

Specification

12.47kV/46kV Generator Step-Up Transformer

Power Plant Substation

**Brigham City Power Corporation
Brigham City, UT**

10/15/2026

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PART 1 - TERMS AND CONDITIONS

Seller shall provide their own terms and conditions, to be reviewed by Brigham City with the proposal.

The desired delivery date for the transformer is October 2027.

PART 2 - GENERAL DESCRIPTION

2.1 SCOPE

- A. This specification covers the technical and reporting requirements for the design, fabrication, inspection, testing, delivery, dressing, and filling of one (1) three phase power transformer that will be owned by Brigham City and installed at their Power Plant Substation in Brigham City, Utah at 4,500 feet above sea level.

2.2 COMMUNICATIONS

- A. Invoices shall be directed to "Owner":

Attn: Troy Dahlgren
Brigham City Corporation
PO BOX 1005
Brigham City, Utah 84302
Phone: (435) 226-1471

Additional Contact:
Birch Benson
Brigham City Corporation
PO BOX 1005
Brigham City, Utah 84302
Phone: (435) 770-0214

- B. Quotations, Exceptions, Submittals and Technical correspondence shall be directed to "Engineer and Owner":

WSP
Attn: Lucas Becker
Lakewood, CO
Phone: 303-716-8913
Email: lucas.becker@wsp.com

2.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the most recent edition of the referenced standards; provided, that wherever the provisions of

said publications are in conflict with the requirements specified herein, the more stringent shall apply.

A. ANSI NATIONAL STANDARDS INSTITUTE (ANSI) - Latest Edition

ANSI/IEEE C57.12.00	General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI/IEEE C57.12.10	Requirements for Transformers 230000 Volts and Below 833/958 Through 8333/10417 kVA, Single Phase, and 750/862 Through 60000/80000/100000 kVA, Three-Phase (Includes Supplement ANSI C57.12.10a-1978)
ANSI/IEEE C57.12.70	Terminal Markings and Connections for Distribution and Power Transformers
ANSI/IEEE C57.12.80	Terminology for Power and Distribution Transformers
ANSI/IEEE C57.12.90	Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
ANSI/IEEE C57.13	Requirements for Instrument Transformers
ANSI/IEEE C57.92	Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Winding Rise
ANSI/ASTM D3487	Specification for Mineral Insulating Oil used in Electrical Apparatus
ANSI/IEEE C57.19.00	General Requirements and Test Procedure for Outdoor Power Apparatus Bushings
ANSI/IEEE C57.19.01	Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushing.
ANSI Y32.2 / IEEE 315 / CSA Z99	Graphic Symbols for Electrical and Electronic Diagrams.
ANSI Z55.1	Gray Finishes for Industrial Apparatus and Equipment.

B. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) -Latest Edition

NEMA TR-1	Transformers, Regulators and Reactors
NEMA TR-98	Guide for Loading Power Transformers with 60°C Average Winding Rise
NEMA 250	Enclosures for Electrical Equipment (1000 V Maximum)
NEMA CC1	Electric Power Connections for Substation

B. BID SUBMITTALS

1. Bid submittals shall include the filled out proposal document included in Section 5 of this Specification as well as;
2. Preliminary outline drawing;
3. Any other drawings or auxiliary information which the Seller feels will be necessary or appropriate for bidding purposes.
4. Any exceptions or terms which the Seller cannot or will not be able to meet as required by this Specification.
5. **Bid submittals shall be submitted electronically via email to the Engineer and are due no later than: November 12, 2026**

C. REVIEW SUBMITTALS

1. One (1) reproducible set of drawings shall be sent for approval by the Engineer. Drawings include the following:
 - a. Transformer nameplate drawing with schematic and phasor diagram, electrical ratings, weights and winding tap data in tabular format per ANSI standards.
 - b. Transformer outline drawing showing plan and elevations with listing and description of all devices and accessories and details showing lifting and anchoring provisions.
 - c. Seller may propose to substitute equal equipment based on pricing and delivery and is required to submit complete material lists for review and approval. Seller shall be responsible for providing component parts that are fully compatible with the Engineer's design as indicated on the drawings. The Engineer's review of the Sellers' Bill-of-Material is for quality assurance purposes and to ensure conformity with the contract documents only.
 - d. Transformer base, general arrangement, assembly, installation and foundation arrangement drawings.
 - e. HV Bushing outline drawing.
 - f. LV Bushing outline drawing.
 - g. Schematic and wiring diagrams showing tap arrangements of wiring of accessories.
 - h. Wiring and connection diagrams for all control, current, potential and alarm circuits.
 - i. Bushing current transformer connection tables (for multi-ratio CT's), excitation curves with lead and turn resistance data, and ratio correction curves with ANSI relay or meter accuracy classes.
2. Drawings for review shall be in electronic format and shall be submitted via email or file server access for download by the Engineer.

3. Documents for review and approval by the Engineer shall be submitted within the number of weeks the Seller specified in the bid submittal documents.

D. FINAL SUBMITTALS

1. One (1) reproducible set of the final drawings in electronic format shall be submitted via email or file server access for download by the Engineer.
2. One (1) reproducible set of installation, operating and maintenance instruction manuals and test reports in electronic format that is properly indexed to identify each major piece of equipment shall be submitted via email or file server access for download by the Engineer.
3. Three (3) hard bound copies of the installation, operating and maintenance instruction manuals which cover all of the equipment furnished. Each copy shall also include final test reports, equipment drawings, CT excitation curves, and renewal parts lists for all replaceable parts and assemblies.
 - a. Each copy shall also include the bill of materials with manufacturer, model/type, description, and catalog number for standard components and accessories. This list shall include bushings, relays, indicators, control equipment, cooling equipment, and all other significant items.
 - b. Manuals shall be bound by a durable means, properly indexed to identify contents and clearly labeled to indicate Buyer, project and equipment covered.
4. Three (3) copies of the certified test reports and test reports of routine shop tests conducted in accordance with ANSI C57.12.00 prior to shipment.
5. Copies of such other information as the Buyer may request.

