

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 project manager for installation of dry type transformers.

DESIGN GUIDELINES:**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. Live-front or Dead-front (*as coordinated with system owner*)
- 1.1.5. Switching options for radial or loop (*as coordinated with system owner*)
- 1.1.6. Standard sizes in table below
- 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).

1.3. Impedance & Losses

- 1.3.1. Percent impedance and losses shall comply with values listed in Table below.

Size (kVA)	Secondary Voltage	Losses Not To Exceed (Watts)			Impedance (in the range of)
		No Load	Full Load	Total	
75	120/208	225	400	625	2.5% to 4.0%
112.5	120/208	325	575	900	2.5% to 4.0%
150	120/208	450	750	1200	2.5% to 4.0%
225	120/208	550	1100	1650	2.5% to 4.0%
300	120/208	700	1650	2350	2.5% to 4.0%
500	120/208	1000	3000	4000	5% to 6%
750	120/208	1200	5000	6200	5% to 6%
1000	120/208	1700	6500	8200	5% to 6%
1500	120/208	2200	10000	12200	5% to 6%
2000	120/208	2800	13500	16300	5% to 6%

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225	277/480	600	1200	1800	2.5% to 4.0%
300	277/480	750	1500	2250	2.5% to 4.0%
500	277/480	1000	2800	3800	5% to 6%
750	277/480	1200	4000	5200	5% to 6%
1000	277/480	1500	6500	8000	5% to 6%
1500	277/480	2200	9000	11200	5% to 6%
2000	277/480	2800	12000	14800	5% to 6%

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

1.5. Construction Features

1.5.1. Pad Mount (ANSI Standard C57.12, latest revision).

1.5.2. Compartment type

1.5.2.1. 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.

1.5.2.2. The high voltage compartment shall be located on the left.

1.5.2.3. High voltage compartment shall be separated from the low voltage compartment by a metal barrier.

1.5.2.4. No bolts, screws or other fastening devices shall be externally removable.

1.5.2.5. There shall be no openings where sticks, rods or other devices could be inserted and contact live parts.

1.5.2.6. Compartments shall limit water entry.

1.5.2.7. A non-conductive, removable barrier shall be installed in the high voltage compartment in a manner which will restrict access to the live front area without lifting and removing the barrier. Barrier shall be clearly marked "Danger High Voltage" (*Live Front Only*).

1.5.2.8. 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.

1.5.3. Liquid immersed

1.5.4. Self cooled

1.5.5. Bolt-on covers

1.5.6. Equipment must be new; re-manufactured equipment will not be accepted.

1.6. Noise level Requirement

1.6.1. IEEE/ANSI/NEMA standards

1.6.2. Not to exceed the levels given by NEMA TR1-1980

- 1.7. Transformer enclosure
 - 1.7.1. Supplied with jacking provisions and lugs for lifting.
 - 1.7.2. Enclosure and base constructed for sliding and rolling.
 - 1.7.3. Enclosure shall be tamper proof.
 - 1.7.4. Have self-starting penta-head bolts
 - 1.7.5. Shall prevent accumulation and pooling of water
- 1.8. Doors
 - 1.8.1. The secondary door shall include provisions for a lock, which must be removed to remove the penta-head bolt.
 - 1.8.2. 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.
 - 1.8.3. The primary door shall also be secured by penta-head bolts other than the bolts securing the secondary door.
- 1.9. Paint
 - 1.9.1. Munsell green #7.0GY3.29/1.5
 - 1.9.2. Minimum Thickness of 2.5 MIL
 - 1.9.3. A small container of touch up paint shall be supplied with the transformer and given to system owner.
- 1.10. Fault Indicator (***Loop Feed Installations only***)
 - 1.10.1. Bottom sill of primary compartment shall have a hole capable of mounting a Fisher Pierce model 1515WB-12A3-10SL-B fault indicator.
 - 1.10.2. The hole shall have a permanent cover installed prior to shipping which can be removed only from the inside of the compartment.
2. Electrical Specifications
 - 2.1. 3 Phase
 - 2.2. 60 Hertz
 - 2.3. Primary Windings
 - 2.3.1. Copper conductors.
 - 2.3.2. Primary windings should be transposed for reduced losses at fundamental (60Hz) and harmonic frequencies, if advisable per manufacturer.
 - 2.3.3. Primary windings shall be designed to withstand high 3rd, 9th, and 15th harmonic circulating currents.
 - 2.4. Secondary Windings
 - 2.4.1. Copper Conductors
 - 2.4.2. Secondary Windings should be transposed for reduced losses, at fundamental (60Hz) and harmonic frequencies, if advisable per manufacturer.
 - 2.4.3. Use smaller paralleled conductors instead of one larger cross-section single conductor or a single thin tape type of conductor.
 - 2.4.4. Individual conductors shall be insulated.
 - 2.5. Transformer Core

