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1. SCOPE

The purpose of this specification is to provide oil immersed, three phase, outdoor type, generator step-up transformers (GSU) with automatic thermostatically controlled forced oil, forced-air cooling equipment and other accessories, spare parts and appurtenances hereinafter specified. Delivery shall be DDP Destination. JEA or JEA's Representative is responsible for offloading. Manufacturer to provide technical support per Field Engineering Services section.

The GSUs shall be designed for reverse power flow operation from the transmission system to the unit auxiliary system at the maximum anticipated reverse power loading, including steady state auxiliary load and motor starting conditions without exceeding any transformer design parameters.

2. PROJECT ENGINEER

The Project Engineer(s) and contact person(s) for technical questions and clarifications concerning this specification are:

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3. GENERAL DESIGN REQUIREMENTS

3.1. The transformer shall be of the highest commercial quality as to material, workmanship, and design.

3.2. The transformer manufacturers and manufacturer plant locations must be pre-approved by JEA.

3.3. The transformer shall be designed, manufactured, assembled, insulated, and tested in accordance with the latest applicable standards including, but not limited to ANSI/IEEE, NEMA and ASTM standards except where specific requirements of these specifications conflict with these standards. In the event of any conflict between Specifications and Codes the more stringent requirements shall apply.

3.4. All materials and equipment shall be new and of first quality and shall conform to these specifications, as well as, any codes governing the use of the material.

3.5. Ambient temperature: thirty degrees Celsius (30ºC) daily average, forty degrees Celsius (40ºC) maximum, minus twenty degrees Celsius (-20ºC) minimum.

3.6. The basic Generator Step Up (GSU) Transformer specifications are:

3.6.1. One (1) Steam Turbine Generator (STG) GSU:

18kV Delta / 230kV Grounded Wye, 360/480 MVA, ONAN/ONAF

Z = 9% at 360 MVA and rated voltage

3.6.2. Two (2) Combustion Turbine Generator (CTG) GSU:

24 KV Delta / 230kV Grounded Wye, 450/600/750 MVA, ONAN/ONAF1/ONAF2

Z = 18% at 450 MVA and rated voltage

3.6.3. ONAN/ONAF1/ONAF2 at 65ºC Rise. The transformer shall be capable of transforming the minimum MVA rating continuously, self-cooled at rated voltage and frequency without exceeding an average winding temperature rise of 65 degrees Celsius (65ºC).

3.6.4. Unless otherwise specified, the transformer shall be equipped with two stages of automatic, thermostatically controlled auxiliary cooling equipment that shall increase its self-cooled MVA rating by 33-1/3% with the first stage of auxiliary cooling equipment and 66-2/3% with both stages of auxiliary cooling equipment in service. The increased capability by forced cooling shall be obtained by forced air. Pumps and directional oil flow are permitted. The auxiliary ratings shall be achieved without exceeding an average winding temperature rise of 65 degrees Celsius (65ºC).

3.6.5. Frequency: 60 Hz

3.6.6. Conservator- Diaphragm Type

3.6.7. Impedance at rated voltage and base (ONAN) rating and shall be based on the self-cooled rating and neutral tap voltage position.

3.6.7.1. The Manufacturer shall state the guaranteed impedance HV DETC at C (nominal voltage) tap in the quotation.

3.6.7.2. The impedance manufacturing tolerance for the final factory tests shall be within ±5% of the specified impedance.

3.6.7.3. In the event that the final factory test impedance exceeds the stated impedance requirements, the manufacturer shall credit JEA a U.S. dollar amount as per the following conditions:

3.6.7.3.1. Above ±3% and up to ±4% of the design impedance – 1% of the contract price.

3.6.7.3.2. Above ±4% and up to ±5% of the design impedance – 2% of the contract price.

3.6.7.3.3. Above ±5% and up to ±6% of the design impedance – 3% of the contract price.

3.6.7.3.4. Above ±6% and up to ±7.5% of the design impedance – 5% of the contract price.

3.6.8. The high voltage winding shall be equipped with five (5) de-energized tap changer (DETC) positions. Two (2), 2.5% taps, above and two (2), 2.5% taps, below rated voltage shall be provided.

3.6.8.1. 5 Tap Positions, +/- 5% - 2.5% Per Tap

3.6.8.1.1. The DETC shall be operated manually by means of a handle brought out through the side of the tank at a height convenient to the transformer design.

3.6.8.1.2. The tap changer handle shall have provision for padlocking in any tap or rated voltage position and shall provide visible indications of the tap position without unlocking

3.6.8.1.3. A metal sign with white background and large red letters cautioning against operating the DETC when the transformer is energized shall be provided.

3.6.8.2. The low voltage windings shall be Delta connected and should be a DAC Connection.

3.6.8.3. Full rated transformer capacity shall be allowed in each of the winding's DETC tap positions.

4. ELECTRICAL DESIGN REQUIREMENTS

4.1. The transformer, including all core and coil assemblies, shall be power class, round core/coil design and construction.

4.2. All windings shall be of copper and shall be circular.

4.3. The core shall be of high-grade, grain-oriented silicon steel.

4.4. The maximum flux density shall be limited to **1.8 Tesla at 110%** maximum rated voltage.

4.5. The transformer shall be designed to withstand geomagnetic disturbance (GMD) events in accordance with IEEE C57.163.

4.6. All transformer components shall be constructed for loading in accordance with the latest revision of IEEE C57.91 "IEEE Guide for Loading Mineral-Oil-Immersed Transformers". The current carrying capability of the transformer shall be limited only be the capacity of the core and coils.

4.7. The transformer design shall be adequate to withstand short circuits with the fault current limited only by the impedance of the transformer itself.

4.8. The insulation on all conductors shall be **thermally upgraded** cellulose insulating paper.

4.9. The paper insulation shall be applied in single or multiple strips such that a minimum of thirty percent (30%) of the paper surfaces are overlapped to provide for a continuous insulating surface. Sufficient tension shall be maintained on the paper strands to prevent loose wraps.

4.10. **The coil clamping rings shall cover the full circumference of the coil cylinder area**.

4.11. The core and coil assembly shall be dried using a "vapor-phase" system prior to vacuum filling.

4.12. The transformer shall be designed and manufactured to withstand the mechanical and thermal stresses caused by external short circuits, as defined by the latest revision of **ANSI/IEEE C57.12.00, Section 7** when connected to an infinite bus on either the high or the low side and thereby be completely self-protecting for all external faults. Evidence of design capability to meet these requirements shall be provided at time of bid evaluation.

4.13. The Manufacturer shall provide the Volts per Hertz (V/Hz) capability curve.

4.14. Internal surge arresters or non-linear resistors shall not be included as part of the internal insulation system, unless authorized by JEA.

4.15. The core and coil assembly shall be such that the electrical stress between windings and the windings to core is limited to 80% of the degassed saturated curves published by Weidmann, using the 2.5 factor for conversion from impulse wave form to applied voltage. The bare conductor electrode curve shall be used for the ducts adjacent to the winding.

4.16. Leakage flux analysis shall be performed to verify the control of temperatures of metallic parts including core, tie plates, core frames, tank panels, shielding materials, etc.

4.17. The maximum acceptable burr on the cut edges of the electrical steel is 0.02 mm (0.0008 inches)

4.18. Transformer sound level shall not exceed levels of NEMA TR1 when measured at tap position DETC (nominal high voltage tap).

5. DESIGN REVIEW

5.1. The manufacturer shall, upon request, provide JEA with all the design data.

5.2. JEA will have a consulting engineer to review the design data provided by the manufacturer.

5.3. JEA may ask the manufacturer to meet by video conference call to discuss the design of the transformer and any other aspect related to these specifications. JEA will require the manufacturer to have the design engineer(s) available to discuss the design with JEA and/or JEA's consulting engineer. These meetings will also be held by video conference call.

5.4. Under no circumstance shall the manufacturer have any authority to change the design agreed upon without consulting with JEA's Project Engineer.

5.5. <u>The manufacturer shall not start manufacturing the transformer until all the design data has been reviewed by JEA and they receive written authorization to proceed from JEA's Project Engineer.</u>

5.6. The manufacturer shall submit a schedule associated with the equipment being provided. Such schedule shall be updated and submitted to the Project Engineer as outlined in the Schedule of Submittals Appendix.

6. INSULATION LEVELS

The winding insulation level shall be as follows:

WINDING INSULATION LEVELS	
Rated Voltage	**Basic Impulse Level**
230KV	900KV
24KV	150KV
18KV	110KV
Neutral	250KV

Phase-to-phase insulation barriers shall be provided between phases. These barriers shall run the full length of the coils.

7. BUSHINGS

7.1. The bushings shall be paper-oil-capacitor type and conform to the latest revision of **ANSI/IEEE C57.19.01** and to **NEMA** standard arrangement, spacing and nomenclature.

7.2. The bushings shall be "Sky Gray" in color **(ANSI-70)**.

7.3. The necessary bushings shall meet the following requirements:

BUSHING INSULATION LEVELS	
Rated Voltage	**Basic Impulse Level**
230KV	900KV
24KV	150KV
18KV	150KV
Neutral	250KV

7.4. All the bushings shall be provided with stud to NEMA four (4) hole pad terminal connectors. The connectors shall be Anderson, stud to flat bar, Type HDSF or approved equal and shall be tin-plated.

7.5. The neutral bushing shall be securely grounded externally to the tank. It shall be provided with enough 500 MCM insulated copper cable and cable to 4-hole connectors to facilitate grounding the bushing to a ground pad at the base of the transformer. Fasteners shall be provided on the tank side to secure this cable to the tank.

7.6. The transformer core shall be securely grounded externally on the tank. The core shall be individually grounded by a connection brought out of the tank through its own dedicated equipment bushing located on or near the top in a gasketed, sealed stainless steel enclosure. The transformer core shall have its own dedicated equipment bushing. Disconnection shall not require entrance into the tank. Enough 300 MCM insulated copper cable and cable to four (4)-hole connectors shall be provided to facilitate grounding the bushing to a ground pad on the transformer. Fasteners shall be provided on the tank side to secure this cable to the tank as needed. The core ground cable shall be connected for shipment to allow an insulation resistance test upon arrival.

7.7. Only bushings manufactured by ABB or P-Core will be acceptable.

8. SURGE ARRESTERS

8.1. Three (3) polymer station class surge arresters for the protection of the high voltage windings shall be provided and mounted on the transformer tank or on suitable mounting brackets attached thereto. The surge arresters shall be mounted such that their line terminals are at the same height as the bushing line terminals.

8.2. Insulated 500 MCM copper cable and all necessary connectors shall be provided to ground the surge arresters to the ground pads at the base of the tank. Three-way or "T" connections must be crimped or cad-welded. Means shall be provided along the tank wall to attach the cables to the tank in a removable fashion. Only one cable shall run down the tank for each set of arresters for grounding.

8.3. The following are the surge arresters voltage characteristics:

SURGE ARRESTER VOLTAGE		
KV CLASS	**MCOV - KV**	**DUTY**
230	144	180
24	19.5	24
18	15.3	18

8.4. The Manufacturer shall advise JEA's Project Engineer if suitable insulation coordination and protection cannot be achieved with the arresters given in the data above. In addition, the Manufacturer shall supply graphical data which shows the transformer's design BIL ratings for each winding the arresters are protecting along with the arrester's protection margin characteristics under lightning surge and switching surge conditions.

