**TECHNICAL SPECIFICATIONS**

**200 MVA AUTOTRANSFORMERS**

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## 1. SCOPE

The purpose of this specification is to provide oil immersed, three phase, outdoor type, step-down autotransformer with self-contained voltage regulating equipment on the low voltage side, automatic thermostatically controlled forced-air cooling equipment and other accessories, spare parts and appurtenances hereinafter specified. Delivery shall be F.O.B autotransformer pad. Manufacturer is responsible for offloading.

## 2. PROJECT ENGINEER

The project engineer and contact person for technical questions and clarifications concerning this specification is:

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## 3. BIDDERS' PREQUALIFICATIONS

3.1 The bidder must show proof of having manufactured at least ten (10 ea.) similar units in design, voltage class, and MVA rating, in the last five years that were successfully installed and are currently in serviceable condition.

3.2 If the company has not been previously prequalified or has not built a unit for JEA within the last five years, then the shop where the autotransformers will be manufactured will have to be inspected and approved by JEA staff and/or a representative appointed by JEA prior to a contract being finalized.

3.4 The shop where the autotransformers are to be manufactured and tested must have been manufacturing autotransformers continuously for at least five years.

## 4. GENERAL

4.1. The autotransformers shall be of the highest commercial quality as to material, workmanship and design. The autotransformers manufacturers must be pre-approved by JEA.

4.2. The autotransformer shall be designed, manufactured, and tested in accordance with the current standards of ANSI/IEEE and NEMA, except where specific requirements of these specifications conflict with these standards.

4.3. All materials and equipment shall be new and of first quality.

4.4. The basic specifications are:

4.4.1. 120/160/200 MVA, ONAN/ONAF/ONAF @ 65° C Rise

4.4.2. Frequency – 60 Hz

4.4.3. 230/69 KV Grounded Wye, 13.8 KV Tertiary Buried Delta, Grounded in one corner – No external bushings

4.4.4. Conservator-Diaphragm Type

4.4.5. Reinhausen Vacuum Interrupter Type LTC, 33 Tap Positions, ±10% - 5/8% Per Tap

4.4.6. Impedance shall be as described below:

4.4.6.1. The design impedance shall be 6.95% @ 120 MVA, 230/69 KV.

4.4.6.2. The impedance manufacturing tolerance for the final factory tests shall be within ±3% of the specified impedance – 6.74% to 7.16%

4.4.6.3. It is expected that the manufacturer use the design impedance specified in Paragraph to design the

autotransformer. The impedance manufacturing tolerance specified in Paragraph 4.4.6.4 shall not be used by the manufacturer to design the autotransformer.

4.4.6.4. In the event that the final factory test impedance exceeds the requirements of Paragraph 4.4.7.2, the manufacturer shall credit JEA a U.S. dollar amount as per the following conditions:

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

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

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

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

## 5. ELECTRICAL DESIGN

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

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

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

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

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

5.6. The regulating winding shall be fully distributed and be electrically independent. The regulating winding shall be placed on a separate winding cylinder with electrically and magnetically balanced windings.

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

5.8. The paper insulation shall be applied in single or multiple strips such that a minimum of 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.

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

5.10. The core and coil assembly shall be dried using a “vapor-phase” system prior to vacuum filling.

## 6. SHORT CIRCUIT CAPABILITY

6.1. The autotransformer 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 C57.12.00-2010, 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.

6.2. Evidence of design capability to meet these requirements shall be provided at time of bid evaluation.

## 7. VOLTS PER HERTZ CAPABILITY

7.1. The manufacturer shall provide the Volts per Hertz (V/Hz) capability curve.

## 8. RATINGS

8.1. The autotransformer shall be designed to operate at a frequency of 60 Hz.

8.2. The autotransformer shall be capable of transforming the minimum MVA rating, as stated in **Paragraph 4.4.1**, continuously, self-cooled at rated voltage and frequency without exceeding an average winding temperature rise of 65 degrees C.

8.3. The autotransformer 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 only. The auxiliary ratings shall be achieved without exceeding an average winding temperature rise of 65° C.

8.4. The impedance of the autotransformer shall be as stated in **Paragraph 4.4.6** and shall be based on the self-cooled rating and neutral tap voltage position.

8.5. The secondary winding voltage shall be equipped with automatic on-load tap changer voltage regulating equipment. The secondary winding shall have full capacity above neutral voltage and reduced capacity below neutral voltage.

## 9. DESIGN REVIEW

9.1. The manufacturer shall, upon request, provide JEA with all the design data, plus **Andersen's format tables**.

9.2. JEA may have a consulting engineer to review the design data provided by the manufacturer.

9.3. At JEA's discretion, JEA may ask the manufacturer to meet in person at a JEA facility to discuss the design of the autotransformer and any other aspect related to these specifications. JEA may ask the manufacturer to have the design engineer(s) available to discuss the design with JEA and/or JEA's consulting engineer. At JEA's discretion, these meetings may also be held by phone via conference calls.

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

9.5. The manufacturer shall not start manufacturing the autotransformer until all the design data has been reviewed by JEA and they receive written authorization to proceed from JEA's Project Engineer.

9.6. The manufacturer shall submit a production schedule associated with the equipment being provided. Such schedule shall be updated and transmitted to JEA via electronic mail by the first of each month until completion and delivery of the unit.

## 10. INSULATION LEVELS

The winding insulation levels shall be as follow:

| WINDING INSULATION LEVELS | |
|---|---|
| **Rated Voltage** | **Basic Impulse Level (BIL)** |
| 230 KV | 825 KV |
| 69 KV | 350 KV |
| 13.8KV | 110 KV |
| Neutral | 110 KV |

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

## 11. BUSHINGS

11.1. The bushings shall be paper-oil-capacitor type and conform to the latest revision of **ANSI/IEEE C57.19.01-2000** and to **NEMA** standard arrangement, spacing and nomenclature. In addition, they shall be "Sky Gray" in color (**ANSI-70**). The necessary bushings shall meet the following minimum requirements:

| BUSHING INSULATION LEVELS | |
|---|---|
| **Rated Voltage** | **Basic Impulse Level (BIL)** |
| HV – 230 KV | 900 KV |
| LV - 69 KV | 350 KV |
| Neutral | 150 KV |

11.2. 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.

11.3. The neutral bushing shall be provided with enough 500 MCM insulated copper cable and cable to 4-hole connectors to facilitate grounding the bushing at the base of the autotransformer. Fasteners shall be provided on the tank side to secure this cable to the tank.

11.4. The autotransformer core shall be securely grounded externally on the tank. The core shall be individually grounded by a connection brought out of the tank through an equipment bushing located on, or near, the top in a gasketed, sealed stainless steel enclosure. The autotransformer core shall have its own, dedicated equipment bushing. Disconnection shall not require entrance into the tank. This bushing shall be grounded to a ground pad with 300 MCM insulated copper cable. The core ground cable shall be connected for shipment to allow an insulation resistance test upon arrival.

11.5 Only bushings manufactured by ABB or PCore will be acceptable

## 12. SURGE ARRESTERS

12.1. Six (6) **polymer station class** surge arresters, three (3) for the protection of the primary windings and three (3) for protection of the secondary windings, shall be provided mounted on the autotransformer tank or on suitable mounting brackets attached thereto. The primary winding surge arresters shall be mounted such that their line terminals are at the same height as the primary winding bushing line terminals. The secondary winding surge arresters shall be mounted such that their line terminals are at the same height as the secondary winding bushing line terminals.

12.2. 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.

12.3. The following are the surge arresters voltage characteristics:

| KV CLASS | MCOV - KV | DUTY CYCLE - KV |
|---|---|---|
| 230 | 144 | 180 |
| 69 | 42 | 54 |

12.4. The manufacturer shall advise JEA's Project Engineer if suitable insulation coordination and protection cannot be achieved with the arresters given in the table above. In addition, the manufacturer shall supply graphical data, which shows the autotransformer'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.