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- 2.5.1. Steel core stock
- 2.5.2. Core shall be designed and constructed to reduce eddy current losses at fundamental and harmonic frequencies.
- 2.6. Neutral Conductor
 - 2.6.1. Sized to handle up to 2 times the rated phase current continuously.
- 2.7. Wiring Connections
 - 2.7.1. Suitable for Copper or Aluminum termination lugs.
 - 2.7.2. High voltage terminals shall be a two-hole lug type connection with 1/2" holes on 1 3/4" centers capable of connection either copper or aluminum (**Live Front Only**).
 - 2.7.3. Low voltage terminals shall be tinned spade having eight (8) – 9/16" holes on 1 3/4" centers for conductor connections.
- 2.8. Arrestors
 - 2.8.1. Three (3) – 10kV rated, 8.4kV MCOV
 - 2.8.2. Transformer must have mountings provided for lightning arrestors.
- 2.9. Primary Bushings
 - 2.9.1. Shall have a 95kV BIL rating
 - 2.9.2. Live Front
 - 2.9.2.1. Three (3) 15kV Live Front porcelain primary bushings, for a delta connection of 13,800V.
 - 2.9.3. Dead Front
 - 2.9.3.1. Six (6) - 15kV, 200A primary bushing wells, in accordance with ANSI standard C119.2, for a delta connection of 13,800V.
 - 2.9.3.2. Bushings for 200 Amp load break elbows shall be supplied for each well.
 - 2.9.3.3. Use other 3 bushings for arrestors if not a loop fed unit.
 - 2.9.3.4. Bushing wells shall have covers in place for shipping and storage
- 2.10. Secondary bushings
 - 2.10.1. Four secondary bushings shall be supplied for wye connections
 - 2.10.2. Shall have a 30kV BIL rating with a tinned spade having eight (8) - 9/16@ holes on 1 3/4" centers for conductor connections
 - 2.10.3. 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.
- 2.11. Primary Voltage Taps shall be supplied to provide five (5) - 2.5% no load tap changes, two above and two below rated voltage.
- 2.12. Fusing
 - 2.12.1. Oil immersed bayonet expulsion fuses and in-tank, current limiting fuses.
 - 2.12.2. Bayonet fuses shall be removable with a hot stick.
 - 2.12.3. Current limiting fuses shall have an interrupting capacity greater than 40,000A
 - 2.12.4. Fusing combination shall provide full range protection for low and high current faults