9. GAUGES AND ACCESSORIES

The transformer shall be equipped with the following accessories:

9.1. A magnetic oil level gauge, MTO series manufactured by Messko GMBH, shall be mounted on the conservator tank, and tilted at 30 degrees to be readable from ground level. It shall have a 6-inch dial and low and high level alarm contacts.

9.2. An oil level gauge, MTO Series manufactured by Messko GMBH, mounted on the main tank and readable from ground level. This gauge is to be used for purposes of filling the transformer only. No alarms or contacts are to be wired to this gauge. A means of covering the gauge, such as a removable blackout face plate, is to be provided for installation after the transformer is filled.

9.3. A top oil temperature indicator, model MT-ST160RM manufactured by Messko GMBH, with alarm contacts and maximum temperature pointer with manual reset shall be provided. It shall be located at an eye-level height for observation and resetting. A capillary tube shall connect this device to the sensing element located in a well near the top oil level. The contacts shall be connected/wired and calibrated as follows:

9.3.1. 1st Contact – to activate the alarm circuit at 75 degrees Celsius (75ºC).

9.3.2. 2nd Contact – to activate the alarm circuit at 120 degrees Celsius (100ºC).

9.4. A winding temperature indicator, MT-ST160WR/RM manufactured by Messko GMBH, shall be located at a convenient eye-level height for observation and resetting. A capillary tube shall connect this device to the sensing element located in a well near the top oil level.

9.4.1. Current from a CT located on the LV winding "A" (X1) bushing shall be used to heat a heater oil around the sensing element well which when added to the temperature of the top oil in the tank shall provide indication of the simulated winding temperature. The indicator shall include the following:

9.4.1.1. A manually resettable red peak temperature pointer.

9.4.1.2. Two (2) internal switches of which the operating temperatures shall be readily visible by use of adjustable switch setting knobs and pointers located along the dial of the indicator. The switches shall be connected/wired and calibrated as follows:

9.4.1.2.1. 1st Switch – to activate the alarm circuit at 95 degrees Celsius (95ºC)

9.4.1.2.2. 2nd Switch – to activate the trip circuit at 140 degrees Celsius(120ºC)

The gradient shall be calibrated using calculated values during the heat-run tests.

9.5. One (1) mechanical pressure relief devices, Messko GMBH MPreC series, with alarm contacts and semaphore shall be provided.

9.5.1. One (1) shall be mounted on the main tank.

9.5.2. When the main tank capacity exceeds 10,000 gallons, two (2) devices shall be mounted on the main tank.

9.5.3. A separate seal-in relay and target shall be provided for each one.

9.5.4. The pressure relief devices shall be mounted without the use of standpipes.

9.5.5. All pressure relief devices shall be of the oil directed type and connected to piping which, in the case of operation, directs expelled oil to a point near ground level.

9.6. Two (2) Qualitrol 900 Series Rapid Pressure Rise Relays and shut off valves shall be provided in oil space.

9.6.1. Two (2) shall be mounted on the main tank.

9.6.2. The two on the main tank shall be located near the corner of the tank and five feet above the base.

9.6.3. The relay shall be connected without the use of any reduction pipes.

9.7. A Buchholz relay from MESSKO, MSAFE series, shall be provided and installed on the piping between Main tank to the Conservator tank.

9.7.1. Isolation valves shall also be installed to allow replacement of Buchholz relay on site without lowering the oil.

9.7.2. The piping from Buchholz relay to the oil conservator must be routed with a consistent incline of at least 2% (1.2 degrees).

9.7.3. The relay should serve the function of both gas detection and rate of oil flow detection.

9.7.4. The relay should consist of an enclosed chamber with two separate floats made of ROHACELL and it should have 4 Form C contacts for Alarm and Trip.

9.7.5. The switches shall be dry-reed magnetic type and shall be separated from oil and placed in brass tubes inside the Buchholz relay.

9.7.6. The relay should have an inspection window made of glass with UV filter to observe the accumulated gas and a cover to protect the inspection window should also be provided.

9.7.7. Each Buchholz relay shall be tested for leakage using helium and a test report for the same shall be provided by the manufacturer.

9.7.8. It shall be coated with CX paint for protection against harsh corrosive environments.

9.7.9. A connection on the Buchholz relay to do pneumatics testing shall be provided along with a gas extraction valve and a test button with a cover sleeve. These provisions shall be accessible from ground level at a working height of approximately five fee (5') from the base of the transformer.

9.8. A SEL-2414 Transformer Monitor Relay, Schweitzer Engineering Laboratories P/N 241421A1A3A3A3A1841, shall be installed in the transformer cabinet at a convenient eye-level height for observation and access. A window should be installed to observe the SEL-2414.

9.8.1. Transformer alarms shall be wired to the inputs for indication purposes.

9.8.1.1. Each alarm will be wired to a trip isolation switch, ABB P/N FRXG001001001, as follows (See Appendix for drawings):

9.8.1.1.1. One switch will be on the DC wetting side of the alarm.

9.8.1.1.2. Second switch will be before the alarm goes to the SEL-2414 input.

9.8.1.1.3. Third switch will be on the return side of the SEL-2414 input to successfully isolate the relay.

9.8.1.2. The three sets of the ABB test switches mentioned above will be installed in the transformer cabinet at a convenient eye-level height for observation and testing.

9.8.2. The transformer manufacturer will provide a SEL test report for the SEL-2414 to JEA.

9.8.3. A separate panduit/punch out shall be provided in the transformer cabinet in order to accommodate a JEA supplied fiber optic cable to the SEL-2414.

9.8.3.1. For the fiber optic panduit, the transformer manufacturer is to install in a location that allows for the minimum number of bends.

9.8.4. Nameplates for the SEL-2414 and test switches shall be provided. Each test switch nameplate nomenclature shall describe the associated transformer alarm or relay input it is wired to. See appendix for further details.

9.8.5. The output contacts for the SEL-2414 shall be wired to spare terminal blocks inside the transformer cabinet.

9.9. The transformer manufacturer shall provide a fiber optic patch panel for fiber optic connections within the transformer.

9.10. Nameplates for the SEL-2414 and test switches shall be provided. Each test switch nameplate nomenclature shall describe the associated transformer alarm or relay input it is wired to. See appendix for further details for SEL2414.

10. BUSHING CURRENT TRANSFORMERS

The bushing current transformers shall conform to the latest revisions of ANSI/IEEE C57.13 and C57.19.01 for bushings' dimensions that will adequately accommodate the maximum "D" dimensions for the subject bushings, as shown in the applicable tables. In addition, they shall be five-terminal, relay accuracy, multi-ratio type and shall be provided as shown in the table(s) below:

For the 450/600/750 MVA units:

BUSHING	AMPERE	ACCURACY
H1-H2-H3	2000/5	C800
H1-H2-H3	2000/5	C800
H1-H2-H3	2000/5	C800
H1-H2-H3	2000/5	C800
X1-X2-X3	20000/5	C800
X1-X2-X3	20000/5	C800
X1-X2-X3	20000/5	C800
X1-X2-X3	20000/5	0.3B -1.8
X0	2000/5	C800

For the 360/480 MVA unit:

BUSHING	AMPERE	ACCURACY
H1-H2-H3	1500/5	C800
H1-H2-H3	1500/5	C800
H1-H2-H3	1500/5	C800
H1-H2-H3	1500/5	C800
X1-X2-X3	16000/5	C800
X1-X2-X3	16000/5	C800
X1-X2-X3	16000/5	C800
X1-X2-X3	16000/5	0.3B -1.8
X0	1200/5	C800

10.1. The high voltage winding CTs shall be arranged so that the highest ratio is placed closest to the winding end of the bushings.

10.2. All secondary leads shall be connected to conveniently mount shorting type terminal blocks in the control cabinet.

10.3. The secondary tap leads of the current transformer shall be copper wire, No. 12 AWG minimum, 600 V insulation class and shall be brought out to a shorting type terminal blocks complete with engraved phenolic type marking strips (tape type labels are not acceptable) white having the wire identities in black.

10.4. Polarity marks on bushing CTs shall be toward external bushing terminals.

10.5. The transformer shall also be provided with the following additional bushing CTs:

10.5.1. One (1) current transformer for the winding temperature indicator located in phase "A" (X1) of the low voltage winding.

11. CONTROL CABINET

11.1. All terminals for remote control wiring shall be located in a suitable control cabinet

11.2. The cabinet shall be furnished with a removable eight gauge aluminum or stainless steel conduit plate in the bottom. The plate shall be 1/8" thick and a minimum of twelve inches (12") by twelve inches (12").

11.3. The cabinet shall be weather tight, NEMA 4X, IEC IP55 minimum, and designed for ISO 12944 corrosion category C4 environments.

11.4. The cabinet shall be equipped with an automatic transfer switch (ATS) to ensure uninterrupted auxiliary power to critical monitoring and protection devices. The power to the pumps and fans should be run through the automatic transfer switch (ATS). The ATS should swap between the two main three phase feeds.

11.5. Transfer switch position indication will be wired to a SEL-2414 digital input.

11.6. It shall be equipped with a lamp socket with switch activated by the door and a duplex grounding type 120 VAC receptacle.

11.7. 120/240 VAC automatically controlled space heaters are to be provided to prevent condensation and keep the components in the cabinet dry.

11.7.1. The heaters shall be provided with guards.

11.7.2. Ventilating holes shall be provided to permit proper air circulation.

11.7.3. A magnetic circuit breaker shall be provided for the heater's circuit. Fuses are not acceptable for the heater's circuit

11.8. Where fuse blocks are required, they shall be modular type with bakelite frame and reinforced retaining clips.

11.9. The control cabinet doors shall have provisions for securing them in the open position. Doors shall be hinged and have heavy-duty handle-type latch. Cabinet shall be equipped with a stainless steel 3-point latching mechanism and a continuous stainless steel hinge. Hinged panels with controls mounted on them shall be provided with suitable stops. All hinges shall be 316 stainless steel.

11.10. All welds on the exterior of the cabinet are to be full welds. Spot, tack or skip welds are not acceptable for attaching hinges, brackets, etc. Designs which minimize pockets and crevices where corrosion may occur are preferred.

11.11. The cabinet interior shall be finished in bright white or equal. The white coat shall be applied over the standard primer coat as described in the Paint section of this specification. The cabinet exterior shall match that of the main tank.

12. CONTROL, INSTRUMENT AND AUXILIARY POWER WIRING

12.1. The control and auxiliary power circuits for the transformer shall be completely wired. All circuits for external connections shall be brought to terminal blocks in the control cabinet.

12.2. Terminal blocks shall be furnished with white marking strips. Twenty (20) percent of terminals on each terminal block shall be allocated as spares for circuit modifications and for termination of all conductors in a multi-conductor control cable.

12.3. Wire for control and power circuits shall be rated for use in conduits, as well as, cabinets and shall utilize insulation which is both fire resistant and resistant to transformer insulating oil.

12.4. Splices will not be acceptable.

12.5. Protective overcurrent devices shall be provided in accordance with industry best practices.

12.6. All control wiring shall be fitted with solderless, uninsulated, ring-type compression terminals. Control wiring terminal boards shall be barrier type and accommodate solderless, uninsulated, ring-type compression connectors.

