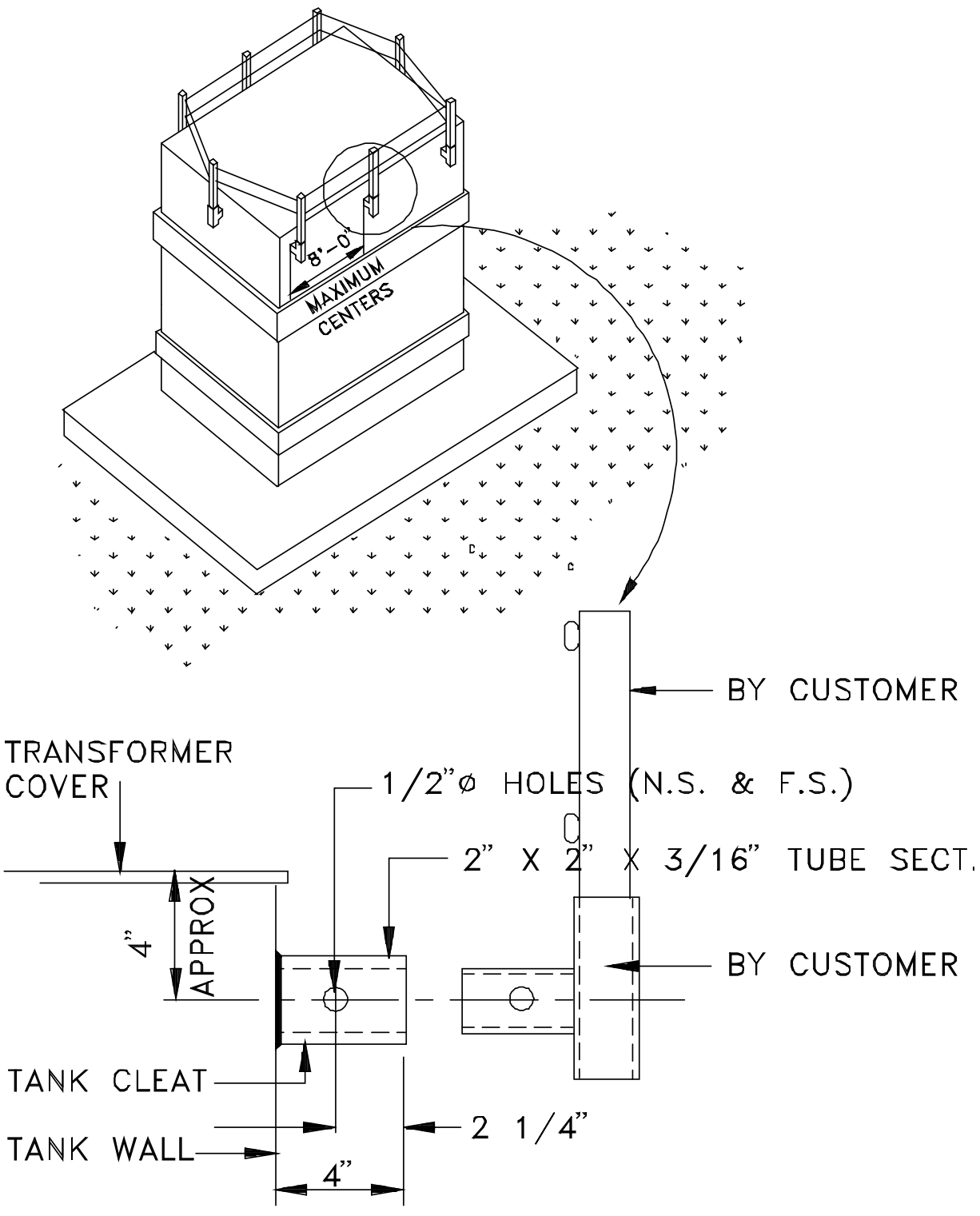
Revision 4
March 7, 2013



NOTES:

1. Methods 1, 2 & 3 suitable for use on all cover openings including manholes and bushings, Method 4 suitable for all tank wall opening.
2. Sufficient space to keep water from being siphoned into joint.
3. Area of gasket to be equal or less than area of groove.
4. Gasket shall be cemented in exact center of groove to prevent possibility of gasket pinching.
5. Gasket groove shall be machined in face of the flange.

