Massachusetts Bay Transportation Authority

SPECIFICATION

FOR

REPLACEMENT

OF

POWER TRANSFORMERS TB, TC and TD

AT

SOUTH BOSTON POWER COMPLEX
Boston, Massachusetts

August, 2020

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SECTION 16310

POWER TRANSFORMER REPLACEMENT

PART - 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. SCOPE

1. This specification covers the requirements for the design, manufacturing, factory testing, delivery, installation, field testing and commissioning of three (3) 115kV delta.-13.8/7.967kV wye, 24 MVA OA/32 MVA FA/40 MVA FA Power Transformers TB, TC and TD at the MBTA South Boston Power Complex in Boston, Massachusetts.

2. The new power transformers TB, TC, and TD shall be installed in parallel with the existing 24/32/40 MVA power transformer TA.

3. The primaries of power transformers TA and TC are connected in parallel with primaries of power transformer TB and TD through a 115kV tie breaker.

4. The existing transformers TB, TC and TD have identical electrical and mechanical ratings and are located at the South Boston Complex owned and operated by MBTA.

5. The replaced transformers furnished under this Contract shall have similar electrical and mechanical ratings, physical dimensions and orientation as the existing transformers.

6. The existing transformers shall be disconnected (high and low voltage power connections and control circuits), removed and replaced without the interruption of the power supply system of South Boston Complex.

7. The new transformers shall be installed on the existing foundation. The Contractor shall verify that existing anchor bolts can be reused.

8. The 115kV high voltage line bushings and the high voltage surge arresters shall be connected to the existing 115kV disconnect switch mounted on the switchyard structure by means of the overhead cables. In order to facilitate the high voltage connection to the disconnect switch, the height from the top of the bushings to the base of the transformer shall be the same as the existing transformers.

9. The existing 15kV low voltage PILC cables (4 cables per phase) from the transformer low voltage terminal chamber to units 52L5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 of 15kV switchgear located inside the substation building shall be replaced under this Contract with EPR insulated cables. The EPR insulated cables (4 cables per phase) shall be terminated at both ends with heat shrink stress cones. The PILC cables shall be pulled out from the existing conduits and the duct banks. The EPR cables shall be installed in the same conduits. For replacement cable specifications, please see the attached P-203. The replacement cable will meet all the requirements of P-203 with one exception, cable size. For this project we will be using a 1,000,000 circular mil cable.

10. The air insulated chamber for low voltage X1, X2 and X3 bushings and for neutral X_0 bushing as well as control cabinet shall be mounted on the new transformer in the same location as the existing ones to facilitate the connections from the bottom.

11. The low voltage terminal chamber shall have removable non - magnetic bottom plate for cable entrance. The twelve cable openings (4 per phase) in the bottom plate shall be in the same location as the openings in the bottom plate of the existing transformers.

12. A load tap changer (LTC) shall be provided on the secondary side of transformer. The LTC shall have similar mode of operation, accessories and control as the LTC of the existing transformer.

13. AII equipment is to be fabricated in accordance with the requirements of this specification and in accordance with the final approved drawings for this equipment.

14. Bidders shall complete the attached data sheets, filling it in completely. Items that do not apply shall be designated N/A. Failure to complete data sheets shall be cause for rejection of the bid. Additional data in the form of catalog cuts and drawings to assist in bid evaluation, shall be supplied by the bidders. Load tap changer data sheets shall be included.

15. AII drawings and technical data shall be submitted for approval by the MBTA. The Vendor shall not proceed with manufacturing without approval, unless otherwise mutually agreed upon and confirmed on the purchase order.

16. Any special tools required for erection and servicing shall be furnished as part of the original equipment.

17. The transformer shall be complete with accessories specified herein and with terminations and standard items necessary to make

the unit complete and workable; although all such items may not be listed or described in detail herein. Any items removed for shipment shall be plainly marked to facilitate reinstallation in the field.

18. The transformer is to be shipped without oil in the tank and the LTC compartment. Both are to be pressurized with nitrogen for shipping. The vendor shall have the required amount of transformer oil shipped to the jobsite. The filled transformer shall be certified to be free of PCB's.

B. CODES AND STANDARDS

1. The equipment shall meet the performance requirements of and be designed, manufactured, and tested in accordance with the latest edition of the following applicable codes and standards:

a) ANSI	American National Standard Institute
b) IEEE	Institute of Electrical and Electronics Engineers
c) NEMA	National Electrical Manufacturer's Association
d) NEC	National Electrical Code
e) NESC	National Electrical Safety Code
f) UL	Underwriter's Laboratory
g) AISE	Association of Iron and Steel Engineers
h) ASTM	American Society for Testing Materials
i) NFPA	National Fire Protection Association
j) OSHA	Occupational Safety and Health Administration
k) NETA	International Electrical Testing Association

2. If there is any conflict between applicable codes and standards and this specification, the more stringent requirement shall apply.

3. If any referenced codes and standards have been superseded, the latest edition shall govern.

C. WORK NOT INCLUDED

1. All 115kV switchyard buses external to the transformer.

2. Transformer foundation and oil containment.

3. Anchor bolts.

4. All cables and conduits for controls and auxiliary power, except those that are internal to the transformer.

D. GENERAL REQUIREMENTS

1. Design Conference

a) Contractor shall start detail design and drafting work for all equipment immediately upon Notice to Proceed and shall process design work to completion without delay and without regard to normal manufacturing schedule.

b) A Design Conference shall be arranged in the Metropolitan Boston area as directed by the contractor with approval from the MBTA. The Design Conference shall be scheduled so that it can be completed within 30 days from the Notice to Proceed. It is estimated that the Design Conference, dealing with the design and manufacturing of power transformer will take not more than two full working days, provided the Contractor will produce the data and drawings specified herein in full compliance with the Specification requirements.The Design Conference will be attended by the Engineer, Authority's Consulting Engineer for the Project, Contractor's Project Manager and technical personnel from major equipment manufacturer. All costs associated in arranging and attending the Design Conference shall be borne by the contractor.

c) A minimum of 14 days prior to the Design Conference Contractor shall submit the following for Engineer's review:

(1) Certified overall dimension drawings showing weights and bases of the transformer.

(2) All pertinent information of the transformer proving the general compliance with the Specification requirements. The submittal shall include published product literature showing construction features of equipment offered, ratings, reference list of users in

USA and any other information useful in illustrating the compliance with the Specification requirements.

(3) The Contractor shall submit a written notification of any difficulties associated with accommodating the proposed equipment into the equipment outlines shown on the attached documents.

d) During the Design Conference, Contractor shall provide the following:

(1) Detailed engineering and design schedule and schedule for submittal of drawings for review, together with the detailed list of drawings to be submitted.

(2) Manufacturing plan, specifically estimated period of manufacturer, planned date of completion and scheduled date of witnessing of tests.

2. Submittals

a) Drawings and Reference Data: The below listed drawings, diagrams, instruction manuals, etc. shall be submitted for all equipment furnished in the latest version of the AutoCAD format.

b) Within 30 days after the Design Conference Contractor shall submit the following:

(1) Certified outline drawings of all major equipment, indicating overall dimensions, space requirements, location of control and protective devices on panels and reference tables to other drawings furnished. The submittal shall include the front and rear view of the transformer, showing all door and panel mounted devices, equipment and device nameplates and door swings.

(2) Certified site plan showing dimensions necessary for installation of the transformer base details; dimensions and weights of shipping sections.

(3) Certified top and bottom views of the transformer, showing available space for entrance of power and control circuit wiring from the bottom.