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- 2.12.5. Three spare bayonet fuses shall be supplied with the transformer. (*This totals six bayonet fuses.*)
 - 2.12.6. The let-through current of the in-tank current limiting fuse cannot exceed the interrupting rating of the switch specified
3. Insulating Media and Ratings
 - 3.1. Maximum average winding temperature rise of 65 degrees C
 - 3.2. Winding insulation shall have a rating of 120 degrees C
 - 3.3. Transformer shall have ambient temperature rating of 40 degrees C
 - 3.4. Transformer shall be filled with a nonflammable fluid (mineral oil is not acceptable).
 - 3.4.1. Liquid level indicator shall be supplied and located inside the low voltage compartment.
 - 3.4.2. Drain valve and sampling device shall be installed in the primary compartment.
 - 3.4.3. Pressure relief valve
 - 3.4.3.1. A pressure relief valve shall be supplied.
 - 3.4.3.2. Qualitrol series 201 pressure relief valve or approved equal for NEC code 450-23 application
 - 3.4.3.3. Volume of valve must meet all applicable codes
 - 3.4.4. Temperature indicator shall be supplied.
 4. Switching
 - 4.1. Switching needs for radial fed configuration
 - 4.1.1. One 300A in-tank two position load break radial switch
 - 4.1.2. One switch on primary to turn the transformer on/off
 - 4.2. Switching needs for loop fed configuration (***Dead Front Only***)
 - 4.2.1. Three 300A load break switches
 - 4.2.2. This allows for transformer on/off and two line terminals each with on/off
 - 4.3. Switch must be rated to interrupt the current for the transformer
 - 4.4. Switch must be capable of being operated with a hot stick
 5. Grounding
 - 5.1. Three grounding connections, each with two (2) 1/2@-13 UNC tapped holes
 - 5.1.1. Primary compartment
 - 5.1.2. Secondary compartment
 - 5.1.3. Outside of the tank
 - 5.2. A copper connection strap from the neutral to ground shall be supplied.
 6. Nameplate
 - 6.1. The nameplate shall be engraved.

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- 6.2. An addition to normal information, the following items shall be included on the nameplate of each unit:
 - 6.2.1. kVA ratings
 - 6.2.2. Primary voltage
 - 6.2.3. Secondary voltage
 - 6.2.4. BIL ratings
 - 6.2.5. Temperature ratings
 - 6.2.6. Primary and Secondary voltages for each tap setting
 - 6.2.7. Date of Manufacture.
 - 6.2.8. Name of Manufacturer.
 - 6.2.9. Transformer K factor (if rated)
 - 6.2.10. Type of conductor in windings.
 - 6.2.11. Impedance expressed in percentage.
 - 6.2.12. Detail circuit diagrams of primary switch configuration and switch ratings.
 - 6.2.13. Delta - wye or delta -delta diagram detailing the relationship of primary to secondary bushings.
 - 6.2.14. Statement "Transformer filled with less-flammable fluid".
 - 6.2.15. Statement "Transformer filled with fluid containing no detectable PCB's at time of manufacture."
 - 6.2.16. Total weight of unit expressed in pounds.
 - 6.2.17. Weight of unit without oil.
7. Labeling
 - 7.1. Standard labeling for pad-mounted equipment
 - 7.2. Transformer shall have a blue "CONTAINS NO PCBs" label placed inside of the secondary compartment door and another same label placed on the outside of the tank
 - 7.3. Transformer shall have a "Danger-High Voltage" label on the outside of the primary compartment door meeting all applicable standards
8. Submittals
 - 8.1. MU Only: Campus Facilities - Energy Management Electric Distribution must approve the construction drawings prior to construction of each type of transformer supplied.
 - 8.2. A completed "Transformer Losses in Watts" data sheet (see attached) must be completed and included in submittal for each type of transformer
 - 8.2.1. Losses cannot exceed the values listed in the table above
 - 8.2.2. A duly authorized officer of the transformer supplier company must sign the data sheet

Installation

1. Refer to Transformer Pad Detail.dwg 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 Energy Management Electric Distribution
2. Grounding
 - 2.1. Must have one ground rod in opening

Testing

1. Tested impedance of the supplied transformer shall be in the range as specified in the table above prior to delivery
2. System owner unit will perform TTR, Megger, and Ground testing prior energizing the transformer

Commissioning

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

REFERENCES