GENERAL:

The scope of this document is to provide instruction for the installation and testing of Medium Voltage, 3 Phase, Pad Mounted Transformers installed at the University of Missouri. Preferred transformers are of pad mounted construction. Special consideration can be made with approval from Owner for installation of indoor type transformers.

DESIGN GUIDELINES:

A. Materials

1. General
   1.1. General Specifications
      1.1.1. The transformer shall be outdoor rated
      1.1.2. Less-flammable liquid filled
      1.1.3. Pad mounted
      1.1.4. Dead-front
      1.1.5. Switching options for radial or loop *(as coordinated with system owner)*
      1.1.6. Standard sizes in table below:

Voltage	Size kVA									
120/208V	75	112.5	150	225	300	500	750	1000	1500	
277/480V				225	300	500	750	1000	1500	2000

      1.1.7. All exterior surfaces shall be designed to prevent holding or pooling of water or liquids.
   1.2. Ratings
      1.2.1. kVA Rating (*as coordinated with system owner*).
      1.2.2. Nominal Primary voltage shall be 13,800 volts line-to-line, three-phase, delta connected.
      1.2.3. Nominal secondary voltage 277/480Y Volts or 120/208Y Volts (4-wire wye secondary).
      1.2.4. Standard kVA ratings only.
      1.2.5. Maximum kVA for 120/208Y Volts shall be 1500kVA
      1.2.6. Maximum kVA for 277/408Y Volts shall be 2000kVA

   1.3. Efficiency, Impedance, and Losses
      1.3.1. Transformer efficiency shall meet all DOE 2010, 10 CFR Part 431 requirements.
      1.3.2. Percent impedance shall meet all applicable standards.

1.4. Required Standards
1.4.1. All equipment shall conform to the latest revision of all applicable standards. A listing of these standards includes, but is not limited to:
1.4.1.1. NEMA
1.4.1.2. NESC
1.4.1.3. NEC
1.4.1.4. ANSI
1.4.1.5. IEEE
1.4.1.6. Federal Occupational Safety and Health Standards

2. Construction Features
2.1. Pad Mount (ANSI Standard C57.12, latest revision).
2.2. Compartment type
2.2.1. The transformer shall have high and low voltage compartments assembled side by side as an integral unit with no live parts accessible without opening the compartment doors.
2.2.2. Depth of compartment shall be 24 inches minimum.
2.2.3. The high voltage compartment shall be located on the left.
2.2.4. High voltage compartment shall be separated from the low voltage compartment by a metal barrier.
2.2.5. No bolts, screws or other fastening devices shall be externally removable.
2.2.6. There shall be no openings where sticks, rods or other devices could be inserted and contact live parts.
2.2.7. Compartments shall limit water entry.
2.2.8. A clear, non-conductive, hinged barrier with latching mechanism shall be installed in the low voltage compartment in a manner which will completely restrict access to the low voltage compartment with barrier in closed position. Barrier shall be clearly marked “Danger Arc Flash Hazard”.
2.2.9. Low voltage bushings shall be supported to the top of transformer to prevent oil leaking from the bushing due to the weight of the cables attached to them.
2.3 Liquid immersed
2.4 Self cooled
2.5 Bolt-on covers
2.6 Equipment must be new; re-manufactured equipment will not be accepted.

2.7 Noise level Requirement
2.7.1 IEEE/ANSI/NEMA standards
2.7.2 Not to exceed the levels given by NEMA TR1-1980

2.8 Transformer enclosure
2.8.1 Supplied with jacking provisions and lugs for lifting.
2.8.2 Enclosure and base constructed for sliding and rolling.
2.8.3 Enclosure shall be tamper proof.
2.8.4 Shall prevent accumulation and pooling of water.

2.9 Doors
- 2.9.1 The secondary door shall include provisions for a lock, which must be removed to remove the penta-head bolt.
- 2.9.2 The primary door shall be separate and interlock with the secondary door in a manner, which the secondary door must be opened first before the primary door can be opened.
- 2.9.3 The primary door shall also be secured by penta-head bolts other than the bolts securing the secondary door.