## 13. GAUGES AND ACCESSORIES

The autotransformer shall be equipped with the following accessories:

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

13.2. 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 autotransformer 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 autotransformer is filled.

13.3. 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:

13.3.1.1st Contact – To activate the alarm circuit at 75° C

13.3.2.2nd Contact – To activate the trip circuit at 100° C

13.4. 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.

13.4.1. Current from a CT located on the LV winding X1 bushing shall be used to heat a heater coil 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:

13.4.1.1. A manually resettable red peak temperature pointer.

13.4.1.2. Four (4) 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:

13.4.1.2.1. 1st Switch - To activate the 1st cooling stage at 50° C

13.4.1.2.2. 2nd Switch – To activate the 2nd cooling stage at 60° C

13.4.1.2.3. 3rd Switch – To activate the alarm circuit at 95° C

13.4.1.2.4. 4th Switch – To activate the trip circuit at 120° C

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

13.5. Two (2) mechanical pressure relief devices, Meskso GmbH MPreC series, with alarm contacts and semaphore.

13.5.1. One (1) shall be mounted on the main tank and one (1) on top of the LTC compartment.

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

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

13.5.4. 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.

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

13.6.1 One (1) shall be mounted on the main tank and one (1) on the LTC compartment.

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

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

13.7. Separate Qualitrol Series 909 Seal-in Relays shall also be provided. The Seal-in Relays shall be designed for 125 VDC operation and mounted in the autotransformer control cabinet. A gas detector relay with alarm and trip contacts rated for 125 VDC operation.

13.7.1. Gas detector relays supplied by the Qualitrol or Bucholtz will be acceptable.

13.7.2. Connection between the main tank and the gas detector shall be made from rigid pipe, except for a length of 316 stainless steel tubing not to exceed 18” for connecting to the detector.

13.7.3. The connection between the rigid pipe and the main tank cover shall be as close as possible to the relay.

13.7.4. A shutoff valve shall be provided to allow removal of the gas detector relay without lowering the oil level.

13.7.5. The use of dresser couplings for rigid pipe connections is not acceptable.

13.7.6. Test and sampling valves shall be located at a working height of approximately 5' from the base of the autotransformer.

13.8. A SEL-2414 Autotransformer Monitor Relay, Schweitzer Engineering Laboratories P/N 241421A1A3A3A3A1031, shall be installed in the autotransformer cabinet at a convenient eye-level height for observation and access.

13.8.1. Autotransformer alarms shall be wired to the inputs for indication purposes.

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

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

13.8.1.1.2. Second switch will be before the alrm goes to the SEL-2414 input.

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

13.8.1.2. Three sets of the ABB test switches in 13.8.1.1 will be installed in the autotransformer cabinet at a convenient eye-level height for observation and testing.

13.8.2. JEA shall provide relay settings to the autotransformer manufacturer to download into the SEL-2414 relay.

13.8.2.1. For confirmation purposes, the autotransformer manufacturer will provide a settings test report after downloading the settings into the relay.

13.8.3. A seperate panduit/punch out shall be provdied in the autotransformer cabinet in order to accomodate a JEA supplied fiber optic cable to the SEL-2414.

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

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

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

## 14. BUSHING CURRENT AUTOTRANSFORMERS

The bushing current autotransformers shall conform to the latest revisions of **ANSI/IEEE C57.13-2008 and C57.19.01-2000** 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 below:

| BUSHING TERMINALS | AMPERE RATIO | ACCURACY CLASS |
|---|---|---|
| H1-H2-H3 | 2000/5 | C800 |
| H1-H2-H3 | 1200/5 | C800 |
| H1-H2-H3 | 600/5 | C800 |
| X1-X2-X3 | 1200/5 | C800 |
| X1-X2-X3 | 1200/5 | C800 |
| X0 | 1200/5 | C800 |

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

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

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

14.4. The autotransformer shall also be provided with the following additional bushing CTs:

14.4.1. One (1) current autotransformer for the winding temperature indicator located in phase "A" (X1) of the low voltage winding, as described in **Paragraph 13.4.1**.

14.4.2. One (1) current autotransformer for the load drop compensation circuit (LDC) of the voltage regulating equipment located in phase B (X2) of the low voltage winding.

## 15. CONTROL CABINET

15.1. All terminals for remote control wiring and LTC control equipment shall be located in a suitable control cabinet.

15.2. The cabinet shall be furnished with a removable 8 gauge aluminum conduit plate in the bottom.

15.3. The cabinet shall be weather-tight.

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

15.5. 120/240 VAC automatically controlled space heaters are to be provided to prevent condensation and keep the components in the cabinet dry.

15.5.1. The heaters shall be provided with guards.

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

15.5.3. A magnetic circuit breaker shall be provided for the heaters' circuit.

15.5.3.1. Fuses are not acceptable for the heaters' circuit.

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

15.7. 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. Hinged panels with controls mounted on them shall be provided with suitable stops. All hinges to be shall be 316 stainless steel.

15.8. 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.

15.9. 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 **Paragraph 22**. The cabinet exterior shall match that of the main tank.

## 16. WIRING

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

16.2. 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.

16.3. Splices will not be acceptable.

16.4. Protective overcurrent devices shall be provided in accordance with industry's good practices.

16.5. 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.

16.6. 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.

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

16.8. JEA will provide auxiliary power supply, three-phase, four-wire, 60 Hz 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 three-phase 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 autotransformer shall be clearly label as to its termination point.

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

16.10. 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 LTC and cooling equipment. The timer shall be used to eliminate alarms due to momentary interruptions of AC power.

16.11. The “off-tap” alarm wiring shall also include an auxiliary timer to eliminate alarms due to momentary “off-position” states during the operation of the tap changer.

## 17. TAP CHANGING EQUIPMENT

17.1. The load tap changer shall vary the low voltage terminal voltage with a constant voltage on the high voltage terminal.

17.2. If the tap changing system requires a series or a booster winding, the design shall be of a power class, round core/coil design and construction, and all windings shall be copper and shall be circular.

17.3. The load tap changer contacts shall be located in an oil-filled compartment separated from the main tank. The load tap changing compartment shall be designed with a continuous lip across the bottom front, at the opening, to prevent residual oil from spilling out upon opening of the compartment door. The compartment door shall provide easy access to the equipment for maintenance and inspection.

17.4. A 3/8" sampling valve shall be provided on the LTC enclosure with pipe cap on the open end.

17.5. The barrier separating the load tap changer from the autotransformer main tank shall be able to withstand full vacuum from either direction. If full vacuum withstand is not possible, piping and a valve to allow for equalization between the load tap changer and main tank shall be installed. A metal sign with white background and large red letters shall be installed on the side of the main tank near the valve stating that the valve shall be open prior to vacuum and closed for normal operation.

17.6. The cover on the oil-filled compartment shall be hinged to support itself when open, regardless of the weight of the cover.

17.7. The load tap changing equipment housing shall be provided with a Messko GmbH type DB100RM maintenance free dehydrating breather to prevent the buildup of pressure and condensation within the housing, as appropriate for the particular tap changer being used.

17.8. A mechanical position indicator visible from outside the equipment shall be provided.

17.8.1. The position indicator shall be calibrated L - N - R – i.e. Lower – Neutral – Raise - from the left end to the right end of the scale.

17.8.2. The position indicator shall be located so that it will be visible to an operator at the control switch for the drive motor and located at eye-level.

17.8.3. The position indicator shall be mechanically driven directly from the drive mechanism without auxiliary devices.

17.9. A hand crank for manual operation of the drive mechanism shall be provided.

17.9.1. The hand crank shall be removable and stored in the cabinet housing of the mechanism.

17.9.2. An electrical interlock switch shall be provided to prevent electrical operation of the LTC mechanism while the hand crank is operated.

17.10. A dead-front operating panel shall be provided whereby the gears and mechanism are covered to provide safety for the operator.