E. FIELD SERVICES SUBMITTAL

1. Three (3) copies of Field Service Engineer report which shall include those items listed in the Testing and Quality Control section, including results of oil sample testing.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL

- A. **The Transformer shall be manufactured and assembled in the United States of America.**
- B. The transformer will be a Grounded Y-Delta Transformer connected to a 3-phase, 60 Hz system, with the following voltage and connection requirements:

High Voltage (wye)	46kV
High Voltage BIL	250kV
Low Voltage (delta)	12.47kV
Low Voltage BIL	110kV
Coolant	Mineral Oil
Winding Material	Copper
Impedance	7.5% on 10 MVA Base

- C. The design and manufacture of the transformer shall utilize new material, modern technology and quality workmanship. All manufacture dates for all equipment installed on the transformer shall be within one year of transformer shipment date.
- D. Internal surge arresters or non-linear resistors shall not be included as part of the internal insulation system.

3.2 TRANSFORMER DESIGN RATINGS

- A. Power ratings at an elevation of 4,500 feet above sea level:

Cooling Class	ONAN/ONAF/ONAF
Temp Rise over 40°C	65°C
Continuous 65°C ONAN/ONAF Rating	12/16/20 MVA

- B. The Transformer control voltages shall be as follows:
 - 1. AC 120/240 VAC, single phase, 60 Hz
 - 2. DC 125 VDC
- C. The transformer losses will be evaluated based on a 30 year transformer life. The following costs will be used to evaluate the losses by multiplying them by the guaranteed no-load and load losses stated in the proposal and adding the results to the quoted price of the transformer.
 - 1. No-load core loss: \$7,890/kW @ rated voltage
 - 2. Full-load winding loss: \$3,264/kW @ 12 MVA

3. Auxiliary loss: \$252/kW @ 20 MVA
- D. The loss determination test system accuracy must be verified for conformance with the requirements of C57.12.00-2015, Section 9.4. The Seller's bid shall include documentation which verifies the accuracy of the loss measurement system in accordance with the method of NIST Technical Note 1204, or in accordance with the method of Dr. Eddie So of the National Research Council of Canada. The documentation provided with the bid shall include sufficient identification of the test system to enable the Buyer to confirm that it is the same used to test the transformer.
- E. The dollar values given above shall also be used to determine cost penalty to the Seller if actual transformer no-load, load and auxiliary losses shown in the certified shop test reports exceed the Seller's guaranteed losses. No credit will be allowed if actual no-load, load and auxiliary losses are less than quote losses.
- F. Reported losses shall use a reference temperature of 20°C for no load losses and 75°C for full load losses.

3.3 CORE AND WINDINGS

- A. The transformer shall incorporate a cylindrical core and cylindrical windings. The windings shall be designed to meet the ANSI C57.12.90 short circuit withstand test for all possible combinations of the voltages specified.
- B. Transformer core shall be of the highest quality, non-aging, cold-rolled, grain-oriented, stress-free, thin-silicone-steel or amorphous metal laminations having high permeability and low hysteresis loss. The steel shall be properly annealed and have smooth surfaces at the edges. Each sheet shall have an insulated surface which is impervious to hot transformer oil.
- C. The core shall be rigidly clamped and blocked to prevent damaging vibrations, interference with oil circulation, short circuits, objectionable noise levels, withstand seismic conditions as identified above, shipment distortions, and weakening over the life of the transformer. Any internal blocking or bracing used with is to be removed from the transformer at its destination shall be painted a bright color, such as red or yellow, clear external marking indicating their presence shall be provided (If included it shall be Manufacturer's responsibility to remove such blocking).
- D. A means shall be provided for properly lifting and handling the core and coil assembly to allow for ease of removal from the tank for repairs.
- E. The transformer winding hot spot temperature shall be measured. The measured temperature shall be used to control the transformer cooling fans and to initiate alarm and trip signals for high winding temperature conditions. The method for measurement shall be by the current transformer simulation method.
- F. The core shall be securely grounded to the tank in a location accessible from the exterior of the transformer.