12.7. There shall be no more than two (2) conductor terminals per terminal strip pole. Nor shall there be more than two (2) conductor terminations per relay or component terminal point.

12.8. Each set of current transformer secondary leads shall be brought to shorting-type terminal blocks in the control cabinet with ring-type compression connectors.

12.9. JEA will provide auxiliary power supply, three phase, four wire, sixty hertz source to terminals in the control cabinet to operate the forced cooling equipment, tap changer motor drive, heaters, and any other low voltage AC requirements. The Manufacturer shall furnish a terminal block for termination of at least four (4) #4 AWG, 600 VAC type RHW cables. This terminal block shall be clearly labeled as the terminal connection of the input AC source. No load shall be connected to this terminal connection. The high leg of the connection is the 208 VAC phase-to-ground associated with 120/240 VAC, three-phase, four-wire Delta connected station service transformer shall be clearly label as to its termination point.

12.10. Terminal blocks for external connections shall be clearly labeled to indicate the function of the connections. Drawings for the cabinet shall be labeled similarly.

12.11. An under voltage relay (Device 27) shall be provided with an auxiliary timer (delay on pickup) to provide alarms for loss of AC auxiliary power to the cooling equipment. The timer shall be used to eliminate alarms due to momentary interruptions of AC power.

12.12. Loss of DC relay shall be provided to allow alarms for loss of DC power to the Sudden Pressure Relay. Loss of DC alarms shall be wired to the SEL-2414.

13. OIL PRESERVATION EQUIPMENT

13.1. The oil preservation system shall be conservator type with a sealed bladder (Atmoseal system or equivalent), as per the latest revision of **ANSI/IEEE C57.12.80, Section 6.5.5**.

13.2. Bladders are to be fully pressure tested before installation in the conservator tank.

13.3. A gate or globe valve suitable for full vacuum shall be placed at both the transformer tank and at the conservator tank. A braided stainless steel flexible connection shall be provided to eliminate potential alignment problems.

13.4. The conservator tank shall be provided with a Messko GmbH MTraB DB200RM-T series maintenance free dehydrating breather and bleeder valve.

13.4.1. The breather shall be mounted 5' above transformer base for easy access.

13.4.2. The power supply of the breather shall be protected by a 15A circuit breaker.

13.5. The conservator tank shall be provided with at least two (2) inspection openings, one in each end of the tank, to allow easy inspection and or replacement of the air cell.

13.6. The conservator tank is to be located such that all parts on the cover of the main tank, including bushing casing, gas detector relay and mechanical pressure relief devices, can be completely filled with oil at the minimum oil level in the conservator tank.

13.7. The conservator tank shall be capable to operate at an ambient temperature range of -10 degrees to 40 degrees Celsius (-10ºC to 40ºC).

13.8. The conservator tank shall be sized to permit continuous 120 degrees Celsius (120ºC) top oil temperature operation without oil discharge.

13.9. The conservator tank shall be located on Segment 2 or Segment 4.

14. COOLING EQUIPMENT

14.1. The heat exchangers/coolers manufactured by the following companies are allowed:

14.1.1. Unifin International

14.1.2. Weidmann - ACTI

14.1.3. Flakt Coiltech

14.1.4. Tranter Radiator Products, Inc.

14.2. Heat exchangers/coolers shall be provided with drain plugs.

14.3. Complete outline dimensional drawings for the heat exchanger/cooler are to be provided, including pipe headers, valve sizes and bolt patterns. The drawings shall be in adequate detail to allow manufacture of replacement heat exchanger/cooler by an independent vendor.

14.4. Fan motors shall be rated for 480 VAC, three-phase operation.

14.4.1. The fan motors should have permanently sealed and lubricated ball bearings.

14.4.2. In the case of using coolers instead of heat exchangers, the fan motors shall be supported from the GSU tank. Mounting the fan motors directly to the coolers is not acceptable.

14.4.3. Fan blades shall be of cast, all aluminum construction and fan guards, shrouds, plenums or venturis shall be hot dipped galvanized.

14.4.4. The fan motors, plugs and cords shall be manufactured by Krenz and Company.

14.5. Pump motors shall be rated for 480 VAC, three-phase operation.

14.6. Heat exchanger/cooler valves:

14.6.1. The heat exchanger/cooler valves shall be pressure seal type butterfly or flapper valve type.

14.6.2. Outline drawings of the heat exchanger/cooler valves shall be submitted for approval.

14.6.3. Heat exchanger/cooler valves shall be welded to the GSU tank in both upper and lower header pipe connection points.

14.6.4. The heat exchanger/coolers shall connect to the valves by a bolted connection.

15. TANK CONSTRUCTION

15.1. The transformer tank shall be of steel plate construction, electrically welded and braced, oil tight and suitable for skidding into position and filling under **full vacuum** with a minimum of visually detectable tank deformation and no permanent deformation.

15.2. Lifting lugs and jacking pads shall be provided on the tank for lifting or jacking and skidding the transformer onto transport vehicles and into place as necessary. The lifting lugs shall be free from sharp edges. Facilities for guying the transformer shall be provided. Permanent deformation shall not occur when hoisting or lifting the unit.

15.3. Center of gravity marks, 2"-3" in diameter, shall be stamped on the side and end of the tank.

15.4. The center line of the transformer tank shall be clearly identified at the base of all four (4) sides.

15.5. The transformer shall be provided with the following valves and fittings:

15.5.1. One (1) 2" globe-type valve, filter press and drain, complete with 3/8" sample device, located at one of the bottom corners of the main tank.

15.5.1.1. The sample device shall be located beyond the valve seat from the tank.

15.5.1.2. Three horizontal marks (+++) shall be stamped on the tank directly above this valve at the oil level required to cover the core and coils assembly. A nameplate could also be an option instead of the stamped marks.

15.5.1.3. The valve shall provide for drainage of the oil to within 1" of the bottom of the tank.

15.5.2. One (1) 2" globe-type valve located at one of the top corners of the main tank, diagonally and opposite to the valve described in **Paragraph 15.5.1**, 6" below the top cover of the main tank.

15.5.3. One (1) 1" globe-type drain valve for the conservator tank.

15.5.4. One (1) 1" glove-type valve located on the top of the conservator tank, opposite to the valve described on **Paragraph 15.5.3**

15.5.5. One (1) 4" ¼ turn ball valve vacuum connection, threaded and capped, located on the top cover, at least 18" from the edge of the main tank, diagonally and opposite to the valve describe in **Paragraph 15.5.2**. An Apollo-70-100-10 or similar may also be used.

15.5.6. One (1) 1" fitting, with valve, located on top of the tank on the opposite end from the vacuum connection, at least 12" from the edge of the main tank, to be used for vacuum monitoring device.

15.5.7. Two (2) 1" fittings, with valves, both located on the same tank wall, one located 6" from the top of the tank and one located 6" above the bottom of the tank and in direct line with the one on the top.

15.5.8. All valves, sampling devices and fittings shall be provided with pipe plugs or caps in the open ends.

15.6. The transformer cover shall be of a domed or shed type design with a continuous upward slope to the gas accumulator fittings to ensure proper gas detection system operation.

15.7. The cover shall also be welded to the tank. During welding of the transformer cover, an inorganic gasket will be permanently located between the cover and the tank flange to prevent the entrance of weld splatter into the tank.

15.8. A minimum of two (2) circular manholes with bolted covers shall be provided on the cover of the transformer.

15.9. A minimum of two (2) circular manholes with bolted and hinged covers shall be provided on the side of the transformer near the base.

15.10. The manholes shall have a minimum diameter of 24" and be provided with lifting eyes or handles and shall be located such that they are accessible without the removal of any other equipment.

15.11. A minimum of four (4) copper faced or stainless steel grounding pads with tapped holes shall be supplied.

15.11.1. The pads shall be minimum four (4) hole wide NEMA (4") and accommodate ½" bolts.

15.11.2. Two (2) ground pads shall be located near the base, on opposite corners, on the sides of the tank to serve as tank and surge arrester grounding. These pads shall each have a minimum of two (2) spare holes to allow the connection of the tank to the station main grounding grid at the site.

15.11.3. One (1) ground pad shall be located near the core ground bushing.

15.11.4. One (1) ground pad shall be located near the base of the tank and used exclusively to ground the neutral bushing. This pad shall have a minimum of two (2) spare holes to allow the connection of the neutral to the station main grounding grid at the site.

15.11.5. **Mounting of the ground pads directly beneath the heat exchangers/coolers is not acceptable.**

15.11.6. The Manufacturer shall provide clamp type connectors for 4/0 – 500 MCM copper cable range connectors for all grounding connections. The connectors shall be attached to the tank ground pads with 1/2" stainless steel bolts, flat washers, and Belleville washers of sufficient length for the connector provided.

15.12. High and low voltage bushings and lightning arresters shall be placed or positioned so that full ANSI BIL levels are maintained for both phase-to-phase and phase-to-ground rated voltages for the unit, as a minimum.

15.13. The bottom of the transformer tank shall be separated from the foundation on which it operates by use of a structure type base or separate 10"-12" galvanized I-beam type supports running the full length of the tank. Complete dimensional data shall be furnished with the outline drawings to show the exact footprint of the base that will sit on the foundation. Structure type bases shall receive an asphaltic or similar corrosion resistant coating.

15.14. All welds on the exterior of the tank are to be full welds. All tank seams shall be double welded (inside and outside) and shall be a minimum of six (6) inches from the corner. Spot, tack or skip welds are not acceptable for attaching hinges, brackets, grounding buses, etc. Tank designs which minimize pockets and crevices where corrosion may occur are preferred. Welds and seams on corners are not allowed.

15.15. Two (2) Unique Concepts, Ltd. Portable Fall-Arrest Weld-On Plates (Model:10816, drawings provided) shall be welded to the tank cover, one near the Segment 2 tank cover edge and one near the Segment 4 tank cover edge.

15.16. All gasketed openings shall be designed with means provided for controlled compression of the gasket, utilizing metal-to-metal stops and reusable gaskets of oil resistant material. All gasketed joints on top of the transformer shall utilize flanges which are raised at least ¾ inches above the cover surface.

15.17. The transformer cover shall have a non-skid, slip resistant coating.

15.18. All conduits shall be supported by ¼" x 2" x 2" steel angle and/or steel hardware.

15.19. All external tank supports, or stiffeners shall be box beam construction and continuously welded.

15.20. Oval tank designs are not permitted.

15.21. The shipping height of the transformer shall not exceed 14'-0"**.**

16. INSULATING OIL

16.1. The insulating oil shall be new, oxidation inhibited **Type II** mineral transformer oil as per latest revisions of **ASTM D 3487-88**, **ANSI/IEEE C57.106, and Doble TOPS**. The only acceptable oxidation inhibitors are 2,6-ditertiary-butyl para-cresol and 2,6-ditertiary-butyl phenol.

16.2. The oxidation inhibitor content shall be not less than **0.3%** by mass, as determined by the latest revisions of **ASTM D 1473 or D 2668**. **Note:** As per **ASTM D 3487-88, Footnote H,** Test Method **D 2668** can be used for **either inhibitors** mentioned. **Method D 1473** can only be used for inhibitor **2,6-ditertiary-butyl para-cresol**.