17.11. A stainless steel nameplate shall be permanently mounted on the outside of the control cabinet housing the manual raise and lower controls, which shall reads "**LOAD TAP CHANGER**". An additional nameplate shall be mounted inside the cabinet, next to the raise and lower controls which shall reads "**LOAD TAP CHANGER - FOR OPERATION WITH AUTOTRANSFORMER ENERGIZED AND CARRYING LOAD**". These nameplates are to be shown on the outline drawing. These nameplates shall also indicate the vacuum capability of the barrier and the manufacturer's model number of the LTC.

17.12. The low voltage winding shall be provided with tap changing under load equipment, which shall connected to and regulate the low voltage winding.

17.12.1. The tap changer shall have full rated MVA on taps above neutral and a current rating corresponding to the full load current of rated voltage on taps below neutral voltage.

17.12.2. This equipment shall be capable of ± 10% voltage regulation in 32 - 5/8% (0.625%) steps at full capacity above neutral and reduced capacity below neutral voltage.

17.12.3. The nomenclature for the various positions shall be 1 through 16 above, neutral and 1 through 16 below neutral voltage. Use of 1 through 33 with 17 as the neutral position is not acceptable.

17.12.4. The current rating of the tap-changing equipment shall be based on the maximum force-cooled rating of the autotransformer.

17.13. Completely automatic, self-contained control equipment shall be mounted in the control cabinet at an accessible height for a person standing on the autotransformer foundation. The control equipment shall include the following items:

17.13.1. JEA will install one (1) tap changer control relay, Beckwith Electric Co. M-2001C, to initiate operation of the tap changer in the raise or lower direction as required. The tap changer control relay will be installed in a JEA installed relay control panel inside the control house. The control cabinet shall be designed to accommodate JEA connection to this tap changer.

17.13.2. Adjustable delay equipment for imposing a time delay between the closing of the voltage regulating relay contacts and the response of the tap changing mechanism. The time delay and adjustment shall have a minimum range of five seconds. The equipment shall be so connected that in the event that more than one tap change is required to restore the voltage to the required level, the time delay may be imposed on the first tap change only (Sequential operation).

17.13.3. One control switch for selecting either automatic or manual operation, with the control so interlocked that manual and automatic control cannot be provided simultaneously, three position, "AUTOMATIC", "OFF", "MANUAL", General Electric Co. type SB-1 or equal.

17.13.4. One control switch to manually operate the tap changer in either the raise or lower direction, General Electric Co. type SB-1 or equal.

17.13.5. One control switch for selecting either local or remote control of the load tap changer, General Electric Co. type SB-1 or equal.

17.13.6. A motor control relay with the two sides mechanically interlocked to prevent any possibility of energizing both windings of the motor simultaneously.

17.13.7. An operation counter to record the number of tap changing operations.

17.13.8. High and low limit contacts for remote alarm (dry “a” contacts).

17.13.9. Off - position contacts for remote alarm.

17.13.10. One LTC control back-up relay to prevent a failure of the voltage control from running the voltage to a high or low limit, complete with time delay, and alarm contacts. Beckwith Electric Company, Inc. Model # M-0329. The back-up relay shall be set for a 120 Vrms band center and 1 Vrms fixed dead band. (Note: The input potential to this relay will be provided independent of the regulating input potential to the Series 2000 regulating relay).

17.14. The autotransformer shall have provisions for remote operation and indication of the load tap changer equipment. The following equipment or provisions shall be provided for remote operation and indication of the load tap changing equipment:

17.14.1. The power transformer control cabinet shall be designed in order to accommodate a connection to JEA installed synchro transmitter (Incon model #1292) and a programmable position monitor (Incon model #1250B). These devices will be provided/installed by JEA in the relay control panel located in the control house.

17.14.2. Wiring provisions shall be provided in the control cabinet for remote connections to a control switch, or switches, for selecting automatic or manual control of the tap changing mechanism and for manual operation of the tap changing mechanism.

17.14.3. Wiring provisions shall be provided in the control cabinet for remote connections to indicating lamps; red to indicate tap-changing mechanism in the “OFF” position and white to indicate a loss of control voltage.

17.15. The only acceptable LTC is the Reinhausen RMV II.

## 18. OIL PRESERVATION EQUIPMENT

18.1. The oil preservation system shall be conservator type with a sealed bladder (Atmoseal system or equivalent), as per the latest revision of **ANSI/IEEE C57.12.80-2010, Section 6.5.5**.

18.2. All gaskets are to be below minimum oil level.

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

18.4. A gate or globe valve suitable for full vacuum shall be placed at both the autotransformer tank and at the conservator tank.

18.4.1. A braided stainless steel flexible connection shall be provided to eliminate potential alignment problems.

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

18.5.1. The silica gel breather shall be mounted 5’ above autotransformer base for easy access.

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

18.6. 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.

18.7. 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.

18.8. The conservator tank shall be capable to operate at an ambient temperature range of -10 degrees to 40 degrees Centigrade.

18.9. The conservator tank shall be sized to permit continuous 120 degrees C top oil temperature operation without oil discharge.

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

## 19. COOLING EQUIPMENT

19.1. The following types of radiator construction are allowed:

19.1.1. Tube and header construction

19.1.2. Plate (pancake) construction

19.2. The above-mentioned radiators shall be constructed from one of the following materials:

19.2.1. Steel header pipes with copper tubes

19.2.2. Steel header pipes with cold rolled steel plates

19.3. Radiators shall be provided with drain plugs and a vent plug located on top. All plugs shall be made of mechanical brass.

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

19.5. The exterior of the radiators shall be protected from corrosion by a duplex-system consisting of hot dip galvanizing then painted according to ISO 12944 Environment C4. Paint shall be applied via flow coating method.

19.6. Radiators shall be filled with positive nitrogen pressure for shipping and short-term storage.

19.7. Packaging of radiators shall be performed to protect them from paint scratches due to packaging materials and handling.

19.8. Fan motors:

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

19.8.2. The fan motors shall be supported from the autotransformer tank.

19.8.2.1. Mounting the fan motors directly to the radiators is not acceptable.

19.8.2.2. Fans shall be vertically mounted. Fans hung under the radiators are not acceptable.

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

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

19.9. Radiator valves:

19.9.1. The radiator valves shall be pressure seal type butterfly or flapper valve type.

19.9.2. Outline drawings of the radiator valves shall be submitted for approval.

19.9.3. Radiators valves shall be welded to the autotransformer tank in both upper and lower header pipe connection points.

19.9.4. The radiators shall connect to the valves by a bolted connection.

## 20. TANK CONSTRUCTION

20.1. The autotransformer 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.

20.2. Lifting lugs and jacking pads shall be provided on the tank for lifting or jacking and skidding the autotransformer onto transport vehicles and into place as necessary. The lifting lugs shall be free from sharp edges. Facilities for guying the autotransformer shall be provided.

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

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

20.5. The autotransformer shall be provided with the following valves and fittings:

20.5.1. 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.

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

20.5.1.2. 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.

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

20.5.2. 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 20.5.1**, 6" below the top cover of the main tank.

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

20.5.4. One (1) 1" globe-type valve located on the top of the conservator tank, opposite to the valve described on **Paragraph 20.5.3**.

20.5.5. 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 described in **Paragraph 20.5.2**.

20.5.6. 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.

20.5.7. 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.

20.5.8. One (1) 1" globe-type drain valve for the LTC tank.

20.5.9. One (1) 1" globe-type valve located on the top of the LTC tank, opposite to the valve described on **Paragraph 20.5.8**.

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

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

20.7. A minimum of two (2) circular manholes, with bolted covers, shall be provided in the cover for entering the autotransformer.

20.7.1. 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.

20.8. A minimum of two (2) circular manholes, with bolted covers, shall be provided on the side near the base for entering the autotransformer.

