

V.C
PJM DESIGN & APPLICATION OF
LARGE POWER TRANSFORMERS

1.0 GENERAL REQUIREMENTS

- 1.1 The nominal voltage ratings of the effectively grounded transmission systems are 230 kV, 345 kV, and 500 kV. The 500 kV system frequently operates at 550 kV continuously. The 345 kV and 230 kV systems frequently, continuously operate at 362 kV and 242 kV respectively.
- 1.2 PJM requires that transformers which are designed to operate at 230 kV, 345 kV and 500 kV shall be designed for these voltages and shall be equipped to operate at these levels as indicated in these requirements.

2.0 SPECIFICATION

- 2.1 All transformers shall meet or exceed the latest applicable ANSI, IEEE, NEMA, ASME, ASTM, NESC and OSHA Standards and Loading Guides. In case of conflict, these standards shall govern in the order stated.
- 2.2 Transformers shall also be designed with adequate electrical and mechanical characteristics for the specific electrical system on which it is installed and for the application for which it is intended. These include but shall not be limited to: continuous current rating, short-circuit capability, operating voltage, BIL, and environmental conditions.
- 2.3 The following ratings apply to 500 kV transformers installed on the 500 kV system:
 - 2.3.1. Voltage Class
500 kV
 - 2.3.2. Maximum Rated Voltage
550 kV
 - 2.3.3. BIL
1675, 1550, 1425, 1300 (kV crest)Transformer BIL shall be carefully selected based on system studies, insulation coordination, and surge protection provided. Higher than minimum BIL levels should be considered.

- 2.4 The following ratings apply to 345 kV transformers installed on the 345 kV system:
- 2.4.1. Voltage Class
345 kV
 - 2.4.2. Maximum Rated Voltage 362 kV
 - 2.4.3. BIL 900, 1050, 1175 (kV crest)

Transformer BIL shall be carefully selected based on system studies, insulation coordination, and surge protection provided. Higher than minimum BIL levels should be considered.

- 2.5 The following ratings apply to 230 kV transformers installed on the 230 kV system:
- 2.5.1 Voltage Class
230 kV
 - 2.5.2 Maximum Rated Voltage 242 kV
 - 2.5.3 BIL 650, 750, 825, 900 (kV crest)

Transformer BIL shall be carefully selected based on system studies, insulation coordination, and surge protection provided. Higher than minimum BIL levels should be considered.

3.0 APPLICATION & SPECIAL CONSIDERATIONS

- 3.1 All transformer terminals shall be equipped with metal oxide surge arresters. The surge arresters shall be installed as close as possible to the transformer bushings keeping the lead length to a minimum and applied in accordance with the latest IEEE Standard C62 taking into account system grounding, transformer BIL levels and temporary over-voltages for abnormal system conditions and during faults. The surge arresters should provide adequate protective margins for chopped wave, basic insulation levels, switching surge and maximum continuous operating voltage
- 3.2 Transformer winding configurations and phase relationship shall be consistent with connection point in PJM system.
- 3.3 Transformer tertiary windings shall be appropriately sized for the intended use and must be properly protected.
- 3.4 Transformer cooling shall be supplied by two separate AC sources with automatic transfer capability.
- 3.5 At a minimum a transformer summary alarm shall be provided from the transformer to the control house.

- 3.3 Local environmental conditions should be considered when selecting creep requirements for transformer bushings.
- 3.4 Transformers, at a minimum, shall be designed to operate at ANSI required ambients of -4°F to +104°F (-20°C to +40°C). All transformers shall be designed to operate satisfactorily in the ambients dictated at their installed location. Start-up and operation of transformers with top oil less than -20°C is considered an unusual service condition by ANSI, and must be specified by purchaser of equipment. Some locations in PJM have required -40°C capability.
- 3.5 Firewalls shall be provided when required by the NFPA.
- 3.6 All environmental impacts of a transformer installation shall be considered, such as, sound, fire, leaks, etc.

4.0 MAINTENANCE

- 4.1 Transformers shall be designed for an in service operating life, considering normal routine maintenance, comparable to other electrical apparatus in the system to which it is applied. For typical maintenance requirements, refer to Section V.L.2.C

5.0 RATINGS

- 5.1 Transformer capability shall not limit the load capability of the circuit or station facility into which it is connected.
- 5.2 Ratings of electrical system apparatus, including transformers, are critical to the reliable operation of the PJM system. Ratings of transformers applied to the PJM system should be determined using the PJM TSDS guide "Guide for the Determination of Power Transformer Ratings" latest revision.