THE SOUTHERN COMPANY		
GASKETING METHODS LARGE POWER TRANSFORMERS	DRAWING NO. PTLP-06	SHEET 2 OF 2



THE SOUTHERN COMPANY		
CLEATS, GUARDRAIL LARGE POWER TRANSFORMERS	DWG. NO. PTLP-07	SHEET 1 OF 1

Revision 4
March 7, 2013

TRANSFORMER OIL
REQUIREMENT - SEE
SOUTHERN COMPANY OIL
SPECIFICATION SES-S-OS01

THE SOUTHERN COMPANY		
INSULATING OIL, STANDARD LARGE POWER TRANSFORMERS	DWG. NO. PTLP-08	SHEET 1 OF 1

APPENDIX A

LARGE POWER TRANSFORMERS
TECHNICAL DATA

INQUIRY NO:_____ DATED: ____/____/____

MANUFACTURER PROPOSAL NO:_____DATED: ____/____/____

MANUFACTURER NAME:_____

ITEM NO: _____ QTY: _____

RATING: HV/LV _____/_____/_____ MVA,_____/_____/_____, _____C RISE
(ONAN/ONAF/ONAF,etc.)

TERTIARY _____/_____/_____ MVA,_____/_____/_____,_____C RISE
(Continuous) (ONAN/ONAF/ONAF,etc.)

HV/CONN: _____V/_____; HV FULL LOAD AMPS AT TOP RATING: _____

LV/CONN: _____V/_____; LV FULL LOAD AMPS AT TOP RATING: _____

TERTIARY/CONN: _____V/_____; _____ PHASE: _____HZ

GUARANTEED LOSSES/CURRENT

NO LOAD:	20C, @ RATED VOLTAGE	_____KW
	20C, @ 105% RATED VOLTAGE (INFO. ONLY)	_____KW
	20C, @ 110% RATED VOLTAGE (INFO. ONLY)	_____KW
LOAD:	85C, SELF-COOLED (AUTO) / MAXIMUM (GSU)	_____KW
AUXILIARY (COOLING) (@MAX MVA):	85C	_____KW

EXCITING CURRENT @ RATED VOLTAGE: _____ % @ _____MVA (ONAN)

IMPEDANCES (R+jX)

	POSITIVE SEQUENCE	ZERO SEQUENCE	ONAN BASE MVA
H-L	_____%	_____%	_____
H-T	_____%	_____%	_____
L-T	_____%	_____%	_____

CAPACITANCE PER PHASE (pf):

INQUIRY NO: _____MANUFACTURER PROPOSAL NO: _____ITEM NO: _____

BIL:		HV TAPS:	
HV	_____KV		_____ V
LV	_____KV		_____ V
TERTIARY	_____KV		_____ V
NEUT END	_____KV		_____ V

_____ WINDING TYPE/COND.

MATERIAL (disc, etc./cu or Al) :HV _____/_____; LV _____/_____

TERTIARY _____/_____

TAP WINDING CONFIGURATION _____

PROPOSED BUSHINGS:	AMPERE RATING	MANUFACTURER	CATALOG NO.
HV	_____	_____	_____
LV	_____	_____	_____
TERTIARY	_____	_____	_____
NEUTRAL	_____	_____	_____

PROPOSED CURRENT TRANSFORMERS:	Ratio	Accuracy	Total No.
HV	_____	_____	_____
LV	_____	_____	_____
TERTIARY	_____	_____	_____
NEUTRAL	_____	_____	_____

Duty	Manufacturer/		
PROPOSED SURGE ARRESTERS:	Cycle	MCOV	Catalog No.
HV	_____	_____	_____
LV	_____	_____	_____

APPROXIMATE WEIGHTS:

TOTAL _____ LBS

SHIPPING (DRY) _____ LBS

OIL _____ GALS_____ LBS

Paper Insulation _____ LBS

APPROXIMATE DIMENSIONS, OVERALL:

SHIPPING

HEIGHT _____INCHES

LENGTH _____INCHES

WIDTH _____INCHES

INSTALLED

HEIGHT _____INCHES

LENGTH _____INCHES

WIDTH _____INCHES

AUDIBLE SOUND LEVEL:

A-Weighted Average: ONAN _____ dB(A), MAX_____dB(A)

OIL PUMP MOTORS: QTY. _____ , _____ PHASE _____ VOLTS

FAN MOTORS: QTY. _____ , _____ PHASE _____ VOLTS

INQUIRY NO: _____MANUFACTURER PROPOSAL NO: _____ITEM NO: _____

AUXILIARY POWER TRANSFORMER – SUPPLY FOR CONTROLS AND COOLING

RATING: HV/LV _____/_____ KVA; _____ C RISE

HV/CONN: _____ V/ _____; LV/CONN: _____ V/ _____

TAPS: _____; ____ PHASE; ____HZ

AUXILIARY STATION SERVICE TRANSFORMER

RATING: HV/LV _____/_____ KVA,ONAN; _____ C RISE

INSULATING LIQUID _____(Mineral Oil, etc.)

HV/CONN: _____ V/ _____; LV/CONN: _____ V/ _____

TAPS: _____; ____ PHASE; ____HZ

FIELD TESTING SPECIAL REQUIREMENTS (See Paragraph 5.5 of Specification):

1.0 GENERAL

1.1 Drawings shall be submitted to the Purchaser for approval of general design, general dimensions, and apparent suitability.

1.2 All drawings and documentation (including test reports) shall be submitted in both electronic file and print form. Instruction books are not required to be submitted electronically.

1.3 Final files and prints of all approved drawings and documents shall incorporate all review comments.

1.4 See Purchase Order for additional requirements.

2.0 ELECTRONIC DRAWING/FILE TYPES

The following drawing/file types are acceptable in the following order of preference:

1. AutoCAD (.DWG) files.
2. AutoCAD DXF (drawing exchange file) file format on approval by Purchaser. DXF files should be created through AutoCad Release 14 or higher, if possible.
3. Raster file in CALS file format.
4. Other suitable format on approval by Purchaser.

3.0 ELECTRONIC DRAWING FILE SUBMITTAL METHODS

Contact the purchaser for compatible system for transmittal.

AUTOTRANSFORMER STANDARD RATINGS

TEMPERATURE RISE: **65 C Average winding rise**

COOLING CLASS: ONAN/ONAF/ONAF, ONAN/ONAF/ODAF or ONAN/ODAF/ODAF

*** Note: See the Detail Specification or Letter of Inquiry.**

STANDARD WINDING VOLTAGES AND CONNECTIONS

HIGH VOLTAGE
(WYE)

RATED VOLTAGE (kV)	161	230	500
BIL (kV)	650	750	1,425
FULL CAPACITY TAP VOLTAGES (kV)	173	241.50	*
	169	235.75	*
	165	230.00	*
	161	224.25	*
	157	218.50	*

LOW VOLTAGE
(WYE)

RATED VOLTAGE (kV)	BIL (kV)
115	450
161	650
230	825

NEUTRAL WILL BE SOLIDLY GROUNDED; NEUTRAL END SHALL BE INSULATED FOR A MINIMUM 150kV BIL

*** Note: For ratings and tap voltage ratings see the Detail Specification or Letter of Inquiry.**

TERTIARY WINDING/AUXILIARY TRANSFORMER (For Three Phase Units)