20.8.1. 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

20.9. Three (3) copper-faced or stainless steel grounding pads with tapped holes, and three (3) clamp type connectors for 4/0 - 500 MCM copper cable range connectors shall be provided for grounding purposes.

20.9.1. Two (2) ground pads shall be located near the base, on opposite corners, on the sides of the tank.

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

20.9.3. Mounting of ground pads directly beneath radiators is not acceptable.

20.10. The "B" phase of the high and low voltage bushings shall have the same centerline as the autotransformer tank.

20.11. 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.

20.12. The bottom of the autotransformer 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.

20.13. All welds on the exterior of the tank are to be full welds. Spot, tack or skip welds are not acceptable for attaching hinges, brackets, grounding bosses, etc. Tank designs, which minimize pockets and crevices where corrosion may occur are preferred. Welds and seams on corners are not allowed.

20.14. 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.

20.15. The autotransformer cover shall have a non-skid, slip resistant coating

20.16 All conduits shall be supported by 1/4" x 2" x 2" steel angle and/or steel hardware.

20.17. The shipping height of the autotransformer shall not exceed 14'-0".

20.18 Oval tank designs are not permitted.

## 21. INSULATING OIL

21.1. The insulating oil shall be new, oxidation inhibited **Type II** mineral autotransformer oil, as per the latest revisions of **ASTM D 3487-16 (2016)** and **ANSI / IEEE C57.106-2015**.

21.1.1. The only acceptable oxidation inhibitors are:

21.1.1.1.2,6-ditertiary-butyl para-cresol

21.1.1.2.2,6-ditertiary-butyl phenol

21.1.2. The oxidation inhibitor content shall be not more than **0.3%** by mass, as determine by the latest revisions of **ASTM D 1473** or **D 2668**.

**Note:** As per the latest revision of **ASTM D 3487-16 (2016), Footnote H**, Test Method **D 2668** can be used for either inhibitors mentioned in **Paragraphs 21.1.1.1 & 21.1.1.2**. Test Method **D 1473** can only be used for inhibitor mentioned in **Paragraph 21.1.1.1**.

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

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

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

21.3. The manufacturer shall provide a written certification and test report that the autotransformer oil fully comply with the latest revision of **ASTM D 3487-16 (2016)**.

21.4. 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:

21.4.1. Dielectric Breakdown Strength – 30 KV minimum, as per the latest revision of **ASTM D 877-87 (1995)**.

21.4.2. Power factor - 0.05% or less at 25 degrees C, as per the latest revision of **ASTM D 924-99e1**.

21.5. The delivered autotransformer oil and oil used at the factory shall be non-PCB oil. The manufacturer shall certify on the autotransformer test report that all oil used in processing and testing the autotransformer had a **"**not detectable**"** content of polychlorinated biphenyl as determined by test method the latest revision of **ASTM D4059-96**.

## 22. PAINT

22.1. The external surface of the tank, cover and bottom shall be prepped per SSPC-SP1 using Carboline Surface Cleaner #3 to remove grease, chlorides, and sulfides. 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.

22.2. Carboline paints are preferred.

22.3. The radiators shall be flow-coated painted.

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

22.5. If Carboline paint products are used on the radiators, the following Alkyd paints shall be used:

22.5.1. Primer Coat - Carboline Carbocoat 2900 Primer - 0500 (Red), 2 mils.

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

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

22.6. The inside of the tank shall be painted white color.

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

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

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

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

22.8. 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 and submit the table in the appendix.

## 23. NAMEPLATE

23.1. A nameplate shall be provided and mounted on or near the control cabinet.

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

23.3. The nameplate shall be as per the latest revision of **ANSI/IEEE C57.12.00-2010, Paragraph 5.12**.

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

23.4.1. Current values for the maximum 65 degree C MVA rating for all tap positions.

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

23.4.3. All applicable weights including shipping.

23.4.4. Date of manufacture.

## 24. FACTORY TESTS

24.1. The tests shall include, but not be limited to, all of the routine tests as described in the latest revision of **ANSI/IEEE C57.12.00-2010, Section 8** and as defined in the latest revision of **ANSI/IEEE C57.12.80-2010, Section 5**.

24.2. The following tests shall be performed on all autotransformers in accordance with methods outlined in the latest revision of **ANSI/IEEE C57.12.90-2015, Part I**:

24.2.1. Resistance Measurements **(Clause 5)**

24.2.2. Polarity and Phase-Relation **(Clause 6)**

24.2.3. Ratio **(Clause 7)**

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

24.2.5. Impedance and Load Losses **(Clause 9)**

24.2.5.1. The resistve component (R) of the Impedance and the reactive component (X) of the Impendance shall be provided. ($R_1+jX_1$; $R_2+jX_2$; $R_3+jX_3$) See Appendix for further details.

24.2.6. Dielectric Tests:

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

24.2.6.2. Applied Voltage **(Clause 10.6)**

24.2.6.3. Induced Voltage (Clause 10.8 - last dielectric test to be performed)

24.2.6.3.1. 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.**

24.3. 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 20 degrees C, will not be acceptable. Values above this shall be reported to the project engineer.

24.4. Core Ground Test **(Section 10.11)**

24.5. Gas Chromatography Test showing any combustible gasses present, in ppm, as a result of testing as per the latest revision of **ANSI/IEEE C57.104.2008**.

24.6. Temperature rise test, in accordance with **Clause 11** (first autotransformer design)

24.6.1. 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 6 hours, until the end of the test.

24.7. Audible sound test, in accordance with **Clause 13** (first autotransformer design)

24.8. Sweep Frequency Response Analysis

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

24.8.2. The frequency sweep shall cover the frequency range from 20 Hz. to 2 MHz.

24.8.3. The test shall be performed twice, once with the autotransformer fully assembled and once with the autotransformer 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 autotransformer and disturbing the leads. The bushings shall be mechanically protected during shipping. The mechanical protection shall be designed not allow release of the shipping gas when removed.

24.8.4. SFRA tests shall be performed on LTC tap 16 Raised and DETC tap 3 and shall remain on these taps for shipping.

23.8.4 The software generated test file shall be received by the project manager prior to shipping.

24.9. Gas detector system test, in accordance with the following procedure:

24.9.1 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 5 minutes in order to pass the test.

24.10. The autotransformer shall be completely assembled throughout the duration of testing to assure the fit of all components and that adequate electrical clearances have been achieved.

24.11. 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.

24.12. Any deficiencies or failures during final testing shall be thoroughly reported, in writing, to the project engineer prior to re-testing.

24.13. The manufacturer shall furnish an electronic copy of the certified test report detailing all tests performed on the autotransformer. The certified test report shall be received by the Project Engineer before shipment of the autotransformer.

24.14. All current autotransformers shall be tested as per the latest revision of **ANSI/IEEE C57.13-2016, Clauses 6.11 & 8.**

24.14.1. CT curves shall be furnished for all CTs and will be used for relaying applications.

24.15 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 shipping of the autotransformer.

## 25. LOSS GUARANTEE

25.1. 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.**

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

25.2.1. No load losses - $5,000/kW

25.2.2. Load losses at 50 MVA - $1,000/kW

25.2.3. Auxiliary Losses - $500/kW

25.3. The measurements shall be made under the following conditions and as per the latest revision of **ANSI/IEEE C57.12.00-2010, Section 5.9**:

25.3.1. No-Load Losses shall be measured and corrected to an ambient temperature of 20 degrees C.

25.3.2. Load Losses shall be measured at ambient and corrected to 85˚C, 200 MVA.

25.3.3. Auxiliary Losses shall be measured and corrected to an ambient temperature of 20 degrees C, 200 MVA.

## 26. LOSS EVALUATION

26.1. For the purpose of determining the best bid, all autotransformer losses shall be measured at rated voltage, frequency and the self-cooled rating. An amount in dollars shall be added to the quoted price based on the following factors:

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

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

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

26.2.3 The test system accuracy for each quantity measured shall fall within the limits specified in the latest revision of **ANSI/IEEE C57.12.00-2015, Section 9.4, Table 19**.