(4) Schematic diagram of transformer controls and alarms. Wire numbers shall be assigned to each

schematic and elementary diagram so that each segment of the circuits can be identified on internal wiring diagrams of the equipment and on the interconnection diagrams. Schematic diagrams shall be self-explanatory and shall be specifically prepared for this Contract and shall include elementary diagrams.

(5) Internal connection diagrams of devices. Contact development of control, test switches.

c) After the return of the schematic diagrams marked "For Construction", or equivalent, the following drawings shall be submitted within 30 days:

(1) General arrangement plans and elevation views, of the transformer, locating all Contractor's furnished and installed equipment.

(2) Connection diagrams showing the following:

(a) Terminal block arrangement, identifying each outgoing power and control terminal.

(b) Internal wiring diagrams of the transformer, showing electrical devices in their relative physical locations, left to right and top to bottom. Each wire and jumper shall be shown on the wiring diagrams. Terminal blocks for external control cable connections shall be shown in their relative physical locations. Inboard wiring connected to these terminal blocks shall be positively identified and marked so as to be readily located at the device end. All wiring shall be identified with wire numbers shown on schematic and elementary diagrams.

(c) Schematic or figurative type wiring diagrams which do not portray the physical wiring of the panels will not be accepted.

(3) Transformer rating nameplate data.

d) After the return of the schematic diagrams marked "For Construction", or equivalent, the following drawings, schedules and diagrams shall be submitted within 60 days:

(1) Detail plan and elevation drawings.

(a) Support details including loads on supports and weight capacity of proposed supports and anchors.

(b) Electrical ratings and weights.

(2) Installation details.

(3) Interconnection cable schedules and cable routing block diagram.

(4) Bills of installation materials.

(5) Renewal parts list.

(6) Interconnection diagrams shall show cable and terminal numbers, make reference to internal wiring of the equipment.

(7) Bills of Materials of equipment, devices and accessories with catalog cuts of all devices and accessories listed, including part numbers.

e) Upon successful completion of factory tests and at the same time the transformer is shipped for installation, the following documents shall be submitted:

(1) Instruction materials for each piece of equipment furnished, including unloading, rigging, handling, and storing of the transformer, as well as installation instructions, operating instructions, maintenance manuals and recommended spare parts lists (with manufacturer's part or drawing numbers). The instructions shall be comprehensive, descriptive and illustrative enough to install, operate and maintain all the equipment furnished. All instruction materials shall be in the form of manufacturer's printed originals; photo-reproductions of manufacturer's originals are not acceptable.

f) Completed and properly indexed instruction/maintenance manuals and "As-Built" drawings must be delivered to the Engineer before the completion of the Contract.

g) Contractor shall submit for approval, a detailed procedure for the installation of the transformers, including rigging crane locations, trailer locations, boom sweeps, etc. The submittal shall be made at least 30 calendar days after the Notice to Proceed and shall contain step-by-step description of the procedure, time table

for each step, precautions he will take and a statement of compliance with all the latest Federal, State, regional and local regulations covering such work. Submittal shall also include the name.

E. COORDINATION OF EQUIPMENT AND SYSTEMS

1. It is the responsibility of the Vendor to furnish equipment, materials, and specialties of the type, design, and performance which will result in an integrated system. Vendor shall be fully responsible for the satisfactory delivery and operation of all equipment and materials covered by this specification whether manufactured by him or by a subcontractor.

F. PERFORMANCE TEST

1. The vendor shall engage the services of an approved testing organization to provide the system performance testing of the electrical equipment as specified in this Section. The testing organization shall be independent of the manufacturer of the assembled products being tested.

2. The testing organization shall be an approved full service company that employs factory trained test engineers capable of troubleshooting as well as identifying power equipment problems. All tests shall be performed using NETA Standards.

3. The testing company shall provide the equipment and technical personnel to perform such tests and inspections. The Contractor shall, at his expense, furnish any personnel necessary to assist in the testing and inspection.

4. After a period of initial operation, the performance test will be conducted for the unit. Permanently installed instruments will be checked and calibrated in preparation for the test, and the results will be calculated on the basis of readings obtained. Data will be obtained for the equipment and/or systems furnished under this specification and will be made available to the Vendor. The Vendor may have representatives present. Vendor may also provide at his expense such additional equipment and instruments which he feels are required for the test.

5. The Vendor shall abide by the results of these tests, or shall provide all additional equipment instruments, make all preparations, furnish testing personnel, and incur all expenses connected with supplementary tests and must be furnished with a complete set of test data and results. If specified design conditions are not met, the Vendor shall change or replace the equipment and/or systems to obtain satisfactory performance.

6. Where operating evidence indicates that any of the auxiliaries, specialties, accessories, controls, or instruments furnished under this specification are not meeting the requirements or have not been properly selected, the Owner may require the Vendor at the latter's expense to conduct special tests to ascertain the suitability of the equipment and/or systems. In case of failure to meet the guaranteed performance, the Vendor shall make all necessary changes or replacement of equipment and/or systems as necessary to meet the guaranteed performance at no cost to the MBTA.

G. FIELD SERVICE ENGINEER

1. The Contractor shall furnish a competent Service Engineer who shall insure that the installation of the equipment being supplied here under is properly installed under this Contract and that the equipment is placed in successful operation. The Service Engineer shall provide a certified statement that the transformer installation has been conducted properly. The cost of this service, including salary, travel, subsistence, and all other items of expense, shall be included in the bid price.

H. FACTORY SERVICE ENGINEER

2. The Contractor shall arrange the services of a qualified Factory Service Engineer from the Supplier of the transformer to perform installation services. The cost of this service including salary, travel, subsistence and all other items of expense, shall be included in the contractor's lump sum bid price.

3. The Contractor shall furnish to the Authority a letter from the Factory Service Engineer certifying that the transformer was installed in accordance with the manufacturer's recommendations.

PART-2-PRODUCTS

2.1 DESCRIPTION

A. TRANSFORMER GENERAL DESIGN

1. The replacement transformers shall be an electrical and physical duplicate of the existing units to be replaced.

2. Transformer Tanks

a) Transformer main tank and radiators and the oil-filled compartments of the load tap changer shall be designed and constructed to include the following features:

(1) Welded steel plate construction, to be oil tight with

all fittings in place. The main tank shall have a welded-on cover. The load tap changer oil-filled compartments shall have removable, bolted-on, top and side covers with gaskets for inspection and maintenance. Tank finish shall be ANSI #70, Light Gray.

(2) The arcing switch compartment of the load tap changer shall be in a separate tank and sealed to prevent transfer of liquid to any other compartment or to the main tank.

(3) The main tank of the completely assembled transformer shall withstand, without permanent deformation or leaks, a pressure of warm oil 25 percent greater than the maximum operating pressure resulting from the oil preservation system used.

(4) Provisions shall be made for full vacuum filling and drying of the main tank and radiator(s) and the oil-filled compartments of the load tap changer in the field.

(5) The tank is to be provided with tanking guides for centering core and coil assembly.

(6) The tank shall be provided with four anchor brackets at appropriate location and height to utilize the existing anchors embedded in the foundation.

(7) All gasket joints shall have machined surfaces on both sides, and are to be provided with gasket retainers and metal-to-metal stops so as to assure even and effective pressure and to avoid overstressing gasket. The gasket shall maintain oil tightness of joint under all service conditions.

(8) All hardware, valves, fittings and hose connections shall be U. S. Standard Threads. Metric shall not be accepted

3. Facilities for Moving and Maintenance

a) Transformer shall have the following features to facilitate moving and maintenance conforming to latest ANSI C57.12.10 standards, and as follows:

(1) The transformer shall be provided with a sled runner type I beam base. A heavy steel flat plate base may be substituted for the sled runner type I beam base subject to review and approval of such design by

the owner.