TERTIARY

VOLTAGE/BIL RATING (kV): 13.2-kV/110-kV BIL OR 26.18-kV/150-kV BIL

CONNECTION: DELTA

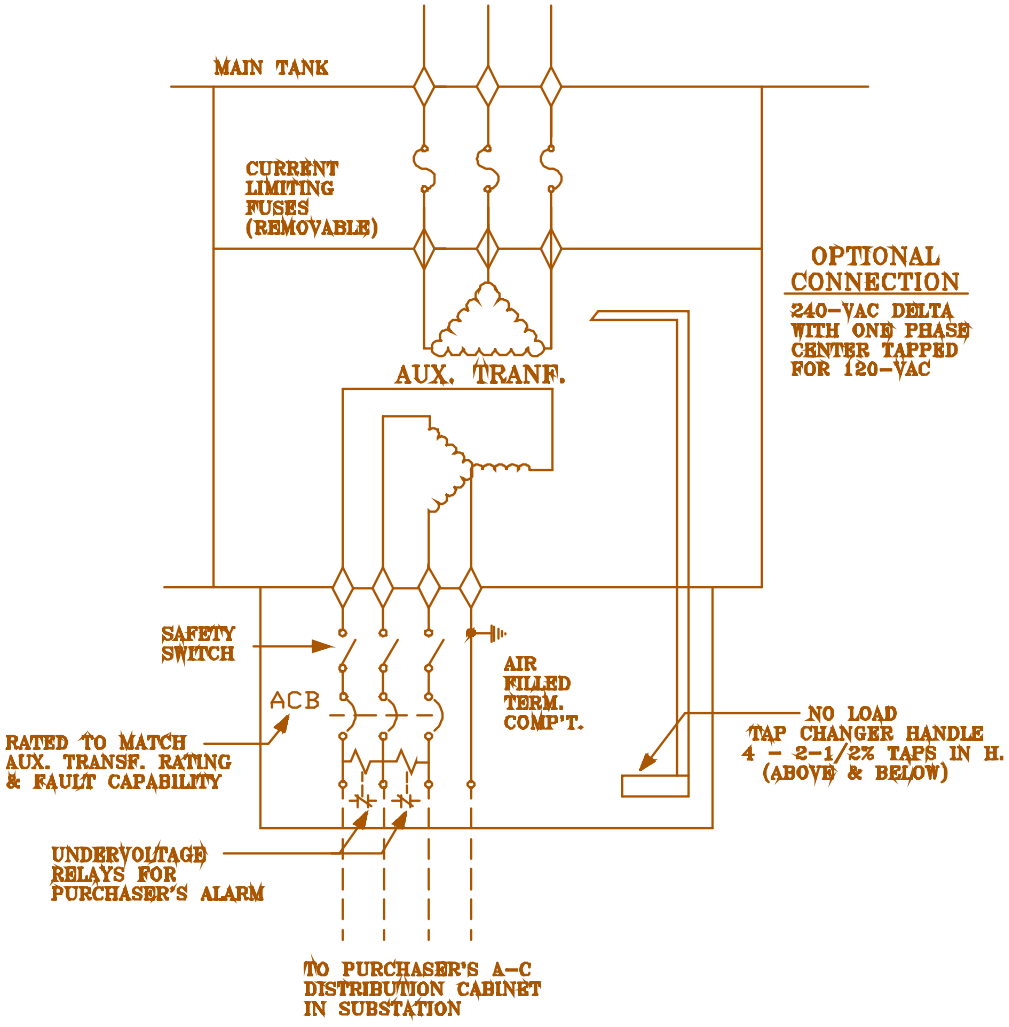
BUSHINGS: Three bushings brought out.

*** Note: For tertiary ratings see the Detail Specification or Letter of Inquiry.**

DELTA-WYE TERTIARY WINDING/AUXILIARY TRANSFORMER (For three phase units)