16.3. Insulating oil must comply with Doble TOPS (Transformer Oil Purchasing Standard).

16.4. The oil shall be delivered in tank trucks upon notification by JEA's Project Engineer.

16.4.1. The oil delivery tank trucks shall be of the common manifold type to allow oil-filling procedures without changing hose connections.

16.4.2. The hose connection valve shall be sealed to ensure that all oil shipped is received at the site.

16.5. The Manufacturer shall provide a written certification and test report that the transformer oil fully complies with **ASTM D 3487-16.**

16.6. JEA will perform the following tests at site arrival and before accepting the oil and failure of any of these tests shall be grounds for refusal of the oil shipment and a new shipment immediately required:

16.6.1. Dielectric Breakdown Strength – 30 KV minimum as per **ASTM D 877-87**.

16.6.2. Power factor – 0.05% or less at Twenty-five degrees Celsius (25ºC) are per **ASTM D 924-99e1**.

16.7. The delivered transformer oil and oil used at the factory shall be non-PCB oil. The Manufacturer shall certify on the transformer test report that all oil used in processing and testing the transformer had a "**not detectable**" content of polychlorinated biphenyl as determined by test method **ASTM D 4059-96**.

17. PAINT

17.1. Surfaces requiring painting shall be rendered clean and smooth and shall be painted in accordance with the requirements of **ANSI/IEEE C57.12.28**. The exterior tank finish shall be ANSI-70 (sky gray).

17.2. The external surface of the tank, cover and bottom shall be prepped per SSPC SP1. Test the surface with Chlor Test Strips to ensure a clean surface. Then clean the surface per SSPC SP6 Commercial blast cleaning to properly treat to remove all corrosion and provide a bare metal surface for painting.

17.3. Carboline paints are preferred.

17.4. All surfaces shall be painted with an alkyd base primer paint followed by at least two (2) finish coats of alkyd base paint, Edison Gray (ASA 70). The complete coating system shall comply with ISO 12944 requirements for a minimum corrosion category C4. The proposed coating system shall be fully documented in the bid submittal and shall be subject to approval by JEA.

17.5. Epoxy paints and polyester powder are not acceptable due to the inability to chemically strip these finishes.

17.6. If Carboline paint products are used, the following Alkyd paints shall be used:

17.6.1. Primer Coat – Carboline Carbocoat 2900 Primer – 0500 (Red), 2 mils.

17.6.2. Body Coat – Carboline Carbocoat 2900-0600 (Yellow), 2 mils.

17.6.3. Finish Coat – Carboline Carbocoat 30-R (Edison Gray ASA-70) Silicon Alkyd, 2-3 mils.

17.7. If Carboline paint products are used, the transformer tanks and all structural surfaces shall be painted with the following:

17.7.1. Prime Coat – Carbomastic 615 Aluminum at 5.0 to 10.0 mils dft.

17.7.2. Stripe Coat all bolts and edges – Carbomastic 615 Gray at 4.0 to 8.0 mils dft.

17.7.3. Finish Coat – Carbothane 134 HG ASA 70 Edison Gray at 2.0 to 3.0 mils dft.

17.8. The inside of the main tank shall be painted white.

17.9. An accelerated aging test must be performed on the paint to be used inside the tank. A plate steel sample coated with the white paint shall be submerged in transformer insulating oil and heated to 130 degrees Celsius (130ºC). After 1,000 hours there may not be any change in the painted surface or in the power factor of the oil used for the test.

17.10. Any proposed variation from the paint specification above shall be approved by JEA's Project Engineer prior to submittal of bid or rejection of bid may be possible. Please complete this table below.

TEST	ASTM TEST METHOD	RESULTS
Adhesion	D-3359-B	
Salt Spray	B-117	
Humidity	D2247	
Impact	D-2794	
U-V Resistance	G-53	
Taber Abrasion	D-4060	
Oil Resistance	72 Hrs. @100˚C	
Thermal Aging	1,000 Hrs. @ 120˚C	
Pencil Hardness	D-3363	
VOC's	D-2369	

18. NAMEPLATE

18.1. Two identical nameplates shall be provided. One shall be mounted on or near the control cabinet. The second shall be mounted inside the control cabinet door.

18.2. The nameplate shall be fabricated from stainless steel and attached with stainless steel hardware.

18.3. The nameplate shall be as per the latest revision of **ANSI/IEEE C57.12.00, Paragraph 5.12.**

18.4. The following additional information shall be stated on the nameplate:

18.4.1. Current values for the maximum sixty-five degrees Celsius (65ºC) MVA rating for all tap positions.

18.4.2. All current transformers including polarity marks, **ANSI/IEEE** tap identification and relay accuracy.

18.4.3. All applicable weights including shipping.

18.4.4. Date of manufacture.

19. FACTORY TESTS

19.1. The tests shall include, but not be limited to, all the routine tests as described in the latest revision of **ANSI/IEEE C57.12.00, Section 8** and as defined in the latest revision of **ANSI/IEEE C57.1280, Section 5**.

19.2. The following tests shall be performed on all transformers in accordance with methods outlined in the latest revision of **ANSI/IEEE C57.12.90, Part I**:

19.2.1. Resistance Measurements (Clause 5) Resistance to be measured on all tap combinations, DETC and OLTC. Results to be included in the certified test report in table format and graphical format.

19.2.2. Polarity and Phase-Relation (Clause 6)

19.2.3. Ratio (Clause 7)

19.2.4. No-load Losses and Excitation Current (Clause 8)

19.2.5. Impedance and Load Losses (Clause 9) - The resistive component (R) of the Impedance and the reactive component (X) of the Impedance shall be provided. (R+Xj)

19.2.6. Dielectric Tests:

19.2.6.1. Standard series of full wave and chopped wave impulse tests on both the high voltage and low voltage windings (Clause 10.3)

19.2.6.2. Applied Voltage (Clause 10.6)

19.2.6.3. Induced Voltage (Clause 10.8 – last dielectric test to be performed) Partial discharge measurements shall be made and reported every five minutes during the induced voltage test. Test procedure and partial discharge measurement shall be in accordance with Clause 10.9.

19.2.7. Overexcitation test (12 hrs.) - The manufacturer shall perform an over-excitation (Volts per Hertz) withstand test with a minimum duration of twelve (12) hours. Test procedures and acceptance criteria shall be in accordance with applicable IEEE standards, and certified test results shall be provided.

19.2.8. Partial discharge measurements shall not exceed 300 pico-coulombs (pC) at 1.5 times rated line-to-ground voltage during induced voltage testing."

19.3. Insulation power factor, as determined by **Doble Method II.** Results shall include separate values for CH, CL, and CHL. These values are not to be combined and a value more than 0.40%, corrected to twenty degrees Celsius (20ºC), will not be acceptable. Values above this shall be reported to the Project Engineer.

19.4. Core Ground Test (Section 10.11)

19.5. Gas Chromatography Test showing any combustible gasses present, in ppm, as a result of testing as per the latest revision of **ANSI/IEEE C57.104.**

19.6. Temperature rise test, in accordance with Clause 11 (first transformer design). Oil samples shall be taken for DGA before any test is done and after the last test. In addition, oil samples shall be taken before the start of the temperature rise test and every six (6) hours, until the end of the test.

19.7. Audible Sound Test, in accordance with Clause 13 (first transformer design) in accordance with IEEE C57.12.90. Transformer sound levels shall not exceed 85 dBA at maximum forced-cooled rating (ONAF2). Certified sound test results shall be provided.

19.8. Gas detector system test, in accordance with the following procedure: A gas sample of 500 cc of dry nitrogen is to be introduced rapidly (within 5 seconds) into an opening on the opposite corner of the tank from the relay, at ground level. The gas detector relay must be activated within five (5) minutes in order to pass the test.

19.9. Sweep Frequency Response Analysis

19.9.1. The Doble Sweep Frequency Response Analyzer shall be used to perform this test.

19.9.2. The frequency sweep shall cover the frequency range from 20 Hz To 2 MHz.

19.9.3. The test shall be performed twice, once with the transformer fully assembled and once with the transformer in its shipping configuration. In the shipping configuration, the bushing leads shall be secured and electrically connected to core ground bushings installed in the bushing shipping covers so that test connections can be made without opening the transformer and disturbing the leads. The bushings shall be mechanically protected during shipping. The mechanical protection shall be designed to not allow release of the shipping gas when removed.

19.9.4. SFRA tests shall be performed on DETC tap 3 and shall remain on this tap for shipping. The software generated test file shall be received by the Project Engineer prior to shipping.

19.10. The transformer shall be completely assembled at the factory to assure fit of all components and accessories.

19.11. JEA's Project Engineer shall be notified at least four (4) weeks prior to tanking the core and coil assembly and testing to arrange travel requirements to inspect the unit and to witness final tests.

19.12. Any deficiencies or failures during final testing shall be thoroughly reported, in writing, to the Project Engineer prior to re-testing.

19.13. The Manufacturer shall furnish certified copies of test data taken on all tests performed on the transformer. Test reports shall be received by the Project Engineer before the shipment of the transformer.

19.14. All current transformers shall be tested as per latest revision of **ANSI/IEEE C57.13, Clauses 6.11 and 8.** CT curves shall be furnished for all CTs and will be used for relaying applications.

19.15. An electronic copy of the Doble test file, with all fields applicable to the above mentioned tests filled completely, shall be received by the Project Engineer prior to shipping of the transformer.

20. LOSS EVALUATION

20.1. For the purpose of determining the best bid, all transformer losses shall be measured at rated voltage, frequency and at maximum MVA.

20.2. The loss measurement system used to measure losses shall be tested for accuracy by an independent agency.

20.2.1. A certified measurement error report shall be made available to the Project Engineer before the bid opening.

20.2.2. Testing of measurement systems shall follow the procedure described in **NBS Technical Note 1204**.

20.2.3. The test system accuracy for each quantity measured shall fall within the limits specified in the latest revision of **ANSI/IEEE C57.12.00, Section 9.4, Table 20.**

20.2.4. The frequency of the test source shall be within **+/- 0.5%** of the rated frequency of the transformer.

20.3. In the event that the certified test report shows that the transformer losses at rated voltage and frequency exceed the guaranteed losses stated in the proposal data, the Manufacturer shall credit JEA the difference between the certified losses and the guaranteed losses in accordance with the Loss Guarantee section criteria.

21. LOSS GUARANTEE

21.1. The losses quoted on the proposal form – i.e. No-Load, Load and Auxiliary shall be considered guaranteed maximum values. **The values quoted will be compared to the actual test values to determine conformance.**

21.2. If the certified test report values exceed the quoted values, then a credit shall be due to JEA in accordance with the following:

21.2.1. No Load Losses - $5,000/kW

21.2.2. Load Losses - $1,000/kW

21.2.3. Auxiliary Losses - $500/kW

21.3. The measurements shall be made under the following conditions and as per the latest revision of **ANSI/IEEE C57.12.00, Section 5.9:**

21.3.1. No-Load Losses shall be measured and corrected to an ambient temperature of twenty degrees Celsius (20ºC).

21.3.2. Load Losses shall be measured at eighty-five degrees Celsius (85ºC).

21.3.3. Auxiliary Losses shall be measured and corrected to an ambient temperature of twenty degrees Celsius (20ºC).

22. TRANSFORMER ONLINE MONITORING REQUIREMENTS

22.1. JEA requires provisions made for online monitoring and the installation of the Vaisala OPT100-OPTIMUS A2A4N0N0N0B0N0N0N1A0 DGA monitor by the transformer manufacturer at the factory.