(2) Pulling eyes to facilitate moving in any direction.

(3) Lifting eyes for lifting the cover.

(4) Lifting lugs for raising complete transformer.

(5) Jack bosses for raising complete transformer per ANSI C57.12.10.

(6) The core and coil assembly shall be of such design that it can be lifted from the tank.

(7) Two or more bolted and gasketed manholes in cover with a minimum diameter of 24 inches.

(8) A pole in the middle of the transformer cover with a safety ring shall be provided per OSHA standards.

4. Core and Coil Assembly

a) The core and coil to be of circular design. The core laminations are to be of non-aging alloy. Locking provisions are to be provided for all inside bolted members or connections. Joint in windings or bushings are to be brazed or clamped, not soldered. Insulation material, varnishes, and compounds in contact with oil shall neither affect the oil nor be affected by it. Core bolt insulation shall be suitable for operation at high temperatures. Assembly shall be braced or bolted adequately to prevent displacement and distortion under all normal conditions of handling and operation under short circuit conditions.

b) The serial number shall be stamped on the core in a conspicuous place.

c) The coils shall be copper.

5. Cooling System

a) The cooling system shall consist of radiators and fans, similar to one provided for the existing transformer TA as shown on drawings included with Attachment-2. All cooling equipment shall include supports, mounting, automatic control equipment, conduits, and wiring as required. Radiators shall be equipped with valves for each radiator section to permit the removal of any radiator without draining the oil from the transformer. Vent holes with plugs shall be provided in the top and drain valves with plugs in the bottom of each radiator.

b) Control equipment shall be installed in a weather tight enclosure, complete with hinged door and located so as to be easily accessible from the ground. It shall automatically start and stop the fans to maintain the transformer temperature within the guaranteed limits.

6. Cooling System Control

a) The fans shall be rated for 480 volt, three phase 60HZ operation. Two separate 480 volt, three phase, 60HZ supplies, called Source 1 and Source 2 will be provided.

b) The fans shall be individually connected to the power supply through a flexible rubber covered cord with weather-proof plugs and receptacles. The power cord of the transformer fans shall be installed in conduit. The motors shall be totally enclosed and furnished without centrifugal switches. Each motor shall have individual overload protection.

c) The control devices for cooling equipment operation shall be rated for 120 volt, single phase, 60HZ operation.

d) The cooling equipment shall be provided with remote supervisory control, local manual control and automatic control from winding hot-spot temperature equipment.

e) All control devices for the cooling system shall be furnished and installed in the control cabinet.

f) Circuit requiring external connections shall be wired to terminal blocks and functionally terminated in the same sequential order as the wiring of the existing transformer.

7. Oil Preservation System

a) The transformer shall have equipment for protecting the oil against atmospheric moisture and oxygen, as defined in the latest ANSI C57.12.10 standards.

b) The transformer will be provided with a conservator tank type oil preservation system. With an approved conservator tank type system, the requirement for an inert gas pressure type oil preservation system could be waived.

c) Vendor shall include an inert gas pressure system in which the transformer has a sealed tank with positive pressure

nitrogen automatically maintained above oil. All equipment, including a standard nitrogen gas cylinder shall be housed in a weatherproof cabinet attached to the transformer. The cabinet door shall have a window to permit reading all pressure gauges.

d) The system shall be complete with piping, hoses, and all required accessories. The following shall be included:

(1) One initial filled nitrogen cylinder.

(2) First stage pressure reducer with high and low pressure gauges to reduce cylinder pressure from 2200 to 100 psi.

(3) Second pressure stage reducer to reduce pressure from 100 to 7 psi.

(4) Third stage pressure reducer to reduce pressure from 7 to 0.5 psi and control gas flow to the transformer tank.

(5) Transformer tank pressure gauge graduated from 15 psi positive to 15 psi negative. The gauge is to have two sets of normally open and normally closed contacts for high and low pressure alarms.

(6) Gas cylinder low pressure alarm switch with normally open and normally closed contacts. The switch is to be activated when the pressure drops below 200 psi.

(7) Oil sump with drain valves.

(8) Transformer inlet valve.

(9) Transformer outer purge valve.

(10) Pressure relief valve.

(11) Heater with thermostat.

(12) All alarm contacts and heater wired to a terminal block.

(13) One spare filled nitrogen cylinder.

8. Transformer Grounding

a) The transformer shall have two (2) standard ANSI two-hole copper grounding pads, welded to the tank near the base on

diagonal corners.

b) Core ground shall be brought out externally through insulated bushing.

9. Current Transformers

a) Transformer shall be equipped with multi ratio bushing current transformers. The following current transformers shall be provided:

(1) Two (2) 600/5 amp, multi ratio, Class C 400 on each high voltage bushing for relaying (Total of 6).

(2) One (1) '2000/5 amp, multi ratio, Class C 800 on each high voltage bushing for relaying (Total of 3).

(3) Two (2) '2000/5 amp, multi ratio, Class C 800 on each low voltage bushing for relaying (Total of 6).

(4) One (1) 2200/5, single ratio, Class 3.0 on low voltage X1 bushing for line drop compensation (Total of 1).

(5) One (1) 2200/1.5, single ratio, Class 3.0 on low voltage X3 bushing for winding hot spot indication (Total of 1).

(6) One (1) 2000/5, multi ratio, Class C 800 on low voltage neutral bushing for relaying (Total of 1).

(7) One (1) 330/5, single ratio, Class 3.0 on center tap of LTC winding for overcurrent blocking for LTC (Total of 1).

10. No-Load Tap Changer

a) The transformer will be equipped with a no-load tap changer in the high voltage winding. The mechanism shall be operated by a single operating handle extended through the wall of the tank four feet above the base of the tank. It shall have position indicator and provision for pad locking. These voltages are for 115kV operation. Tap 1 will be 2.5% above the primary rated voltage. Tap-2 will be at primary voltage. Tap-3 will be 2.5% below the primary voltage. Tap-4 will be 5% below the primary voltage. Tap-5 will be 7.5% below the primary voltage. Tap position shall be as follows:

(1) Position (1) 117,900 volts

(2) Position (2) 115,000 volts

(3) Position (3) 112,100 volts

(4) Position (4) 109,300 volts

(5) Position (5) 106,400 volts

11. Load Tap Changer

a) The transformer shall be provided with a vacuum load tap changing equipment for automatic adjustment of the low voltage winding to compensate for varying voltage applied to the high voltage terminals. Load tap changer shall be in accordance with the latest ANSI C57.12.10 as specified below.

b) The load tap changer shall be capable of 500,000 full current operations before contact replacement is required. Current rating shall be for continuous 45 MVA operation for all tap positions above and below rated voltage. The LTC shall be equipped to automatically lockout operation when its current rating is exceeded.

c) The load tap changer shall provide plus 22 adjustments and minus 10 adjustments from rated 13,800 volt secondary voltage in 32 equal steps of 140 volt each.

d) The tap changer switch and selector switch shall be located in one or more oil-filled compartment mounted on the transformer tank. A separate magnetic liquid level gauge and a drain and sampling valve shall be provided for each compartment. Include pressure relief device with alarm contacts.

e) Tap changer mechanism motor, control and auxiliary circuits shall be rated for operation on a 480 volt, three phase and 60-Hertz power supply.

f) The operation mechanism and control devices shall be mounted in a weatherproof cabinet equipped with a full-access hinged door. The cabinet shall be accessible from ground level. Equipment and control devices to be supplied shall include, but not be limited to the following:

(1) Operating mechanism drive and motor.

(2) Hand crank mechanism with a safety switch to disconnect motor when mechanism is operated by hand.