- G. The internal high voltage leads of the transformer shall be installed rigidly and spaced to provide dielectric and mechanical strength and ensure absolute phase isolation.
- H. All coils shall have each turn supported at frequent intervals by means of insulating spacers which shall be permanently secured in place so arranged as to assure positive and effective oil circulation. To assure that the coil stacks remain permanently tight, all insulation spacers shall be dried and compressed at high pressure before placement in the coil stacks.
- I. Bolted connections will be acceptable only to form lead to bushing connection. All other connections shall be welded, brazed or made with compression connectors.
- J. If the coil is impregnated, the insulating compound used shall be nonhygroscopic, insoluble in, and not acted upon by, the transformer oil at overload temperatures. All varnish and other insulating materials used shall be unaffected by ordinary petroleum distillates having flash points above 170°C.
- K. Each core, main series, etc. shall be single-point grounded and shall be brought through the top of the tank through an insulated bushing for an external grounding connection. The bushing shall have a removable ground strap or lead for meggering the core without opening the transformer tank.
- L. As part of the manufacturers bid submittal, a BH curve for the core steel proposed for use shall be provided. The proposed transformer design core flux density shall also be submitted.
- M. The conductors and insulation shall be designed so that the formation of corona will be prevented, not only at the operating voltage, and during the dielectric tests.
- N. Winding conductors shall be made of copper and shall be designed to ensure mechanical strength and to minimize flux concentrations. The conductors shall be smooth and free of scale, burrs, and slivers. Joints in conductors shall be brazed or welded. Joints in conductors shall be properly formed and finished, and carefully insulated to conform to the basic insulation. The number of joints shall be minimized.
- O. All coils shall have each turn supported at frequent intervals by means of insulating spacers which shall permanently secured in place and so arranged as to ensure positive and effective oil circulation. To ensure that the coil stacks remain permanently tight, all insulation spacers shall be dried and compressed at high pressure before placing them in the coil stacks.
- P. The transformer design shall be adequate to withstand short circuits, of the values available when limited only by the impedance of the transformer itself, without damage or displacement of the coil on the core and to withstand normal moving and handling.
- Q. There shall be no deformation to the completed winding assembly by the stress's incident to shipment or short circuits.
- R. The assembled core and coils shall be dried in vacuum to ensure proper moisture removal to attain the best insulation resistance or lowest power

factor obtainable. Immediately after drying, the assembly shall be immersed in dry oil.

- S. Winding temperature rise by resistance and hottest-spot winding temperature rise shall be in accordance with ANSI C57.12.90 for 55°/65°C insulating system.
- T. Winding leads shall be readily accessible from a manhole in the tank cover.
- U. The core ground lead shall be brought through the tank side and be grounded to the outside of the tank for ease of testing.

3.4 TANK

- A. The tank shall be of welded construction, with round corners with lifting lugs near the top of the tank and jacking provisions near the base. The transformer shall be capable of being lifted with either the lifting lugs or jacking plates without damage to the tank. The transformer shall be constructed to allow rolling or skidding on either main base axis.
- B. The tank, attached compartments, and piping which is subject to operating pressures shall be designed to withstand without permanent deformation, pressure 25 percent greater than the maximum operating pressures resulting from the system of liquid preservation as well as the vacuum filling and vacuum drying of the tank in the field.
- C. The tank shall be properly prepared, cleaned of all rust and scale before finish is applied.
- D. The tank cover shall be welded to the top of the tank. The top of the tank shall be prepared with a non-skid surface and equipped with lifting eyes sized to lift the cover only.
- E. A device suitable for mounting a safety device in the approximate center of the tank cover and capable of supporting hardware including harnesses utilizing gravity brakes shall be provided.
- F. The tank cover shall be provided with at least two manholes. Manholes shall be located and sized to permit access to all bushing connections and current transformers. The manholes shall be bolted and gasketed to provide a leak free tank.
- G. The transformer tank shall be provided oil preservation system incorporating a nitrogen inert-gas pressure system complete with the following minimum accessories:
 - 1. Pressure regulation system
 - 2. High/Low Tank pressure alarm contact points
 - 3. Nitrogen bottle low pressure alarm
 - 4. All accessories shall be housed in separate water tight lockable compartment accessible from the outside of the transformer. All pressure gauges must be visible through a window in the door of the compartment.
- H. The center of gravity of the transformer with and without oil shall be permanently and plainly marked on two adjacent sides of the tank. Metal plates shall be used for this purpose.

- I. The tank and enclosures subject to operating pressures of the oil preservation system shall be designed to withstand internal operating pressure of 8 psi with margin for a minimum of 125% positive or negative pressure of the preservation system furnished. In addition, the transformer shall be designed with sufficient bracing and strength to permit essentially full vacuum filling with insulating liquid. All joints in the tank and radiators shall be made oil tight and gas tight by welding inside and outside. Seams on the tank wall corners will NOT be acceptable.
- J. The transformer tank shall be provided with the following valves and fittings:
 - 1. One drain/filter valve located to allow complete draining of the tank. Attached to this valve shall be a sample valve not less than 1/4 inch in diameter
 - 2. One filling valve located near the top of the tank
 - 3. One vacuum valve located above the oil level at the top of the tank; the valve shall be so designed and installed to prevent oil from entering into the valve during oil processing.
 - 4. Provision for connection of portable gas detection and sampling equipment. Shall be easily accessible to allow for maintenance activities to be performed without exposing live energized parts.
- K. All gaskets shall be of nitrile rubber with gasket retainers provided on all oil tight gasketed joints. Stops shall be provided so that over compression of the gaskets cannot occur. One (1) set of spare gaskets shall be provided for the manhole covers and all bushings and openings.
- L. The tank shall be designed to shed water.

3.5 RADIATORS AND COOLING SYSTEM

- A. The transformer shall be furnished with removable radiators which shall be rigidly supported from the transformer tank by bolted flange connections. The radiators shall be galvanized and shall be designed to withstand the same pressures and vacuum as the main tank. The radiators shall be provided with lifting eyes with valves located on top and bottom.
- B. Each radiator shall include lockable shut off valves and a drain valve. The design shall allow for the removal of an individual radiator from the tank by closing the shut off valve, draining the individual radiator and removing the radiator for repair without draining the transformer.
- C. Radiators shall be interchangeable and each shall be provided with brass drain plugs. Vent plugs shall be provided in radiator headers to positively assure against any air being injected into the transformer tank.
- D. Radiators shall be braced to withstand the vibrations and impacts which occur during shipment, and to withstand the vibrations which prevail during operation. The bracing of the radiators shall not interfere with or present hazards to personnel engaged in reading meters or gauges. Radiators shall be constructed to withstand tank operating pressure and full vacuum. The

arrangement of radiators shall be such as to permit easy installation of the fans and pumps.