22.2. The monitor shall be provided with a single IP56 acquisition box and mounted to transformer. The monitor shall be powered by 125VDC from the control cabinet with a separate circuit breaker for isolation.

22.3. Communication requirements will be provided by JEA at the time of monitor selection. The monitor(s) shall be configurable at factory per user's instructions with DNP3 (RS232/Ethernet) or optionally with Modbus or IEC 61850 (Ethernet only) communication protocols.

23. DRAWINGS

23.1. Drawings shall be submitted to the Project Engineer for approval before the manufacturing of equipment.

23.2. Drawings shall meet ANSI/IEEE standards. The only language to be used on drawings is English.

23.3. Each drawing shall include JEA as the owner, the JEA purchase order number and "JEA" with the name of the JEA substation where the equipment is designed to operate.

23.4. All drawings shall be 24" x 36" in dimension unless otherwise specified by the Project Engineer.

23.5. An electronic copy (.pdf format) of the approval drawings submitted for the transformer shall include the following:

23.5.1. Transformer outline drawings showing physical dimensions, weights, center of gravity and location of all accessories including a detailed list of all accessories.

23.5.2. Nameplate drawing.

23.5.3. All schematic and wiring diagrams. Tabular type wiring drawings will not be acceptable. These drawings shall locate each piece of equipment and terminal blocks and indicate individual wiring between each item.

23.5.4. Internal layout drawing.

23.5.5. CT excitation curves.

23.5.6. Primary and Secondary Air Termination Compartment Details

23.5.7. Terminal Connection Details

23.5.8. Original equipment manufacturer drawings and catalog/part numbers for equipment as follows:

23.5.8.1. HV, LV, N, and core ground bushings

23.5.8.2. High and low voltage surge arresters

23.5.8.3. All gauges

23.5.8.4. Gas Detector relay

23.5.8.5. Switches

23.6. The Manufacturer shall furnish the Project Engineer with a complete list of all items which will be sent on each shipment, i.e., the number of boxes, bundles, pieces, etc. and the contents of each. This list shall be received by the Project Engineer prior to shipment from the factory. The Manufacturer will be notified of any items not received at time of delivery.

23.7. All final drawings shall be submitted in 24" x 36" hard copies and a flash drive containing Intergraph CAD system (MicroStation) and PDF format. The manufacturer shall also provide a link to a file server where these drawings can be downloaded for a period of 30 days from the date of delivery.

24. INSTRUCTION BOOKS

24.1. The Manufacturer shall provide three (3) hardcopy instruction books and one (1) complete electronic document copy instruction book. All information shall be in English.

24.2. These instruction books shall contain information on receiving, storing, assembly and maintenance of the transformer and its components.

24.3. The instruction books shall be assembled and bound in a three-ring binder with removable cover and edge sheets.

24.4. The instruction books shall be high quality original documents. **Photocopies are not acceptable.**

24.5. A complete set of final drawings shall be included in a pocket-type page in the back of the instruction books.

24.6. The OEM drawings shall be 11" x 17" drawings and included in the instruction books.

24.7. The cover sheet of each instruction book is to be identified with the serial number and JEA purchase order number. The job order number is not an acceptable substitute for the serial number.

24.8. A complete set of photographs of the core and coil assembly, taken just prior to placing the completed core and coil assembly into the tank, shall be furnished with each instruction book. The five views shall include each side, top, front and rear. All photographs shall be 8.5" x 11" gloss prints properly labeled as to the views taken.

24.9. Another complete set of photographs of the core and coil assembly, taken just prior to placing the tank cover onto the tank, shall be furnished with each instruction book. The photographs shall be taken in such a manner that it is clear how much space is available between the core and coil assembly and the tank walls and cover. All photographs shall be 8.5" x 11" gloss prints properly labeled as to the views taken.

24.10. The instruction books shall include, but not be limited to the following:

- 24.10.1. Table of contents and index tabs
- 24.10.2. Specifications, test data and curves
- 24.10.3. A copy of the factory test report
- 24.10.4. Description of the equipment
- 24.10.5. Operating instructions
- 24.10.6. Instructions in the methods of receiving, inspection, storage, and handling
- 24.10.7. Complete installation and maintenance instructions
- 24.10.8. Assembly drawings
- 24.10.9. Parts lists
- 24.10.10. Nameplate information and shop order numbers for each item of equipment and component part
- 24.10.11. Instructions of accessories
- 24.10.12. Photographs of core and coil assembly

24.11. A flash drive shall be included with each copy of the instruction book. The flash drive shall contain the following:

- 24.11.1. A complete set of drawings in .PDF format
- 24.11.2. An electronic copy of all instruction manuals included in the instruction book
- 24.11.3. An electronic copy of all photographs included in the instruction book
- 24.11.4. An electronic copy of the final factory test report
- 24.11.5. An electronic copy of all Doble test files.

24.12. The manufacturer shall also provide a link to a file server where the items required on the flash drive can be downloaded for a period of 30 days from the date of delivery.

25. SHIPPING REQUIREMENTS

25.1. The transformer shall be shipped DDP Destination to project location in Jacksonville, Florida.

25.2. The Manufacturer shall assume responsibility for safe arrival and handle all claims if damaged in shipment.

25.3. The transformer shall be shipped from the Manufacturer's facility filled with dry air having a -50 degree Fahrenheit dew point or better.

25.3.1. A record of the exact dew point shall be included in the instruction book shipped with the unit.

25.3.2. All valves, shipping covers, etc. shall be sealed and effectively crated to prevent tampering or removal while in transit.

25.3.3. A valve/gauge arrangement to put in the one (1) inch filling valve located on the side of the tank shall be provided for allowing gas pressure measurement and dew point reading without the release of the gas.

25.4. The coolers shall ship wrapped adequately to protect them from transportation and handling hazards.

25.5. Core ground lead and connector shall be in place for shipment to allow an insulation resistance test (Megger) of the unit core ground, without opening the tank, to be performed at the arrival at the site. A rigid housing shall be installed to protect the core ground lead and connector during shipping.

25.6. All conduits and auxiliary equipment mounting positions shall be sealed and/or covered to prevent water damage during shipment and storage.

25.7. **The Manufacturer shall attach two (2) two-way (vertical and horizontal) GPS capable impact recording devices to the transformer.**

25.7.1. The requirement of two recorders is for redundancy in case one fails during transit.

25.7.2. The Manufacturer shall provide JEA with the necessary login credentials to review the impact recorders data via the internet.

25.7.3. Upon arrival and before unloading the transformer, the impact recorder records will be inspected by JEA and the Manufacturer's representative.

25.7.4. If, in the opinion of JEA and or the Manufacturer's representative, the impact recorder records indicate rough handling during shipment, the Manufacturer will be notified immediately.

25.7.5. The records will be retained by JEA for study.

25.7.6. The Manufacturer shall provide the necessary information for returning the impact recorders.

25.8. All equipment furnished which requires packaging shall be clearly labeled with the JEA purchase order number, substation name, item number (corresponding to the suppliers Bill of Materials) and a description of the contents enclosed.

25.8.1. Any package, which contains more than one (1) item, shall have a separate packing list attached for the specific contents of that package.

25.8.2. All equipment and packages shipped separate from the transformer shall be shipped either on pallets or bundled in an acceptable manner for off-loading.

25.8.3. The method of packing shall be such as to adequately protect the contents from any damage that might reasonably be encountered in transportation and handling.

25.8.4. Packing crates shall be such that long outdoor storage will not result in deterioration of crates or damage to contents.

25.8.5. Any equipment that requires protection from the weather shall use packing material such that it will provide weatherproof protection for a period of one (1) year in outdoor storage areas.

25.8.6. **Any packages that require indoor storage, shall be clearly marked.**

25.8.7. Prior to shipment the Project Engineer shall receive a complete packing list of all items to be shipped in order to check for complete shipment upon arrival.

25.9. All spare parts shall be **packaged separately** and clearly marked **"SPARE PARTS – SJRPP GSU's".**

25.9.1. The spare parts shall be shipped separately from the transformer and shall be delivered F.O.B. to:

JEA
Commonwealth Service Center
6674 Commonwealth Avenue
Jacksonville, FL 32254
Attn: Material and Stores Department

26. FIELD ENGINEERING SERVICES

26.1. The manufacturer shall provide the services of a Field Engineer to provide technical advice and instruction to JEA and JEA's representative for assembly the transformer. This shall include, but not limited to, offloading, setting, assembly, vacuum drying, oil filling, testing and shall assist in placing in operation and in making necessary adjustments of the equipment and any other activity needed to place the transformer in service.

26.2. The manufacturer shall include in the Response the cost for Field Engineering Services. The price shall include travel and per diem during the entire duration.

26.3. The Field Engineer must be thoroughly knowledgeable and experienced in the installation of the specific transformer and all its parts and accessories.

26.4. JEA reserves the right to delete the Field Engineer service requirements from the Bid Proposal.

26.5. The Field Engineer service cost will not be used for the bid evaluation.

26.6. JEA also reserves the right to refuse the services of the Field Engineer, after issuing a P.O., unless required by the manufacturer, and deduct that amount from the payment schedule.

27. SPARE PARTS

27.1. A list of recommended spare and replacement parts shall be included with the bid. This list shall include a complete description of the part, including Manufacturer, catalog number and/or part number and prices for each item. This list shall include all items which will or may need replacement during the life of the transformer including gaskets, seals, O-rings, lubricants, etc. The spare part list prices will not be used for the bid evaluation.