26.2.4 The frequency of the test source shall be within **±0.5%** of the rated frequency of the autotransformer.

26.3. In the event that the certified test report called for in **Paragraph 24.13** shows that the autotransformer 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 **Paragraph 25.2**.

## 27. DRAWINGS

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

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

27.3. Each drawing shall include the JEA purchase order number and the name of the JEA substation that the equipment is designed to operate.

27.4. An electronic copy (.pdf format) of the approval drawings for the autotransformer shall be submitted and shall include the following:

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

27.4.2. Nameplate drawing.

27.4.3. All schematic and wiring diagrams.

27.4.3.1. Tabular type wiring drawing will not be acceptable.

27.4.3.2. These drawings shall locate each piece of equipment and terminal blocks, and indicate individual wiring between each item.

27.4.4. Internal layout drawing.

27.4.5. CT excitation curves.

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

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

27.4.6.2. High and low voltage surge arresters

27.4.6.3. All gauges

27.4.6.4. Gas detector relay

27.4.6.5. Switches

27.5. The manufacturer shall furnish the Project Engineer with a complete list of all items which will be sent on each shipment, i.e. 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.

27.6. All final drawings shall be submitted in 24" x 36" hard copies and a flash drive containing Intergraph CAD system (Microstation SE) **and** PDF format.

**28. INSTRUCTION BOOKS**

28.1. The manufacturer shall provide four (4) instruction books. All information shall be in English.

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

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

28.4. The instruction books shall be high quality original documents.

28.4.1.Photocopies will not be accepted.

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

28.6. The OEM drawings shall be 24" X 36" drawings and included in the instruction books.

28.7 The face 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.

28.8 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/construction manual. All photographs shall be 8-1/2 inch by 11 inch gloss prints properly labeled as to the views taken. Five different views shall be provided as follows:

28.8.1 Top view

28.8.2 Front view

28.8.3 Left side view

28.8.4 Rear view

28.8.5 Right side view

28.9 A 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. All photographs shall be 8-1/2 inch by 11 inch gloss prints. 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.

28.10 The instruction books shall include but not be limited to the following:

28.10.1 Table of contents and index tabs

28.10.2 Specifications, test data and curves

28.10.3 A copy of the factory test report

28.10.4 Description of the equipment

28.10.5 Operating Instructions

28.10.6 Instructions in the methods of receiving, inspection, storage and handling

28.10.7 Complete installation and maintenance instructions

28.10.8 Assembly drawings

28.10.9 Parts lists

28.10.10 Schedule of required lubricants for the LTC mechanism

28.10.11 Nameplate information and shop order numbers for each item of equipment and component part

28.10.12 Instructions of accessories

28.10.13 Photographs of core and coil assembly

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

28.11.1 A complete set of drawings in .PDF format

28.11.2 An electronic copy of all instruction manuals included in the instruction book

28.11.3 An electronic copy of all photographs detailed in **Paragraph 28.8 and 28.9**

28.11.4 An electronic copy of the certified test report

## 29. SHIPPING

29.1 The autotransformer shall be shipped F.O.B. to the substation autotransformer pad, in Jacksonville, Florida. The manufacturer shall assume responsibility for safe arrival and handle all claims if damaged in shipment.

29.2 The autotransformer shall be shipped from the manufacturer's facility filled with dry air having a -50° F dew point or better.

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

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

29.2.3 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.

29.3 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 arrival at site. A rigid housing shall be installed to protect the core ground lead and connector during shipping.

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

29.5 **The manufacturer shall attach <u>two (2), two-way (vertical and horizontal), GPS enabled impact recorders</u> to the autotransformer.**

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

29.5.2 Upon arrival and before unloading the autotransformer, the impact recorder records will be inspected by JEA and the manufacturer's representative.

29.5.3 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.

29.5.4 The records will be retained by JEA for study.

29.5.5 The manufacturer shall provide the necessary information for returning the impact recorders.

29.6 All equipment furnished hereunder 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.

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

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

29.6.3 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.

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

29.6.5 Any equipment, which 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.

29.6.6 **Any packages, which require indoor storage, shall be clearly marked.**

29.6.7 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.

29.7 All spare parts shall be **<u>packaged separately</u>** and clearly marked "**<u>SPARE PARTS</u>**".

29.7.1 The spare parts shall be shipped separate from the autotransformer and shall be delivered F.O.B. to:

JEA

Commonwealth Service Center

6674 Commonwealth Avenue

Jacksonville, Florida 32254

Attn: Material and Stores Dept.

## 30. FIELD ENGINEERING SERVICES

30.1 The manufacturer shall provide the services of a Field Engineer to provide technical advice and instruction to

JEA for assembly the autotransformer.

30.1.1 This shall include, but not limited to, 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 autotransformer in service.

30.2 The manufacturer shall include in the Bid Form the cost for three (3) working days, Monday through Friday, of field service.

30.2.1 The price shall include travel and per diem during the entire duration.

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

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

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

30.6 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.

## 31. TRAINING

31.1. The manufacturer shall provide one day of training with each autotransformer purchased by JEA.

31.1.1. Training shall take place at a JEA facility.

31.1.2. Training topics will be related to autotransformer and substation design and maintenance. JEA will provide topics of interest to the manufacturer.

31.2. The manufacturer shall include an optional line item on each autotransformer quote for the cost for one (1) working day, Monday through Friday, of training.

31.2.1 The price shall include travel and per diem during the entire duration.

31.2.2 JEA reserves the right to refuse the training services after issuing a PO and to deduct that amount from the payment schedule.

31.3 The training service cost will not be used for the bid evaluation.

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## 32. SPARE PARTS

32.1. 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 replacing during the life of the autotransformer including gaskets, seals, O-rings, lubricants, etc. The spare part list prices will not be used to award the bid.