2.10 Paint
- 2.10.1 Munsell green #7.0GY3.29/1.5
- 2.10.2 Minimum Thickness of 2.5 MIL
- 2.10.3 A small container of touch up paint shall be supplied with the transformer and given to system owner.

2.11 Fault Indicator (***Loop Feed Installations only***)
- 2.11.1 Bottom sill of primary compartment shall have a hole capable of mounting a Fisher Pierce model 1515WB-12A3-10SL-B fault indicator.
- 2.11.2 The hole shall have a permanent cover installed prior to shipping which can be removed only from the inside of the compartment.

3. Electrical Specifications

3.1. 3 Phase

3.2. 60 Hertz

3.3. Primary Windings
- 3.3.1. Copper conductors.
- 3.3.2. Primary windings should be transposed for reduced losses at fundamental (60Hz) and harmonic frequencies, if advisable per manufacturer.
- 3.3.3. Primary windings shall be designed to withstand high 3rd, 9th, and 15th harmonic circulating currents.

3.4. Secondary Windings
- 3.4.1. Copper Conductors
- 3.4.2. Secondary Windings should be transposed for reduced losses, at fundamental (60Hz) and harmonic frequencies, if advisable per manufacturer.
- 3.4.3. Use smaller paralleled conductors instead of one larger cross-section single conductor or a single thin tape type of conductor.
- 3.4.4. Individual conductors shall be insulated.

3.5. Transformer Core
- 3.5.1. Steel core stock
- 3.5.2. Core shall be designed and constructed to reduce eddy current losses at fundamental and harmonic frequencies.

3.6. Neutral Conductor
- 3.6.1. Sized to handle up to 2 times the rated phase current continuously.

3.7. Wiring Connections
- 3.7.1. Suitable for Copper or Aluminum termination lugs.
- 3.7.2. Low voltage terminals shall be tinned spade having eight (8) – 9/16" holes on 1 ¾" centers for conductor connections.
- 3.7.3. Low voltage service conductors shall use 2-hole compression type lugs.

3.8. Arrestors
- 3.8.1. Three (3) – 10kV rated, 8.4kV MCOV, elbow type.
- 3.8.2. Transformer must have mountings provided for lightning arrestors.

3.9. Primary Bushings
- 3.9.1. Shall have a 95kV BIL rating
- 3.9.2. Shall have 15kVA, 600A bushings for no-load break, bolted elbow connection
- 3.9.3. Shall conform to ANSI/IEEE Standard 386 (ANSI Standard C119.2)
- 3.9.4. Shall include a semi-conductive coating.
- 3.9.5. Shall be mounted in such a way that the semiconductive coating is solidly grounded to the tank.
- 3.9.6. Shall have covers in place for shipping and storage.
- 3.9.7. Dead Front
  - 3.9.7.1. Radial Feed
    - 3.9.7.1.1. (1) Three (3) - 600A primary bushing, suitable for delta connection of 13,800V dead break elbow connectors.
  - 3.9.7.2 Loop Feed
    - 3.9.7.2.1 (1) Six (6) - 600A primary bushing, suitable for delta connection of 13,800V dead break elbow connectors

3.10. Secondary bushings
- 3.10.1. Four secondary bushings shall be supplied for wye connections
- 3.10.2. Shall have a 30kV BIL rating with a tinned spade having eight (8) - 9/16" holes on 1 ¾" centers for conductor connections
- 3.10.3. Shall be supported to the top of transformer to prevent oil leaking from the bushing due to the weight of the cables attached to them.

3.11. Primary Voltage Taps shall be supplied to provide five (5) - 2.5% no load tap changes, two above and two below rated voltage.

3.12. Fusing
- 3.12.1. Oil immersed bayonet expulsion fuses and in-tank, current limiting fuses.
- 3.12.2. Bayonet fuses shall be removable with a hot stick.