27.2. The spare parts list shall include the following parts as a minimum for each transformer:

27.2.1. One (1) High Voltage Bushing

27.2.2. One (1) Low Voltage Bushing

27.2.3. One (1) Neutral Bushing

27.2.4. One (1) Pump

27.3. If additional spare parts are required for general maintenance procedures, they shall be included on this list.

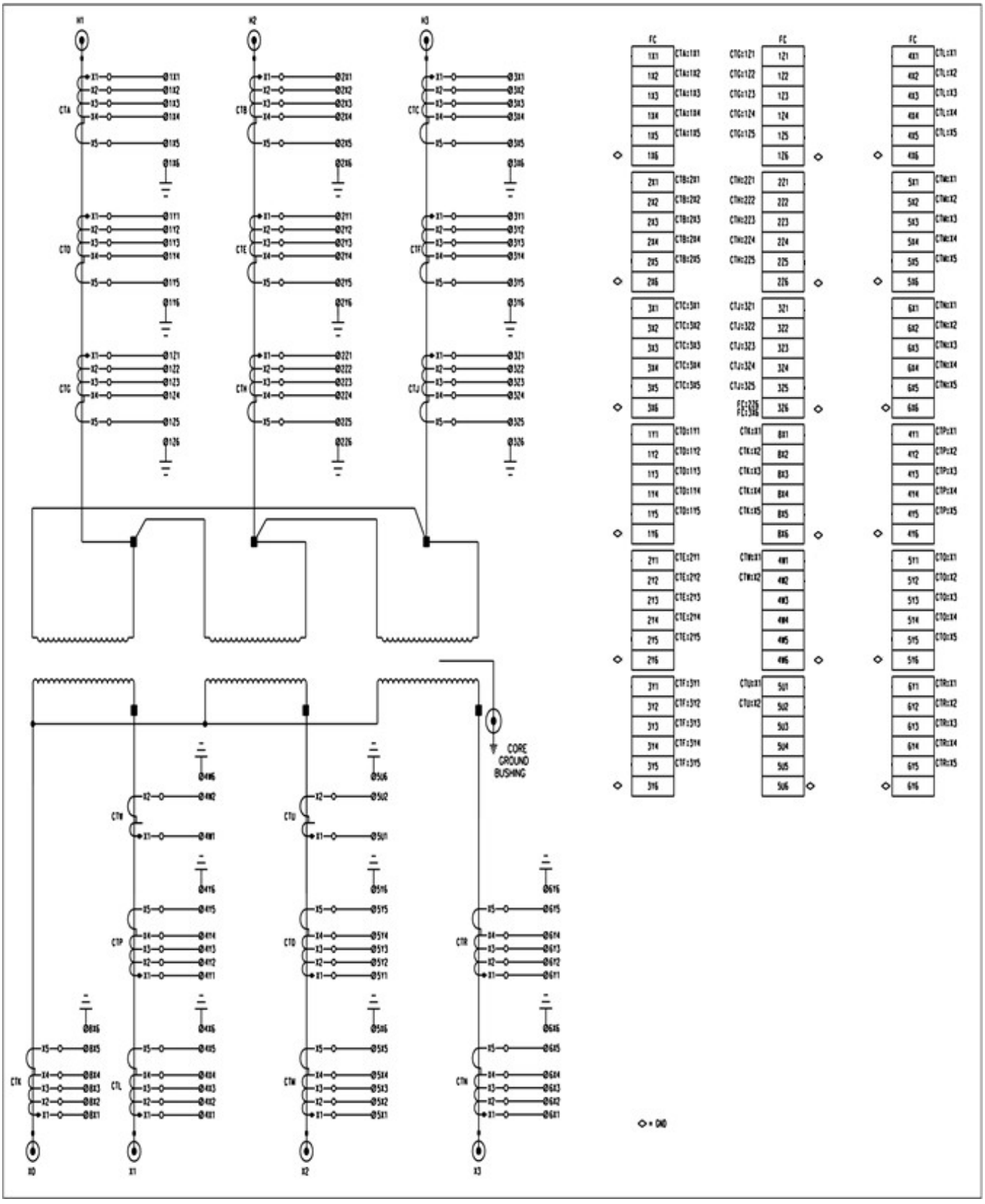
27.4. JEA reserves the right to purchase any or all of the spare parts on the spare parts list. Only those parts required to meet inventory requirements will be purchased.

27.5. The spare parts shall be shipped separate from the transformer and its assembly parts in accordance with shipping instructions.

28. MANUFACTURER'S WARRANTY

The Manufacturer shall provide a standard five (5) year warranty commencing on the date of JEA's acceptance at the delivery site.

29. APPENDIX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CORE GROUND BUSHING
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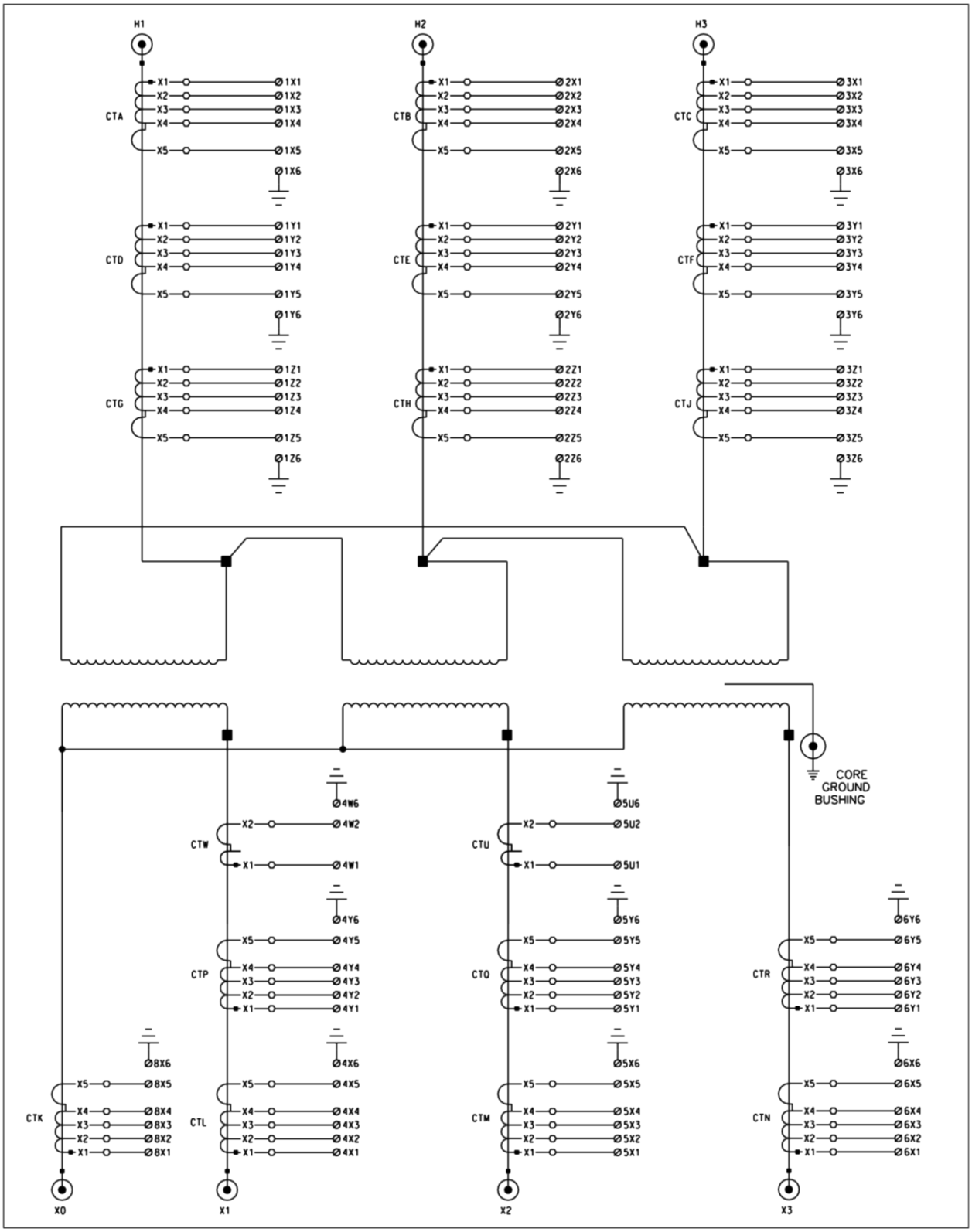
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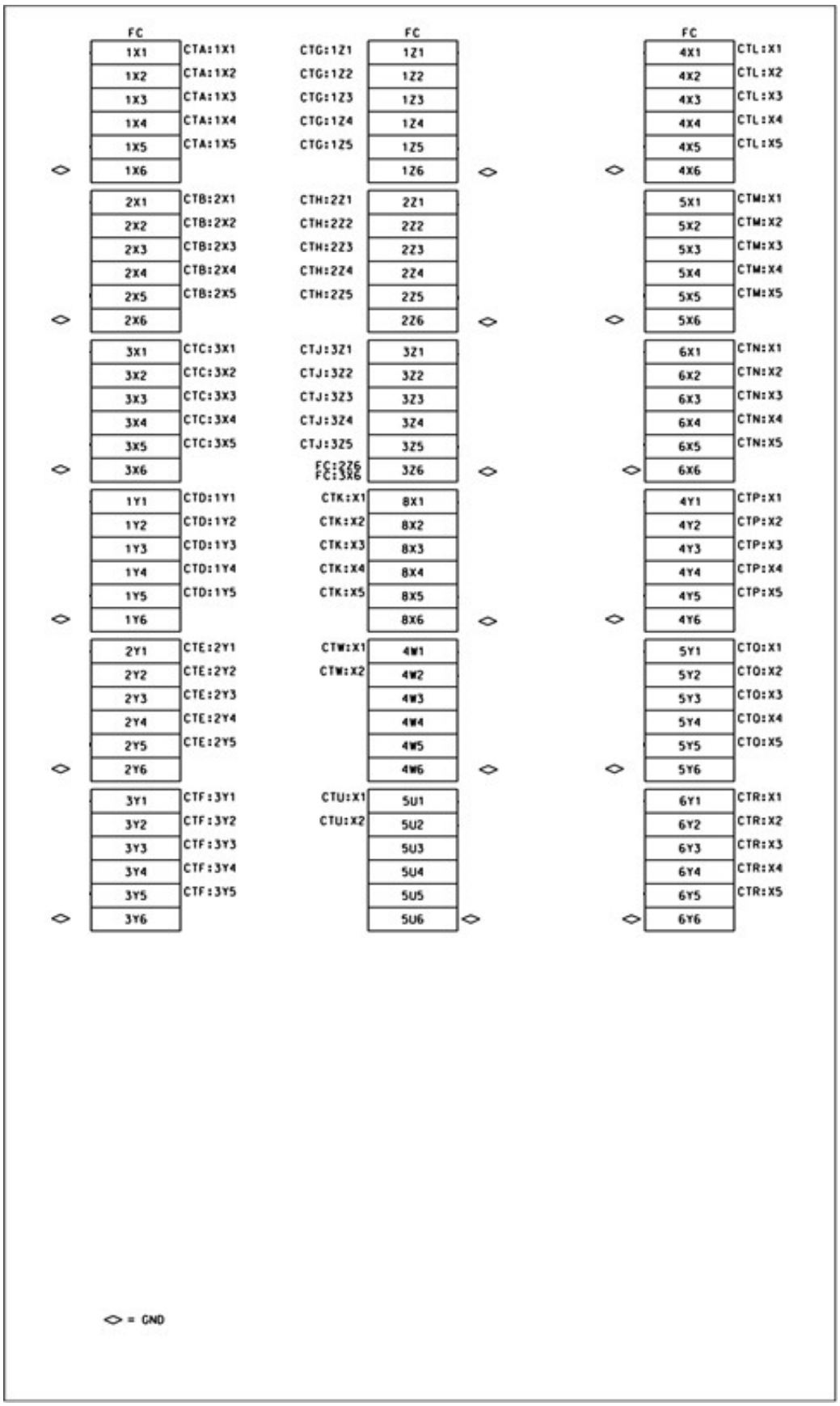
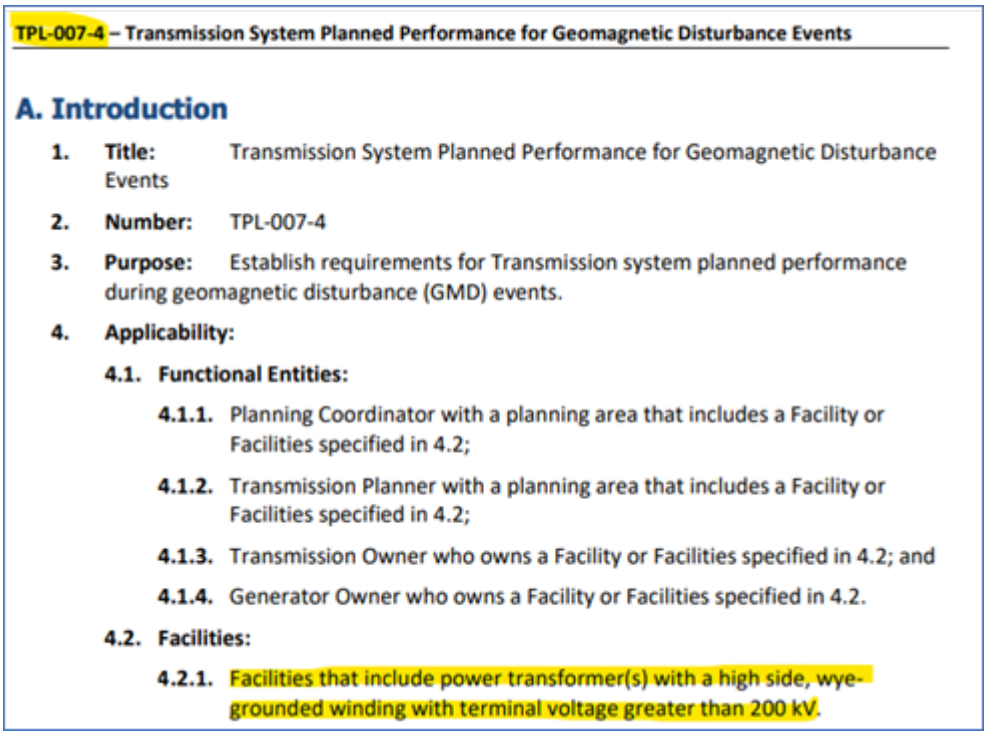
X2
X3