32.2. The spare parts list shall include the following parts as a minimum for each autotransformer:

32.2.1. One (1) high voltage bushing (230, 138, 69 KV)

32.2.2. One (1) low voltage bushing (34.5 KV)

32.2.3. One (1) neutral bushing

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

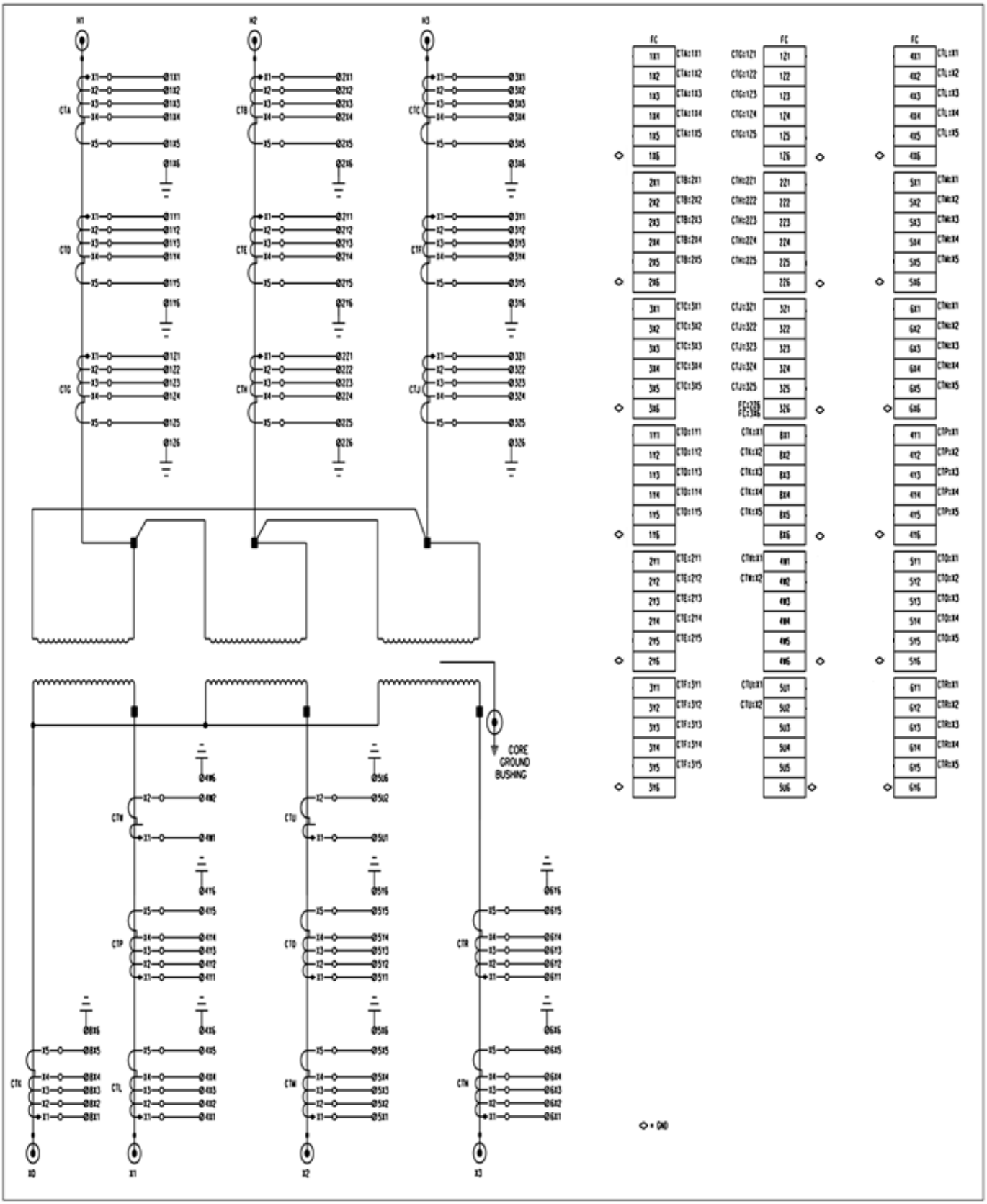
32.4. JEA reserves the right to purchase any or all of the spare parts on the spare parts list. Only those parts required to meet inventory requirements will be purchased.