- E. Transformer Cooling System. Transformer cooling fans shall be operated in two stage, controller from winding temperature devices and from a manual switch (Auto/On). All auxiliary relays, devices, etc., required for the operation shall be furnished.
1. Cooling equipment shall be furnished as required to provide the transformer's rated capacity without exceeding the guaranteed temperature rise.
 2. Cooling equipment motors shall be rated for service on a 120/240 volt, 60 Hz, single-phase, power supply. All fans shall have galvanized fan guards and be provided with one piece fan blades.
 3. Forced cooling capacity shall be provided by the use of fans for forced air cooling. Temperature control shall be provided by winding temperature equipment, including a temperature indicator and relay contacts to automatically actuate forced cooling equipment in proportion to the transformer load.
 4. Manual control switches shall be provided in the control cabinet to allow testing and maintenance of the cooling fans and to enable selection of which group of fans is used for the first forced cooled stage. Transformer cooling equipment shall be designed for continuous ONAN/ONAF operation.
 5. The fan motors and motor overload protection provided shall be totally enclosed and weatherproof. Motor bearings shall be designed for a continuous as well as intermittent duty. Provisions shall be made for suitable lubrication and, where required, for bearings to withstand end thrust. Manual-resetting overload protection shall be supplied for each individual motor unless the motors are capable of withstanding full-stalled rotor current continuously without damage. The fan leads shall be weatherproof, or totally enclosed in a weatherproof flexible conduit. The leads or conduits shall be terminated at one end with a suitable waterproof connector and, on the other end, with a waterproof plug to be inserted into a receptacle mounted on the transformer tank. Fan blades shall be of aluminum alloy, stainless steel or other corrosion-resistant material and shall have surfaces designed to keep fan noise to a minimum. The fan unit, including motor and fan blades, shall be dynamically balanced so that the operation of the fan assembly will be essentially free of vibration and thereby safeguard the motor bearings against excessive wear.
- F. A combination drain and lower filter valve shall be provided. This valve shall provide for drainage of oil to within one inch of the tank bottom and for outlet of the oil to a filtering means. The size of the drain valve shall be two inches and have two-inch NPT threads with a pipe plug in the open end. The drain

valve should have a built-in 3/8-inch sampling device which should be located on the side of the valve between the main valve seat and the pipe plug. This sampling device shall have a 5/16 inch - 32 male thread and be equipped with a cap. An upper filter valve of the globe type shall be located below the 25°C liquid level and shall be suitable for the return of filtered oil. The size of the upper filter shall be one inch and have one inch NPT threads with a pipe plug in the open end. The upper filter valve shall have an oil sample valve for dissolved gas analysis. There shall be a filling valve with a minimum size of two inches.

3.6 BUSHINGS

- A. Bushings shall have the continuous current carrying capacity necessary to carry the maximum current ratings of the transformer for all combinations of the voltages specified. Bushings shall have ANSI 70 grey glazed porcelain insulated housings. Bushing electrical characteristics and tests shall be in accordance with ANSI C57.12.00 and IEEE 21. Bushing dimensions shall be in accordance with IEEE 24 and NEMA TR1. Bushing terminals shall be in accordance with applicable parts of ANSI C57.12 family of standards. Bushings shall be in accordance with IEEE Standards 21-76 and 24-84 and ANSI C76.1 and C76.2.
- B. All bushings shall be furnished with silver-plated external contact surfaces and have provisions for power factor testing.
- C. Bushings and terminals must be suitable for service conditions provided herein at an altitude of 4,700 feet above sea level.
- D. The transformer bushings shall be rated as follows (Please include bushing manufacturer information in bid submittal):
 - 1. The primary H1, H2 and H3 bushings shall be rated at altitude:

Bushing Voltage Rating	46kV
Bushing BIL Rating	250kV
Bushing Manufacturer	ABB
Bushing Location	Tank Lid Segment 3

- 2. The secondary X1, X2 and X3 bushings shall be rated at altitude:

Bushing Voltage Rating	12.47kV
Bushing BIL Rating	110kV
Bushing Manufacturer	ABB
Bushing Location	Air Terminal chamber Segment 1 wall

3. The H0 bushing shall be rated at altitude:

Bushing Voltage Rating	46kV
Bushing Manufacturer	ABB
Bushing BIL Rating	250kV

- E. All bushings shall be provided with 4-hole tin-plated NEMA terminals. Provide one terminal stud to NEMA 4-hole pad on each bushing (total of 7).
- F. Both high and low voltage bushing shall be of the oil filled type, paper insulated, and have a clear visual indication of the internal oil level from any angle.
- G. All bushings shall be feed-through type and interchangeable.
- H. Bushings shall be one piece porcelain under compression only. Porcelain used in the bushings shall be manufactured by the wet process and shall be homogeneous, free from laminations, cavities, or other flaws affecting its mechanical strength or dielectric quality; it shall be well vitrified, tough, and impervious to moisture. The glazing of the porcelain shall be free from imperfections, such as blisters or burns.

1.1 I. AIR TERMINAL CHAMBER

- I. The transformer shall come equipped with a 15kV air terminal chamber suitable for terminating Owner supplied and installed 15kV cables. Air terminal chamber must be a fully enclosed and lockable cabinet suitable for application per the environmental requirements of Section 3.2.
- J. Air terminal chamber must not extend closer than 18" above the transformer base to allow for cable entry into bottom of compartment.
- K. Bottom of compartment shall be supplied with a removeable aluminum cover no smaller than 24" by 48" to be field modified and utilized by Owner for 15kV cable penetrations. Base of cabinet must extend a minimum of 4" beyond each side of cable penetration knockout.
- L. Air terminal chamber must have a minimum of one means of cable support (Unistrut or full width rigid bar set no closer than 2" away from transformer wall) within chamber.
- M. Air terminal chamber must have full length lockable access door, door must be hinged on one vertical side. Door must be securely latched in no fewer than three locations.

3.7 CURRENT TRANSFORMERS

- A. Bushing current transformers shall be furnished with standard ratio taps in accordance with ANSI Standards.

- B. All current transformers shall have fully distributed windings and a minimum thermal rating factor of 2.0 at 30°C ambient.
- C. Current transformers shall be installed on the HV and LV bushings inside the transformer tank as follows:

H1, H2, H3 Bushings	Nine (9) CTs total (two relaying (2) per bushing, one (1) metering): Inside CT: 600:5, 5 lead multi-ratio, ANSI C400 Middle CT: 300:5, Single Ratio Metering class 0.3B-1.8 Outside CT: 600:5, 5 lead-multi-ratio, ANSI C400
X1, X2, X3 Bushings	Six (6) relaying accuracy grade (two (2) per bushing): 1200:5, 5 lead-multi-ratio, ANSI C400
H0 Bushing	One (1) relaying accuracy grade 600:5, 5 lead multi-ratio, ANSI C400

3.8 SURGE ARRESTERS

- A. Metal-oxide station class polymer, color ANSI 70 gray arresters shall be provided and mounted on standoff brackets. The arrester standoff brackets shall be designed so that the arrester terminal height is within 2 inches of the bushing terminal height. The arresters shall be provided with 4-hole tin-plated NEMA terminals.
- B. Arresters shall be adequate for transformer protection at an altitude of 4,700 feet above sea level. Arrester ratings shall be as follows:

High Voltage	Duty Cycle: 48.3kV MCOV: 39kV Ohio Brass
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- C. Seller shall submit complete arrester information including catalog numbers and outline drawings for approval by the Engineer.

3.9 CONTROL CABINET

- A. The enclosure shall be an outdoor, weather proof, NEMA type 4.
- B. All control power, current transformer leads, alarm and control wiring shall be contained in the one (1) control cabinet per transformer.
- C. The incoming control cables shall enter from the bottom of the cabinet.
- D. Space shall be provided on the bottom of the enclosure for conduit entrances. Conduit entrance shall have field removable bolted steel plate.
- E. The enclosure shall be front accessible for the control wiring. The front access shall be by lockable, hinged, full length doors. Each door shall have three-point latching type handles. Doors shall be provided with a mechanism to secure the door in the open position at approximately 120°.
- F. The cabinet doors shall be provided with a metal drawing pocket on the interior side.
- G. The control cabinet shall be in an accessible location mounted at a convenient operating height.
- H. All wiring, devices, and connections within the control cabinet shall be readily accessible for maintenance and labeled to correspond to the wiring diagram.
- I. A 120 V, 60 Hz, 15A, single phase, GFI receptacle shall be mounted at an accessible location inside the control cabinet.
- J. The control cabinet shall be provided with a protected heater strip rated 240 V, 60 Hz, operated at 120 V, 60 Hz. The heater shall be controlled with a thermostat. The heaters shall be located so as to not damage incoming cables or other equipment. A separate 2-pole, circuit breaker shall be provided for each heater circuit.
- K. The main control cabinet shall have a 120 V, 60 Hz ceiling LED light to illuminate the interior of the cabinet. The light shall be controlled by an automatic push button switch actuated by opening the cabinet doors.
- L. The heaters, receptacle, and lights shall be protected by an over-current automatic-trip circuit breaker with manual reset.
- M. A 1/8" x 1" x 2'0" copper bar shall be provided in the control cabinet for grounding purposes. The bar shall be drilled and tapped for 10-32 screws on one-inch (1") centers.
- N. The control cabinet shall have terminal blocks for terminating alarms, control and current transformer wiring, space for cooling equipment controls, and spares. Each terminal block, circuit breaker and all other devices shall be permanently labeled with nameplates (black with 5/32" white letters) to coincide with the identification shown on the transformer drawings

3.10 GROUNDING PROVISIONS

- A. All non-energized metallic components of the transformer shall be grounded.
- B. The transformer tank base shall have two, NEMA, 2-hole, copper faced grounding pads mounted at the base of the transformer, diametrically opposite from each other. The pads shall be provided with 1/2"-13 threads per inch tapped holes a minimum of 3/4" deep.
- C. One similar ground pad on tank cover near neutral bushing.
- D. Provide 1/4" x 4" copper bus bar connecting first base-rail ground pad to neutral bushing ground pad, continuous across top of tank and down to opposite base-rail ground pad. Provide minimum 4/0 AWG copper cable between surge arrestor grounds and copper grounding bar.
- E. Provide removable ground connection between neutral bushing and cover mounted ground pad. Minimum ampacity equal to copper bar.
- F. A 2-hole NEMA transformer core ground pad shall be welded to the tank cover. The pad shall be provided with 1/2"- 13 threads per inch tapped holes a minimum of 3/4" deep. Location shall be detailed on an outline drawing.

