

## SECTION 26 12 19 – PAD MOUNTED LIQUID FILLED MEDIUM VOLTAGE TRANSFORMER

### 1.01 SUMMARY:

- A. **Basic Function:** Medium voltage pad mounted liquid filled transformers are use to lower the voltage from the 12 kV medium voltage distribution level to 480 volts low voltage level for equipment use.
- B. **Scope of Work:** Liquid filled pad-mounted transformers shall be installed outdoors, adjacent to every electrical Room in the <sup>A17</sup>locks complex, to step down voltage for the motor control centers or wherever the Contractor's design of the new locks requires a distribution transformer. <sup>A17</sup>

### 1.02 <sup>A16</sup>REFERENCES: <sup>A16</sup>

A. **American Society for Testing and Materials (ASTM) International Standards:**

<sup>A7</sup> D 92 – 05A <sup>A7</sup>	Flash and Fire Point by Cleveland Open Cup Tester
D 445 – 06	Kinematic Viscosity of Transparent and Opaque Liquids (and the calculation of Dynamic Viscosity)
D 924 – 04	Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
D 971 – 04	Interfacial Tension of Oil against Water by the Ring Method
D 974 – 06	Acid and Base Number by Color-Indicator Titration
D 1500 – 04	ASTM Color of Petroleum Products (ASTM Color Scale)
D 1524 – 04	Visual Examination of Used Electrical Insulation Oils of Petroleum Origin in the Field
D 1533 – 05	Water in Insulating Liquids by Coulometric Karl Fischer Titration

B. **Institute of Electrical and Electronics Engineers (IEEE) Standards:**

C57.12.00 – 06	Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
C57.12.29 – 05	Switchgear and Transformers-Pad-Mounted Equipment-Enclosure Integrity for Coastal Environments

C57.12.90 – 06	Test Code of Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
386 – 06	Separable Insulated Connector Systems for Power Distribution Systems above 600V.
C57.12.34 – 04	Standard Requirements for Pad-Mounted Compartmental – Type, Self Cooled, Three Phase Distribution Transformers (2500 kVA and Smaller High – voltage 34 500 GrdY/19 920 Volts and Below; Low – Voltage: 480 Volts and Below.

### 1.03 REQUIREMENTS:

#### A. Capacity:

1. Transformer shall be standardized in size as much as possible.
2. Transformer shall have 20% spare capacity, in addition to having the capacity to carry the load connected and the transferred load from the adjacent transformer, in case of failure of the adjacent transformer. <sup>A17</sup>Refer to one line diagram Drawings No.5802-400 and 5803-400 for reference. (Refer to Vol. VI, Part 1, for location of drawings). <sup>A17</sup>

- B. **Short Circuit Capability:** Each transformer shall be capable of withstanding, without damage, the mechanical and thermal stresses produced by external short circuits in accordance with IEEE C57.12.00, <sup>A17</sup>short circuit capability of the transformer shall exceed the short circuit current available at the point of installation of the transformer, as determined by the study required in Section 7 (*Short Circuit and Load Flow Coordination Study*). Short circuit capability calculations shall be submitted in lieu of short-circuit test. <sup>A17</sup>

- C. **Transformer Regulation:** Transformer regulation for the rated voltage, kVA, and frequency shall be determined in accordance with IEEE C57.12.00.

- D. **Corrosion Resistance:** All interior and exterior ferrous metal shall be cleaned and painted with corrosion protective coating system as per IEEE C57.12.29 and Section 09 96 00 (*Corrosion Control Coatings*).

- E. **Appearance:** The coating color of the transformer tank, including radiators, shall be ANSI Standard 61 Light Gray.

- F. **Protection:** Transformers shall be protected from direct impact from vehicles.

- G. **Installation:** Transformers shall be installed in concrete pedestals with dedicated manhole for cabling.

- H. **Standard Products:** Materials and equipment submitted for approval shall be standard cataloged products of concerns regularly engaged in the commercial production of these products and shall be the latest standard design that conforms to the specifications.

**1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:**

A. **Pad-Mounted Transformer:**

1. **General:** The Contractor shall furnish pad-mounted transformers as specified, outdoor, with flame retardant, ambient friendly oil, three phase, 60 Hz, as specified below:

a.	Rated kVA @ 65 °C Self Cooled:	Sized by Contractor
b.	Phase:	3
c.	Hertz:	60
d.	High Voltage:	12000 V
e.	Low Voltage:	480Y/277V
f.	Connection (High-Low):	Delta-Wye
g.	Windings material (High-Low):	Copper - Copper
h.	High Voltage Taps:	As Specified
h.	Impedance at Self-Cooled:	5.75% ± 7.5%
i.	Distribution type:	Radial-Feed

2. **Rating:** The transformers shall be three phase, 60hertz, and be filled with flame retardant, biodegradable and ambient friendly oil, Class OA, No-Load high voltage tap changer. The core material shall be high-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10 percent over-voltage excitation. The cores shall be properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses. The kVA rating to be determined by Contractor
3. **Temperature Rise:** For continuous operation at nominal rating, kVA self cooled, the average winding temperature rise by resistance measurement shall not exceed 65°C, with hottest-spot winding temperature rise not to exceed 80°C and the temperature rise of the insulating oil shall not exceed 65°C when measured near the top of the tank, according to IEEE C57.12.34.
4. **Insulation:** The high-voltage winding insulation shall be 15kV class, 95 kV<sup>A17</sup>Basic impulse insulation level, and the low voltage winding insulation level shall be 30 kV basic impulse insulation level.<sup>A17</sup>

5. **Taps:** The transformers shall be provided with full capacity high voltage taps as follows: 12.6kV, 12.4kV, 12.0kV, 11.7kV and 11.4kV. The tap selection shall be made by means of a manual externally operated, no-load tap changer with means for padlocking the operating handle in each tap position, and with tap position indicator.
6. **Impedance:** The impedance of transformers shall be 5.75%. Impedance shall be record at 65°C, according to the IEEE C57.12.34. Tolerance shall be  $\pm 7.5\%$ , according to the IEEE C57.12.00.
7. **Tank:**
  - a. The pad-mounted transformer shall consist of a transformer tank and full-height, bolt-on high- and low-voltage cable terminating compartments located side-by-side separated by a rigid metal barrier. The tank base must be designed to allow rolling or skidding in any direction.
  - b. Each compartment shall have separate doors, designed to provide access to the high-voltage compartment only after the low-voltage has been opened. A hex-head bolt shall be incorporated into the high voltage door latching mechanism, accessible only after the low-voltage door has been opened, which must be removed to open the high-voltage door. Doors shall be mounted flush with the cabinet frame. The low-voltage door shall have a handle-operated, three-point latching mechanism designed to be secured with a single padlock. Both high- and low- voltage doors shall be equipped with lift-off type stainless steel hinges and doorstops to secure them in the open position.
  - c. Transformer main tank shall be supplied with a welded cover and be of a sealed-tank construction designed to withstand a pressure of 7 psi without permanent distortion and 15 psi without rupturing or displacing components of the unit or affecting cabinet security. The tank cover shall be domed to shed water and be supplied with a tamper-resistant access hand-hole sized to allow access to internal bushing and switch connections. The transformer shall remain effectively sealed for a top-oil temperature of -5°C to 105°C. When necessary to meet the temperature rise rating specified above, flat-cooling panels of the common header type shall be provided.
  - d. Compartment sills, doors and covers shall be removable to facilitate cable pulling and installation. The high-voltage door shall be on the left with the low-voltage door on the right. Compartments shall be designed for cable entry from below and shall be sized to the minimum dimensions of IEEE C57.12.34. The transformer shall be compartmental-type, self-cooled, and tamper resistant for mounting on a pad. The unit shall restrict the entry of water (other than flood water) into the compartments so as not to impair its operation. There shall be no exposed screws, bolts, or other fastening devices, which are externally removable.

8. **Features and Accessories:** The transformer shall be furnished complete with the following features and accessory equipment:
- a. Lifting hooks for lifting the completely assembled transformer.
  - b. Jack pads on case bottom for jacking complete transformer.
  - c. One or more hand-holes and manholes on cover for leads connection access and bushing removal.
  - d. Tank with welded cover suitably braced for partial vacuum, and capable of vacuum filling in the field.
  - e. Magnetic liquid gauge.
  - f. Dial-type liquid temperature indicator.
  - g. Transformer gas pressure/vacuum gauge
  - h. Upper filter press inlet 1" valve.
  - i. Lower filter press outlet 1" valve-drain with sampling device.
  - j. Automatic reset pressure-relief device with a flow of 35 SCFM at sea level and 15 psi at the transformer tank.
  - k. Two tank-grounding pads tapped for and furnished with suitable connectors for 250 MCM bare stranded copper ground cable.
  - l. Standard diagrammatic nameplate conforming to IEEE C57.12.00
  - m. Skid surface provisions.
  - n. High temperature prealarm and alarm sensor with remote indication
9. **Bushings:**
- a. **High-Voltage Bushings:** Provide high-voltage integral bushings Radial-Feed configuration on the high-voltage compartment of the transformers suitable for load-break elbow terminations, 200A and 15kV class, 95kV BIL rating. Elbows terminations shall include insulating plugs with test point and test point caps. Contractor shall coordinate termination size with the cable dimensions. The bushings shall comply with IEEE C57.12.00 and C57.12.34.
  - b. **Low-Voltage Bushings:** Provide four epoxy or porcelain bushings enclosed in low-voltage compartment as per IEEE C57.12.34. Terminal shall copper plated six holes NEMA configuration per IEEE C57.12.34. Bushings shall be rated for full transformer capacity. Bushings shall be able to be replaced, hand holes must be provided if necessary.
10. **Over-current protection:** Transformers shall be protected for internal transformer fault and thermal protection. For 500kVA and above: The transformer shall have bayonet type cutout with oil immersed expulsion current limiting fuses.

11. **Load-break oil-immersed switches:** The transformer shall have an on/off radial switch with three internal oil immersed ganged, manually operated load-break switches installed. The switches shall sectionalize the incoming lines and transformer. Switch handles shall be located in the primary compartment and must be hot-stick operable. Switches shall meet the following ratings:
  - a. Voltage Rating: 15 kV
  - b. BIL: 95 kV
  - c. One-minute Withstand: 34 kV
  - d. Maximum Continuous & Load-break Current: 200 A
  - e. Momentary and Fault Close Current: 10,000 A RMS symmetrical
  - f. Momentary and Fault Close Current: 10,000 A RMS asymmetrical
12. **Insulating oil:** Transformer oil must be biodegradable, ambient friendly, flame retardant type. Oil fluid shall be Envirotemp® FR3® fluid from Cooper Power Systems or an equivalent ambient friendly fluid. The transformer manufacturer shall certify that the transformer's oil is Non-PCB containing no PCB's.
13. **Nameplates:** Equipment shall have manufacturer's name, address, catalog number, model, style or type identified and technical data as kVA, voltages, current, Hz, etc. on a plate securely and conspicuously attached to each item of equipment. Nameplates for electrical apparatus shall be stainless steel and conform to IEEE C57.12.00.

#### 1.05 SUBMITTALS:

##### A. Before Manufacture:

1. **Certifications:** Electrical materials shall be new and listed by the Underwriters Laboratories, Inc., wherever standards have been established by that agency.
2. **Standard Products:** Materials and equipment submitted for approval shall be standard cataloged products of concerns regularly engaged in the commercial production of these products and shall be the latest standard design that conforms to the specifications.
3. **Drawings and Descriptive Literature:** The Contractor shall submit to the Employer's Representative for review, copies of drawings and literature describing the equipment furnished and including, but not limited to, the following items:
  - a. Detailed dimension drawings of the transformers, and accessory equipment.
  - b. Connection diagrams.
  - c. Transformer nameplate.

- d. Technical Literature and Material Safety Data Sheet for transformer's oil.

**B. Before Shipment:**

1. **Final manufacturing Drawings:** After the transformer have been manufactured, and before installation, the Contractor shall furnish drawings of each final drawing, and shall include all authorized changes made during the course of manufacture.
2. <sup>A16</sup>**Reserved.** <sup>A16</sup>
3. **Factory Test Reports:** Submit certified factory test reports of all factory tests performed by the manufacturer, including tests required by the applicable standards. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted following successful completion of the tests.
4. **Installation Manuals and Field Test Procedures:** Submit copies of installation manuals and field test procedures for the pad-mounted transformers. The manufacturer's pass/fail criteria for field tests shall be included.
5. **Field Test Plan:** Submit a proposed field test plan, prior to testing equipment and subsystems. No field test shall be performed until the test plan has been reviewed by the Employer's Representative. The test plan shall consist of the manufacturer recommended field test procedures, including tests to be performed, qualifications of personnel performing the testing, test equipment required, pass/fail criteria and tolerance limits. In addition to the manufacturer recommended tests, field testing shall be in accordance with the applicable requirements in Section 26 90 00 (*Field Testing Electrical Systems*). After completion of field testing, submit Certified Field Test Reports.

**C. Before Taking Over:**

1. **Equipment List:** Shall provide an electronic data base of all installed Pad-Mounted transformers with the following information:
  - a. Unit Identification (name or number)
  - b. Manufacturer & Serial Number
  - c. Voltages primary/secondary
  - d. kVA rating
  - e. Location
  - f. Tap position
  - g. Protection settings
2. Field Tests Report.

**D. <sup>A16</sup>Reserved <sup>A16</sup>**

## 1.06 Quality Assurance:

- A. **Manufacturer:** The manufacturer shall be a firm specialized in manufacturing pad-mounted transformers with minimum ten years documented experience.
- B. **Applicable Standards:** <sup>A17</sup>The transformers shall be designed and tested by the manufacturer in accordance with IEEE C57.12.90. <sup>A17</sup> When applicable certified test of similar equipment are acceptable.
- C. **Defective Material:** Defective material or material damaged in the course of shipment, transportation or test shall be replaced or repaired in a manner meeting with the approval of the Employer's Representative.
- D. **Certifications:** All transformers shall be UL listed and bear the UL label
- E. **Testing**
  - 1. **Factory Tests:** The following standard factory tests shall be performed on the equipment provided under this Section. All tests shall be in accordance with the latest version of ASTM and IEEE standards.
    - a. Resistance measurements of all windings on the rated voltage connection of each unit and at the top extremes.
    - b. Ratio tests on the rated voltage connection and on all tap connections.
    - c. Polarity and phase relation tests on the rated voltage connection.
    - d. No-load losses at rated voltage and frequency on the rated voltage connection.
    - e. Excitation current at rated voltage on the rated voltage connection.
    - f. Impedance and load losses at rated current and frequency on the rated voltage connection.
    - g. <sup>A17</sup>Temperature rise <sup>A17</sup> tests, at minimum and maximum ratings shall be made when there is no record available of a temperature test, made in accordance with IEEE standards, on a unit with essentially the same thermal characteristics.
    - h. Applied potential tests to determine the adequacy of the barrier insulation and the space between windings and ground.
    - i. Induced potential test to test turns insulation.
    - j. Dielectric Tests
    - k. Low Frequency



I. Lightning Impulse

2. **Testing the Insulation Fluid:** The Employer reserves the right to conduct any of the tests listed in part of this paragraph. The comparison parameters shall be supplied by the oil manufacturer. The table listed below is based on Envirotemp® FR3® fluid from Cooper Power Systems. When tested, the dielectric breakdown voltage of the oil shall be greater than 50 kV. Employer's Representative will not accept a transformer that does not pass this test.

- a. The Contractor shall test the oil for the transformers as per the ASTM standard listed below. Oil exhibiting the following characteristics shall be considered acceptable.

PROPERTY	VALUE	ASTM No.
Dielectric strength, 0.100" gap	50 kV min	D877
Neutralization number, mg	0.06 max	D 974
Color	L0.5 max	D1500
Condition, visual clear	Clear, light green	D1524
Moisture content, mg/kg	50 max	D1533
Interfacial tension, dynes/cm	35 min	D 971
Dissipation factor @ 25°C, %	0.06 max	D 924
Power factor @ 100°C, per cent	3.0 max	D 924
Flash point, °C	300 min	D92
Fire point, °C	340 min	D92
Viscosity @ 100°C, cSt	9 max	D445
Viscosity @ 25°C, cSt	35 max	D445

3. **Field Tests:** The Contractor shall perform the field tests in accordance with the Field Test Plan.
4. <sup>A17</sup>**Commissioning:** Shall conform to Section 01 91 00 (*Tests on Completion and Tests After Completion*).<sup>A17</sup>

**END OF SECTION**

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