32.5. The spare parts shall be shipped separate from the autotransformer and its assembly parts per **Paragraph 29.7**.

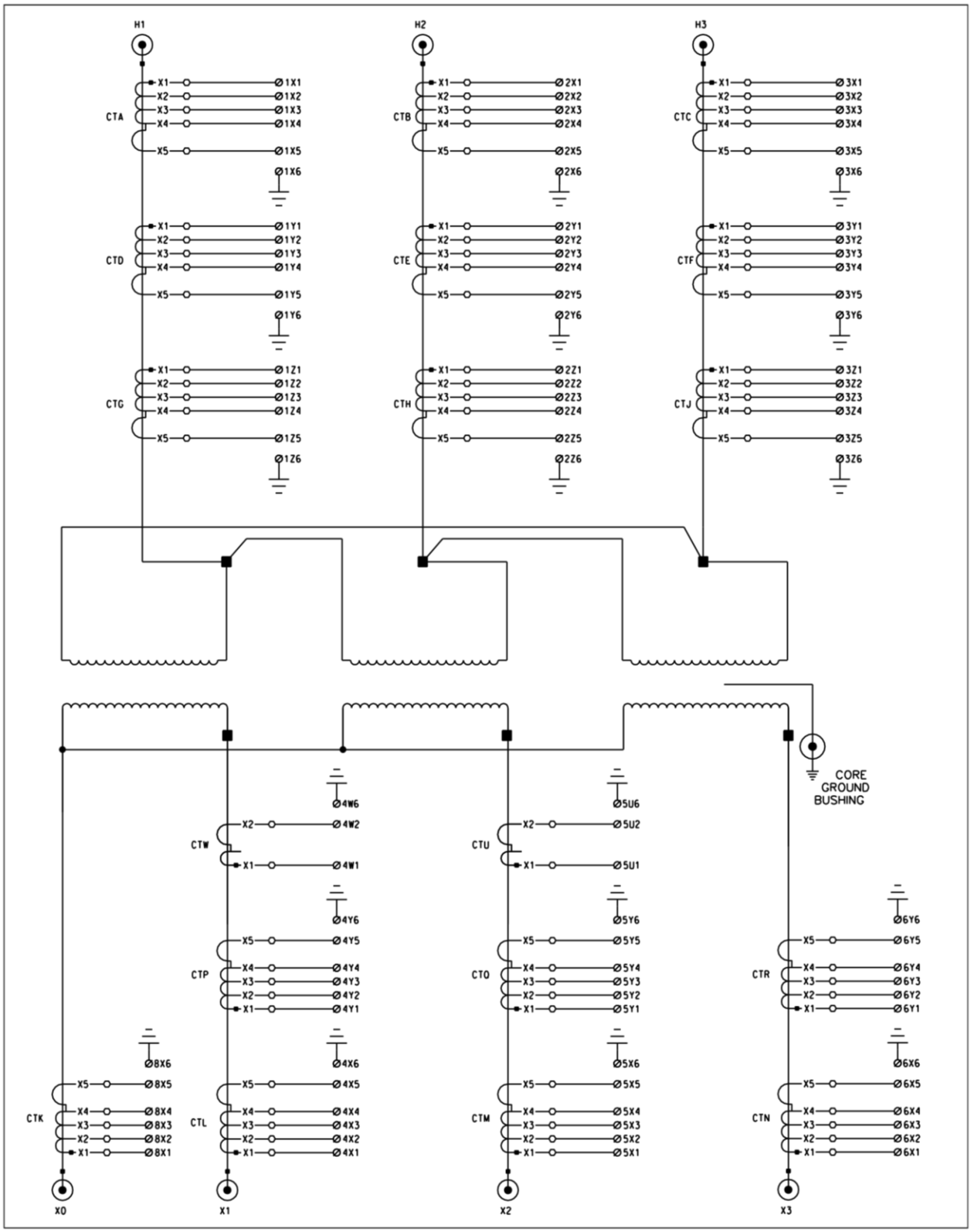
## 33. MANUFACTURER'S WARRANTY

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

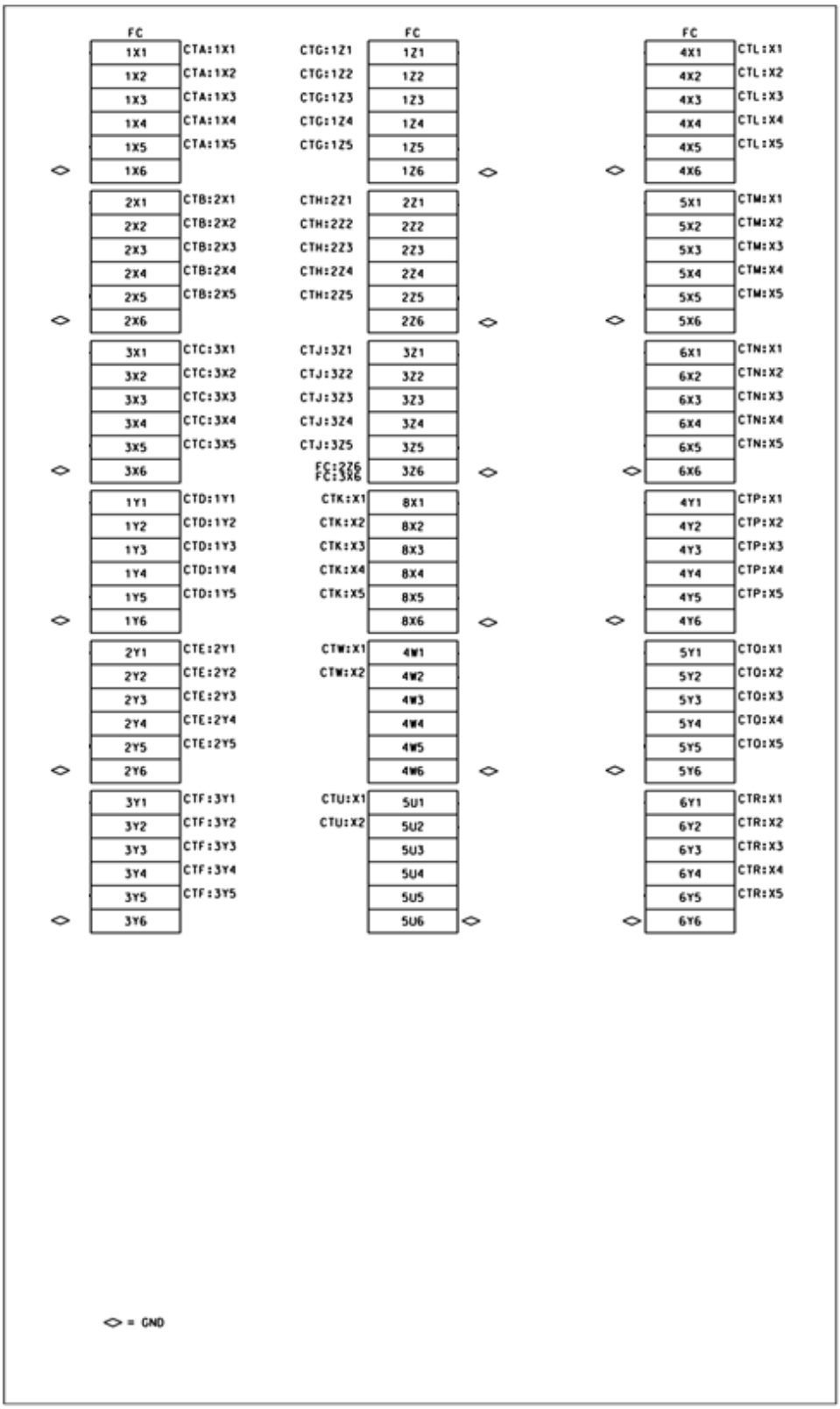
## 34. APPENDIX




From Section 14




From Section 14




From Section 14

| 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 | |

From Section 21.8

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 auto 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.

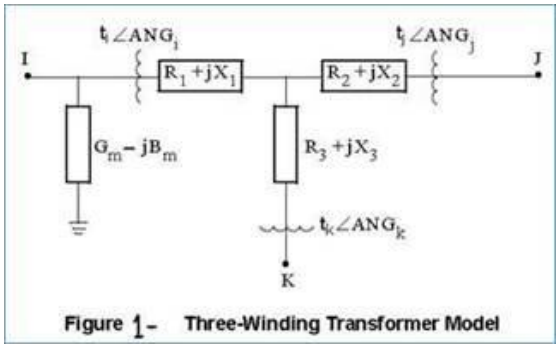



Figure 1 – Three-Winding Transformer Model

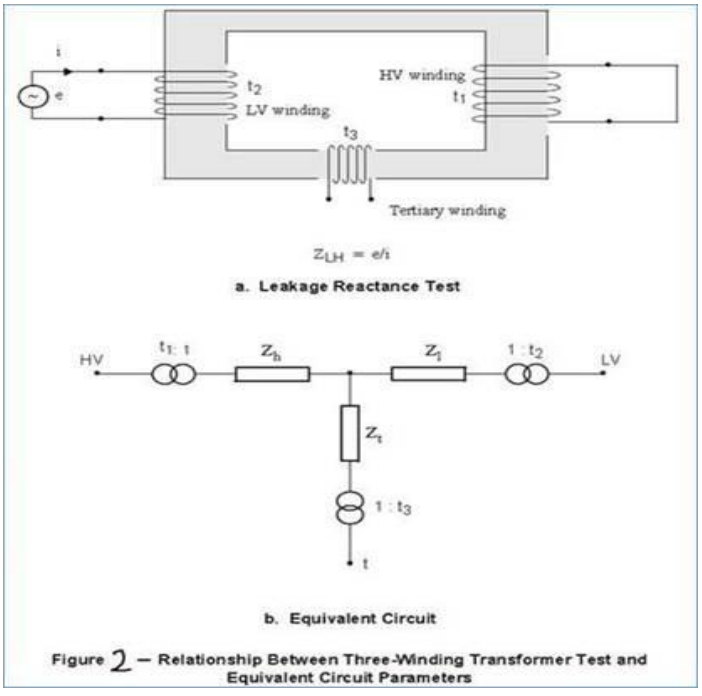
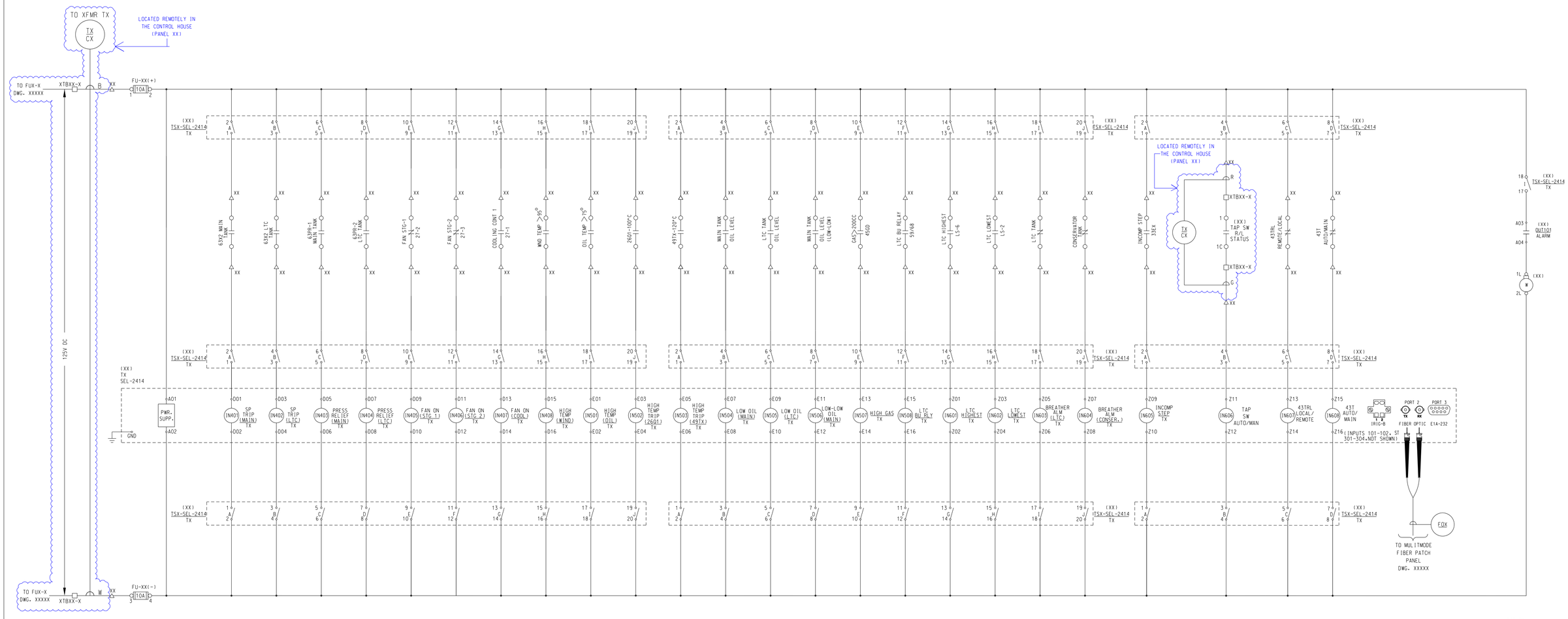



Figure 2 – Relationship Between Three-Winding Transformer Test and Equivalent Circuit Parameters

From Section 24.2.5.1




LEGEND:

- CONTROL PANEL TERMINAL
- DEVICE TERMINAL
- SWITCHYARD DEVICE TERMINAL
- INPUT TO RELAY
- RELAY OUTPUT
- HYBRID (HIGH-CURRENT INTERRUPTING) RELAY OUTPUT
- HIGH SPEED/HIGH CURRENT RELAY OUTPUT

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

| NO. | REVISIONS TO DRAWING | BY | DATE | APPROVED |
|---|---|---|---|---|

| NO. | REVISIONS TO DRAWING | BY | DATE | APPROVED |
|---|---|---|---|---|

| ENGINEERING | BY | DATE |
|---|---|---|
| DESIGNED | SPCP | 08/2016 |
| CHECKED | DDH | 08/2016 |
| APPROVED | DDH | 08/2016 |
| **DRAFTING** | **BY** | **DATE** |
| PRELIMINARY | | |
| FINAL DESIGN | | |
| PLOTTED | HAMIST | 11/20/17 |

XXXXXX SUBSTATION

# DC SCHEMATIC DIAGRAM 2414 RELAY INPUT

TANSFORMER TX

JEA BUILDING COMMUNITY

SCALE: NONE

SYSTEM PROTECTION & CONTROL PROJECTS 20413

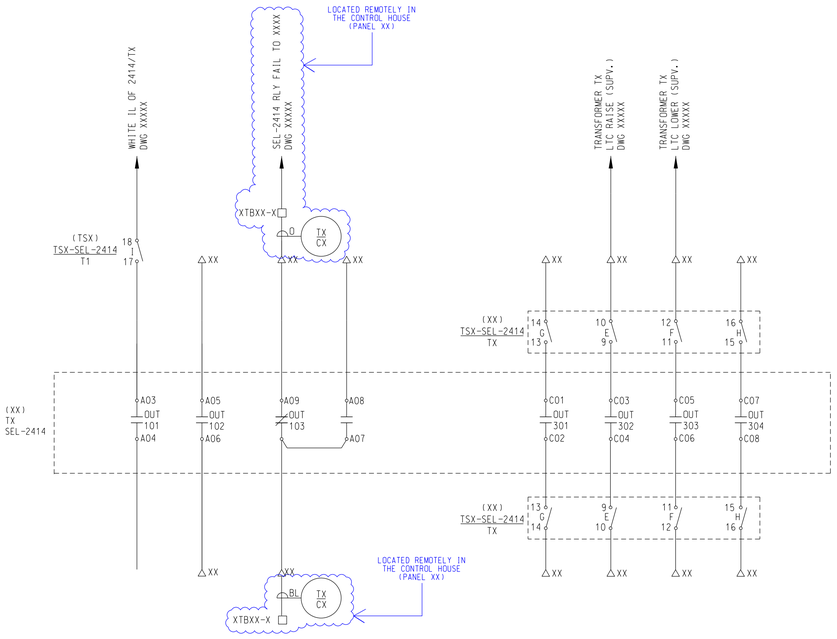
IFB NO:

DESIGN FILENAME: SPEC1.DGN

DRAWING NO: SPEC1

SHEET NO:

SAVED BY: hamist 11/20/2017 2:12:48 PM




LEGEND:

- CONTROL PANEL TERMINAL □
- DEVICE TERMINAL ○
- SWITCHYARD DEVICE TERMINAL △
- INPUT TO RELAY
- RELAY OUTPUT
- HYBRID (HIGH-CURRENT INTERRUPTING) RELAY OUTPUT
- HIGH SPEED/HIGH CURRENT RELAY OUTPUT

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

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|---|---|---|---|---|

| NO. | REVISIONS TO DRAWING | BY | DATE | APPROVED |
|---|---|---|---|---|

| ENGINEERING | BY | DATE |
|---|---|---|
| DESIGNED | SPCP | 08/2016 |
| CHECKED | DDH | 08/2016 |
| APPROVED | DDH | 08/2016 |
| **DRAFTING** | **BY** | **DATE** |
| PRELIMINARY | | |
| FINAL DESIGN | | |
| PLOTTED | HAMIST | 11/20/17 |

XXXXXX SUBSTATION

# DC SCHEMATIC DIAGRAM 2414 RELAY OUTPUT

TANSFORMER TX

JEA BUILDING COMMUNITY

SCALE: NONE

SYSTEM PROTECTION & CONTROL PROJECTS 20413

IFB NO:

DESIGN FILENAME: SPEC2.DGN

DRAWING NO: SPEC2

SHEET NO:

SAVED BY: hamist 11/20/2017 1:51:22 PM

# SEL-2414 (XX)

FT-1 TSX-SEL-2414-TX

| 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-TX

| HIGH TEMP TRIP (49TX) (+) | 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-TX

| INCOMPLETE STEP (+) | TAP SW AUTO/MAN (+) | 43TRL STATUS (+) | 43T STATUS (+) | LTC RAISE - SUPV. (+) | LTC LOWER - SUPV. (+) | | | OUT 101 WIL (+) | |
|---|---|---|---|---|---|---|---|---|---|

DETAIL 'C'
N3 SCALE 4:1

FT-1 TSX-SEL-2414-TX

| 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-TX

| HIGH TEMP TRIP (49TX) (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-TX

| INCOMPLETE STEP (IN605) | TAP SW AUTO/MAN (IN606) | 43TRL STATUS (IN607) | 43T STATUS (IN608) | LTC RAISE - SUPV. (-) | LTC LOWER - SUPV. (-) | | | | |
|---|---|---|---|---|---|---|---|---|---|

DETAIL 'F'
N6 SCALE 4:1

FT-1 TSX-SEL-2414-TX

| IN401 (-) | IN402 (-) | IN403 (-) | IN404 (-) | IN405 (-) | IN406 (-) | IN407 (-) | IN408 (-) | IN501 (-) | IN502 (-) |
|---|---|---|---|---|---|---|---|---|---|

DETAIL 'G'
N7 SCALE 4:1

FT-1 TSX-SEL-2414-TX

| IN503 (-) | IN504 (-) | IN505 (-) | IN506 (-) | IN507 (-) | IN508 (-) | IN601 (-) | IN602 (-) | IN603 (-) | IN604 (-) |
|---|---|---|---|---|---|---|---|---|---|

DETAIL 'H'
N8 SCALE 4:1

FT-1 TSX-SEL-2414-TX

| IN605 (-) | IN606 (-) | IN607 (-) | IN608 (-) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|

DETAIL 'I'
N9 SCALE 4:1

LEGEND:
- CONTROL PANEL TERMINAL □
- DEVICE TERMINAL ○
- SWITCHYARD DEVICE TERMINAL △
- INPUT TO RELAY (INXX)
- RELAY OUTPUT
- HYBRID (HIGH-CURRENT INTERRUPTING) RELAY OUTPUT
- HIGH SPEED/HIGH CURRENT RELAY OUTPUT

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

| NO. | REVISIONS TO DRAWING | BY | DATE | APPROVED |
|---|---|---|---|---|

| NO. | REVISIONS TO DRAWING | BY | DATE | APPROVED |
|---|---|---|---|---|

| ENGINEERING | BY | DATE |
|---|---|---|
| DESIGNED | SPCP | 08/2016 |
| CHECKED | DDH | 08/2016 |
| APPROVED | DDH | 08/2016 |
| DRAFTING | BY | DATE |
| PRELIMINARY | | |
| FINAL DESIGN | | |
| PLOTTED | HAMIST | 11/20/17 |

XXXXXX SUBSTATION

# DC SCHEMATIC DIAGRAM 2414 TEST SWITCH NAMEPLATES

TANSFORMER TX

JEA BUILDING COMMUNITY

SCALE: NONE

SYSTEM PROTECTION & CONTROL PROJECTS 20413

IFB NO:

DESIGN FILENAME: SPEC3.DGN

DRAWING NO: SPEC3

SHEET NO:

SAVED BY: hamist 11/20/2017 3:05:20 PM