3.11 GASKETS

- A. All bolted transformer tank or accessory openings shall be gasketed.
- B. Gaskets shall be unaffected by hot insulating oil, retain their resiliency during the life of the transformer and be unaffected by the weather while maintaining oil and gas tightness.
- C. Gaskets shall have a minimum compressed thickness of 1/8 inch.

3.12 FINISH

- A. The transformer enclosure shall be cleaned, primed and painted for maximum protection from the environment. Surfaces to be painted shall be washed and prepared by a chemical etching process or sand, grit or shot blasted.
- B. The transformer exterior shall be painted ANSI Gray 70. The internal of transformer tank interior walls shall be painted white and compatible with the insulating fluid and, if applicable, in accordance with ASTM 3455.
- C. Accelerated aging test must be performed on the paint to be used inside the tank. A plate steel sample coated with the white paint shall be submerged in transformer insulating oil and heated to 130°C. After 1,000 hours, there shall not be any measurable change in the painted surface or in the power factor of the oil used for the test.
- D. The Manufacturer shall furnish 5 gallons of "touch up" paint.
- E. All external connection and mounting hardware (bolts, nuts, brackets and accessories must be stainless steel.

3.13 WIRING

- A. All general purpose and control wiring shall be tinned, stranded copper, SIS not smaller than No. 12 AWG terminated with ring-type insulated compression barrel type connectors equal to the T&B Sta-Kon connectors.
 - 1. Bidder may make an exception to 3.13A for fan circuits or other circuits not adequately served by No. 12 AWG wiring. Bidder must note where SIS not smaller than No. 12 AWG is utilized so Buyer can evaluate.
- B. All CT wiring shall not be less than No. 10 AWG SIS.
- C. Each individual conductor shall be clearly identified using a machine printed, heat shrink type cable marker with destination labeling on both ends of the wire.
- D. All wiring shall have no more than two (2) wires under each screw or connection point.
- E. Heavy-duty terminal blocks with barriers shall be furnished and installed for external AC supply cables.
- F. Blocks used for inter-panel wiring shall be readily accessible.
- G. Terminal blocks shall be heavy duty, protected washer screw type equal to the General Electric type EB-25. Marker strips shall be engraved, white backing with black lettering. All current transformer secondary leads shall be terminated in short circuiting, washer-screw type terminal blocks equal to the General Electric type EB-27. All leads for each individual current transformer shall be brought to a separate terminal block with individual ground connections.
- H. The arrangement and location shall be such that incoming and outgoing cables can be supported. Adjacent rows of terminal blocks shall be separated at least six inches (6") from sides, top, bottom or front for all wiring.
- I. One spare twelve (12) terminal-terminal block or 25% spare points on existing terminal blocks, whichever is greater, shall be provided.
- J. All customer connection side of terminal blocks shall not be used by the Seller.
- K. Wireway systems with removable covers, completely accessible for operation, troubleshooting, and maintenance, shall be used within the control cabinet. Wireway systems shall be large enough to accommodate wiring for all existing and future devices. Bolted clamp-type wireway bundles may be used as an alternative as approved by the Engineer. The use of stick-on anchors with "tie-raps" for securing wire bundles is strictly prohibited.
- L. All wiring leaving an enclosure shall leave from terminal blocks and not from other devices in the enclosure.
- M. The terminals shall be fastened to the contact strip of terminal boards with machine screws. The contact strips shall be separated by insulated barriers. Terminal blocks with clamp type fittings are not acceptable.

3.14 NAMEPLATE

- A. The nameplate shall be firmly attached with stainless steel self-tapping screws or stainless-steel rivets.
- B. The transformer nameplate shall be engraved stainless steel and mounted on the control cabinet and include the information required by ANSI C57.12.00 by the Manufacturer.
- C. The current transformer nameplate(s) shall be located inside the control cabinet.
- D. Any other information which the Manufacturer deems necessary for proper installation, maintenance, and operation of the transformer shall be included on the nameplate.

3.15 INSULATING OIL

- A. The transformers shall be oil filled using insulating oil in conformance with ANSI/ASTM standards.
- B. The insulating oil shall meet or exceed ASTM standards and be certified to be non-PCB oil. The certification shall be permanently fastened to the tank of the transformer.
- C. Transformer oil shall be inhibited per applicable standards.
- D. Oil shall be Type II, pure, unadulterated, mineral oil obtained by the fractional distillation of petroleum. Oil shall be prepared and refined especially for use in transformers, having a minimum flash point of 145°C. It shall be free from moisture, acid, alkali, and injurious sulfur compounds. The oil shall not form a deposit under normal operating temperatures. The minimum allowable dielectric strength of the oil shall be 35 kV when measured in accordance with American National Standard Methods of Testing Electrical Insulating Oils, C59.2 (latest revision).
- E. The pathway for oil flow shall be piped off the side of the transformer.

3.16 ACCESSORIES

- A. Alarm and trip contacts shall be Form C, 10 A rated, 250VDC contacts.
 - 1. Form C, 10A rated, 250VDC contacts shall also be used to wire the status's of fan stages 1 & 2.
- B. The transformer shall be provided with the following gauges:
 - 1. Magnetic liquid level gauge shall be mounted to be readable from ground level and shall be furnished with two (2) sets each of low level alarm and trip contacts (device 71) wired to terminal blocks. The device shall be a Qualitrol or Engineer approved equal.
 - 2. Top oil temperature gauge shall be mounted at eye level and shall be furnished with resettable drag hands, two (2) sets each of high

temperature alarm and trip contacts wired to terminal blocks. The device shall be a Qualitrol or Engineer approved equal. Top oil temperature gauge shall have analog 4-20mA output wired to terminal block in main control cabinet.

3. Winding hot spot temperature gauges shall be mounted at eye level and shall be furnished with resettable drag hands, two (2) sets each of high temperature alarm and trip contacts wired to terminal blocks. The device shall be a Qualitrol or Engineer approved equal. Winding hot spot temperature gauge shall have analog 4-20mA output wired to terminal block in main control cabinet.

- C. The transformer shall have a fault pressure relay (device 63) complete with seal-in relay and auxiliary contacts wired to terminal blocks. Provide an auxiliary seal-in relay and reset pushbutton. The device shall be a Qualitrol, no substitutions.
- D. The transformer shall have a pressure relief device complete with a visible target and shall have two (2) sets of alarm contacts. The device shall be a Qualitrol or Engineer approved equal.
- E. A loss of voltage alarm relay shall be provided to indicate a loss of power conditions at fan motors and DC circuits. The loss of voltage relay shall operate on time delay and include contacts for alarming 4 minimum per relay and transfer to auxiliary power.
- F. Owner will provided 120/240 volt, single phase, 60 Hz power for auxiliary equipment and controls.

3.17 DE-ENERGIZED TAP CHANGER

- A. A full capacity HV Tap Changer for de-energized operation, with lockable operating handle brought out through the side of the tank at a convenient height, is to be supplied.
- B. Tap changer shall be an ABB DTUB
- C. The tap changer is to include 5 steps with nominal set at 3 and is to have a range of 5 percent above and 5 percent below nominal voltage in equal 2.5 percent steps. Tap voltage shall be:

Dial Position	Volts
1	<u>48300 V</u>
2	<u>47100 V</u>
3	<u>46000 V</u>
4	<u>44800 V</u>
5	<u>43700 V</u>

PART 4 - TESTING, FIELD SERVICES AND QUALITY CONTROL

4.1 REQUIRED FACTORY TESTING

- A. All routine tests listed in ANSI C57.12.00 plus additional tests as specified herein are required. The transformer shall be fully assembled, including all permanent radiators and bushings during testing. Seller shall notify Engineer and Buyer 4 weeks prior to factory testing for Engineer and Owner to witness.
- B. The following factory tests shall be performed as a minimum and three copies of the certified test reports shall be submitted to the Engineer
 1. Winding Resistance and Insulation Resistance
 2. Winding Turns Ratio on all taps
 3. Polarity and phase relation
 4. Exciting current at rated voltage
 5. Applied potential
 6. Induced potential at each voltage at the ANSI test levels
 7. Insulation power factor performed on all winding-to-winding and winding-to-ground insulation. Measured values exceeding 0.5% corrected to 20°C will not be accepted.
 8. Quality Control Impulse at each voltage at the ANSI test levels.
 9. Frequency Response Analysis (FRA) from 20 Hz to 2 MHz.
 10. Losses: no-load, load, auxiliary and total
 11. Regulation and Efficiency
 12. Oil dielectric
 13. H.V. and L.V. bushing insulation power factor, C1 and C2 tap tests
 14. Full cycle temperature test ("heat run") if design test results not available.
 15. Zero phase sequence
 16. Temperature at each stage of cooling, including the maximum Kva rating given on the nameplate.
 17. Short Circuit
 18. Power factor to be completed after all other tests with bushings and oil in place.
- C. The factory resistance and losses tests shall include calculation procedures to correct the measurements to standard temperature basis data.
- D. Current Transformers polarity, ratio, and saturation tests shall be performed per ANSI C57.12.13.

4.2 FIELD SERVICES

- A. Provide separate line-item quote for below services.
- B. Seller shall provide a field services engineer to direct the dress out of the transformer after it has been placed on the foundation. The field services engineer shall direct the assembly, filling, and connection of any equipment such as, but not limited to, bushings, radiators, nitrogen systems, drying and vacuum filling with oil which were removed or modified for shipping and are required for transformer operation.
- C. Field Service Engineer shall conduct a complete visual and mechanical inspection field dressing is complete and shall submit a written report containing the following, at a minimum:
 - 1. Compare equipment nameplate data with the drawings and specifications.
 - 2. Inspect physical and mechanical condition including documented readings or observations from manufacturer supplied SFRA and Impact recorders.
 - 3. Inspect anchorage, alignment, and grounding.
 - 4. Verify the presence of PCB content labeling.
 - 5. Verify removal of any shipping bracing after placement.
 - 6. Verify the bushings and transformer is clean.
 - 7. Verify that alarm, control, and trip settings on temperature and level indicators are as specified.
 - 8. Verify that cooling fans and/or pumps operate correctly and that fan and pump motors have correct over-current protection.
 - 9. Verify correct liquid level in tanks and bushings.
 - 10. Verify that positive pressure is maintained on gas-blanket transformers.
 - 11. Perform inspections and mechanical tests as recommended by the manufacturer.
 - 12. Confirm radiator valves are locked in the open position.
 - 13. Take oil sample and have complete oil test report completed.
 - 14. Confirm No Load Tap Changer.
 - 15. Any other inspections normally performed by the Seller

4.3 ACCEPTANCE TESTING AFTER INSTALLATION

- A. Provide separate line item quote for below services. However, Owner may not purchase Acceptance Testing Services from Manufacturer.
- B. The following tests MUST be performed by an independent testing company contracted by the Seller:
 - 1. Winding and core ground resistance
 - 2. Winding Ratio of high and low voltage on all taps
 - 3. FRA Testing

4. Polarity and phase relation of winding
 5. Polarity and ratio tests of Current Transformers
 6. Insulation power factor and excitation current test of all windings
 7. H.V. and L.V. bushing insulation power factor, C1 and C2 tap tests
 8. H.V. and L.V. arresters power factor
 9. Functional testing of all alarms to terminal blocks
- C. The transformer shall be accepted based on the results of the field tests.