(3) Tap position indicator, 8 inch round scale, showing positions 1-33. This indicator shall be clearly visible through a window from the outside.

(4) Selsyn type position transmitter suitable for remote tap position indication.

(5) Manual/Automatic control selector switch.

(6) Load Tap changer Controller.

(7) LTC control relay for overcurrent blocking. Circulating feedback to block automatic tap changer operation.

(8) Air circuit breaker(s) for protection of motor and control circuits.

(9) Motor control relay or contractor.

(10) "Lower-N-Raise" manual control switch.

(11) Operations counter to record the number of tap changer operations.

(12) Cabinet heaters, light and light switch, and outlet.

(13) Outgoing wiring terminal blocks.

(14) Parallel operation controls, including AC current relay, parallel/balancing module and tap changer control module.

(15) Selsyn position receiver, semi-flush switchboard type, 4-inch dial, and positions 1-33 (Shipped loose).

g) A reactance style tap changer is required and must be of the vacuum switching.

12. Magnetic Liquid level Gauge

a) A magnetic liquid level gauge shall be provided for the main tank and each oil-filled compartment of the load tap changing equipment per latest ANSI C57.12.10 standards.

Each level gauge shall have one normally open and one normally closed contact suitable for operation on a 125 volt DC circuit, for remote low level alarm.

13. Oil Temperature Indicator

a) An oil temperature indicator shall be provided for the main tank, located no higher than six feet from the base. The indicator shall be of the dial type per latest ANSI C57.12.10 standards, having one normally open and one normally closed contact, suitable for operation on a 125 volt DC circuit, for remote high temperature alarm.

b) An additional oil temperature well shall be provided for future addition of an oil temperature transducer for remote oil temperature indication.

14. Simulated Winding Hot Spot Indicator

a) A simulated winding hot spot indicator shall be provided located no higher than six feet from the base of the tank. Winding hot spot temperature equipment shall include a dial type temperature indicator, a current transformer, and a top oil temperature measuring device. In addition to the auxiliary switches required for the two-stage forced-cooling equipment control, one normally open and one normally closed contact shall be provided, suitable for operation on 125 volt DC, for remote high temperature alarm.

15. Sudden Pressure Relay

a) The sudden pressure relay shall be of the QUALITROL 900/910 RPRR, or equal, type designed to respond to the sudden increase of gas pressure caused by an internal arc. The relay shall be rated for operation on a 125 volt DC circuit and shall have one normally open contact, with a seal in relay, for remote trip of the transformer lockout relay (device 86) and isolated normally open and normally closed contacts for remote alarm. A Calisto Gas Collection monitor shall be provided in addition to the sudden pressure relay specified.

16. Pressure Relief Device

a) The pressure relief device shall be of the automatic resetting type, designed to relieve dangerous pressures which may build up within the transformer tank. The device shall have a position indicator clearly visible to a person standing on the ground and one normally open and one normally

closed contact, suitable for operation on a 125 volt DC circuit, for remote alarm.

b) OLTC pressure relief contact shall be provided for remote trip of transformer lockout relay (device-86).

17. Morgan Schaffer Calisto 2 Hydrogen-Moisture Carbon Monoxide

a) Morgan Schaffer, Calisto 2: Fault detector and monitoring of cellulose degradation. Calisto 2 shall be supplied for the main and LTC tank.

B. TRANSFORMER RATINGS

1. Capacity

a) The transformer shall have the data sheet specified continuous ratings with an average ambient temperature of 30°C and a maximum ambient temperature of 40°C during a 24 hour period.

b) 24/32/40 MVA with OA/FA/FA cooling, not exceeding 65 °C average winding temperature rise by resistance or hot spot temperature of 80 °C, in accordance with ANSI C57.12 standards.

2. Electrical Ratings

a) The transformer shall have the following electrical ratings:

	High Voltage H-Winding	**Low Voltage X-Winding**
Line-to Line Voltage - kV	115	13.8
Temperature Rise - Deg. Celsius	65	65
Connections	Delta	Ground Wye
Winding Insulation (Uniform)- kV Class	115	13.8
Neutral Winding End Insulation - kV Class		13.8
Basic Impulse Insulation Level - kV	650	150

	High Voltage H- Winding	**Low Voltage** X- **Winding**
Neutral Basic Impulse Insulation Level- kV		150
Winding Construction	Copper	Copper

3. Phase Displacement

a) The angular displacement between the high and low voltage winding vectors shall be 30 electrical degrees, with the low voltage (X) lagging the high voltage (H), assuming H1-H2-H3 rotation.

4. Impedance

a) Vendor shall give special design consideration to matching the impedance of other existing transformers on the system. The impedance is to be 16.4% on a 24 MVA base.

C. BUSHINGS

1. Bushing Ratings and Location

a) High voltage bushings shall be Lapp Insulator Co. POC (Paper-Oil-Capacitor) type, Cat. No. 8-67320, 650kV BIL, 1200/1600 ampere, draw lead, magnetic oil gauge, capacitance tap, No. 70 Gray glaze, and shall be mounted on top of the tank.

b) Low voltage bushings shall be Lapp Insulator Co. POC (Paper-Oil-Capacitor) type, Cat. No. B-89221, 150kV BIL, 2000 ampere, 27.5 inch creep, draw lead, magnetic oil gauge, capacitance tap, No. 70 Gray glaze, and shall be mounted on side of the tank, enclosed in a terminal chamber.

c) Neutral bushing shall be Lapp Insulator Co. POC (Paper-Oil-Capacitor) type, 46kV, high current bushing, Cat. No. B-89221, 2000 amp, 150kV BIL, bottom connected transparent bottom reservoir, capacitance tap, No. 70 Gray glaze, and shall be mounted on side of tank, enclosed in terminal chamber.

Note: Vendor is to confirm suitability of specified bushings for busing current transformer installation.

D. SURGE ARRESTERS

1. Primary: Station - Class Surge Arresters.

2. Secondary: Station - Class Surge Arresters.

E. TERMINAL CONNECTIONS

1. The Vendor shall include suitable stud connectors to connect the high and low voltage line bushings to a NEMA standard 4-hole pad.

F. TRANSFORMER OIL

1. As shipped, the insulating oil shall have passed the standard dielectric test in accordance with ASTM-0877-64. Should field test of the insulating oil fail the 30kV standard dielectric test, the Vendor shall, at his own expense, perform such filtering and/or oil replacement as necessary to bring the dielectric strength of the oil up to 30 kV.

2. Should the Vendor fail to supply oil meeting the above requirements, the Owner reserves the right to filter or replace the oil and back charge the Vendor.

G. AUDIBLE SOUND LEVEL

1. The average sound level of the transformer shall not exceed 65 decibels with transformer energized at rated voltage and rated frequency and carrying full load, when measured in accordance with ANSI/IEEE Standard 057.12.90.

H. SHORT CIRCUIT REQUIREMENTS

1. Transformer shall withstand without injury the mechanical and thermal stresses caused by short circuits specified in ANSI 057.12.00, when tested in strict accordance with ANSI C57.12.90-Distribution and Power Transformer Short Circuit Test Code.

I. SPECIAL REQUIREMENTS

1. High voltage side station class surge arresters shall be rated for 70kV RMS MCOV for an effectively grounded system. Arresters shall be mounted on the transformer for connecting to the incoming lines.

2. Low voltage side station class surge arresters shall be rated for 12.7kV RMS MCOV for a solidly grounded system. Arresters shall be mounted on the transformer for connecting to the outgoing cables.

3. Control cabinet shall be an outdoor type NEMA 3R with hinged, gasket doors three point latching, padlocking provisions and provisions for holding the doors open. Cabinet shall allow bottom access for power and control circuits.