FC
1X1
1X2
1X3
1X4
1X5
1X6
CTA:1X1
CTA:1X2
CTA:1X3
CTA:1X4
CTA:1X5
2X1
2X2
2X3
2X4
2X5
2X6
CTB:2X1
CTB:2X2
CTB:2X3
CTB:2X4
CTB:2X5
3X1
3X2
3X3
3X4
3X5
3X6
CTC:3X1
CTC:3X2
CTC:3X3
CTC:3X4
CTC:3X5
1Y1
1Y2
1Y3
1Y4
1Y5
1Y6
CTD:1Y1
CTD:1Y2
CTD:1Y3
CTD:1Y4
CTD:1Y5
2Y1
2Y2
2Y3
2Y4
2Y5
2Y6
CTE:2Y1
CTE:2Y2
CTE:2Y3
CTE:2Y4
CTE:2Y5
3Y1
3Y2
3Y3
3Y4
3Y5
3Y6
CTF:3Y1
CTF:3Y2
CTF:3Y3
CTF:3Y4
CTF:3Y5
FC
CTG:1Z1
CTG:1Z2
CTG:1Z3
CTG:1Z4
CTG:1Z5
1Z1
1Z2
1Z3
1Z4
1Z5
1Z6
CTH:2Z1
CTH:2Z2
CTH:2Z3
CTH:2Z4
CTH:2Z5
2Z1
2Z2
2Z3
2Z4
2Z5
2Z6
CTJ:3Z1
CTJ:3Z2
CTJ:3Z3
CTJ:3Z4
CTJ:3Z5
FC:2Z6
FC:3X6
3Z1
3Z2
3Z3
3Z4
3Z5
3Z6
CTK:X1
CTK:X2
CTK:X3
CTK:X4
CTK:X5
8X1
8X2
8X3
8X4
8X5
8X6
CTW:X1
CTW:X2
4W1
4W2
4W3
4W4
4W5
4W6
CTU:X1
CTU:X2
5U1
5U2
5U3
5U4
5U5
5U6
FC
4X1
4X2
4X3
4X4
4X5
4X6
CTL:X1
CTL:X2
CTL:X3
CTL:X4
CTL:X5
5X1
5X2
5X3
5X4
5X5
5X6
CTM:X1
CTM:X2
CTM:X3
CTM:X4
CTM:X5
6X1
6X2
6X3
6X4
6X5
6X6
CTN:X1
CTN:X2
CTN:X3
CTN:X4
CTN:X5
4Y1
4Y2
4Y3
4Y4
4Y5
4Y6
CTP:X1
CTP:X2
CTP:X3
CTP:X4
CTP:X5
5Y1
5Y2
5Y3
5Y4
5Y5
5Y6
CTQ:X1
CTQ:X2
CTQ:X3
CTQ:X4
CTQ:X5
6Y1
6Y2
6Y3
6Y4
6Y5
6Y6
CTR:X1
CTR:X2
CTR:X3
CTR:X4
CTR:X5
◇ = GND

GEOMAGNETIC DISTURBANCE EVENTS

NOTE: USE AS APPLICABLE – DOES NOT APPLY TO ALL TRANSFORMERS

The GMD standard NERC TPL-007 is applicable only to transformers with HV greater than 200 kV with high side WYE-grounded (screenshot below). If this lower than 200kV and is a load-serving transformer, the first and second items are not required for Planning's modeling and studies and can be skipped.



TPL-007-4 – Transmission System Planned Performance for Geomagnetic Disturbance Events

A. Introduction

1. **Title:** Transmission System Planned Performance for Geomagnetic Disturbance Events
2. **Number:** TPL-007-4
3. **Purpose:** Establish requirements for Transmission system planned performance during geomagnetic disturbance (GMD) events.
4. **Applicability:**
   - **4.1. Functional Entities:**
     - **4.1.1.** Planning Coordinator with a planning area that includes a Facility or Facilities specified in 4.2;
     - **4.1.2.** Transmission Planner with a planning area that includes a Facility or Facilities specified in 4.2;
     - **4.1.3.** Transmission Owner who owns a Facility or Facilities specified in 4.2; and
     - **4.1.4.** Generator Owner who owns a Facility or Facilities specified in 4.2.
   - **4.2. Facilities:**
     - **4.2.1.** Facilities that include power transformer(s) with a high side, wye-grounded winding with terminal voltage greater than 200 kV.

Factory test data needed for GMD standard modeling:

i) The TX impedance value to be provided in **R+jX** format instead of **Z%** only. This is required to develop pseudo-dc model in PSSE for TPL-007-1 GMD standard.

ii) The modeling of transformers as a 3-winding transformer for use in PSSE (Fig. 1 below) for power system short-circuit studies. In this test, first winding (HV side, t1) is short-circuited, and a voltage is applied on the second (LV side, t2) while the third (tertiary, t3) is left open circuited (Fig. 2-a). This test, when repeated for each winding with open, short and voltage applied scenarios, yields the magnitudes of the *three leakage impedances*- ZLH, ZLT, and ZHT and 3 winding copper losses- WLH, WLT, and WHT. The impedance, ZLH, is the sum of low- and high-voltage winding leakage impedances when the tertiary winding is open, etc. The test parameters are measured at nominal tap position and are, accordingly, related to the nominal tap impedance as designated in Fig 2-b (below). The deliverable to JEA Electric T&D Planning would be: R_1+jX_1; R_2+jX_2; R_3+jX_3

Note:
Historically, JEA has not modeled our transformers in PSSE as a three-winding machine but as a two-winding one for short- circuit studies due to the missing data for the above test. With the new GMD NERC Standard becoming effective, the R-value is additionally required for compliance with correct modeling. The measured R-value will also aid in correctly calculating JEA's system losses annually with actual (I^2R) numbers than with an estimated R-value like today.

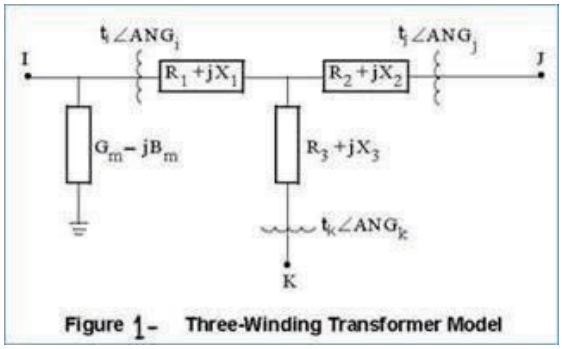


Figure 1 – Three-Winding Transformer Model

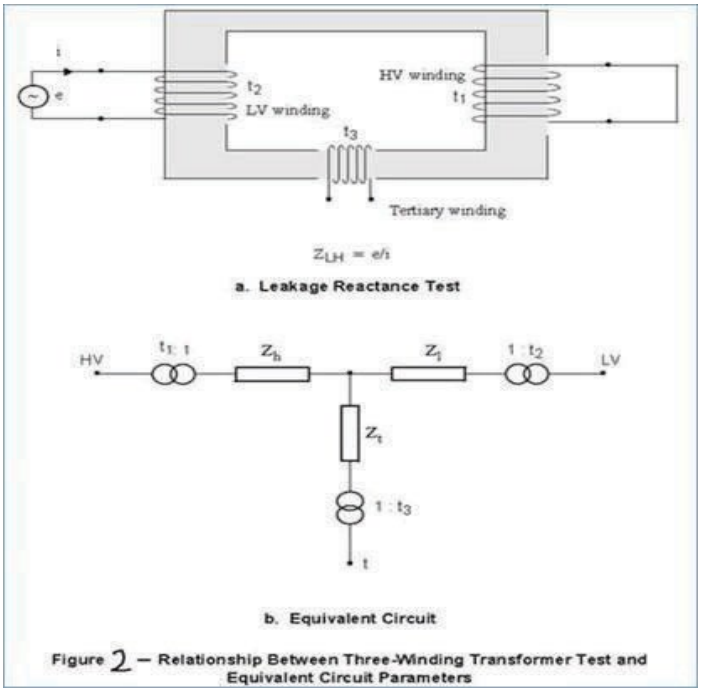
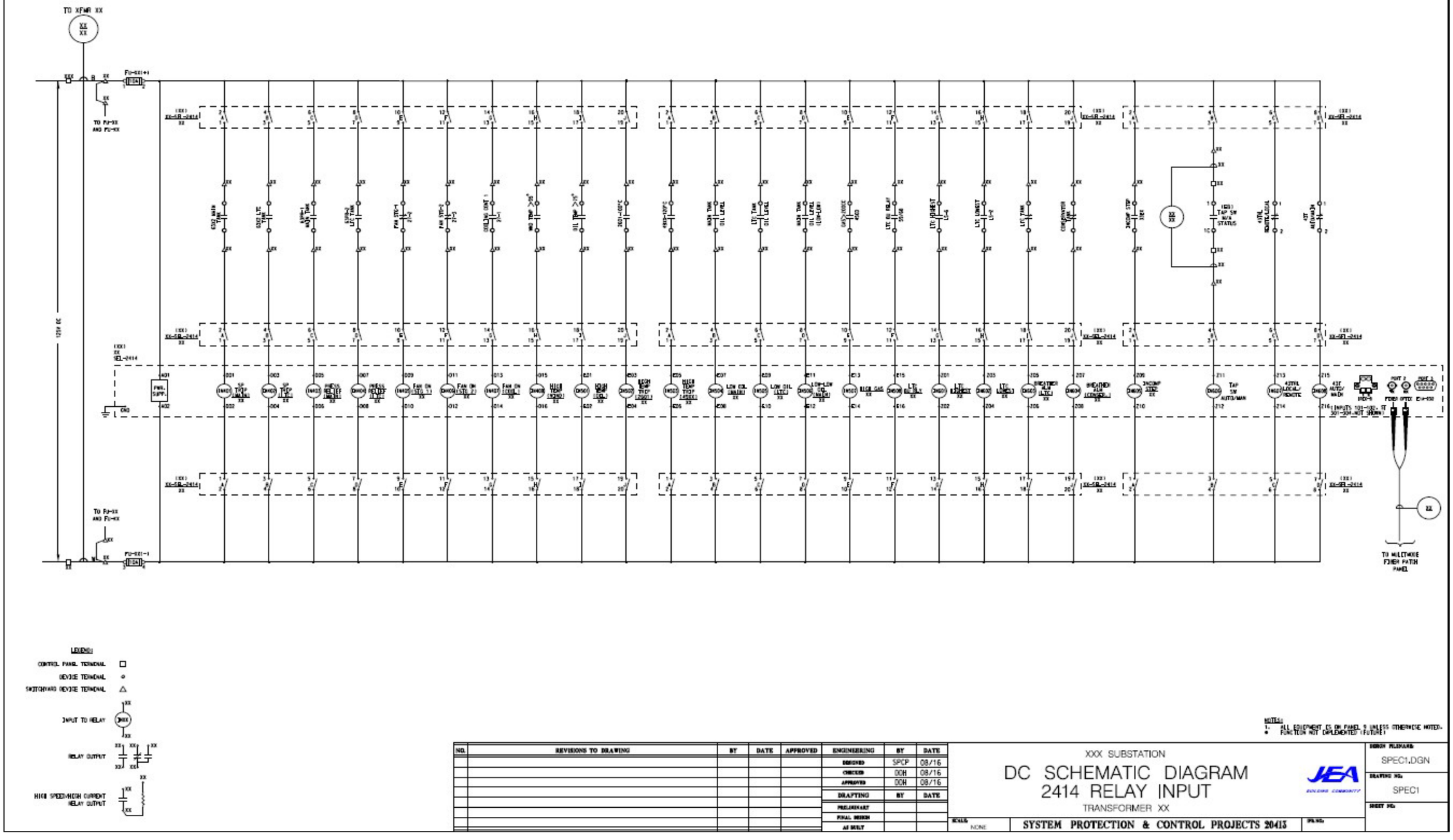


