Utilities Commission, City of New Smyrna Beach

SPECIFICATIONS FOR

Smyrna Substation Equipment
ITB # 18-18

SECTION 33-73-00
POWER TRANSFORMERS- GENERAL REQUIREMENTS

PART 1- GENERAL

1.01 WORK INCLUDED

A. The work consists of furnishing a Power Transformer as herein specified, delivering transformer to the designated site and installing the transformer on a concrete foundation pad to be furnished by others, and factory and field testing.

B. This section outlines equipment standards, and requirements for the transformer tank, weatherproofing and painting, oil preservation equipment, insulating oil, progress photographs, submittal requirements, and shipping, delivery, installation and field testing.

C. As used herein, "Manufacturer" shall mean the firm with facilities and expertise, regularly engaged in the design, production, assembly and testing of substation class power transformers for electric utilities.

D. As used herein, "Equipment Contractor" shall mean the person, firm, or Corporation whose bid is accepted and to whom the Owner has issued a Purchase Order or Contract to supply one or more items of Equipment. This can be either the transformer Manufacturer or their agent or representative.

1.02 RELATED SECTIONS

Related section is Section 33-73-13, Power Transformers- Class II, Category III.

1.03 REFERENCES

The transformer, accessories and equipment shall be of a design accepted as standard except as otherwise specifically stated herein. The work shall, as a minimum, conform to applicable provisions of the latest edition or revision of the following standards, except as modified herein.

A. Institute of Electrical and Electronics Engineers (IEEE):

C57.12.00	General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
C57.12.10	Requirements for Liquid-Immersed Power Transformers
C57.12.90	Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers
C57.13	Requirements for Instrument Transformers
C57.19.00	General Requirements and Test Procedure for Outdoor Power Apparatus Bushings
C57.19.01	Performance Characteristics and Dimensions for Outdoor Apparatus Bushings

C57.91	Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators
C57.98	Guide for Transformer Impulse Tests
C57.109	Guide for Liquid-Immersed Transformer Through-Fault-Current Duration
C57.113	Recommended Practice for Partial Discharge Measurement in Liquid-Filled-Power Transformers and Shunt Reactors
C57.131	Requirements for Tap Changers

B. American Society for Testing and Materials (ASTM):

A 343	Test Method for Alternating-Current Magnetic Properties of Materials at Power Frequencies Using Wattmeter-Ammeter-Voltmeter Method and 25-cm Epstein Test Frame
A 712	Test Method for Electrical Resistivity of Soft Magnetic Alloys
A 876	Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types
D 88	Test Method for Saybolt Viscosity
D 92	Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D 97	Test Methods for Pour Point of Petroleum Products
D 664	Test Method for Acid Number of Petroleum Products by Potentiometric Titration
D 971	Test Method for Interfacial Tension of Oil Against Water by the Ring Method
D 974	Test Method for Acid and Base Number by Color-Indicator Titration
D 1275	Test Method for Corrosive Sulfur in Electrical Insulating Liquids
D 1533	Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration
D 1816	Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes
D 1933	Nitrogen Gas as an Electrical Insulating Material
D 2029	Test Methods for Water Vapor Content of Electrical Insulating Gases by Measurement of Dew Point
D 3487	Mineral Insulating Oil Used in Electrical Apparatus
D 4059	Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

C. National Electrical Manufacturers Association (NEMA)

TR1 Transformers, Step Voltage Regulators and Reactors

D. The Society for Protective Coatings (SSPC)

SP 1 Solvent Cleaning

SP 6 Commercial Blast Cleaning

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. The workmanship, design and materials shall be of the highest quality and be the most suitable for the application. The material shall be new, of proven manufacture, and free of defects. The design shall provide maximum mechanical and dielectric strength of the insulation, uniform flux density on distribution, minimum dielectric losses, minimum interference with oil circulation, and the elimination of potential discharge (corona) at test and operating voltages.

B. All standard fittings and accessories shall be included and located in accordance with latest ANSI Standards.

C. The transformer shall be constructed in accordance with IEEE C57.12.10 and shall include all items necessary for complete assembly. The material and workmanship shall be of high quality and the unit shall be modern in appearance and design.

D. The transformer shall be designed and constructed to be completely self-protected by its ability to withstand, without mechanical damage, the effects of external short circuits, as specified in IEEE C57.12.00, Section 7, IEEE C57.12.90, Section 12 and IEEE C57.109.

1.05 SUBMITTALS

The Equipment Contractor shall provide a complete schedule of data submittals within ten days of the receipt of Purchase Order.

The Equipment Contractor shall submit Adobe PDF copy of the required Submittals by e-mail for review and approval by the Owner. Review by the Owner or their representative is for determining conformance with this Section and related documents. It does not relieve the Manufacturer of responsibility for quantities and compatibility of components.

Submittals will be marked with any comments and returned to the Equipment Contractor by e-mail within ten business days after receipt, if possible. Manufacturing shall not begin until the required Design Calculations and Shop Drawings are reviewed and approved with “No exceptions noted” or “Approved as noted”.

A. Submit Transformer Outline Drawing (including bushing, stud size and details of terminals), Transformer Base Details, Nameplate Drawings, and Auxiliary Schematic Diagrams, Physical Drawings for remote mounted equipment and performance data for review within 60 days of the receipt of Purchase Order. Submittal shall include the following data:

1. Weight of core and coils
2. Weight of tank and fittings

3. Weight and quantity of oil
4. Total weight
5. Shipping weight
6. Height overall
7. Height over tank
8. Floor space (footprint)
9. Center of gravity
10. Details of bushings terminals
11. Location and detailed list of all accessories
12. Number, size and type of fan and/or pump motors

B. Bushing Drawings, Lightning Arrester Drawings, Radiator Details, Wiring Diagrams, and Current Transformer Curves shall be submitted for review within one-half (50%) of the quoted delivery time.

C. Submit description of the Manufacturer's process for painting and protective finishes.

D. Submit proof of short circuit design considerations by short circuit calculations. The calculations shall include electrical and mechanical forces.

1. Short circuit force values shall include, but not be limited to, short circuit amperes, repulsion force in pounds and vertical force in pounds.

2. Indicate mechanical safety factors used in design of: hoop strength of the outer winding, buckling strength of the inner winding, core clamp strength, vertical bar strength, clamping ring strength and jackscrew strength.

E. Factory Tests: Certified test reports for tests performed by the Manufacturer shall be submitted for review prior to shipment.

F. A draft of the Instruction Manual shall be submitted for review not less than four weeks before shipment. After approval, furnish one bound paper copy with each transformer unit, plus three additional copies, including legible copies of final approved as built drawings. If possible, also provide the Instruction Manual as a searchable PDF file on a USB drive.

Instruction Manuals shall contain information on receiving, storing and assembly of the transformer; they shall provide complete description, including manufacturer's catalog or part numbers for all components, including, without limitation, relays, switches, bushings, arresters, gauges, LTC, radiators, valves and all other parts which might require maintenance or replacement in the course of normal operation.

G. Submit the Manufacturer's written oil treatment and oil filling requirements and procedures, prior to shipment. Requirements and procedures should be in accordance with industry standard practices. The document should address how the oil is to be received, treated, and placed in the equipment. The document should identify the following:

1. The receiving inspections and tests necessary to demonstrate that the oil delivered meets the requirements, including dew point tests (ASTM D 2029).

2. The characteristics of the required oil processing equipment.

3. Safety operations and precautions to be followed.

4. Requirements for vacuum levels, moisture content, and gas content during the treating and filling process.

5. Any time requirements for steps in the process.

6. Documentation requirements for the treating and filling process.

H. Submit proposed method of delivery for the power transformer. Submit impact recorder information with the shipping instructions, including brand, type, quantity and model number of the impact recorders to be used. The Equipment Contractor shall also state the maximum force limits the recorders can register for vertical, longitudinal and horizontal axes before the Manufacturer considers the transformers may have been damaged during shipment. The Equipment Contractor's site representative shall arrange for returning the impact recorders. The Equipment Contractor shall provide access to the impact recorder data logs to the Owner for record purposes.

I. Installation Tests

1. A complete outline of the transformer installation testing procedures to be conducted by the Equipment Contractor or their Subcontractor shall be submitted to the Owner for review, and comments shall be incorporated before installation testing commences at the site.

2. Submit final field test results, including the service engineer's field copied test sheets, before the equipment is accepted as ready to be put into service.

J. Final record drawings shall be furnished on a USB drive in a format compatible with AutoCAD Release 2017 (two copies).

1.06 PHOTOGRAPHS

A. The Equipment Contractor shall furnish three complete sets of photographs of the core and coil assembly of the transformer. The photographs shall be 8-1/2" x 11" glossy color prints, plus high-resolution digital photo files furnished on a USB drive.

B. The photographs shall be taken just prior to placing the completed core and coil assembly into the tank. Photographs shall be properly labeled as to the views taken. A total of five different views are required as follows (Segments as defined in IEEE C57.12.10):

1. Top view
2. Front view
3. Left side view, Segment 2
4. Rear view, Segment 3
5. Right side view, Segment 4.

1.07 DELIVERY, STORAGE AND HANDLING

Deliver the transformer with all manufacturers' tags and labels intact. Deliver packaged material and equipment in manufacturer's original unopened containers bearing manufacturer's name. Handle and store the transformer and packaged materials in such a manner so as to avoid damage to the units.

1.08 WARRANTY

A. The transformer Manufacturer's warranty period shall extend five (5) years from date of on-site acceptance tests and incorporation of any comments made during the review of the test and include coverage of the transportation in and out charges for the duration of the warranty.

B. The transformer Manufacturer's extended warranty shall include all parts of the transformer regardless of original manufacturer.

PART 2-PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All material and equipment shall be new, approved and labeled, where required, by UL. Only products by manufacturers regularly engaged in production of specified units will be acceptable

B. Where two or more units of the same class of equipment or materials are required, provide all units from a single manufacturer.

C. Provide materials and equipment of suitable material to perform satisfactorily when exposed to conditions of project site.

1. Provide breather and drain fittings in all raceways and enclosures where necessary to prevent condensation or trapping of moisture.

2. Provide humidistat-controlled heaters in all control panels to prevent condensation.

2.02 TANK AND BASE

A. The transformer tank shall be rectangular or equivalent oval and shall be of welded steel plate construction. Welding shall comply with applicable requirements of the latest codes of the American Welding Society. All tanks shall be suitable for vacuum filling in the field. Tanks, covers and appurtenances (i.e., valves, etc.) shall be designed to withstand full vacuum with 800 pounds on the cover, and shall include the required number of manholes in the cover necessary for inspection and installation (two minimum) with handholes as necessary. Minimum inside diameter of manholes shall be 20 inches.

B. The tank cover shall be provided with lifting eyes for lifting cover or hood assembly only. The main tank shall be provided with lugs for jacking the entire unit with oil. A stainless steel bar of sufficient strength shall be secured laterally along the center line of the tank cover, for attachment of fall protection devices. Two copper-faced ground pads shall be welded at diagonal corners of the bottom of the main tank for grounding purposes. Ground pads shall be drilled and tapped on 1.75 inch centers for 0.5-13 bolts. A stainless steel name and diagram plate describing the unit, its taps and ratings, with schematic diagrams, shall be furnished and attached to the tank at not more

than five feet above top of concrete pad. Screws, if used to attach name and diagram plate, shall be stainless steel.

C. The base shall be furnished with pulling eyes and skid noses suitable for skidding on rails on rollers in directions parallel and perpendicular to a line through the high voltage bushings. Provision for jacking shall be furnished per ANSI Standards. The transformer shall be provided with channel base rather than flat base, (the channel base shall not have a continuous plate on the bottom side) and shall allow free circulation of air to bottom of tank. The base shall be designed for direct placement on the Owners foundation without the use of additional rails or supports.

D. The tank shall be furnished with a combination oil drain, sampling, and lower filter press valve and upper filter press valve. A vacuum filling connection shall be furnished on the cover. Gas purging connections shall be furnished on the side wall to allow purging from ground level.

E. The transformer shall be furnished with two 1-inch valves located approximately 6 inches down from the cover. One valve is to be located at the end away from the vacuum connection on the low voltage side and one valve is to be located above the main drain valve. Three horizontal +++ marks shall be stamped on the tank directly above the main drain valve at the oil level required to cover the core, coils and all critical high voltage insulation.

F. The transformer shall be furnished with detachable radiators with provisions to drain each individual radiator unit and with shut-off valves located between each radiator and main tank or header at both top and bottom connections. Valves shall be repairable without requiring a person to enter the transformer tank. Radiator flanges shall be supplied and arranged such that radiators may be mounted or removed for repair with 3500-pound handling facilities.

G. All valves shall be designed and manufactured to operate at full vacuum.

H. Hinged doors shall be provided in all outer tank walls for easy access to, and exposing, complete load tap changer compartment, inspection doors, drain and shut off valves, filling and vacuum plugs, vent and exhaust devices. Any hinged door exceeding 5 feet in height shall be split into two doors of equal vertical height.

I. The transformer shall be equipped with one automatic reset pressure relief device per each 10,000 gallons of oil or fraction thereof in the main transformer tank. The device(s) shall be located on the tank cover, complete with visual indicator and alarm contacts, shall be of self-resealing type and shall minimize discharge of oil and exclude the weather after operation. The device shall be located as close to the HV and LV bushings as practical for maximum protection of tank in the event of bushing failure.

2.03 PAINT AND WEATHERPROOFING

A. Exterior of transformer tank and base (and the outside shell of a double wall where required to maintain low noise level) shall be given two primer coats of one mil each and three finish coats of one mil each to a minimum thickness of 3 mils.

B. The interior surfaces of the transformer tank, control compartment and tap changer compartment shall be primed and painted.

C. Paint shall be the Manufacturer's best quality specifically selected for the application and shall not be affected by insulating oil. Exterior finish shall be ANSI 70 Gray. Interior finish shall be white.

D. Prior to painting, all surfaces shall be properly cleaned by sand blasting or shot blasting per SSPC SP6 or be solvent-, steam-, or pressure-washed per SSPC SP1 to remove all dirt, grease, rust or mill scale. After cleaning, all surfaces shall be degreased using an appropriate commercially available degreasing solution and rinsed with clean water, dried, primed and painted as outlined above. All galvanized surfaces shall be properly primed before painting.

E. The transformer will be installed outdoors in a locality subject to high ambient temperatures and humidity, tropical hurricane winds and torrential rains. The Manufacturer shall be responsible for adequate weatherproof design to protect against these conditions.

F. External Fasteners (bolts, nuts, washers, lock washers, machine screws) shall be stainless steel or bronze. Hot dipped galvanized external fasteners are not acceptable.

G. The transformer tank base and internal surfaces "boxed-in" by the support channels shall be undercoated with bitumastic at the factory.

2.04 OIL PRESERVATION EQUIPMENT

The transformer shall be provided with an approved type of automatic, positive pressure, gas seal system to protect the insulating oil against oxidation. The equipment provided shall be a complete unit with compressed gas cylinder, pressure regulator, necessary gauges, alarm contacts, valves and piping, all contained in a weatherproof cabinet on the side of the transformer tank. All gasket joints shall be located below the minimum oil level so transformer leaks will be detected.

2.05 INSULATING OIL

A. Insulating oil shall be new fractionally distilled pure oxidation-inhibited mineral oil especially refined for transformers per ASTM D3487, free from moisture, acid, alkali and injurious sulphur compounds and shall not form a deposit under maximum anticipated operating temperatures.

B. The delivered transformer oil and oil used at the factory shall be non-PCB oil. The Manufacturer shall certify, by statement on the transformer test report, that all oil used in processing and testing the transformer contained less than 1 PPM polychlorinated biphenyls as determined by test method ASTM D4059 or equivalent.

C. Physical properties of insulating oil shall be as follows:

1. Dielectric Breakdown Voltage- 35,000 volts min. (curved electrodes), ASTM D1816.

2. Viscosity- Not over 62 Saybolt at 37.8 °C, ASTM D88.

3. Pour Point- Not higher than minimum -40 °C, ASTM D97.

4. Flash Point- Not under 146 °C, ASTM D92.

5. Fire Point- Not Under 160 °C, ASTM D92.

6. Neutralization Number- 0.03 maximum, ASTM D664 and D974.

7. Interfacial Tension- 40 dynes per square centimeter minimum, ASTM D971.

8. Water Content at 25 °C- 25 ppm maximum, ASTM D1533 (Karl Fisher Method).

9. Corrosive Sulphur- None, ASTM D1275.

10. Inorganic Chlorides and Sulphates- None.

PART 3-EXECUTION

3.01 SHIPMENT

A. Assembly: The transformer core and coil shall be shipped completely assembled in the tank, in oil, or in a dry inert gas atmosphere having a maximum dew point of -50 °F. The dew point of the gas in the tank shall be determined just prior to shipment. If shipped in dry inert gas atmosphere, the assembly shall be pressurized to 5 psig sufficiently in advance of shipment to permit verification that a seal is obtained. The transformer shall be shipped upright and as complete as possible consistent with shipment limitations and protection of the equipment. At the option of the Equipment Contractor, the oil, bushings, frames, minor accessories and radiators may be shipped separately.

B. Packing: Packages of any supplemental parts or materials shall be shipped either on pallets or bundled in an acceptable manner for off-loading. The method of packing shall be such as to adequately protect the case, radiators, core and coils, bushings and all other auxiliary devices or accessories against corrosion, dampness, breakage or vibration injury that might reasonably be encountered in transportation and handling. Packing crate shall be such that prolonged outdoor storage will not result in deterioration of crates or damage to contents. Any packages that require indoor storage shall be clearly marked to that effect.

1. All spare parts and any special tools required for equipment assembly and installation shall be furnished with first shipment. Spare parts which are sensitive to humidity shall be sealed in appropriate airtight containers complete with desiccant.

2. All materials furnished which require packaging shall be labeled with the following information:

UCNSB P.O. Number
Substation Name
Item Number per Manufacturer's Bill of Material
Content Description

C. Weatherproof: All auxiliary equipment shall be shipped in weatherproof packages. Packing material shall be such that it will provide weatherproof protection for a period of one year in outdoor storage areas. Accessories shall not be shipped separately without the prior knowledge and consent of the Owner.

D. Moisture Control: All conduits and auxiliary equipment mounting positions shall be sealed and/or covered to prevent water damage during storage.

E. Positive Pressure: All valves, shipping covers, etc. shall be sealed and effectively crated to prevent tampering or removal while in transit, and a means shall be provided for allowing gas pressure to be measured without requiring release of the gas.

F. Recorder Installation: The Equipment Contractor shall furnish a minimum of two, three-way (horizontal, longitudinal and vertical) measurement impact recorders for the transformer shipped. Recorders shall be attached to the transformer and to the carrier on which the transformer is shipped. At least one recorder must operate satisfactorily throughout the time the transformer is in transit.

G. Complete Shipment: Shipment of the transformer shall be made so that the transformer, complete with all accessories, can be made to an individual destination simultaneously. Fans shall be packed so they can be removed readily from the transporting unit for storage.

H. FOB Site: Shipment shall be made FOB Foundation Pad at site. Freight and handling shall be prepaid for delivery to designated site.

3.02 PREPARATION

A. The Equipment Contractor shall advise the Owner not less than twenty days in advance of the date of arrival of the transformer. Delivery shall be scheduled on normal business days during normal business hours. The Equipment Contractor shall coordinate with the Owner for site access and for receipt and offloading of supplemental packages. Final notice of at least 48 hours (not counting weekends and holidays) must be given prior to delivery to enable the Owner to make necessary arrangements.

1. Notice shall be given to:
   Louis Benishek
   Electric Substation Supervisor
   Utilities Commission, City of New Smyrna Beach
   200 Canal Street
   New Smyrna Beach, FL 32168
   (386) 424-3167

B. Prior to shipment, the Equipment Contractor shall provide the Owner with all applicable Submittals as described in Article 1.05 herein.

C. Prior to shipment, the Equipment Contractor shall provide the Owner with a complete packing list of all the items to be shipped in order for the Owner to verify complete shipment upon arrival.

3.03 INSPECTION

A. The transformer shall be inspected upon receipt. In the event residual pressure (allowing for differences in temperature) is not sufficient to ensure that positive pressure was maintained throughout the temperatures encountered during shipment, the transformer shall be considered as possibly contaminated by moisture, and special precautions acceptable to the Owner shall be taken by the Equipment Contractor prior to placing the transformer in service.

B. Upon arrival and before unloading the transformer, the impact recorder data log will be downloaded and inspected by the Owner, the Equipment Contractor and the Carrier's Agent. It shall be the Equipment Contractor's responsibility to see that the transformer is supplied with a recorder that is still operating when the transformer is received. If in the opinion of the Owner, the Equipment Contractor or the Carrier's Agent the impact recorder data log or other considerations indicates rough handling during shipment, the Equipment Contractor shall take immediate action to

determine if any damage has occurred and shall report in writing to the Owner defining the conditions that exist and recommending corrective action. The recorder data log will be retained by the Owner as record information.

C. The Equipment Contractor shall assume responsibility and handle all claims if there is damage in transit.

3.04 DELIVERY AND INSTALLATION

The transformer furnished hereunder shall be delivered to the Owner complete and ready to be placed in service, including satisfactorily completing all required field acceptance tests.

A. The Equipment Contractor shall make all necessary provisions required for the transportation, receipt, handling and unloading of the transformer and provide delivery and placement as described herein. This shall include but not be limited to: loading and unloading, rigging, transporting, handling, placing, assembling, and filling with insulating oil, as work of this Contract.

B. All work involved in assembling and testing the transformer shall be performed under the supervision of a fully qualified factory-trained service engineer thoroughly knowledgeable and experienced in the installation, operation and maintenance of the Equipment. The Equipment Contractor shall provide all necessary supervision, labor, equipment, materials, tools and devices necessary for complete and satisfactory assembly and testing.

1. The foundation will be provided by others. Connections to the high voltage, low voltage, neutral, and ground terminals, and connections of low voltage power, CT, and control circuits to incoming terminals will also be provided by others.

2. Owner will notify the Equipment Contractor when sufficient connections have been made to allow the field testing portion to begin.

3.05 OIL INSTALLATION

A. An oil analysis shall be performed, and shall mean, as a minimum, the following tests: Dielectric test, acidity test, color test, power factor test and interfacial tension test. Where acidity, interfacial tension or other tests indicate the presence of acidic, colloidal or other contaminants, a re-refining process, the Fuller's Earth pressure percolation method, shall be used to remove these contaminants.

1. Failure of any of the above tests shall be grounds for refusal of the oil shipment, and a new shipment required immediately.

B. Insulating oil for the transformer shall be treated, heated, filtered and processed, with a vacuum in the tank, in strict accordance with the published requirements and procedures of the equipment Manufacturer.

1. Necessary arrangements shall be made for the delivery, placement and setup of oil processing equipment. Necessary safety precautions shall be taken, and provisions for required oil testing shall be satisfactorily completed.

2. Oil testing, treatment and vacuum filling operations must be under the observation and control of the factory service engineer.

3.06 FIELD INSTALLATION TESTS

All tests recommended, or required by the transformer Manufacturer, shall be conducted; and, in addition thereto, a nitrogen dew point test, an oil analysis, Power Factor Tests, TTR tests, Insulation Resistance tests, current transformer tests, and an operational test of the sudden pressure relay. The hot oil and hot spot dial indicators shall be calibrated with the thermocouple in hot oil and a current input, where applicable.

A. A Sweep Frequency Response Analysis (SFRA) test shall be performed on the transformer at the site, after it has been installed on the foundation and assembled to the same degree as tested at the factory. The SFRA test equipment used, and test procedures used for the field tests, shall be those recommended by Doble Engineering. Results of the SFRA field tests shall be compared with the Certified Factory tests made prior to shipping, to determine that no shipping damage was sustained and that the unit is ready for service. A composite test report, approved by the Manufacturer and reviewed by the Owner, shall be provided to the Owner for future reference.

B. All current transformers shall be checked for ratio, saturation excitation, and polarization. The correct location and polarity as per identification marking shall be verified.

C. A complete Doble or Biddle power factor test shall be performed on the transformer. Power factor tests shall be performed in accordance with the standards and procedures established by the test equipment manufacturer for the type of equipment and voltage class applicable and shall include windings, bushing hot collar tests and surge arresters.

D. Ratio Tests shall be made (1) at all tap positions of the manual tap changer for de-energized operation with the automatic load-tap-changer on the rated voltage (Neutral Tap) position, and (2) at all automatic load-tap-changer positions with the manual tap changer for de-energized operation on the rated voltage (Neutral Tap) position.

E. The insulation resistance test, by resistance bridge or an approved electronic voltmeter, shall be performed so as to produce results that can be directly compared to the factory test techniques used and results obtained for establishing the base resistance values. Resistance readings shall be recorded for all windings on the full winding tap position.

Three copies of a complete written report shall be submitted to the Owner for the oil and for each power transformer unit, identifying test equipment, the test procedures followed, and the "as-found" and "as left" condition of the components tested.

3.07 FACTORY SERVICE ENGINEER

The services of a fully qualified factory-trained service engineer shall be made available during assembly, filling with oil, and testing after assembly. Proper operation of other accessories and/or auxiliaries shall also be confirmed prior to placing the transformer in service. The responsibility for the equipment to be installed shall remain with the Equipment Contractor until the service engineer certifies the equipment as ready to be energized, and the equipment is accepted as being in that condition by the Owner's representative.

A. The work of the service engineer to be performed under the scope of this contract shall be coordinated with the work to be performed by the Owner.

B. Upon separate authorization and request, the service engineer shall be made available for one eight-hour day to instruct Owner's personnel in the proper operation, adjustment, test, and maintenance of the transformer.

C. Upon separate authorization and request, the service engineer shall perform all operations required to establish that the unit has been installed properly and is ready to be placed in service, to advise the Owner when the unit is ready to be energized, and upon approval by the Owner, to assist in placing the unit in service. As part of this operation, the service engineer shall afford opportunity to Owner's personnel to observe and learn the correct practices to be followed prior to energizing equipment.

D. A fully qualified service engineer must be available upon 24 hour notice, and shop facilities qualified with the equipment Manufacturer must be available within a radius of 400 miles of the Owner.

END OF SECTION

SECTION 33-73-13
POWER TRANSFORMERS- CLASS II, CATEGORY III

PART 1 – GENERAL

1.01 WORK INCLUDED

This section supplements Section 33-73-00 and provides technical design information for the manufacture, assembly, accessories, factory test requirements and operating requirements for high-voltage type outdoor oil-immersed power transformers.

1.02 RELATED SECTIONS

Related section is Section 33-37-00, Power Transformers- General Requirements.

1.03 TRANSFORMER CAPABILITY

The transformer unit shall be capable of transforming its self-cooled rating continuously, oil to air, at rated voltage and frequency without exceeding an average winding temperature rise by resistance of 55 ºC. The transformer shall be equipped with two stages of automatic, forced air auxiliary cooling equipment which shall increase its self-cooled rating to the levels stated with the auxiliary cooling equipment in service and without exceeding a temperature rise of 55 ºC. The transformer shall be insulated to permit safe operation at temperature rise of 65 ºC with increased thermal operating capacity of not less than 12%.

1.04 TRANSFORMER RATING

A.	Number of Phases	Three
B.	Coolant	Insulating Oil
C.	Type	ONAN/ONAF/ONAF
D.	Frequency	60 Hz
E.	Winding Impedances	8.4% @ 18.0 MVA 55 °C Rating
F.	Capacity	18/24/30//33.6 MVA
G.	High Voltage Winding Rated Voltage	115 kV Delta
H.	Low Voltage Winding Rated Voltage	22.86/13.2 kV Grd. Wye
I.	Full Rated Taps	As specified hereafter above and below rated voltage; manual for de-energized operation; and automatic for load tap change operation.
J.	Basic Insulation Level (BIL)	High Voltage – 550 kV Low Voltage – 150 kV HOXO Neutral Voltage – 110 kV

K.	Avg. Winding Temperature Rise	55 °C, with additional 12% capacity at 65 °C
	1. Hot Spot	55 °C Rating – 65 °C
	2. Hottest Spot Temperature	65 °C Rating – 80 °C
L.	Duty	Continuous
M.	Phase Displacement	IEEE Standard C57.12.00 (Typical) Low voltage winding line-to-neutral voltage shall lag by 30 degrees the high voltage winding line-to-neutral voltage
N.	Sound Level	Shall not exceed NEMA TR1: 72 db @ 18.0 MVA 75 db @ 30.0 MVA 76 db @ 33.6 MVA

As a preference, Owner prefers ONAN/ONAF/ONAF. It is recommended that the base bid incorporate a transformer of this type. However, if the bidder believes a different design would be to the mutual interest of the Bidder and the Owner, an alternate may be submitted, incorporating the preferred alternate method of cooling.

1.05 TYPE AND SERVICE

A. The power transformer will be used as a connection point between a 115 kV looped transmission system and a supply bus for distribution service at 22.9Y/13.2 kV. The neutral of the transformer secondary will be solidly grounded.

B. The power transformer will be located outdoors, in an environment subject to high humidity, salt spray, and hurricane force winds (NESC 125 mph wind zone) and rain.

C. Available power is single phase, 120/240 VAC, for motors and accessories and 125 VDC for control power.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall comply with the requirements of Section 33-73-00.

2.02 TANK

The transformer tank and base are specified in Section 33-73-00.

Provide nameplate per IEEE C57.12.00. The Owner's purchase order number shall be included as information on the nameplate. A duplicate nameplate shall be mounted inside the control cabinet. Screws, if used to attach nameplates, shall be stainless steel. Nameplates shall be shown on the outline drawing.

2.03 CORES

A. Cores shall be assembled and tested to conform to the requirements of ASTM A712 and A876, with core losses limited per ASTM A343.

B. The transformer shall be free from unusual or harmful vibration. Lifting eyes or lugs shall be provided for handling the core assemblies when un-tanked.

C. The core laminations shall be free of burrs and shall be stacked using modern joint design to provide uniform flux density and magnetic reluctance over the joint region. The lamination insulation coating shall be impervious to hot insulating transformer oil.

D. The core shall be rigidly clamped with the electrical centers of all coils in line to prevent deteriorating vibrations, interference with oil circulation, objectionable noise conditions, and short circuit and shipment distortions. The core shall be securely grounded externally on the tank. The core ground lead shall be brought out through the tank cover, or through the side of the tank close to the cover, with a 5 kV insulated bushing.

2.04 WINDINGS

A. The transformer windings insulation level shall conform to the latest requirements of IEEE C57.12.00 Table 5, as follows:

1. *High Voltage Requirement*

a.	Voltage Class	115 kV
b.	BIL	550 kV
c.	Applied Voltage Test	207 kV
d.	Induced Voltage Test 7200 cy.	145 kV
e.	Chopped Wave Impulse Test	605 kV

2. *Low Voltage Requirement*

a.	Voltage Class	25 kV
b.	BIL	150 kV
c.	Applied Voltage Test	26 kV
d.	Induced Voltage Test 7200 cy.	29 kV
e.	Chopped Wave Impulse Test	165 kV

B. The transformer windings shall be designed and tested to withstand impulse test voltages in accordance with IEEE Standard C57.12.00. The windings shall be made of copper and assembled in a manner as best suited for the particular application. Proper consideration shall be given to all factors of service such as high dielectric and mechanical strength of insulation, coil characteristics, and minimum restrictions to free circulation of oil. Coils shall be made up, shaped, and braced to provide for expansion and contraction due to temperature changes in order to avoid abrasion of insulation and to resist movement and distortion caused by abnormal operating conditions. Adequate insulation to withstand proper dielectric strength per IEEE shall be provided between windings and core, and between high-voltage and low-voltage windings. End turns or section of coils shall have additional insulation protection against abnormal line disturbances. The entire design, construction, and treatment of the windings and their assembly on the core shall embody the latest improvements in the art and conform to best modern practice.

C. The components of the transformer shall take into account the increased capacity allowed by the 65 °C insulating system and the ability of the transformer to operate at the higher temperature shall not be limited by any ampacity or other limitations.

2.05 INSULATING OIL

Insulating oil and oil preservation equipment are specified in Section 33-73-00.

2.06 TAP CHANGER REQUIREMENTS

A. Manual Tap Changer:

1. A manual tap changer shall be provide for full capacity range of plus 5% and minus 5% in two steps of 2-½% above and below the middle tap position for the particular voltage rating at taps of 120,750; 117,875; 115,000; 112,125 and 109,250 volts. This tap changer shall be referred to on the transformer nameplate and at the tap changer handle as "DEENERGIZED TAP CHANGER".

2. The handle for manual operation of the tap changer for De-energized operation shall be brought out through the tank wall and must provide adequate clearance from any energized part. Preferably the handle shall be located at not more than 5 feet above top of concrete pad, but may be located at greater height above top of concrete pad if in accordance with Manufacturer's standard design. Provisions shall be made for padlocking the handle in the chosen position and for positive visual tap position indication without unlocking. A stainless steel plate, which states **"WARNING - Do Not Operate This Tap Changer When Transformer is Energized**", shall be permanently attached to the tank located next to the operating handle. Screws, if used to attach plate, shall be stainless steel. This plate shall be shown on the outline drawing.

B. Automatic Load Tap Changer (LTC) and Controls:

1. LTC shall be reactance vacuum type as manufactured by Reinhausen (type RMV-II) or ABB (type VRLTC); NO SUBSTITUTION.

2. Automatic LTC equipment shall be provided for automatic operation of the low voltage taps and shall provide approximately 10 percent plus and 10 percent minus adjustment of the voltage rating of the low voltage windings. The voltage change shall be in approximately 5/8 percent steps with 16 steps above and 16 steps below rated low voltage.

3. The LTC equipment shall be designed to provide regulation of the low voltage winding, maintaining full capacity KVA at all tap positions above rated voltage and not less than rated current at all tap positions below rated voltage.

4. LTC Windings

a. The regulating winding shall be electrically independent or placed on a separate winding tube from the high and low voltage windings and shall be fully distributed.

b. Preventive auto and series transformers, if required, shall be constructed to Class II power transformer standards including circular winding construction, using all copper conductors.

5. The LTC equipment shall consist of a tap selector with vacuum interrupting switch, a motor-driven mechanism, and automatic and manual control devices. The LTC equipment shall be capable of a minimum of 500,000 operations before contact replacement is required.

    a. The LTC mechanism drive motor shall be located at operator height, if possible, for ease of maintenance and replacement. Draining of the LTC compartment shall not be required for access to the drive motor.

6. A dead-front operating panel shall be provided whereby the gears and mechanism are covered. The LTC shall be controlled by a Beckwith #M2001D solid state control, or approved equal. If fuses are used in the control circuits, two sets of spare fuses for each transformer shall be provided by the Manufacturer and one set shall be stored in a suitable clip next to the control panel.

7. Local position indicator shall be calibrated L (lower) - N - R (Raise) from the left end to the right end of the scale. Position indicator shall be located so that it will be visible to an operator at the control switch for the drive motor. Indicator shall be mechanically driven directly from the drive mechanism without auxiliary devices. Drag hand reset shall be accessible by operator standing at ground level.

    a. A stainless steel nameplate shall be permanently mounted on the outside of the control cabinet housing the manual raise and lower controls so an operator can identify the LTC control housing. A duplicate nameplate shall be mounted inside the cabinet next to the raise and lower controls. The nameplates shall state: "LOAD TAP CHANGER – for Operation with Transformer Energized and Carrying Load". Screws, if used to attach nameplates, shall be stainless steel. The nameplate shall be shown on the outline drawing. The nameplates shall include the following information:

        1) Manufacturer of the mechanism
        2) Model number of the mechanism
        3) Year of manufacture
        4) Maximum rated through current of the mechanism
        5) Type of transition impedance
        6) Method of arc interruption (type of mechanism)
        7) Type of drive mechanism, direct or energy spring
        8) Amount of oil in the mechanism compartment

8. The automatic LTC equipment shall include:

    a. Voltage regulating relay and line drop compensator.

    b. The load tap changer shall be provided with a 17-position switch with 16-80 ohm resistors or with a 33-position switch with 32-40 ohm resistors for tele-metering of tap position. The switch shall be mechanically connected to the tap changing mechanism and is to switch the taps of the resistor and the moving contacts of the switch are to be wired to terminal blocks for the Owner’s remote connections. The circuit is to be insulated for 125 VDC operation. Limit switch and stops to prevent travel beyond extreme tap positions shall be provided.

c. Auxiliary control.

d. Current transformer for the line-drop compensator with a 0.2 ampere or other suitably rated secondary.

e. Reversing switch for reactance portion of the line-drop compensator.

f. Provisions for Owner's wiring for supervisory control of the LTC equipment.

g. All other features standard on manufacturer's LTC equipment.

h. Note: It shall be possible for others to install complete supervisory control and indication. All necessary terminals, etc., shall be provided at this time. Drawings indicating modifications required and facilities provided as part of original manufacture shall be provided.

9. Control equipment shall be mounted in a suitable outdoor weatherproof compartment on the transformer, designed to provide protection against windblown dust and rain. The control equipment shall be accessible by an operator at ground level and shall be maximum of 5 feet above top of concrete pad. The control equipment shall include the following:

a. Local-Remote-Auto switching for automatic control or local control of the LTC, and for remote LTC raise-and-lower operations from control building panel.

b. Position indicator with drag hands to indicate maximum tap position travel, with manual reset in control cabinet.

c. On-position indicator.

d. Electrically actuated operation counter in cabinet.

e. Power supply switch.

f. Resistors mounted and wired to terminal blocks for telemetering position indication. (See Paragraph 2.06.B.9.b)

g. Hand-wheel for use during maintenance, interlocked with motor control.

h. Light and G.F.C.I. convenience outlet.

i. 120 or 240 VAC space heaters and fused switch with personnel barrier.

j. Local voltmeter test connection.

10. The tap selector switch and contactor mechanisms shall be located in a compartment mounted on the transformer and filled with oil separate from the oil in the main transformer tank. This tap changer compartment shall be sealed from the main transformer tank so there can be no transfer of oil between the two and shall have the capability of being completely drained or filled, under vacuum, without dropping the oil level in the main transformer tank. The LTC compartment shall be capable of withstanding full vacuum in

the main tank without damage to the LTC compartment or components. This compartment shall be provided with the following accessories:

a. Non-corrosive hinged doors with oil-resistant gaskets and stainless steel hinges and hardware.

b. A combination oil drain, sampling and lower filter press valve, and an upper filter press valve.

c. An automatic reset pressure relief device shall be furnished for relief of excessive internal pressure. The design of this device shall minimize discharge of oil and exclude the weather after operation, and shall be equipped with alarm contacts.

d. Weatherproof cabinet breather.

e. Magnetic liquid level oil gauge with low level alarm contacts. Qualitrol only.

11. The 120 VAC reference voltage for the regulating relay will be obtained from an Owner-supplied voltage transformer in the substation, and the power required to drive the LTC mechanism will be obtained via an AC panelboard from an Owner-supplied substation control power transformer. All internal wiring required to interface with external wiring shall be terminated on terminal blocks. Each individual function shall be supplied by a separate circuit which shall be individually protected by an approved circuit breaker device. Outline drawings shall completely indicate internal and external wiring.

2.07 THERMAL PROTECTION

A. Cooling equipment shall be provided for the transformer and shall be fully automatic, operating in response to winding or top level oil temperature, the means being optional with the Manufacturer. Manually operable switches connected in parallel with the automatic control contacts shall be included, and may be in the control compartment. Auxiliary cooling equipment shall be complete up to incoming supply terminal box. All equipment shall be coordinated for operation at single phase, 120 or 240 VAC.

B. The cooling equipment shall be fabricated so that water cannot collect on the outside, oil flow will not be impeded inside, and maintenance painting will be facilitated.

C. The transformer shall be provided with a sufficient number of radiators to provide adequate cooling with maximum ambient air temperature of 40 °C, and average ambient air temperature of 30 °C over a 24-hour period.

1. The radiators shall be attached to flanges welded into the case wall and the joints shall be made tight by means of suitable gaskets.

2. Radiator metal wall thickness shall not be less than 18 gauge.

3. Radiators or groups of radiators shall be attached to the flanges welded to the tank wall by means of approved valves, (pressure seal type butterfly or flapper valve type) which may be used to isolate or remove sections of radiators without decreasing the capacity of the transformer by more than one-sixth (1/6) at any stage of cooling.

4. Radiators shall be provided with drain plugs.

5. Radiators shall be hot-dip galvanized after fabrication.

D. The cooling and control equipment shall be self-contained for the unit. Two Stages of auxiliary cooling shall be provided, with each of the two auxiliary stages subsequently increasing the transformer rating by a minimum of 33.33% over the Base rating. Control equipment for the cooling equipment shall be furnished and shall be fully automatic, in operation, with facilities provided for continuous manual run control, if desired. In the fully automatic operation mode, the control equipment shall be designed to start and stop the fans, and/or oil pumps, as the oil or transformer winding temperature requires. To equalize wear, selection of the cooling fan bank which operates on first stage shall be manually selectable by the Operator. The control equipment shall be supplied as a unit, complete with all necessary protective devices and accessories. Each fan circuit shall be individually protected. Fans supplied as cooling equipment which have blades that are riveted to their rotating base mount are not acceptable. However, cast aluminum blades are acceptable. Fan blades shall be encased in an OSHA approved safety screen. The number of fans provided in each cooling bank shall be as required to meet the required design cooling capacity for the stage, plus an additional 10% of the cooling bank's design rating.

E. An additional fan starting contact shall provide for local/remote control of air cooling equipment.

F. A digital transformer temperature monitor shall be furnished and mounted within the control cabinet, to monitor and alarm for liquid temperature and winding temperatures. APT TTC-1000 or approved equal.

G. The circuit from the "Thermal Load" current transformer to the digital transformer temperature monitor shall be brought through a test switch in the transformer control cabinet. This test switch shall be capable of shorting the "Thermal Load" current transformer circuit before it terminates at the digital transformer temperature monitor.

H. If pumps are provided as part of the cooling system, necessary valves and fittings shall be installed to make it possible to remove a pump for service and continue to operate the transformer at a load level no less than 133% of its self-cooled rating.

2.08 TRANSFORMER PROTECTION

A. Surge Protection:

1. Three Station-Class gray polymer extra-creep surge arresters shall be mounted adjacent to the high voltage bushings, Eaton Cooper 96 kV "Vari-STAR", Cat. No. UHAA096076A4845A11, or ABB "Polim-S" Cat. No. Q096SC076B, or approved equal. Three Station-Class gray polymer extra-creep surge arresters shall be mounted adjacent to the low voltage bushings, Eaton Cooper 18 kV "Vari-STAR", Cat. No. UHAA018015A1845A11, or ABB "Polim-S" Cat. No. Q018SC015A, or approved equal. Surge arrester mounting brackets shall be an integral part of the sides of the transformer tank or the double wall enclosure. Rating of arresters shall be fully coordinated with BIL level of the transformer.

2. Surge arresters shall be equipped with 4-hole NEMA pad line terminals.

3. A ¼" x 1-½" (minimum) copper bus arrangement shall be provided as a means to ground surge arresters to ground pads at the base of the tank. One bus arrangement for each set of arresters shall be secured to tank wall or structural members with removable fasteners.

B. Winding Thermal Protection:

Thermal protection shall be provided consisting of one 3-element thermal load indicating gauge and relay, with heater and thermometer bulb mounted in a leak-proof well, calibrated to operate on duration and magnitude of the transformer hot spot winding temperature (ANSI Device 49). This relay shall be equipped with one set each of four sequence contacts: two for controlling the cooling equipment fans, one for alarm when winding temperature approaches the maximum safe operating value, and one to trip and lock out the circuit breakers if this temperature is exceeded. Qualitrol only.

The winding temperature relay shall drive the separate fan starting contactor which provides for automatic control of air cooling equipment. The winding temperature relay shall include a remote reset switch for the temperature drag hand in the transformer control cabinet.

C. Fault Detection:

1. The transformer shall be provided with an oil-operated fault pressure relay (ANSI Device 63) responsive to rate of rise of pressure, Qualitrol 900 or approved equal. Contacts shall be rated for 125 Vdc operation and shall be suitable to operate a remote auxiliary seal-in relay.

2. The oil-operated fault pressure relay shall be furnished and properly installed in strict accordance with the original manufacturer's recommendations. A suitable valve shall be supplied between the tank and the relay.

3. Provide a certified test report to demonstrate that the relay has been fully tested and is properly calibrated. A copy of the test report shall be included with the transformer test reports.

4. Pressure relief devices shall be provided for the transformer main tank and LTC compartments. Suitably sized pressure relief devices manufactured by Qualitrol shall be supplied with local operation indication and output contacts suitable for alarm of operation.

2.09 CURRENT TRANSFORMERS

A. Current transformers shall be designed for the appropriate classification accuracy rating. The basic impulse insulation level, multi-ratio current rating, secondary taps, continuous rating and short-time current ratings shall be in accordance with IEEE C57.13.

B. Unless noted, all current transformers shall be multi-ratio, five (5) tap minimum, with industry standard tap configuration and ratios. All taps shall be brought out using type SIS/XHHW #10 AWG stranded copper cables, and terminated on shorting type terminal blocks located in the control compartment. ANSI classification shall be as noted.

Note: Current transformer ranges may be adjusted by Owner at or prior to the time of shop drawing review at no additional cost to the Owner.

C. C.T.'s required for power transformer:

1. High Voltage Bushing – One per bushing (three) 600:5 MR (C800) and one per bushing (three) 1200:5 MR (C800). (Installation Note: The 1200:5 MRCT shall be the bottom set). All current transformers shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

2. Low Voltage Bushing – Two per bushing (six), 1200:5 MR (C800). All current transformers shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

3. HOXO Neutral Bushing – One per bushing 1200:5 MR (C800). The current transformer shall be of Relaying Accuracy Class with a Thermal Rating Factor of 2.0.

D. Bushing C.T. information shall be shown on separate nameplate or main nameplate and shall be per IEEE C57.13, Paragraph 6.8.

E. Polarity marks on bushing CT's shall be toward external bushing terminals.

2.10 BUSHINGS

A. The insulation level of line bushings shall be equal to or greater than the insulation level of the windings to which they are connected.

B. All windings leads (including the neutral) and core ground(s) shall be brought out and connected to terminal bushings. The bushings shall be designed and terminations so made that no undue stressing of the bushings shall occur due to conductor expansion or temperature changes.

C. High Voltage and Low Voltage bushings shall be paper-oil condenser bushings interchangeable with ANSI Standard bushings for power circuit breakers in the same voltage classes. The bushing porcelain shall be gray glaze and manufactured by the wet process method and shall be homogenous, free from laminations, cavities or other flaws affecting its mechanical strength or dielectric qualities. The porcelain shall be well vitrified, tough and impervious to moisture. The glazing shall be free of imperfections such as blisters or burns. Bushings shall be as manufactured by ABB, Lapp, or Hubbell PCore (NO SUBSTITUTIONS).

D. High Voltage bushings shall be located in Segment 3, and Low Voltage and HOXO neutral bushings shall be located in Segment 1, per IEEE C57.12.10. The Low Voltage X2 bushing shall be on the same centerline with the High Voltage H2 bushing.

E. All necessary connectors and hardware shall be furnished for connecting the core ground bushing to the transformer ground.

F. Terminal stud connectors shall be provided as follows for the bushing studs:

High Voltage	Spade Terminals, 4 hole
Low Voltage	Spade Terminals, 4 hole
Core Ground	Spade Terminals, 2 hole

G. Bushing Ratings:

Bushings shall comply with the dimensions, performance and test requirements of IEEE C57.19.00 and IEEE C57.19.01 and shall have minimum ratings as follows:

Quantity/ Type	Insulation Class kV	Current Rating Ampere	BIL & Full Wave kV	Withstand 60 Sec. Dry	Withstand 10 Sec. Wet	Min. Creep Dist.-In.
3 - H.V.	115	800	550	260 kV	230 kV	92
3 - L.V.	25	1200	150	60 kV	50 kV	20
1 - Neut.	25	1200	150	60 kV	50 kV	20
1 - Core Ground	5	600	75	27 kV	24 kV	6

2.11 CONTROL WIRING

A. All control wiring shall be type SIS/XHHW #12 AWG minimum, stranded copper, and shall be terminated in the control compartment on terminal strips with markings in accordance with wiring diagrams. This shall include termination of wiring for all control relays and devices, auxiliary switches, safety switches and device interconnections. All conductors shall be identified by shrink fit or wrap-on sleeve with legible black characters on a white background to denote the destination terminal point of the conductor from the Home Terminal Point.

B. Terminal connectors shall be compression non-insulated ring-type of appropriate size, Burndy Type YAV or approved equal.

C. All taps from five tap multi-ratio current transformers shall be brought to shorting type terminal blocks in the control compartment.

D. Auxiliary Control Wiring- All control wire runs on the outside of the transformer shall be installed in hot dip galvanized rigid steel conduit. Drain fittings shall be provided at the lowest points and breather fittings at upper points such that all moisture that collects will be drained. Control wires may be run in the transformer bracing, but must be readily accessible for maintenance. Leads to fans may be made with open cable with PVC jacket and connected to a suitable outdoor waterproof box next to the fan. Fan supply cables shall not exceed six feet in length. Stainless steel terminal studs shall be supplied in the enclosure box so that a motor may be disconnected and repaired with all other equipment in operation.

2.12 TERMINAL BLOCKS

Wiring shall be terminated on terminal blocks clearly marked for circuit identification as follows:

A. All mechanism control wiring shall be terminated on heavy-duty 12-point terminal blocks by Penn-Union, G.E., or Marathon.

B. C.T. secondaries shall be terminated on heavy-duty shorting type terminal blocks by Penn-Union, G.E., or Marathon.

2.13 ON-BOARD TRANSFORMER MONITOR AND ANNUNCIATOR

A. On-Board Transformer Monitor- The Manufacturer shall provide a dissolved gas analysis transformer oil monitor, permanently-mounted in a NEMA 4X enclosure, calibrated to NIST standards. The monitor shall use gas chromatography to monitor levels of key fault gases and also monitor moisture content, and shall have programmable alarms. The monitor shall have ability to perform sampling at a minimum increment of 4-hours, store time-stamped data in non-volatile memory, and shall have Ethernet fiber communications interface. Serveron Model TM8, or approved equal.

B. Annunciator- The Manufacturer shall provide contacts and wiring terminations for all transformer alarms. The Owner will install a remote annunciator to provide monitoring and indication of alarm points. Anticipated alarms include, but may not be limited to, the following:

1. Main Tank Low Oil
2. LTC Low Oil
3. Conservator Low Oil
4. Main Tank Pressure Relief
5. LTC Pressure Relief
6. Main Tank Rapid Pressure Rise
7. LTC Rapid Pressure Rise
8. High Oil Temperature
9. High Winding Temperature
10. Gas Detector Alarm

2.14 NEUTRAL GROUND CONDUCTOR

The transformer neutral will be connected to the substation ground grid. A minimum of two insulated mounting supports shall be provided on the transformer tank. The mounting supports shall be secured to the transformer tank and be provided with 4-hole-pad bronze conductor clamps suitable for securing copper conductors up to 1000 kcmil.

2.15 TRANSFORMER ACCESSORIES

Other accessories and features shall include, but not be limited to, the following:

A. Control Cabinet A.C. Power:

1. Power Supply Switch (Source by Owner).
2. Light(s) and G.F.C.I. Convenience Outlet.
3. Space Heater(s) and Switch.

B. Conduit entrance provisions, current transformer connections including wiring, conduit and test switches; controls, accessories and auxiliaries, and related wiring as specified elsewhere in this specification.

C. Magnetic liquid level oil gauge with low level alarm contacts. Qualitrol only.

D. Combination Pressure - Vacuum gauge with alarm contacts.

E. Free-standing gauges shall be mounted at eye level, or not more than a height of 7’-6”. Gauges equipped with ungrounded alarm contacts shall be suitable for 125 VDC operation.

2.16 SPARE PARTS

The Equipment Contractor shall furnish a complete power transformer as described herein, plus a complete set of spare parts as follows:

A. One (1) high voltage bushing

B. One (1) low voltage bushing

C. One (1) core ground bushing

D. One (1) set gaskets

E. Two (2) sets low voltage fuses for LTC

F. One (1) complete set of LTC stationary contacts

G. One (1) complete set of LTC reversing switch contacts

H. Two (2) 1 quart cans of touch-up paint for base coat

I. Two (2) 1 quart cans of touch-up paint for finish coat

Where spare parts and tools are recommended in addition to those required above, the Bidder shall attach an itemized listing to the bid, including description, part number, recommended quantity and Prices (as additive alternate). The Equipment Contractor shall furnish such additional spare parts and tools if the associated additive alternate proposal is accepted by the Owner as part of the Purchase Order.

PART 3-EXECUTION

3.01 FACTORY TESTS

A. The following transformer tests shall be performed. The following standards shall be used for completing the test: IEEE C57.12.00, IEEE C57.12.10, IEEE C57.12.90, IEEE C57.91, IEEE C57.98, IEEE C57.109, IEEE C57.113 and IEEE C57.131.

1. Resistance measurement of all windings on the rated voltage tap position and at the tap extremes. Use 2,500 V test equipment and correct to rise above 20 °C temperature reference.

2. Ratio tests on the rated voltage connection and on all tap positions.

3. Polarity and phase relation tests on the rated voltage connection.

4. No-load loss and excitation current at rated frequency and at 100 percent and 110 percent of rated voltage.

5. Impedance and load loss at rated current and rated frequency on the rated voltage connection and at the tap extremes.

6. Fan and/or pump power consumption for each rating.

7. Total loss at rated self-cooled kVA and rated forced-cooled kVA(s) at rated voltages and frequency.

8. Regulation at unity power factor and 80 percent power factor lagging.

9. Percent impedance, resistance and reactance on rated self-cooled kVA base.

10. Hottest spot temperature rise at rated self-cooled kVA and forced-cooled kVA(s). Temperature rise test data shall be on minimum and maximum ratings, or may be given from a "thermal duplicate" unit.

11. Applied voltage tests.

12. Induced voltage tests - IEEE Standard.

13. IEEE C57.113 Partial Discharge (Corona) Tests: Test on completed unit based on one hour at 150% of maximum operating voltage to demonstrate satisfaction of a guaranteed level of 150 micro-volts and 500 pC.

14. Audible Sound Level Tests: Results of sound level tests shall be provided on each unit at the self-cooled rating and all forced-cooled ratings.

15. Resistance Measurement of Insulation: Use 2,500 V test equipment and correct to 20 °C temperature reference to establish basis for future comparisons.

    a. Measurements shall be made between windings and all windings and ground.

16. Insulation Power Factor: Record data shall state test method and specify style and serial number of test equipment and shall include temperature reference to establish basis for future comparisons. Tests shall be performed using a minimum test voltage of 5 kV. Results shall include separate values for CH, CL and CHL. These values shall not be combined, and a value above 0.5%, corrected to 20 °C, will not be acceptable.

17. The tests shall include a quality control impulse series in accordance with IEEE C57.98. The leakage impedance measured after the test series shall not differ from that measured before the test series by more than two percent of its former value.

18. A Sweep Frequency Response Analysis (SFRA) test shall be performed on the transformer at the factory prior to shipment. SFRA test equipment and testing procedures, as recommended by Doble Engineering, shall be used for the tests. This test shall be performed with the transformer main tank filled with oil and all bushings installed. Transformer radiators may not be installed for this test. Response curves measured shall be provided to the Owner for comparison with subsequent SFRA field tests taken after the unit has been installed at the final substation site (See Section 33-73-00, 3.05.A).

19. Bushing Tests: Power factor of bushing shall be furnished both as individual units and as installed in tank.

20. Terminal bushing test and flashover voltages - IEEE Standard.

21. Current transformer tests, (ratio, saturation and excitation, polarity) with curves.

22. Fault Pressure Relay Test: A report for the fault pressure relay shall be obtained from the original manufacturer. The test report shall verify that the relay has been fully tested at the manufacturer's test laboratory and that it is properly calibrated. A copy of this test report shall be included with the transformer test report.

B. Owner reserves the right to witness testing. The Equipment Contractor shall notify Owner, in writing, no less than 2 weeks prior to the scheduled starting date of the factory tests to allow Owner to witness testing if so desired.

C. The Equipment Contractor shall notify Owner of any unusual event or damage occurring during the fabrication of the transformer and of all tests which do not meet the specified standard values. Owner reserves the right at its option to inspect such damages or test failures. Corrective measures to overcome such damage or failure shall be subject to acceptance by Owner

3.02 CERTIFIED FACTORY TEST REPORTS.

The Equipment Contractor is expressly advised that certified test reports on the unit(s) delivered must include values to permit determination of No Load and Load Losses and other power requirements. In the event such losses or requirements exceed the values guaranteed at time bids are submitted, the Equipment Contractor will be assessed as liquidated damages an amount to be determined as follows:

A.	No Load Losses	For each kW or fraction thereof that actual test losses exceed guaranteed losses, the Equipment Contractor will be assessed an amount computed on the basis of $7,414 per kW.
B.	Load Losses	For each kW or fraction thereof that actual test loss exceeds guaranteed losses, the Equipment Contractor will be assessed an amount computed on the basis of $2,775 per kW.
C.	Power Requirements	For each kW or fraction thereof that actual power requirements as for Cooling Equipment established by test exceeds the approximate power requirements furnished with the bid, the Equipment Contractor will be assessed an amount computed on the basis of $7,414 per kW.

END OF SECTION

SECTION 33-75-00
HIGH-VOLTAGE SWITCHGEAR AND PROTECTIVE DEVICES
OUTDOOR CIRCUIT BREAKER- GENERAL REQUIREMENTS

PART 1 -GENERAL

1.01 WORK INCLUDED

A. The work consists of furnishing Outdoor Circuit Breaker equipment as herein specified, delivering the Equipment to the substation site, and coordinating with the Owner for receipt and offloading. Equipment shall be designed, built and delivered completely wired, tested and ready for installation.

B. This section includes referenced standards for design and requirements for warranty, submittals, painting, shipping, and factory and field testing.

C. As used herein, “Manufacturer” shall mean the firm with facilities and expertise, regularly engaged in the design, production, assembly and testing of high-voltage outdoor gas circuit switchers or medium-voltage outdoor vacuum circuit breakers for electric utilities.

D. As used herein, “Equipment Contractor” shall mean the person, firm, or Corporation whose bid is accepted and to whom the Owner has issued a Purchase Order or Contract to supply one or more items of Equipment. This can be either the circuit breaker or circuit switcher Manufacturer or their agent or representative.

E. It is the intent of these specifications for the Equipment Contractor to furnish the standard outdoor circuit breaker or circuit switcher design of a Manufacturer, complete with standard accessories, but with modifications as detailed in these specifications.

1.02 RELATED SECTIONS

A. The bidding documents are a part of this section as if incorporated herein.

B. Other related sections are as listed below.

1. Section 33-75-20, High-Voltage Gas Circuit Switcher, Supplemental Requirements - Outdoor 121kV 1200A

2. Section 33-77-23, Medium-Voltage Vacuum Circuit Breaker, Supplemental Requirements - Outdoor 27kV 1200A

1.03 REFERENCES

The Equipment described by these specifications shall, as a minimum, be built in accordance with applicable standards of the American National Standards Institute, the Institute of Electrical and Electronics Engineers, the American Society for Testing and Materials and the National Electrical Manufacturer's Association as to ratings, characteristics and tests. The work shall conform to applicable provisions of the latest edition or revision of the following publications and standards, except as otherwise specifically stated herein:

A. Institute of Electrical and Electronics Engineers (IEEE):

IEEE C37.04	Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.06	High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for AC Voltages Above 1000V
IEEE C37.09	Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.011	Guide for the Application of Transient Recovery Voltage for AC High-Voltage Circuit Breakers
IEEE C37.081	Guide for Synthetic Fault Testing of AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C57.13	Requirements for Instrument Transformers

B. American Society for Testing and Materials (ASTM):

A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

C. National Electrical Manufacturers Association (NEMA):

SG 4	Alternating Current High-Voltage Circuit Breakers

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

The workmanship, design and materials shall be of the highest quality and the most suitable for the application. The materials and equipment shall be new, of proven manufacture and free from defects. The design shall provide maximum mechanical and electrical strength and shall include ample safety factors to cover the maximum voltage rating and interrupting capacity rating of the Equipment. The Equipment shall be of dead tank design and environmentally protected.

1.05 SUBMITTALS

The Equipment Contractor shall provide a complete Schedule of data submittals within ten days of the receipt of Purchase Order.

The Equipment Contractor shall submit Adobe PDF copy of the required Submittals by e-mail for review and approval by the Owner. Review by the Owner or their representative is for determining conformance with this Section and related documents. It does not relieve the Manufacturer of responsibility for quantities and compatibility of components.

Submittals will be marked with any comments and returned to the Equipment Contractor by e-mail within ten business days after receipt, if possible. Manufacturing shall not begin until the required Shop Drawings are reviewed and approved with “No exceptions noted” or “Approved as noted”.

A. Shop Drawings

Shop drawings shall be submitted within 60 days of the receipt of Purchase Order.

1. Circuit Breaker submittals shall include:

   a. Equipment outline and assembly showing: total weight, all principal features and dimensions, bushing numbering plan, and required foundation bolt sizes and locations

   b. Breaker Nameplate

   c. Bushing data

   d. Ratio curves for bushing current transformers for each ratio and at various volt-ampere burdens

   e. Diagrams of bushing current transformer connections, showing number of turns, polarity, ratios and connections to terminal blocks

   f. Detailed views of control cabinet, CT junction box or other enclosures, including equipment layout, nameplates, conduit entrance, and terminal block orientation and numbering

   g. Separate AC and DC schematic diagrams.

   h. Full size control wiring and interconnection diagrams, based on actual physical arrangement of terminal blocks

   i. Bill of Material / Parts bulletin.

   j. Description of Manufacturer’s paint process

   k. Manufacturer’s recommended installation tests.

2. Circuit Switcher submittals shall include:

   a. Equipment outline and assembly showing: total weight, all principal features and dimensions, and required foundation bolt sizes and locations

   b. Detailed views of control cabinet(s), including equipment layout, conduit entrance, and terminal block orientation and numbering

   c. Control wiring and interconnection diagrams, based on actual physical arrangement of terminal blocks

3. Drawing title block shall include the Owner’s name, purchase order number, and the name of the substation.

B. Factory Tests

1. All production tests included in IEEE C37.09 shall be made on each Circuit Breaker. In addition, an operation recording test shall be made at the factory and copies of the charts shall be furnished to the Owner as record information.

2. Circuit Switcher production tests shall include, leak tests, dielectric test, operating speed and timing test, current path resistance test, and a mechanical operations test.

3. Certified test reports for tests performed by the Manufacturer shall be submitted for review prior to shipment.

C. Instruction Manual

The Equipment Contractor shall provide one bound paper copy of an instruction manual, conveniently mounted inside the door of each circuit breaker or circuit switcher, plus three additional copies. The cover sheet shall reference the applicable serial number(s), date of manufacture, and the Owner’s name and purchase order number. The instruction (operation and maintenance) manual shall contain, as a minimum:

1. Instructions for receiving, storing and installing the Equipment; including recommended installation procedures and tests

2. Operating instructions

3. Maintenance instructions; including preventive maintenance schedule, required lubricants, adjustment values, and recommended periodic testing

4. Final approval drawings and assembly drawings; full size, or reduced to 11”x17” if legible

5. Test data and curves

6. Original manufacturer's catalog or part numbers for all components, including, without limitation, relays, switches, coils, fuses, mechanism components and all other parts which might require maintenance or replacement in the normal operation of the device.

D. As-Built

Final "as-built" submittals shall be furnished on a USB drive in a format compatible with AutoCAD 2013 (two copies).

1.06 DELIVERY, STORAGE AND HANDLING

Deliver the Equipment with all manufacturers' tags and labels intact. Handle and store the Equipment in such a manner so as to avoid damage to the units.

1.07 WARRANTY

A. The equipment Manufacturer's warranty period shall extend a minimum of two years from date of delivery.

B. The equipment Manufacturer's extended warranty shall include all parts of the Equipment regardless of original manufacturer.

PART 2-PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. All material and equipment shall be new, approved and labeled, where required, by UL. Only products by manufacturers regularly engaged in production of specified units will be acceptable.

B. Where two or more units of the same class of equipment or materials are required, provide all units from a single manufacturer.

C. Provide materials and equipment of suitable material to perform satisfactorily when exposed to conditions of project site.

2.02 ENCLOSURES

Enclosures for operating mechanism, compressors or pumps, wiring terminations, and relays and controls shall be weatherproof stainless steel or aluminum, mounted on the supporting framework.

A. All enclosures shall be mounted not less than 18 inches above the framework baseplate.

B. All enclosures shall be sufficiently rigid to prevent warping of doors and to ensure positive operation of doors and latches. Design of the enclosures shall be such that overlapping metal surfaces are sealed to prevent corrosion. Welds, if used, shall be full-penetration throughout.

C. Doors shall be hinged and shall have heavy duty 3-point latches. Hinges and pins shall be stainless steel. Each door latch shall be lockable in the latched position with a padlock having up to a 3/8-inch shackle and a one-inch clear opening when locked closed. Devices shall be provided on the hinge end of doors and swing panels to hold them in the open position while work is being performed in the cabinet.

D. A conduit entrance with removable cover plate shall be located in the bottom of each enclosure. Location of the entrance(s) in the mechanism housing(s) shall be such that remote cables can be easily terminated on terminal blocks without routing through the operating mechanism(s).

E. Suitable ventilating holes shall be provided and located in each enclosure to permit proper air circulation. The vents shall be durable, maintenance free, and designed to prevent entry of water and insects.

F. One or more space heaters shall be furnished and mounted in each enclosure to prevent condensation.

G. All enclosures shall be securely grounded to the equipment frame.

H. Provide breather and drain fittings in all raceways between enclosures, if applicable, to prevent condensation or trapping of moisture.

2.03 METAL PREPARATION AND PAINTING

A. Galvanized parts furnished on the equipment shall be hot dip galvanized in accordance with ASTM A123.

B. Prior to painting, all surfaces shall be cleaned by sandblasting, shot-blasting, or be solvent-, steam- or pressure-washed to remove all dirt, grease, rust or mill scale.

C. After cleaning, all surfaces shall be degreased using an appropriate commercially available degreasing solution and rinsed with clean water and dried prior to application of the primer coats.

D. After the metal has been cleaned and pretreated, it shall be primed and painted by the Manufacturer's best quality paint process suitable for the environment of the equipment installation. Color shall be ANSI 61 or ANSI 70 gray.

E. Complete painting procedures must be submitted to the Owner for review. Written acceptance must be received prior to paint application.

F. For a spray-type process, two coats of an epoxy primer shall be applied to a minimum thickness of 1 mil per coat. Adequate drying time shall be allowed between coats to insure proper bonding. The primed material surface shall be sprayed with three finish coats of the manufacturer's best quality paint. Each coat shall have a minimum dry thickness of 1 mil for an overall dry film thickness of 5 mil, including finish and prime coats.

G. The interior surfaces of the equipment cabinets and control compartments shall be treated and finished to prevent rust and corrosion.

2.04 NAMEPLATES

Stainless steel nameplates shall be furnished in accordance with IEEE C37.04, mounted at a height for easy reading. All pertinent data of the circuit breaker or circuit switcher, operating mechanism, current transformers and accessories shall be marked on the associated equipment nameplate. The Owner's purchase order number shall be added to the equipment nameplate. Appropriate instructions and warning signs shall be located at essential locations.

PART 3-EXECUTION

3.01 SHIPMENT, DELIVERY AND INSTALLATION

A. The Equipment shall be completely assembled, wired and tested at the factory. All necessary provisions shall be made to insure that Equipment is maintained in a dry condition.

B. Circuit Breakers shall be shipped in the position (open or closed) as recommended by the Manufacturer. The Equipment shall be shipped to its destination upright and as complete as possible consistent with shipment limitations and protection of the Equipment.

C. The Equipment Contractor shall advise the Owner not less than ten days in advance of the method of shipment and anticipated date of arrival. Delivery shall be scheduled on normal business days during normal business hours. Final notice of at least 48 hours (not counting weekends and holidays) must be given prior to delivery to enable the Owner to make necessary arrangements.

1. Notice shall be given to:

Louis Benishek
Electric Substation Supervisor
Utilities Commission, City of New Smyrna Beach
200 Canal Street
New Smyrna Beach, FL 32168
(386) 424-3167

D. The Equipment furnished hereunder shall be delivered to the Owner complete and ready for installation. The Equipment Contractor shall furnish any special tools required for assembly and installation, and shall furnish touch-up paint to match any painted surfaces.

1. If spare parts are included in the Purchase Order, they shall be furnished along with the shipment of the equipment. Spare parts which are sensitive to humidity shall be sealed in appropriate airtight containers complete with desiccant.

E. The Equipment Contractor shall make all necessary provisions required for the assembly, handling, and transportation of the Equipment, and shall coordinate with the Owner for receipt and offloading.

F. The Equipment Contractor shall assume responsibility and handle all claims if there is damage in transit.

G. The equipment foundations will be provided by others. The Owner or their substation contractor will place, level and secure the Equipment on the foundations. Connections to source, load, and ground terminals, and connections of low voltage power, CT, and control circuits to incoming terminals will also be provided by others.

3.02 INSTALLATION TESTS

A. Upon the Owner's request and with separate authorization, the Equipment Contractor shall make available a fully qualified factory-trained service engineer to instruct Owner's personnel in the proper operation, adjustment, test, and maintenance of the Circuit Breakers.

B. For Bidding purposes, assume all work involved in testing and startup of the Circuit Breakers will be performed by others.

C. The testing procedure will include the following anticipated elements.

1. A complete outline of the testing procedures will be reviewed by the Engineer, and comments will be incorporated before installation testing commences at the site.

2. Circuit Breaker tests will include the recommended tests of the Manufacturer. In addition, a test of contact alignment, a Ductor Resistance Test, and a Hi-Pot Test will be performed.

3. All current transformers will be checked for ratio, saturation excitation, and polarization. The correct location and polarity as per identification marking will be verified.

4. Copies of a complete written report will be submitted to the Engineer, indentifying test equipment, the test procedures followed, and the "as-found" and "as left" condition of equipment tested.

5. The Engineer will receive final field test results, including the technician's field copied test sheets, before the Equipment is considered ready to be put into service.

3.03 FIELD SERVICES

The services of a fully qualified factory-trained service engineer shall be made available in accordance with the following schedule:

A. A fully qualified service engineer must be available upon 24-hours notice and qualified shop facilities must be available within a radius of 400 miles of the Owner.

END OF SECTION

SECTION 33-75-20
HIGH-VOLTAGE GAS CIRCUIT SWITCHER
SUPPLEMENTAL REQUIREMENTS- OUTDOOR 121 KV 1200 AMP

PART 1 -GENERAL

1.01 WORK INCLUDED

This section supplements the Outdoor Circuit Breaker General Requirements Section 33-75-00. The technical design requirements and associated structures and accessories for transmission Circuit Switchers are outlined herein.

1.02 RELATED SECTIONS

A. The bidding documents are a part of this section as if incorporated herein.

B. Other related sections are as listed below:

1. Section 33-75-00, High-Voltage Switchgear and Protective Devices, Outdoor Circuit Breaker General Requirements

1.03 REFERENCES

The work shall conform to the applicable requirements of all Federal, State and local agencies and applicable provisions of the latest edition or revision of the standards set forth in Article 1.03 (References) of Section 33-75-00, except as modified herein.

1.04 RATINGS

The Circuit Switcher shall conform to the ratings as defined in IEEE C37.04 and as listed in IEEE C37.06, and shall meet or exceed the following ratings:

A.	Maximum voltage	121 kV
B.	Operating voltage	115 kV
C.	Continuous current	1200 A
D.	Short circuit current, minimum	40 kA at 121 kV
E.	Interrupting time	6 cycles
F.	Full wave withstand, dielectric	550 kV
G.	Phase Spacing	84 inches
H.	Control voltage	125 Vdc

PART 2-PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall comply with the requirements of Section 33-75-00, and the following.

2.02 CIRCUIT SWITCHER

A. The circuit switcher shall be an outdoor type, 3-pole, single throw gang-operated, frame-mounted, with vertical mounted interrupters, without integral motor-operated vertical break disconnect

switch, and complete with appurtenances and accessories as hereinafter specified. All current carrying parts shall be copper or appropriate copper alloy. S&C type 2030 or Southern States type CSV or Siemens type CPV2, or approved equal.

B. The ampere, voltage, and interrupting ratings of the circuit switcher shall have been established by test on the type circuit switcher proposed. Interrupting medium shall be SF6 gas. Interrupting capacity shall be based on O - 15 Sec. - CO - 15 Sec. - CO duty cycle.

C. The circuit switcher shall be mounted on a hot-dip galvanized steel square-tube supporting framework with a mounting height of 168 inches, and with all enclosures securely attached to the frame. Galvanized steel anchor bolts for the supporting structure shall be furnished by the Equipment Contractor. All external hardware such as nuts, bolts, washers, hinges, door handles, etc., shall be stainless steel type 316.

D. The circuit switcher shall have gauges for pertinent systems, if applicable. Enclosures shall have window glass to view any gauges contained within.

E. A mechanical open / closed position indicator shall be provided which is driven by the power train and clearly visible from ground level.

F. The circuit switcher frame shall have two copper-faced or stainless steel ground pads, diagonally opposite, with two 0.50-13 tapped holes on 1.75-inch centers.

2.03 OPERATING MECHANISM

A. The circuit switcher shall include an operating mechanism arranged to close and trip the circuit switcher by local or remote electrical control. The equipment shall be trip-free mechanically and electrically.

B. The operating mechanism and its components shall be designed for use with a 125 Vdc control voltage.

C. The opening and closing mechanism shall be stored energy type, with simultaneous operation of the three individual interrupter poles. Charging of the stored energy system shall be compatible with the duty cycle.

D. The circuit switcher shall provide local alarm for low SF6 gas pressure, with provision for remote alarm.

2.04 INTERRUPTERS

A. Interrupters shall be SF6 single gap, with indication of adequate gas density, and equipped with a pressure relief device.

B. Interrupters shall be contained within wet process porcelain insulators, ANSI 70 gray in color, and shall be impervious to moisture. Interrupters shall be equipped with NEMA 4-hole pad line terminals.

C. Support insulators shall be station class wet process porcelain, ANSI 70 gray in color, of appropriate strength for the application.

2.05 INTEGRAL DISCONNECT

A. An integral three-pole gang-operated vertical-break motor-operated disconnect switch is not required.

2.06 OPERATOR CABINET

The circuit switcher operator cabinet shall be a weatherproof and dustproof aluminum or stainless steel enclosure, equipped with the following:

A. Trip and Close push buttons or pistol-grip control switch, clearly labeled.

B. One tripping device for manually tripping the interrupters without control voltage.

C. Trip and close coils.

D. One non-reset operation counter.

E. Indication of charged / discharged state of the stored-energy mechanism.

F. One auxiliary switch. The switch shall provide a minimum of four N.O. and four N.C. contacts in addition to those necessary to operate the circuit switcher.

G. One lot of terminal blocks. The control cabinet shall be provided with adequate terminal blocks for each conductor entering or leaving the cabinet, Penn-Union, GE or Marathon. Terminal positions shall be provided for each conductor, and shall be conveniently located for making connections to external power and control wiring entering.

H. One lot of internal control wiring, minimum #14 AWG stranded copper conductor, 600 V insulated. Manufacturer shall not piggyback more than two internal wires on any single terminal position.

I. The operator cabinet shall be ventilated and equipped with an appropriate space heater.

2.07 APPLICATION

The circuit switcher will be installed between the breaker elements of a ring bus and the high voltage terminals of a substation power transformer. The circuit switcher will be called on to operate as part of various relay schemes. Relays will be installed in a separate control building.

2.08 ELECTRICAL

A. All operating devices shall be suitable for 120 or 240 VAC single-phase and/or 125 Vdc, as applicable.

B. Heaters shall be connected with or without thermostats to a separately protected 120 or 240 VAC source. Heaters shall be supplied with high temperature insulated wire, and shall have personnel protective barriers.

C. Protective devices for power and control circuits shall be fused knife switches or molded-case circuit breakers.

2.09 SPARE PARTS

If applicable, the Bidder shall list their recommended spare parts for the Circuit Switcher described herein on Bid Tabulation Form Appendix 2, Sheet 2, including description, part numbers, cost of each, and total cost.

END OF SECTION

SECTION 33-77-23
MEDIUM-VOLTAGE VACUUM CIRCUIT BREAKER
SUPPLEMENTAL REQUIREMENTS- OUTDOOR 27 KV 1200 AMP

PART 1 -GENERAL

1.01 WORK INCLUDED

This section supplements the Outdoor Circuit Breaker General Requirements Section 33-75-00. The technical design requirements and associated control systems and operating systems for distribution feeder breakers are outlined herein.

1.02 RELATED SECTIONS

A. The bidding documents are a part of this section as if incorporated herein.

B. Other related sections are as listed below:

1. Section 33-75-00, High-Voltage Switchgear and Protective Devices, Outdoor Circuit Breaker General Requirements

1.03 REFERENCES

The work shall conform to the applicable requirements of all Federal, State and local agencies and applicable provisions of the latest edition or revision of the standards set forth in Article 1.03 (References) of Section 33-75-00, except as modified herein.

1.04 RATINGS

The Circuit Breaker shall conform to the ratings as defined in IEEE C37.04 and as listed in IEEE C37.06, and shall meet or exceed the following ratings:

A.	Maximum voltage	27 kV
B.	Operating voltage	22.9 kV
C.	Continuous current	1200 A
D.	Short circuit current, minimum	25 kA at 27 kV
E.	Interrupting time	3 cycles
F.	Closing and latching capability, Asymmetrical	39 kA
G.	Full wave withstand, dielectric	150 kV
H.	Control voltage	125 Vdc

PART 2-PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Materials and equipment shall comply with the requirements of Section 33-75-00, and the following.

2.02 CIRCUIT BREAKER

A. The circuit breaker shall be an outdoor type, 3-pole, single throw, frame-mounted, complete with, but not limited to, appurtenances, accessories and spare parts, as hereinafter specified. All current

carrying parts shall be copper or appropriate copper alloy. ABB type R-MAG or Siemens type SDV7-MA, or approved equal.

B. The ampere, voltage, and interrupting ratings of the circuit breaker shall have been established by test on the type breaker proposed. Interrupting medium shall be vacuum. Interrupting capacity shall be based on O - 0.3 Sec. - CO - 15 Sec. - CO duty cycle.

C. The circuit breaker shall be mounted on a hot-dip galvanized steel supporting framework, adjustable in height, with all enclosures securely attached to the frame. All external hardware such as nuts, bolts, washers, hinges, door handles, etc., shall be stainless steel type 316.

D. The circuit breaker shall have gauges for pertinent systems, if applicable. Enclosures shall have window glass to view any gauges contained within.

E. A typical elementary diagram is shown on Figure No. AA-3, appended to this Section of the specifications. This elementary shows the basic functional operation requirements, but is not necessarily complete.

F. The circuit breaker cabinet shall have two copper-faced or stainless steel ground pads, diagonally opposite, with two 0.50-13 tapped holes on 1.75-inch centers[, each equipped with a clamp type grounding connector, for #4/0 AWG copper cable, Hubbell/Anderson Cat. No. SWL-025B or approved equal].

2.03 OPERATING MECHANISM

A. The circuit breaker shall include an operating mechanism arranged to close and trip the breaker by local or remote electrical control. The equipment shall be trip-free mechanically and electrically.

B. Operating mechanism shall be magnetically-actuated, and shall have a 120 VAC / 125 Vdc closing coil and two 125 Vdc shunt trip coils.

C. The closing mechanism shall be stored energy type. Closing of the circuit breaker shall completely charge all stored energy devices so that the circuit breaker is ready for all subsequent operations that may be required.

D. The circuit breaker shall provide local and remote alarms for failure of the stored energy devices to fully charge subsequent to a close operation of the circuit breaker. Alarm must activate when stored energy devices fail to charge, regardless of whether the breaker contacts are open or closed.

2.04 BUSHINGS

A. The bushings shall be dry or sealed-condenser type with oil impregnated paper, wet process porcelain of manufacturer's standard design for the particular application. Bushings shall have uniform smooth hard glaze, light gray in color. The glaze shall be free from imperfections. The bushings shall be impervious to moisture. The bushings shall comply in full with performance and test requirements of the applicable ANSI and NEMA standards. Bushings shall be equipped with 1-1/2”-12 threaded studs.

B. Bushings shall comply with the dimensions, performance and test requirements of IEEE C57.19.00 and IEEE C57.19.01 and shall have minimum ratings as follows:

1.	Voltage Class	25 kV
2.	Continuous Current	1200 A
3.	BIL	150 kV
4.	Low frequency dielectric, one minute dry	60 kV
5.	Low frequency dielectric, 10 second wet	50 kV
6.	Minimum Creep	20 inches

2.05 CURRENT TRANSFORMERS

The circuit breaker shall be equipped with twelve 1200/5 ampere bushing-type, five tap multi-ratio, current transformers as shown on Figure No. AA-2, appended to this Section of the specifications. The bushing current transformers shall have an accuracy classification of not less than C200. Polarity marks on BCT's shall be toward external bushing terminals.

A. The following data shall be furnished with shop drawing submittals for multi-ratio transformers:

1. Typical ratio correction factor curves for each ratio for the ANSI Standard B2 burden (50 VA at 0.5 PF) over a range of 0.25 to 2.0 times rated primary current.

2. Typical ANSI excitation curve for each ratio.

3. Actual turns ratio for each tap.

B. Secondary leads shall be installed in weatherproof rigid galvanized steel or aluminum conduit from the current transformers to the terminal blocks in the control cabinet.

1. CT wiring shall be #12 AWG stranded copper conductor with type SIS insulation.

2. The leads from the current transformers shall be marked to indicate the taps and polarity and shall be brought out to shorting type terminal blocks within the control mechanism housing.

2.06 CONTROL AND RELAY CABINET

The control and relay cabinet shall be equipped with the following:

A. One circuit breaker control switch, with spring return operation, pistol grip handle, and target escutcheon. Number of stages and contact arrangement will be as required. General Electric Type 16SB1, or similar. ANSI Device No. 52CS.

B. Two LED indicating lamps, complete with resistor for 125 Vdc. One red lens (left) for OCB "close" position indication and one green lens (right) for OCB "open" position indication. General Electric Type ET-16, or similar.

C. One “local-remote” SCADA cut-out switch, minimum four-stage, 8 contacts (half of the contacts closed in "local," half closed in "remote"), with knurled handle. General Electric Type 16SB1, or similar. ANSI Device No. 43.

D. One mechanical position indicator, clearly visible with the control cabinet door closed, to indicate whether the breaker is in the open or closed position.

E. One mechanically actuated operation counter, advancing upon breaker opening, visible with the control cabinet door closed.

F. One tripping device for manually tripping the breaker without opening the control cabinet, protected to prevent inadvertent operation, with an automatic lockout switch to prevent electrical reclosing.

G. One sixteen-pole (minimum) auxiliary switch. The switch shall provide a minimum of five N.O. and five N.C. contacts in addition to those necessary to operate the circuit breaker.

H. One lot of terminal blocks. The control cabinet shall be provided with adequate terminal blocks for each conductor entering or leaving the cabinet, Penn-Union (Cat. No. 6006-SC for current transformer and 6012 for controls), or equivalent GE or Marathon. Terminal positions shall be provided for each conductor, and shall be conveniently located for making connections to external power and control wiring entering.

1. Terminal blocks shall have an engraved phenolic type white marker strip having the terminal point identification in black as shown on the Manufacturer's certified drawings. The Owner's standard terminal numbering shall be used for interconnection terminal points, and will be provided to the successful Bidder.

2. In addition to those terminals required for internal purposes and those required for external conductors to be connected at the time the circuit breaker is installed, a minimum of two twelve-point terminal blocks shall be provided as spare positions for use of the Owner.

I. One lot of internal control wiring, including one lot wiring provisions for tripping and close circuit blocking by transformer and/or bus differential lockout relays. Switchboard control wiring shall be #14 AWG, minimum, stranded copper conductor with type SIS insulation material.

1. Manufacturer shall not piggyback more than two internal wires on any single terminal position.

2. Factory wiring shall be arranged neatly, grouped and tie-wrapped, or in appropriate raceways.

J. Connectors for control wiring shall be seamless non-insulated ring tongue of appropriate size, Burndy Type YAV or approved equal.

K. All control wiring shall be identified at both ends with wrap around markers carrying the same wire marks as shown on the Manufacturer's certified drawings and shall be supported in such a manner as to permit visual tracing of all the wires. Wire marking shall be performed by the use of T & B "E-Z Code" self-laminating adhesive material or equal.

L. A plastic nameplate shall be furnished for each control device, instrument and protective relay. Nameplates shall be black with white lettering, engraved as specified at time of shop drawing review. Nameplates shall be permanently attached adjacent to and above the corresponding device.

M. One latch checking switch, if applicable.

N. Elapsed time meters for pertinent systems, if applicable.

O. Pressure lockout/alarm switches, if applicable.

2.07 APPLICATION

The Circuit Breakers will be installed as feeder breakers serving off a main-tie-main configuration. Trip Coil 1 will interface with a bus differential relay and lockout (block close) and with feeder relaying. Trip Coil 2 will interface with under-frequency relaying. Relays will be installed in a separate control building, and the control wiring shall provide for these applications.

2.08 ELECTRICAL

A. All operating devices shall be suitable for 120 or 240 VAC single-phase and/or 125 Vdc, as specified.

B. AC service voltages listed are nominal. The following voltage ranges shall be used in designing and selecting the components:

Nominal Voltage	Operating Voltage
120 volts	110 volts to 140 volts
240 volts	220 volts to 280 volts

C. All heaters shall be connected with or without thermostats to a separately fused 240 VAC source, with provision for reconnection at 120 VAC. All heaters shall be supplied with high temperature insulated wire, and shall have personnel protective barriers.

D. Fused knife switches shall be provided for the trip circuits, close control circuit, pump motor circuit (if applicable), and heater circuit. The knife switches shall be located in a safe or guarded position. All protective devices for other circuits shall be approved circuit breakers. Breakers shall be thermal magnetic with front adjustable, non-interchangeable, ambient and enclosure compensation.

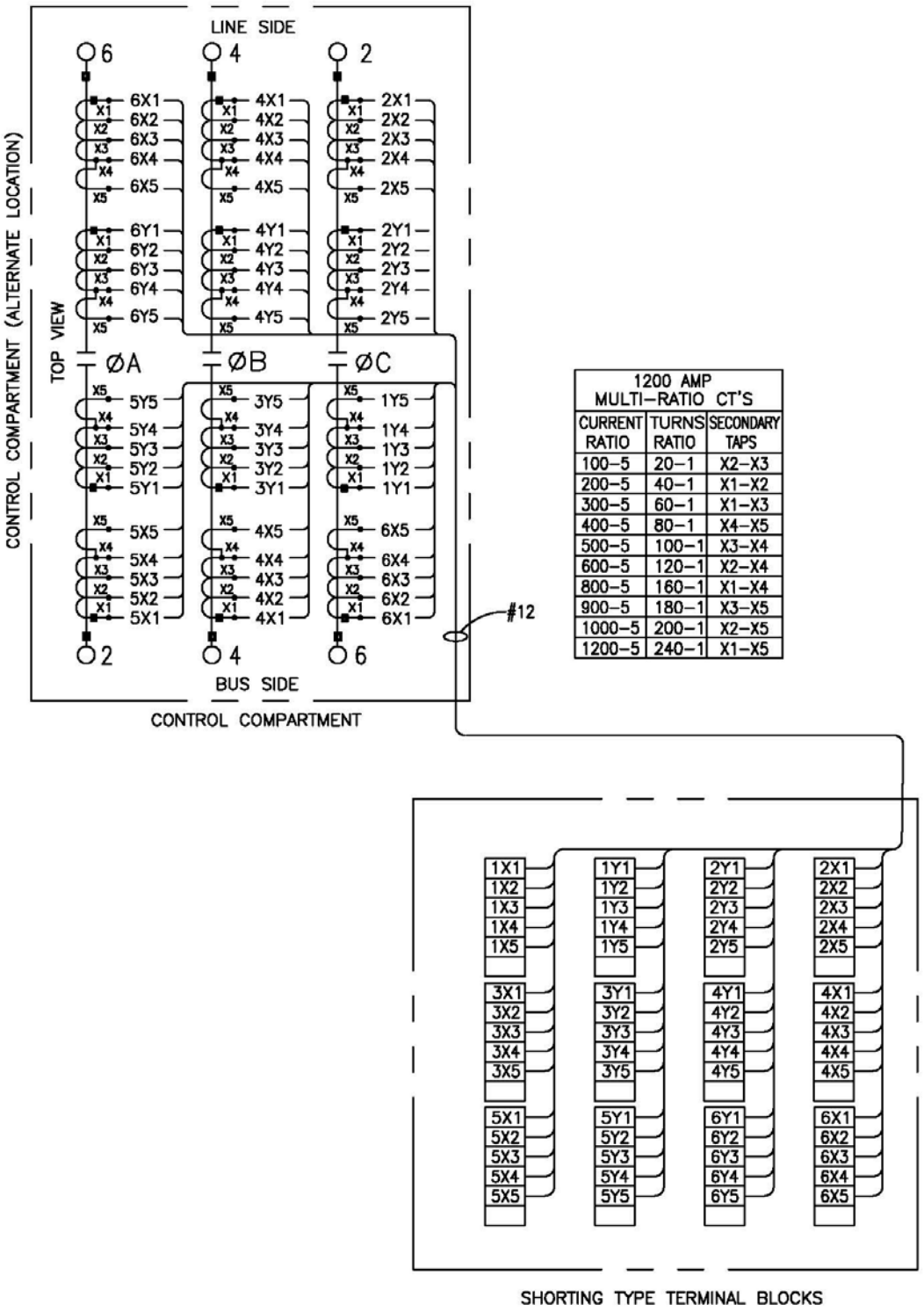
a. The wiring shall be such that the charging motor is separately protected by a circuit breaker from the close control circuit.

E. The Manufacturer shall supply a spare fuse block, modular type. with two spare fuses for the close circuit and two spare fuses for the trip circuit.

F. One duplex G.F.C.I., 15 ampere, 120 VAC 3-wire grounding utility outlet (NEMA 5-15R) and one cabinet light with switch shall be installed inside the control cabinet on a dedicated power circuit.

2.09 SPARE PARTS

If applicable, the Bidder shall list their recommended spare parts for the Circuit Breaker described herein on Bid Tabulation Form Appendix 3, Sheet 2, including description, part numbers, cost of each, and total cost.



1200 AMP MULTI–RATIO CT'S

CURRENT RATIO	TURNS RATIO	SECONDARY TAPS
100–5	20–1	X2–X3
200–5	40–1	X1–X2
300–5	60–1	X1–X3
400–5	80–1	X4–X5
500–5	100–1	X3–X4
600–5	120–1	X2–X4
800–5	160–1	X1–X4
900–5	180–1	X3–X5
1000–5	200–1	X2–X5
1200–5	240–1	X1–X5

Figure AA-2
Circuit Breaker Current Transformer Connection Diagram

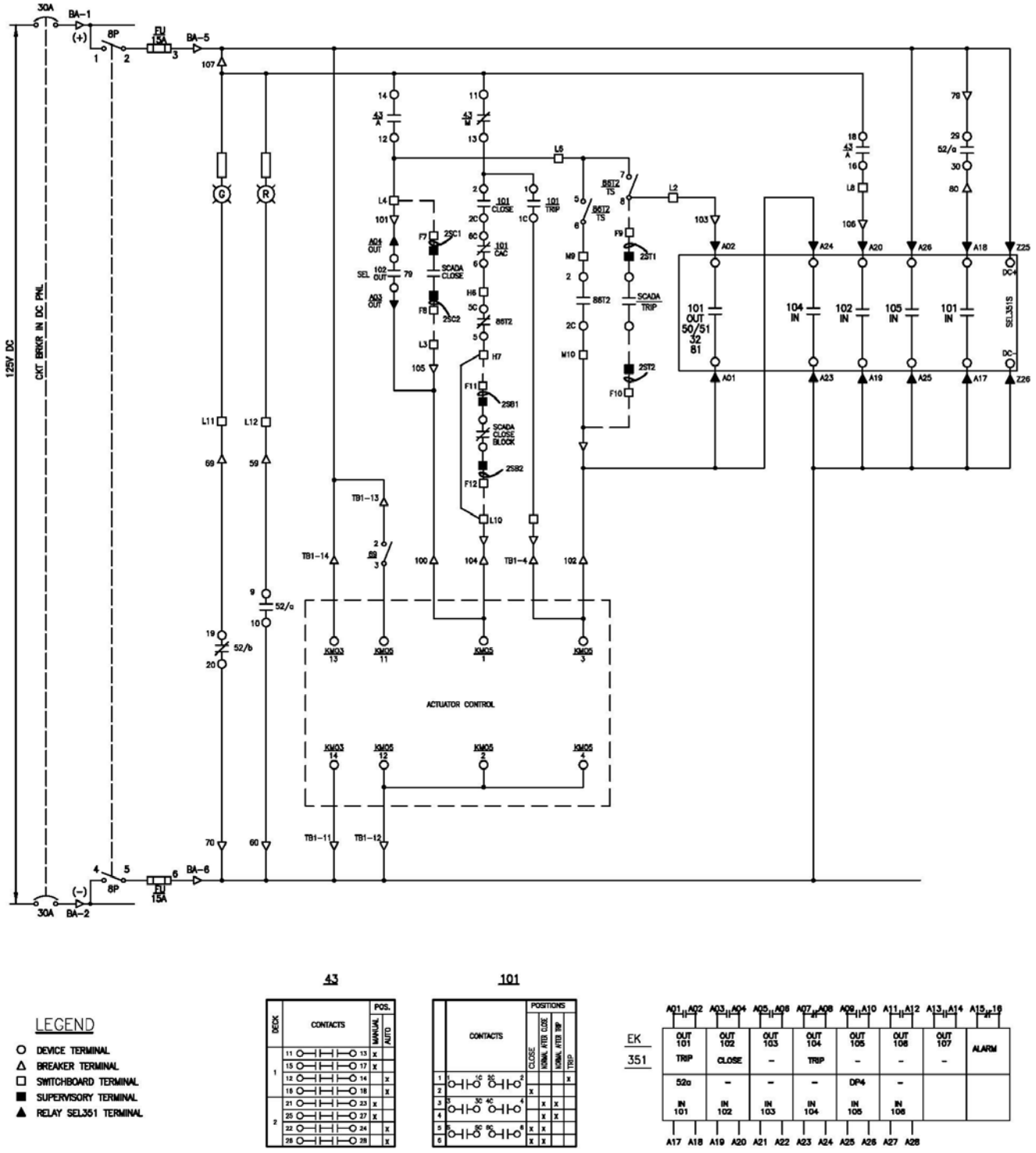


Figure AA-3
Circuit Breaker Control Elementary

END OF SECTION