3.12.3. Current limiting fuses shall have an interrupting capacity greater than 40,000A
3.12.4. Fusing combination shall provide full range protection for low and high current faults
3.12.5. Three spare bayonet fuses shall be supplied with the transformer. *(This totals six bayonet fuses.)*
3.12.6. The let-through current of the in-tank current limiting fuse cannot exceed the interrupting rating of the switch specified

4. Insulating Media and Ratings
4.1. Maximum average winding temperature rise of 65 degrees C

4.2. Winding insulation shall have a rating of 120 degrees C

4.3. Transformer shall have ambient temperature rating of 40 degrees C

4.4. Transformer shall be filled with a nonflammable fluid (mineral oil is not acceptable).
4.4.1. Liquid level indicator shall be supplied and located inside the low voltage compartment.
4.4.2. Drain valve and sampling device shall be installed in the primary compartment.
4.4.3. Pressure relief valve
4.4.3.1. A pressure relief valve shall be supplied.
4.4.3.2. Qualitrol series 201 pressure relief valve or approved equal for NEC code 450-23 application
4.4.3.3. Volume of valve must meet all applicable codes
4.4.4. Temperature indicator shall be supplied.

5. Switching
5.1. Switching needs for radial fed configuration
5.1.1. One 300A in-tank two position load break radial switch to turn the transformer on/off.

5.2. Switching needs for loop fed configuration
5.2.1. Three 300A load break switches
5.2.2. This allows for transformer on/off and two line terminals each with on/off

5.3. Switch must be rated to interrupt the current for the transformer

5.4. Switch must be capable of being operated with a hot stick

6. Grounding
6.1. Three grounding connections, each with two (2) ½"-13 UNC tapped holes
6.1.1. Primary compartment
6.1.2. Secondary compartment
6.1.3. Outside of the enclosure on the tank

6.2. A copper connection strap from the neutral to ground shall be supplied.

7. Nameplate
   7.1. The nameplate shall be engraved.

   7.2. In addition to normal information, the following items shall be included on the nameplate of each unit:
      7.2.1. kVA ratings
      7.2.2. Primary voltage
      7.2.3. Secondary voltage
      7.2.4. BIL ratings
      7.2.5. Temperature ratings
      7.2.6. Primary and Secondary voltages for each tap setting
      7.2.7. Date of Manufacture.
      7.2.8. Name of Manufacturer.
      7.2.9. Transformer K factor (if rated)
      7.2.10. Type of conductor in windings.
      7.2.11. Impedance expressed in percentage.
      7.2.12. Detail circuit diagrams of primary switch configuration and switch ratings.
      7.2.13. Delta - wye or delta -delta diagram detailing the relationship of primary to secondary bushings.
      7.2.14. Statement "Transformer filled with less-flammable fluid".
      7.2.15. Statement "Transformer filled with fluid containing no detectable PCB's at time of manufacture."
      7.2.16. Total weight of unit expressed in pounds.
      7.2.17. Weight of unit without oil.

8. Labeling
   8.1. Standard labeling for pad-mounted equipment

   8.2. Transformer shall have a blue "CONTAINS NO PCB's" label placed inside of the secondary compartment door and another same label placed on the outside of the tank

   8.3. Transformer shall have a "Danger-High Voltage" label on the outside of the primary compartment door meeting all applicable standards

   8.4. Transformer shall have "Secondary Barrier Installed" label installed on the outside of the secondary compartment door.

9. Submittials
   9.1. MU Only: Campus Facilities - Energy Management Electric Distribution must approve the construction drawings prior to construction of each type of transformer supplied.

B. Installation

1. Refer to Transformer Pad Detail drawing for foundation and mounting requirements.

1.1. Care shall be taken during lifting/moving not to damage or bump the transformer.

1.2. Must have 8’ clear area in front of doors and 3’ clear area on the sides.

1.3. Locate unit in accessible location for maintenance, operation, and replacement.

1.4. Bollards may be needed.

1.5. Number and location of transformers coordinated with Owner’s Representative.

2. Grounding
   2.1. Must have one ground rod in opening

B. Testing

1. Tested impedance of the supplied transformer shall be in the range as specified.

2. MU Only: System owner unit perform TTR, Megger, and Ground testing prior energizing the transformer

C. Commissioning

1. MU Only: System owner will set the proper tap on the transformer, energize the transformer and check for proper voltage.

REFERENCES