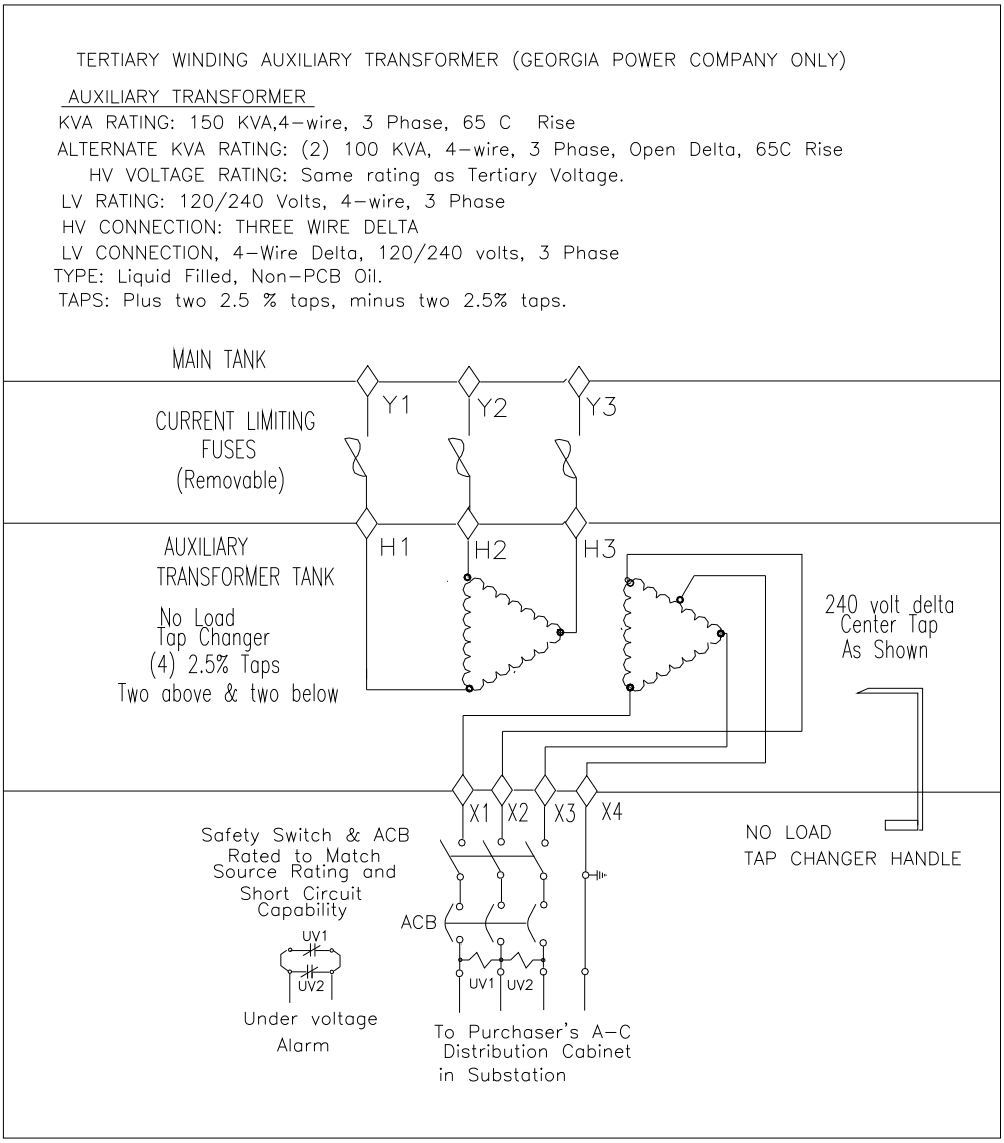
AUXILIARY TRANSFORMER

KVA RATING:	150 KVA, OA, 65°C Rise
HV VOLTAGE RATING:	Same rating as tertiary winding
LV VOLTAGE RATING:	See the **Detail Specification** or **Letter of Inquiry**
CONNECTION:	See the **Detail Specification** or **Letter of Inquiry**.
	If wye-connected, the phases are to be in-phase with the transformer.
TYPE:	Liquid-filled, Three phase, 60Hz
TAPS:	±2 - 2 1/2% (no load) with external operating handle



Note: For single phase units see the **Detail Specification** or **Letter of Inquiry.**

DELTA- DELTA TERTIARY WINDING/AUXILIARY TRANSFORMER (For three phase units)



Note: For single phase units see the **Detail Specification** or **Letter of Inquiry.**

GSU STANDARD RATINGS AND IMPEDANCES

TEMPERATURE RISE: 65°C average winding rise or as stated in the **Detail Specification** or **Letter of Inquiry**

COOLING CLASS: FOA or as stated in the **Detail Specification** or **Letter of Inquiry**

MVA RATINGS: See the **Detail Specification** or **Letter of Inquiry**

IMPEDANCE: See the **Detail Specification** or **Letter of Inquiry**

WINDING VOLTAGES AND CONNECTIONS

PRIMARY (LOW VOLTAGE) (DELTA)

VOLTAGE CLASS (kV)	BIL (kV)
15	110
23/25	150

SECONDARY (HIGH VOLTAGE) (WYE)

RATED VOLTAGE (kV)	115	230	500
BIL (kV)	450	750	1425

FULL CAPACITY

TAP VOLTAGES (V) See the **Detail Specification** or **Letter of Inquiry**

NEUTRAL WILL BE SOLIDLY GROUNDED; NEUTRAL END SHALL BE INSULATED FOR A MINIMUM 150 kV BIL

THE SOUTHERN COMPANY

RATINGS, STANDARD LARGE POWER TRANSFORMERS	APPENDIX C	SHEET 4 OF 4