Figure 2 – Relationship Between Three-Winding Transformer Test and Equivalent Circuit Parameters

From Section 20.2.5.1


TO XFMR XX
XX
XX
FU-XX1-1
XX
B
XX
XX
TO FU-XX
AND FU-XX
125V DC
XX-SB-2414
XX
XX-SEL-2414
XX
XX
SEL-2414
PWR. SUPP.
GND
TO FU-XX
AND FU-XX
FU-XX1-1
TO MULTIMODE FIBER PATH PANEL
LEGEND:
CONTROL PANEL TERMINAL
DEVICE TERMINAL
SWITCHYARD DEVICE TERMINAL
INPUT TO RELAY
RELAY OUTPUT
HIGH SPEED/HIGH CURRENT RELAY OUTPUT
NOTES:
1. ALL EQUIPMENT IS ON PANEL 5 UNLESS OTHERWISE NOTED.
* FUNCTION NOT IMPLEMENTED (FUTURE)
NO.
REVISIONS TO DRAWING
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DATE
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CHECKED
DDH
08/16
APPROVED
DDH
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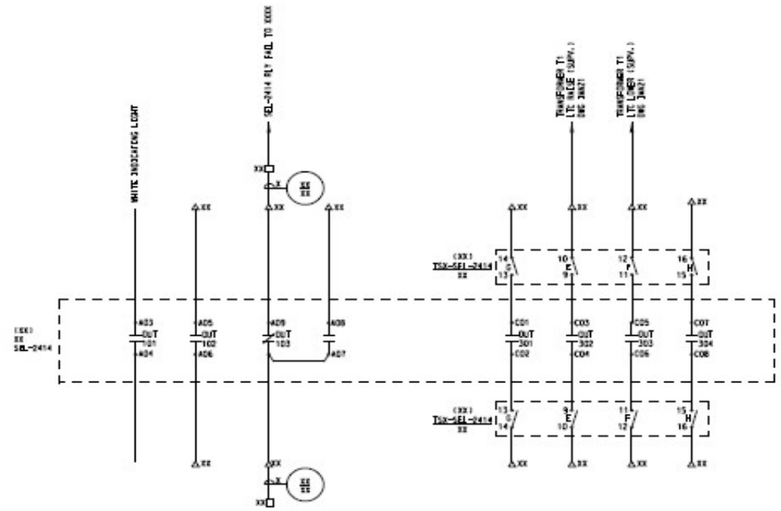
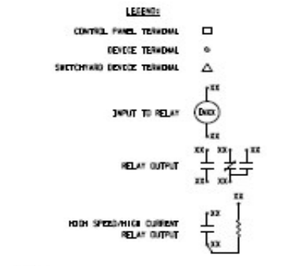
BY
DATE
PRELIMINARY
FINAL DESIGN
AS BUILT
XXX SUBSTATION
DC SCHEMATIC DIAGRAM
2414 RELAY INPUT
TRANSFORMER XX
SCALE NONE
SYSTEM PROTECTION & CONTROL PROJECTS 20413
JEA
DESIGN FILENAME
SPEC1.DGN
DRAWING NO.
SPEC1
SHEET NO.





NOTES:
1. ALL EQUIPMENT IS ON PANEL X UNLESS OTHERWISE NOTED.
* FUNCTION NOT IMPLEMENTED (FUTURE)

NO.	REVISIONS TO DRAWING	BY	DATE	APPROVED

ENGINEERING	BY	DATE
DESIGNED	DDH	
CHECKED	DDH	
APPROVED		
DRAFTING	**BY**	**DATE**
PRELIMINARY		
FINAL DESIGN		
AS BUILT		

XXX SUBSTATION

DC SCHEMATIC DIAGRAM
2414 RELAY OUTPUT

TRANSFORMER XX

JEA

SCALE: NONE

SYSTEM PROTECTION & CONTROL PROJECTS 20413

DRAWING FILENAME: SPEC2

DRAWING NO.: SPEC2

SHEET NO.:

SEL–2414 (XX)

FT-1	TSX-SEL-2414-XX
SP TRIP (MAIN TANK) (+)	
SP TRIP (LTC TANK) (+)	
PRESS RELIEF (MAIN TANK) (+)	
PRESS RELIEF (LTC TANK) (+)	
FAN ON STG-1 (+)	
FAN ON STG-2 (+)	
FAN ON COOLING CONT 1 (+)	
HIGH TEMP (WIND TEMP) (+)	
HIGH TEMP (OIL TEMP) (+)	
HIGH TEMP TRIP (26Q1) (+)	

DETAIL 'A'
N1 SCALE 4:1

FT-1	TSX-SEL-2414-XX
HIGH TEMP TRIP (49T1) (+)	
LOW OIL (MAIN TANK) (+)	
LOW OIL (LTC TANK) (+)	
LOW-LOW OIL (MAIN TANK) (+)	
HIGH GAS (+)	
LTC BU RLY (+)	
LTC HIGHEST (+)	
LTC LOWEST (+)	
BREATHER ALM (LTC TANK) (+)	
BREATHER ALM (CONSER.) (+)	

DETAIL 'B'
N2 SCALE 4:1

FT-1	TSX-SEL-2414-XX
INCOMPLETE STEP (+)	
TAP SW AUTO/MAN (+)	
43TRL STATUS (+)	
43T STATUS (+)	
LTC RAISE - SUPV. (+)	
LTC LOWER - SUPV. (+)	
LTC AUTO - SUPV. (+)	
LTC - 43TRL LOCAL (+)	
LTC - 43T MAN (+)	

DETAIL 'C'
N3 SCALE 4:1

FT-1	TSX-SEL-2414-XX
SP TRIP (MAIN TANK) (IN401)	
SP TRIP (LTC TANK) (IN402)	
PRESS RELIEF (MAIN) (IN403)	
PRESS RELIEF (LTC) (IN404)	
FAN ON STG-1 (IN405)	
FAN ON STG-2 (IN406)	
FAN ON COOL CONT 1 (IN407)	
HIGH TEMP (WIND) (IN408)	
HIGH TEMP (OIL) (IN501)	
HIGH TEMP TRIP (26Q1) (IN502)	

DETAIL 'D'
N4 SCALE 4:1

FT-1	TSX-SEL-2414-XX
HIGH TEMP TRIP (49T1) (IN503)	
LOW OIL (MAIN TANK) (IN504)	
LOW OIL (LTC TANK) (IN505)	
LOW-LOW OIL (MAIN) (IN506)	
HIGH GAS (IN507)	
LTC BU RLY (IN508)	
LTC HIGHEST (IN601)	
LTC LOWEST (IN602)	
BREATHER ALM (LTC) (IN603)	
BREATHER (CONSER.) (IN604)	

DETAIL 'E'
N5 SCALE 4:1

FT-1	TSX-SEL-2414-XX
INCOMPLETE STEP (IN605)	
TAP SW AUTO/MAN (IN606)	
43TRL STATUS (IN607)	
43T STATUS (IN608)	
LTC RAISE - SUPV. (-)	
LTC LOWER - SUPV. (-)	
LTC AUTO - SUPV. (-)	
LTC - 43TRL LOCAL (-)	
LTC - 43T MAN (-)	

DETAIL 'F'
N6 SCALE 4:1

FT-1	TSX-SEL-2414-XX
IN401 (-)	
IN402 (-)	
IN403 (-)	
IN404 (-)	
IN405 (-)	
IN406 (-)	
IN407 (-)	
IN408 (-)	
IN501 (-)	
IN502 (-)	

DETAIL 'G'
N7 SCALE 4:1

FT-1	TSX-SEL-2414-XX
IN503 (-)	
IN504 (-)	
IN505 (-)	
IN506 (-)	
IN507 (-)	
IN508 (-)	
IN601 (-)	
IN602 (-)	
IN603 (-)	
IN604 (-)	

DETAIL 'H'
N8 SCALE 4:1

FT-1	TSX-SEL-2414-XX
IN605 (-)	
IN606 (-)	
IN607 (-)	
IN608 (-)	

DETAIL 'I'
N9 SCALE 4:1

LEGEND:
- △ BREAKER OR TRANSFORMER TERMINALS
- □ SWITCHBOARD TERMINAL POINTS
- ○ DEVICE TERMINAL POINTS

NO.	REVISIONS TO DRAWING	BY	DATE	APPROVED

ENGINEERING	BY	DATE
DESIGNED	SPCP	[illegible]
CHECKED	DOH	[illegible]
APPROVED	DOH	[illegible]
DRAFTING	**BY**	**DATE**
PRELIMINARY		
FINAL DESIGN		
AS BUILT		

XXX SUBSTATION

DC SCHEMATIC DIAGRAM
2414 TEST SWITCH NAMEPLATES

TRANSFORMER XX

JEA BUILDING COMMUNITY

SCALE: NONE

SYSTEM PROTECTION & CONTROL PROJECTS 20413

DESIGN FILENAME: SPEC3.DGN

DRAWING NO.: SPEC3

SHEET NO.: