SECTION 26 20 00

TRANSFORMERS

PART 1 - DESIGN DIRECTIVES

1.1 RELATED SECTIONS

- A. Section 26 21 00 Low-Voltage Feeder Entrance
- B. Section 26 10 00 Medium Voltage Feeder Entrance
- C. Power Study Short Circuit, Overcurrent Coordination and Arc Flash Hazard Analysis Study
- D. Section 26 05 26 Grounding and Bonding for Electrical Systems
- E. Identification/Labeling
- F. Submittals
- G. Close-Out Documents

1.2 DESIGN CRITERIA

- A. System Design
 - 1. No transformer connected to the 4.16 kV system shall be specified to be larger than 1500 KVA. Should the load require transformation greater than 1500 KVA a double-ended unit substation shall be specified.
 - 2. No transformer connected to the 13.2 kV system shall be specified to be larger than 1500 KVA. Should the load require transformation greater than 2000 KVA a double-ended unit substation shall be specified.
 - 3. Medium voltage transformer fuse sizes shall be reviewed by Dartmouth College FOM-Engineering approved MV system engineers.
 - 4. Transformers rated 750 KVA through 1500 KVA connected to the 4.16 kV distribution system shall have primary fusing in accordance with the table below to ensure coordination with upstream overcurrent relay settings:

a.	750 KVA	100 E max
b.	1000 KVA	150E max

- c. 1500 KVA 200E max
- B. Pad-Mount Transformers Medium Voltage Rated
 - 1. Copper windings.
 - 2. Coolant and insulating fluid shall be less flammable seed-oil based, Envirotemp[™] FR3[™] fluid
 - 3. The transformer shall have a 75 °C average winding temperature rise rating. The above winding temperature rise shall not exceed 75 °C when loaded at base kVA rating.

- 4. The high voltage terminations and equipment shall be dead front.
 - a. HV dead front bushings shall be 600 Amp, one-piece integrated, with removable stud, for use with separable connectors. Bushings shall be externally clamped and front removable.
- 5. The low voltage bushings (<600V) shall be molded polymer and provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical take-off.
- 6. The low voltage neutral shall be an insulated bushing, grounded to the tank by a removable ground strap.
- 7. Switch(es) shall consist of a load break, gang operated, liquid immersed switch that is externally operable from the high voltage compartment using a distribution hot-stick. Switch(es) shall be:
 - a. Liquid-immersed, rated at: 600 A
 - b. Three 2-position switches to be used as "sectionalizing" switches on loopfeed system with feed-from- the-left, feed-from-the-right, isolated-fromeither-side, or through-feed-to-both-sides.
- 8. Provide Bay-O-Net liquid immersed fuses that are externally replaceable with a hot-stick without opening the transformer tank.
- 9. The following accessories shall be provided:
 - a. Nameplate in low voltage compartment.
 - b. 1" upper filter press and filling plug
 - c. Tap changer with silver-plated stationary and movable contacts, for deenergized operation only, which is externally operable and pad-lockable.
 - d. Dial type thermometer.
 - e. Magnetic liquid-level gauge.
 - f. Pressure vacuum gauge.
 - g. Automatic pressure relief device (self-resealing with indicator).
 - h. Nitrogen blanket.
 - i. Pentahead bolts for compartment doors.
 - j. External drain valve with sampler A 1.0" drain valve with sampling device shall be located outside of the cable compartment on the low voltage side of the tank. A pressure vacuum gauge shall be provided adjacent to the drain valve. The valve and gauge shall be protected by a hinged cover box with padlock provisions. Setup shall be equivalent to SD Myers SampleSafe.
 - k. Additional transformer rating nameplate In addition to the standard nameplate located on the transformer tank, a second nameplate shall be included. The nameplate shall be mounted external to the termination compartments with an industrial grade double-sided adhesive. Its location shall be identified on the data sheet.
 - 1. Surge Arrestors
 - m. Three spare fuses shall be supplied.
- C. Interior Oil-Filled Transformers
 - 1. Copper wound.
 - 2. Coolant and insulating fluid shall be less flammable seed-oil based, Envirotemp[™] FR3[™] fluid
 - 3. The transformer shall have a 75 °C average winding temperature rise rating. The above winding temperature rise shall not exceed 75 °C when loaded at base kVA rating.

- 4. Transformers shall be equipped with four full capacity taps on the HV winding rated $2\frac{1}{2}$, two above and two below, nominal voltage.
- 5. Provided with containment tank, or other spill containment means.
- D. Dry Type Transformer 300 kVA and above:
 - 1. Copper wound.
 - 2. Cast Coil for demanding environments- exterior, roof, unfiltered air locations.
 - 3. Vacuum Pressure Impregnated (VPI) as a minimum for all other interior locations.
 - 4. 220 degree C insulation system designed to operate at a temperature rise of 80 degrees C.
 - 5. Transformers shall be equipped with four full capacity taps on the HV winding rated $2\frac{1}{2}$, two above and two below, nominal voltage.
 - 6. Equipped with a forced cooling package and three phase electronic temperature monitor.
- E. Dry Type Transformer below 300 kVA:
 - 1. Aluminum or copper wound.
 - 220 degree C insulation system designed to operate at a temperature rise of 150 degrees C. (Alternate pricing shall also be included for all transformers below 300KVA for 80 degree C rise construction).
 - 3. Transformers shall be equipped with four full capacity taps on the HV winding rated $2\frac{1}{2}$, two above and two below, nominal voltage.

1.3 SUBMITTAL REQUIREMENTS

- A. Shop Drawings for purchase approval
 - 1. Since the nameplate on a transformer today does not accurately indicate the manufacturer of the unit the contractor shall be instructed to procure the transformers in the project from the same manufacturer that is supplying the switchboards and other major components of the system. The following submittal information must always be provided:
 - 2. Provide transformer dimensional information to include length, depth and height of the overall enclosure and size of conduit entry spaces and recommended installation clearances. Close coupled switchboard and transformer combinations shall have coordination drawings for review by the owner.
 - 3. Elevation and plan views showing all connections and internal bus layout
 - 4. No-load losses and load losses for 25%, 50%, 75% and 100% of rated load.
 - 5. Primary and secondary connections and ratings for current and voltage.
 - 6. Percent Impedance (guaranteed).
 - The submittal shall also state if the transformer offered meets NEMA Standard TP-1-1999. If the transformer does not meet NEMA TP-1-1999 an alternate price shall be included to provide a unit so rated.
 - 8. The designer shall request the loss ratio of the transformer be included as part of the submittal package to aid in the evaluation of the efficiency of a given transformer at the load applied.
 - 9. Alternate pricing shall also be included for all transformers below 300KVA for 80 degree C rise construction.

PART 2 - PRODUCTS

- A. Approved Manufacturers
 - 1. ABB
 - 2. Eaton/Cooper
 - 3. Schneider Electric

PART 3 - EXECUTION

3.1 INSTALLATION

- 1. Unit substations and pad mounted transformers shall be securely fastened to the housekeeping pad on which they are mounted.
- 2. Where transformers are directly coupled to the switchboard the line-up shall be provided with a high voltage cable enclosure for the primary connections to the transformer.
- 3. Connection of primary and secondary conductors to unit substations shall be made via under floor raceways whenever possible. If pits are employed under the primary connection enclosure the rules found in section 16425 (Switchboards) shall apply.
- 4. Conductors connected to free-standing transformers shall enter the enclosure below the bottom of the transformer windings or within the manufacturer's recommendations, whichever is lower.
- 5. Raceways enclosing transformer conductors shall be connected to transformer enclosures by means of flexible conduit. Raceways containing a grounding electrode conductor without phase conductors shall be nonmetallic.
- 6. Clear space around ventilation openings shall conform to manufacturer's specifications and NEC Article 450-9.

3.2 IDENTIFICATION, LABELLING

- A. Pad Mount transformers
 - 1. All identification and warning labels and nameplates exterior to the MV Transformer shall be resistant to weather, UV, and their intended installation environment.
 - 2. Each MV Transformer shall be provided with an engraved nameplate identifying the project specific equipment tag and service description.
 - 3. Warning labels and nameplates shall be present at access locations to advise personnel of possible hazards.

3.3 ACCEPTANCE TESTING, START-UP AND ENERGIZING

- A. Start-up and Energizing requirements: (See LV &MV Building Entrance for complete building energizing requirements)
- B. Transformers over 225 kVA shall be tested by third party testing company per specifications, and test reports delivery to DC-FOM Engineering and project commissioning agent.

- C. Testing shall be done in accordance with IEEE C57.12.91□ and shall include, as the minimum, the following tests:
 - 1. Ratio
 - 2. Polarity
 - 3. Phase Rotation
 - 4. No-Load Loss
 - 5. Excitation Current
 - 6. Impedance Voltage
 - 7. Load Loss
 - 8. Applied Potential
 - 9. Induced Potential
 - 10. QC Impulse Test
 - 11. Temperature Test [Typical test data from previous testing may be used.]
 - 12. Sound Test [Typical test data from previous testing may be used.]
- D. Transformers shall be started up and tested by manufacturer per specifications, and reports delivered to DC-FOM Engineering and project commissioning agent.
- E. Transformers shall be cleaned, wiped with lint free rags to be free of all dust and dirt.

3.4 TRANSFORMER OIL HANDLING AND REPORTING

- A. Oil removed from tanks for disposal/recycling should be moved in an approved container for transportation to a hazardous waste accumulation area for disposal by Dartmouth College Environmental Health & Safety through an approved vendor.
- B. Devices containing 55-gallons or more of oil, gas, or another hydraulic fluid shall be reported to Dartmouth College Environmental Health & Safety if they are being installed, removed, or modified.
- C. Existing transformers that are being taken out of service should be evaluated by Dartmouth College Environmental Health & Safety to determine if PCBs are present and may need to be cleaned or disposed of as a hazardous waste.

END OF SECTION