PART 5 - PROPOSAL

5.1 GENERAL

A. The Seller shall complete this section in its entirety and submit it with their proposal.

B. "Seller" _____

C. Location of factory _____

5.2 PROPOSAL DATA

A. Base Price-FOB Transformer Foundation
(Including offloading and setting)

\$ _____

B. Shipping Dates
Approval Drawings:

C. Equipment in full: _____

D. Complete Field Service Supervision Including
travel, lodging and expenses (3 days required)
as Described in Section 4.2

\$ _____

E. Complete Field Testing. Including travel,
lodging and expenses (3 days required)
(Sections 4.3)

\$ _____

F. Cost of additional days of Service Engineer

\$/day _____

G. Cost of Spare HV Bushing

\$ _____

H. Cost of Spare LV Bushing

\$ _____

I. Amount and type of oil filling required in field

J. Ship by truck or rail

K. Rail siding name if by rail

5.3 LOSS SUBMITTALS

A. The Seller shall guarantee that their proposed transformer's loss values will not be exceeded. The certified test values will be compared and evaluated with the losses provided in the Seller's proposal. If the loss guarantees are exceeded, the difference between the total bid loss evaluation and the total certified test report loss evaluation will be deducted from the transformers invoice.

B. Losses

- | | | |
|----|---|----------|
| 1. | No-load losses at rated nominal voltage | _____ kW |
| 2. | No-load losses at 110% rated nominal voltage | _____ kW |
| 3. | Full-load losses (65°C ONAN/ONAF rating)
(Corrected to 75°C) | _____ kW |
| 4. | Auxiliary losses (65°C ONAN/ONAF rating)
(Corrected to 75°C) | _____ kW |

5.4 EXPECTED ELECTRICAL DATA

A. Submit data which demonstrates that the transformer meets short-circuit requirements listed in paragraph 7 of IEEE C57.12.00 by one of the following methods:

1. Certified test data showing that transformers with core and coil identical in design and construction and identical or similar with respect to kVA capacity, kV ratings, BIL, impedance, and voltage taps have been tested without failure for short-circuit strength.
2. History of successful experience with transformers of identical or similar ratings, design and construction. List transformers in service with core and coils which are essentially identical in design, construction and manufacture to transformers covered by this Specification and provide information on date of installation, locating and failures if any.

B. Exciting current at 100% rated nominal voltage _____

C. Exciting current at 110% rated nominal voltage _____

D.	Percent positive sequence impedance based on 65°C ONAN rating	
E.	Positive sequence impedance X/R ratio	
F.	Nominal High Voltage Rating	kV
G.	Nominal Low Voltage Rating	kV
H.	Transformer MVA Ratings	/ / MVA ONAN/ONAF
I.	Transformer Tertiary MVA Ratings	/ / MVA ONAN/ONAF
J.	RIV per NEMA TR-1 not to exceed	MV
K.	Audible sound level not to exceed	DbA @ ONAN
		DbA @ ONAN/ONAF
L.	Regulation at ONAN rating (Calculated per ANSI/IEEE C57.12.90)	% @ 1.0 pf
		% @ 0.8 pf

5.5 MECHANICAL DATA

A.	Bushing manufacturer and catalog number:	(HV)
		(LV)
B.	Weights and Volumes:	
	Core and Coils	lb
	Tank & Access	lb
	Oil	lb
	Total	lb
	Shipping Weight	lb

Oil Volume _____ gal

C. Dimensions:

- | | | | |
|----|--|--------|----|
| 1. | Height to top of tank | | in |
| 2. | Height to top of HV bushings | | in |
| 3. | Height to top of LV bushings | | in |
| 4. | Height to top of TV bushings | | in |
| 5. | Base Dimensions: | Width | in |
| | | Length | in |
| 6. | Overall dimensions including radiators: | Width | in |
| | | Length | in |
| 7. | Do dimensions match specified constraints? (Y/N) | | |

5.6 ADDITIONAL INFORMATION

A. Anticipated timeline for delivery of drawings to be approved by the Engineer. Delivery of drawings is the number of weeks after receipt of order.

- | | | |
|----|---|-------------|
| 1. | Outline, general arrangement, assembly, installation, and foundation arrangement drawings. | _____ Weeks |
| 2. | Drawings of transformer nameplate with schematic and phasor diagram, electrical ratings, weights and winding tap data in tabular format per ANSI standards. | _____ Weeks |
| 3. | Schematic and wiring diagrams for tap arrangements of wiring of accessories. | _____ Weeks |

4. Wiring and connection diagrams for all control, current, potential and alarm circuits. _____ Weeks

B. Any exceptions to these specifications shall be clearly stated and attached to the bid data sheets.

C. Attach all bid submittal documentation as required by Submittal Section of this Specification.

5.7 AUTHORIZED SIGNATURE

A. Seller: _____

B. Signature &
Title: _____

C. Address: _____

City: _____ State: _____ Zip: _____

D. Date: _____