4. An incandescent lamp receptacle with conveniently located and properly labeled toggle switch and a ground fault convenience outlet shall be provided in the cooling equipment control cabinet, and in the inert gas system cabinet.

5. All cabinets shall be furnished with thermostatically controlled space heaters in quantity and rating sufficient to minimize condensation.

6. The lamp receptacles, convenience outlets, and space heaters shall be wired to circuit breakers.

J. . CONTROL WIRING

1. Control, power supply, and current transformer secondary wiring in all cabinets shall be 600 volt, stranded copper, type SIS. Wiring shall be of adequate current carrying capacity but shall not be smaller than No. 14 AWG. Current transformer secondary wiring shall be No. 10 AWG.

Wiring shall be provided with ring type compression terminals with insulated sleeves and sleeve type wire markers at each termination. The transformer shall be supplied with a 16 AWG SO cord for instrument circuits.

2. Circuits requiring external connections shall be factory wired to terminal blocks, and functionally terminated in the same sequential order as the circuits of the existing transformer, readily accessible within the cabinets, near the base of the transformer, for bottom entry cables. No more than two connections shall be made to one terminal. A sufficient number of terminals to satisfy all external connection requirements plus a minimum of ten percent spares shall be provided. Terminal blocks shall be heavy-duty, washer-head screw type, thirty amperes minimum, 600 volt. Terminal blocks for current transformers shall be the short circuit type with all grounding screws in place and shall have all taps connected. All terminal blocks shall have bolted on covers with terminal numbers stamped on the covers.

K. NAMEPLATES

1. All bushings, auxiliary devices, and equipment shall have the manufacturer's standard nameplate attached as required by the codes and standards. All outside nameplates shall be stainless steel. The following nameplates shall be included:

a) A stainless steel transformer diagrammatic nameplate per latest ANSI C57.12.00 standards mounted four feet above the bottom of the tank.

b) Stainless steel current transformer diagrammatic nameplates, mounted inside the cooling control cabinet door.

c) A stainless steel number nameplate mounted four feet above the bottom of the tank

L. PAINTING

1. All surfaces shall be thoroughly cleaned of mill scale and rust by grit blasting. Oil and grease shall be removed chemically and at least three air dried coats of paint shall be applied by spraying, brushing, or dipping as follows:

a) Initial coat: Manufacturer's standard primer.

b) Second coat: Manufacturer's standard.

c) Finish coat: Light gray, ANSI No. 70 (Munsell No. 5.0BG7.0/0.4).

2. A description of the paint system to be used shall be supplied with the quotation.

3. Two quarts of touch up paint shall be furnished.

4. The interior transformer tank, control cabinet interiors, and the interior LTC compartment shall be painted white.

M. INSPECTIONS AND EXPEDITING

1. Vendor shall give the Owner reasonable notice (at least 30 days) when factory tests will be made on equipment specified herein so that the Owner can have representatives present during such tests. If the Owner desires to have the Vendor conduct tests above and beyond those specified, the Vendor will perform those tests providing he has the facilities to do so. The expense of such tests will be over

and above the contract price in the purchase order.

2. The Owner's representatives may witness tests and periodically inspect materials and equipment during manufacture and prior to shipment. The Vendor shall permit free access at all times to his manufacturing facilities to the representatives for the purposes of inspection and expediting.

N. SHIPPING

1. Equipment requiring removal for shipment clearances such as radiators, bushings, etc. are to be removed prior to shipment.

2. All travel by railroad shall be monitored in the lateral and longitudinal directions by recording meters furnished and installed by the transformer manufacturer.

3. The transformers is to be shipped as completely assembled as possible. It shall be protected for shipment in such a manner to preclude the possibility of damage not only to the equipment, but also to the finish of the unit.

4. The transformers shall be shipped dry, filled with nitrogen, under pressure. A low range pressure gauge shall be provided to permit direct observation of the gas pressure. The gauge shall be located so as to permit easy inspection during shipment and handling so as to determine whether the gas seal has remained intact.

5. Insulating oil shall be furnished and shipped by Vendor in tank truck(s) specifically designed and used for this purpose as instructed by the Owner. Oil shipments to be coordinated with the Owner.

0. CONFLICTS

1. If there is conflict between applicable codes and standards, and this specification, the more stringent requirement shall apply.

2. If any referenced codes and standards have been superseded, the latest edition shall govern.

P. EQUAL PRODUCTS

1. When a manufacturer's product is specified by name, or equal, it shall be the sole judgment of the Owner as to acceptability of any product which is offered as an equal to that specified.

Q. PERFORMANCE GUARANTEES

1. The Vendor guarantees that the transformer and accessory equipment will meet the requirements of this specification and that the equipment is manufactured and tested in accordance with the applicable standards.

2. Should the equipment fail to meet the requirements, performance or tests specified herein, or fail to operate as required, the Vendor, at his own expense, shall promptly make all necessary repairs and replace failed or defective components.

3. Transformer efficiency shall not be less than 97.5 percent, a displacement power factor above 90 percent lagging and a regulation or voltage characteristic based on 500 MVA ac supply capacity and X/R ratio of 15 such as to provide output voltage within the limits when ac system voltage at no load corresponds to transformer tap voltage.

4. The Vendor guarantees that the transformer no-load losses, load-losses, and auxiliary power consumption will not exceed values quoted by the bidder. Vendor agrees to be back charged for values exceeding the quotation, using the following cost factors:

Cost of no-load losses: $ 2,000/KW at 100% of rated voltage.

Cost of Load losses: $1,000/KW at 100% of rated self-cooled kVA.

Cost of Auxiliary losses: $800 at maximum continuous load.

Note: In evaluating the bids for this transformer, quoted losses will be added to each bidder's price using the above cost factors.

5. The data recorded at Factory Acceptance Test shall be used to determine if penalties are warranted.

R. SPARE PART LIST

1. The following spare parts shall be provided:
   a) One high voltage bushing with gasket
   b) One low voltage bushing with gasket
   c) One neutral bushing with gasket
   d) One complete set of gaskets for manhole, handhole and terminal chamber

e) One pressure relief device
f) One gas and oil actuated relay
g) One pressure relay for OLTC
h) Three contactors with coils
i) Two indicating lamps

PART-3-EXECUTION

3.1 INSTALLATION

A. GENERAL

1. South Boston Power Complex is an active generating plant and 115kV substation providing 15kV incoming service to traction power substations throughout Metropolitan Boston Area. The replacement work shall be carried out without interruption of power to these substations.
2. The Contractor should note that the replacement work involves working in close proximity with 115kV energized and operating equipment. Therefore utmost safety measure shall be utilized in performing the work.
3. Only MBTA power department will be responsible to remove or restore 115kV or 13.8kV power to any circuits. The Contractor is not permitted to operate any power circuits without the permission of MBTA power department.
4. The Contractor shall take every precaution in disconnecting, removing and disposing the existing transformer as well as in handling, setting, aligning and assembling the new transformer to be installed. The Contractor shall thoroughly familiarize himself with the manufacturer's instructions before attempting to handle, install and operate the equipment. Contractor shall ensure that all personnel working with the equipment fully understand the operation of the various components to avoid mis-operation, damage to equipment and possible personal injury. Contractor shall determine the application of all power, control, indication, supervisory and auxiliary function specified.

B. REPLACEMENT WORK

1. Prior to dismantling and removal of the transformer, the Contractor shall verify that the Authority has disconnected and locked out the 115kV incoming power to the transformer and 13.8kV outgoing feeders to the switchgear. Removal of power to the transformers will be accomplished by opening and locking out the 115kV disconnect switch and opening and removing the

feeder circuit breakers from the 15kV cubicles in the switchgear line-up. The cable to neutral bushing shall be disconnected and the end of the cable taped for connection to the new transformer after the neutral breaker is opened and locked out.

2. All external wires for controls, CTs, SCADA and auxiliary power shall be removed from the control cabinet, end of these wires shall be taped and each wire shall be identified by wire and cable number. These wires will be reconnected to the control cabinet of the replaced transformer. All CT circuits connected to the transformer shall be shorted.
3. After the transformer is completely de-energized, auxiliary and control power disconnected, the Contractor shall take field measurements and observed the method and type of terminations used for connecting 115kV cables at high voltage bushings/surge arresters and at 115kV transformer disconnect switch. These measurements and observations will be needed to provide appropriate type and size of terminators and bushings at the correct height to facilitate cable connections between the high voltage bushings/surge arresters of the replaced transformer and 115kV transformer disconnect switch 89TB, 89TC and 89TD.
4. The Contractor shall disconnect and remove 115kV high voltage cables (wires) between the transformer disconnect switch and high voltage bushings/surge arresters. The Contractor may salvage and reuse the terminal connectors, 4 hole pads and the wires for the future use.
5. The Contractor shall also take the field measurements of 15kV cable terminations. These measurements will be needed to terminate 15kV new EPR cables almost at the same locations where the existing connections are made.
6. Disconnect 15kV PILC cables (4 per phase) at the transformer end and at 15kV switchgear end in cubicles. Remove and turn over to MBTA the entire length of cables (4 per phase) from the transformer to the switchgear ends.
7. New 15kV EPR insulated cables (4 per phase) to be furnished under this Contract shall be installed utilizing the same routing and same conduits used by existing PILC cables. These EPR cables shall be terminated with stress cones at both ends.
8. Drain and dispose oil of the transformer and load tap changer.
9. Carefully dismantle, remove and dispose existing transformer.
10. Make note of the location, length and size of the anchor bolts protruding through the foundation, as these will be utilized in anchoring the replaced transformer.
11. Place the new transformer on existing concrete foundation. Assemble radiators and other accessories removed for shipment. Provide oil handling facilities for removing moisture in the oil,

testing and filling the transformer and load tap changer chamber with oil.

12. After filling of the transformer with oil, the Contractor shall perform, in presence of the Engineer, the standard ASTM 30kV breakdown test and shall if necessary, purify and filter the oil to raise the insulation properties to the specific value.
13. The 115kV high voltage connections utilizing the existing cables shall be connected from high voltage surge arresters at the transformer to the terminal pads of 115kV transformer disconnect switch 89TB, 89TC and 89TD.
14. The 15kV low voltage EPR insulated cables (4 per phase) furnished under this Contract shall be terminated with stress cones at transformer low voltage bushing and as well as at 15kV switchgear cubicles for each transformer. The existing cable for the neutral shall be connected to the neutral bushing.
15. Test existing ground riser prior to making connection to the ground pads of the transformer. If ground resistance is less than 5 ohms, connect ground riser to the transformer ground pads. If the ground resistance exceeds 5 ohms, report immediately to the Authority. Additional ground rods may be required to bring down the resistance less than 5 ohms.
16. Prior to terminating all external wires removed from the existing transformer for CT, control, SCADA and auxiliary power circuits, the Contractor shall conduct continuity and insulation test on each and every wire. If a wire is found to be defective, it shall be immediately reported to the authority for proper action. After connection to the CT circuits, remove the jumpers.
17. All new cable racks and clamps must be installed in the four manholes that the 15kV secondary cables pass through between the transformer and the switchgear. All racks must be bonded and grounded. A new ground rod must be installed as part of this contract. The rack system must match the one provided on the Hubbell Power Systems drawing or an approved equivalent.
18. The 15kV cables supplied must meet Specification P-203 with the exception of Part 4, Measurement and Payment. The cables will also be 1,000,000 circular mils, not 500,000 mils as stated in P-203.
19. The (2) two existing block firewalls between TA & TC and TB & TD must be replaced. The new walls will be replaced with an Oldcastle Trufirewall, or approved equivalent. The barrier must meet the requirements of NFPA 850, ASTM E-119 and compliant with IEEE Std 979, IBC, CBC, UBC construction codes. The existing wall foundation may be re-used if it meets the requirements of the new walls.
20. All hazardous waste will be properly disposed of, following all local, state and federal laws. All waste oil will be removed from the site by a qualified disposal company. Manifests will be required for all waste oil removed from the site.

C. EQUIPMENT TESTING

1. SUMMARY
   a) This sub-section covers the requirements for factory and field testing of the equipment furnished under this Contract.
   b) All equipment furnished and installed under this Contract shall be subject to the test program described herein. Testing shall include tests at the manufacturer's facility and in the field.
   c) The Contractor shall formulate overall test program of the equipment which shall include but not be limited to the tests specified herein to ensure the equipment compliance with relevant standards and this Specification and provide satisfactory and reliable performance for the intended operation.
   d) Tests at the factory shall include but not be limited to:
      (1) Manufacturer's standard tests.

      (2) Tests as per currently applicable NEMA, IEEE, and ANSI Standards. Any other test to ensure satisfactory performance of the equipment.

   e) Tests in the field shall include but not be limited to:
      (1) Manufacturer's standard tests.
      (2) Test as per currently applicable NEMA, IEEE and ANSI Standards.
      (3) Any other test to ensure satisfactory performance of the equipment.
2. TEST REPORTS

a) The Contractor shall submit four copies of certified of test reports of all the tests conducted at the factory and in field for the Engineer's approval. Test reports shall be submitted to the Engineer within seven days after completion of tests. Test reports shall contain the characteristics curves, etc. where required for interpretation of results.

3. CONDITIONS FOR TESTS
   a) General Conditions
      (1) Prior to testing all of the following conditions shall be fulfilled by the Contractor:
         (a) All shop drawings of the equipment to be tested have been approved by MBTA
         (b) The Contractor shall submit a step by step test procedure including pass-fail criteria to the Authority four weeks in advance of the commencement of the test. The Authority reserves the right to add, delete and make necessary changes in the test procedures. The Contractor

shall arrange to conduct all tests per the Authority approved procedure.

(c) A minimum of four weeks advance notification shall be given to MBTA on the scheduled date of tests to enable the Authority to witness the same.

(d) Testing shall not commence without an approved test procedure.

b) Witnessing Tests

(1) Authority's personnel and/or their authorized agents will witness complete testing of all equipment unless a waiver is granted, in which case test reports of the equipment for which the waiver was granted, shall be submitted for review to obtain clearance for packing and shipping.

c) Responsibility

(1) The Contractor shall assume full responsibility during the factory and field testing of all equipment and installation provided by him. Should there be any loss of damage to such equipment, material or the building due to these tests, the Contractor shall be fully responsible for replacing the damaged equipment. Replacement of damaged equipment shall include all costs, including but not limited to transportation of, testing and installation of the replacement equipment.

d) Rejection and Retesting

(1) Failure of equipment to successfully pass the tests or to meet ratings shall be sufficient grounds for rejection of the equipment.

(2) Any equipment rejected shall be retested in presence of the Engineer after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams or any other documents submitted and accepted by the Engineer, revised drawings or diagrams shall be submitted, showing proposed changes and Engineer's approval need to be obtained before changes or modifications are made on the equipment. Modifications or changes which do not warrant revision of any drawing shall be furnished to the Engineer along with notice of retesting.

(3) If it is not possible to rectify rejected equipment, new equipment shall be manufactured and the requirements of the drawings and design calculations of the original unit shall be applicable for the new unit.

e) Cost of Rectification or New Unit

(1) The entire cost of rectification of new unit shall be

borne by the Contractor including retesting and cost of witness of retesting.

f) Test Costs

(1) Any transportation (air-coach class and any other necessary) and first class lodgings required outside the Boston Metropolitan area by the Authority's personnel, their authorized agents or their authorized consultants which are necessary for testing and to accomplish the satisfactory inspection of this contact shall not be included in the bid price.

(2) Following is the anticipated number of personnel and length of lodging for the tests:

Test	Number of Personnel	Lodging Days
Transformer	5	3
15kV Cable	3	2

(3) If additional trips are required due to problems developed because of the negligence of the Contractor, the cost of those trips shall be borne by the Contractor.

4. FACTORY TEST

a) The following tests as listed in ANSI C57.1200-2000 Table 19 shall be performed at manufacturer test facilities. If facilities for conducting any of the tests listed below are not available to the Contractor, these tests shall be conducted elsewhere by him or by an independent agency as approved by the Engineer. Contractor shall, however, clearly indicate in his proposal, the name of the facilities where he intends to conduct those tests:

(1) Resistance measurement for all winding of the rated voltage connections and all tap positions. The bridge method or high accuracy digital instrumentation is to be used.

(2) Ratio tests on the rated voltage connection and all tap connections.

(3) Polarity, phase-relation, and phase-sequence test, using a ratio bridge with phase angle correction.

(4) No-load losses at rated voltage on the rated voltage connection

(5) . The three wattmeter method is to be used.

(6) Excitation current at rated and 110 percent of the rated voltage.

(7) Impedance and load-losses at 25, 50, 75 and 100 percent rated current on the rated voltage connection and on the highest and lowest taps.

The three-wattmeter method is to be used.

(8) Zero-phase-sequence impedance test.

(9) Applied potential test.

(10) Induced potential test.

(11) Standard ANSI impulse tests on line terminals. Oscillogram test reports are to be included.

(12) Temperature rise tests at the highest tap position.

(13) Insulation power factor tests on all winding-to-winding and winding-to-ground insulation. All measurements exceeding 0.5 percent must be reviewed with and approved by the Engineer.

(14) Partial discharge/corona during induced potential testing.

(15) Temperature rise test to determine that the temperature rise of the windings are within the permissible limit after delivering full load continuously and fulfilling the transformer duty cycle.For the purpose of this test, reading will be considered to have stabilized when the rate of temperature rise is less than two degree Celsius during a consecutive 3 hour period. The test shall be performed per Standard C57.12 the following sequence:

(a) Step 1:

I. Temperature stabilized at 100% continuous load at lowest voltage and highest current tap. This temperature will be used as a base line for the remaining temperature rise test.

II. Record data at shut down.

(b) Step 2:

I. Re-stabilize the temperature at 100% continuous load.

II. Apply 110% full load current for 2 hours. Ill. Record data at shut down.

IV. Pass/Fail Criteria: The temperature rise shall not exceed 80 degrees Celsius in an ambient corrected to 30 degree Celsius.

(16) Audible sound level test in accordance with lEEE Standard C57.12. The transformer shall be connected and energized at rated voltage and frequency at no load. Pass/Fail Criteria less than 65 dB (A).

(17) Gas in oil analysis before and after all testing.

5. FIELD TEST
   a) The work includes furnishing labor, material, test instruments and services necessary to perform required testing and checking of electrical equipment installation.
   b) All tests shall be successfully completed to show that the installation meets the specification requirements and that the equipment and devices operate as intended, before final acceptance by the Authority.
   c) Tests and checkouts shall be conducted in accordance with the Engineer's approved test procedure specified herein and in National Electrical Code, and applicable Standards and Specifications ' of ANSI, NEMA, etc.
   d) Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all the electrical field testing and checking work and shall maintain a written record of tests conducted.
   e) Safety devices consisting of all arc flash resistant equipment meeting NFPA-70E standard and OSHA regulation for protection against electric shock and arc flash hazard including but not limited to di-electric rubber gloves, protective hooded jackets, arc suppression blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protect and warn all personnel in the vicinity of the tests.
   f) Testing and checkouts shall be performed in the presence of the Engineer.
   g) Contractor shall furnish four copies of all tests results to the Engineer. Result sheets shall include date of test, personnel involved, items tested, type of test and test data.
   h) Any equipment of material damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by Contractor at his expense.
   i) Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protest and warn all personnel in the vicinity of the tests.
   j) All test instruments used shall have a certified calibration sticker showing last date of calibration and expiration date.
6. FIELD TEST REQUIREMENTS
   a) Contractor shall formulate a complete Field Test procedure for all equipment to be furnished and installed under this Contract. Test procedure shall be comprehensive and shall include the required tests as specified in relevant standards of ANSI, NEMA and IEEE, supplementing the Factory Test Procedure.
   b) The Contractor shall submit the test procedure to the Engineer for review and approval well in advance to

the commencement of field tests.

c) Engineer reserves the right to add, delete or make necessary changes in the test procedure. The Contractor shall arrange to conduct all the field tests as per the Engineer's approved procedure. Since the Contractor is responsible for the performance and installation of the equipment furnished under this specification, he shall, therefore, prior to testing, verify that the installation is proper and in accordance with all applicable installation instructions specified herein.

7. FIELD SERVICES AND TESTING

a) The following field services shall be performed by the factory services engineer.

(1) Inspect the equipment and impact recorder printouts for damage during shipment.
(2) Direct the installation Contractor's crew during all phases of assembly and oil top-off filling of the transformer.
(3) Inspect coil and core assemblies, the LTC, and all auxiliary equipment for damage.

b) The following tests shall be performed by the field service engineer.

(1) All tests recommended by the manufacturer.
(2) Winding-to-winding and winding-to-ground resistance test.
(3) No load and load tap changer operation and ratio test.
(4) Apply full vacuum to assembled transformer, hold and monitor for twelve (12) hours to check for leaks.
(5) Oil dielectric test before pumping into transformer.
(6) Oil dielectric test after transformer is topped off.
(7) Test all auxiliary equipment.
(8) Test operation of inert gas system. N/A for conservator system.
(9) Current transformer excitation and insulation resistance.

c) The field service engineer shall submit a certified report for all tests performed at the conclusion of these tests.

PART- 4- MEASUREMENT AND PAYMENT

4.1 PAYMENT SCHEDULE

A. The work for replacing the transformer will be measured on line item basis commissioned in place as indicated herein the specification.

10%	Approved submittal per spec. 16310, 1.1, D.1 and 16310, 1.1, D.2.b
10%	Approved submittal per spec. 16310, 1.1, D.2.c and 16310, 1.1, D.2.d
5%	Approved submittal per spec. 16310, 1.1, D.2.e and 16310, 1.1, D.2.f
15%	Shipment of Transformer TB
15%	Shipment of Transformer TC
15%	Shipment of Transformer TD
15%	Completion of installation per spec 16310, 3.1 Installation
10%	Energization of Transformers of TB, TC and TD
5%	Contract closeout

ATTACHMENT 1

SPECIFICATION DATA SHEET

Transformer shall comply with the following requirements:

A. TRANSFORMER

1.	Number of Identical Units:	3
2.	Equipment Tag No.:	Transformer – TB, TC and TD
3.	Type:	(X) Outdoor ( ) Indoor
4.	Class:	( ) OA ( ) OA/FA/FA ( ) OA/FA (X) OA/FA/FA ( )OA/FA/FOA ( ) OA/FAO/FOA
5.	MVA:	24/32/40 MVA (Based on 65°C winding temperature rise by resistance)
6.	Voltage:	HV: 115 kV LV: 13.8 kV
7.	Connections:	HV: Delta LV: Grd. Wye
8.	No. of Windings:	Two
9.	Winding Material:	Copper
10.	Impedance:	16.4% Based on 65°C Rating@ 24 MVA
11.	Winding BIL:	HV: 650 kV LV: 150 kV
12.	Frequency:	( ) 50 Hz (X) 60 Hz
13.	Insult. Liquid:	(X) Oil ( ) Silicon ( ) RTEmp
14.	Insult. Liquid Pre.Sys:	Manufacturer's Standard
15.	Parallel Operation:	(X) Yes () No
16.	Matched Impedances:	(X) Yes () No

B. TAP CHANGER (HIGH SIDE)

1.	Type:	( ) On load (X) No load
2.	Location:	(X) HV ( ) LV

1. ATTACHMENT 1

SPECIFICATION DATA SHEET

3. Operation: ( ) Energized (X) De-energized

4. Operator: (X) Hand ( ) Motor

5. Full Capacity Taps
6. Above Rated Voltage: 2-1/2%

a) Below Rated Voltage: 2-1/2%, 5% & 7-1/2%

C. TAP CHANGER (LOW SIDE)

1. Type: (X) On load ( ) No load

2. Location: ( ) HV(X) LV

3. Full Capacity Taps:
   a) Above Rated Voltage: 22 @ 140 volts each

   b) Below Rated Voltage: 10 @ 140 volts each

4. The following types of tap changers shall be acceptable:
   a) REACTIVE TYPE
   b) VACUUM TYPE

Note: The manufacturer shall identify which type of load tap changer will be provided as a part of the proposal.

D. BUSHINGS

1. Voltage Class:	HV: 115 kV	LV: 15 kV	Neutral: kV
2. BIL:	HV: 650 kV	LV: 150 kV	Neutral: 150 kV
3. Location:	HV: Top	LV: Side	Neutral: Side

E. TERMINAL CHAMBERS AND THROATS

1. Bushing Enclosure:
   a) HV Side: ( ) Terminal Chamber ( ) Primary switch

   ( ) Throat connection to Circuit Breaker (X) None

1. ATTACHMENT 1

SPECIFICATION DATA SHEET

b) LV Side: (X) Terminal Chamber ( ) Throat connection to Circuit

Breaker ( ) None

2. Terminal Chamber Type:
   a) HV Side: ( ) Oil Filled ( ) Air Filled (X) None

   b) LV Side: ( ) Oil Filled (X) Air Filled ( ) None

3. Connections :
   a) HV Side: (X) Aerial ( ) Cable ( ) Load Break switch

   b) LV Side: ( ) Aerial (X) Cable ( ) Bus-Duct ( ) Switchgear

4. Entry:
   a) HV Side: (X) Top ( ) Bottom ( ) Side

   b) LV Side: ( ) Top ( ) Bottom (X) Side

F. TERMINATIONS

1. HV Side: 1 per phase, KCMIL AAC.
2. LV Side: 4 per phase, KCMIL CU, EPR Insulated
3. Neutral: Cu.
4. Ground: Cu.

G. CURRENTTRANSFORMERS

1. HV Bushings: 2-600:5 per bushing and 1-2000:5 per bushing
2. LV Bushings: 2-2000:5 per bushing, 1-2200:5 on X, bushing,

   1-2200:1.5 on X_3 bushing
3. Neutral: 1-2000:5
4. Center tap of LTC winding: 1-330:5

H. COOLING SYSTEM

Temperature Sensing Method: (X) Top Liquid (X) Winding

I. AUXILIARY EQUIPMENT (Fans, Etc.)

1. Power Source: (X) External ( ) Internal
   480 Volts, 3 Phase, 60Hz

3. ATTACHMENT 1

SPECIFICATION DATA SHEET

J. SUDDEN PRESSURE RELAY

1. Status: (X) Required ( ) Not Required

2. Type: ( ) To match with existing transformer (X) Manufacturer's Standard

K. ACCESSORIES

1. Auxiliary contacts, actuated by the oil pressure buildup, oil level and high winding temperature of the transformer, for annunciation.

L. LIGHTNING ARRESTER

1. Status: (X) Required ( ) Not Required
2. Type: (X) Station ( ) Intermediate ( ) Distr.
3. Location: (X) HV Side (X) LV Side (X) Tank Mounted
4. Rating: HV: 70kV MCOV LV: 12.7kV MCOV

ATTACHMENT 2

VENDOR DATA SHEET

The following is in addition to the general requirements for this project. The data called for below shall be furnished with each quotation. In the event the bidder becomes the seller, this data shall be considered guaranteed and become part of this specification.

A. BIDDER

1. Name _____
2. Address _____
3. Phone _____

B. MANUFACTURER

1. Name of Transformer Manufacturer _____
2. Name of LTC Manufacturer _____
3. Place of Manufacturer _____
4. Place of Testing _____

C. PHYSICAL OATA

1. Weight of transformer, complete _____ lbs.
2. Weight of coil and core assembly _____ lbs.
3. Weight of insulating oil _____ lbs.
4. Shipping weight of largest item _____ lbs.
5. Number of radiator banks. _____
6. Number of fans _____ HP (ea.) _____

D. ELECTRICAL DATA

1. Transformer rating at 40°C ambient and 65°C temperature rise.

Self-Cooled _____ _____ MVA

a) Forced Air Cooled
   1) 1st Stage @ 65°C Rise _____ MVA
   2) 2nd Stage @ 65°C Rise _____ MVA

2. Insulation Rating

a) Primary Winding _____ kV
b) Secondary Winding _____ kV

4. ATTACHMENT 2

VENDOR DATA SHEET

3. Basic Impulse Level (BIL)
   a) Primary Winding _____ kV
   b) Secondary Winding _____ kV
4. Load Losses@ 40°C Ambient
   a) Self-Cooled Rating _____ kW
   b) % Self Cooled Rating _____ kW
   c) % Self Cooled Rating _____ kW
   d) Full Self Cooled Rating _____kW
   e) Full Forced Air Cooled Rating _____ kW
5. No Load Loss at 100% Voltage _____kW
6. No Load Loss at 110% Voltage _____kW
7. Magnetizing In Rush Current _____A
8. Magnetizing Current @ 100% Voltage _____ A
9. Magnetizing Current @ 110% Voltage _____ A
10. Voltage Regulation at Full Load 100% P.F_____%@Base
11. Voltage Regulation at Full Load 80% P.F _____ %@Base
12. Transformer Impedance _____%
13. Cooling Equipment Power Requirement_____kW
14. Sound Level at Full Load OA _____dB
15. Sound Level at Full Load FA _____ dB
16. Sound Level at Full Load FA _____dB

ATTACHMENT 3

DRAWINGS

The following is a list of the existing transformer drawings included in this attachment:

1. Tl-104-514e- Outline Drawing, Transformer
2. Tl-104-535d- CT Connection Diagram
3. Tl-104-552g- Wiring Diagram of Supervisory Equipment
4. Tl-104-553d- Ckt Diagram of Supervisory & Cooling Equipment
5. Tl-104-559d- Wiring Diagram of Control Cabinet
6. Tl-104-560d- Connection Diagram for Control Wiring
7. Tl-104-766c- Name Plate of Transformer
8. Tl-104-786e- Circuit Diagram- Motor Drive for OLTC
9. Tl-104-798b- Physical Layout Control Cabinet
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12. Tl-104-355d- Bill of Material for Circuit Diagram
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19. AC Schematics 115KV / 13.8KV Transformer TB
20. AC Schematics 115KV / 13.8KV Transformer TC
21. AC Schematics 115KV / 13.8KV Transformer TD
22. Substation Conduit Plan