

4.1 Ambient temperature measurement

4.1.1 Types of equipment

Users have many choices for instruments to measure ambient temperature, including:

- Commercially available weather stations
- Substation hardened Electronic Temperature Monitors
- Standalone RTD, thermocouple, or thermistor sensor interfaces
- Mechanical temperature indicating devices using bi-metallic strip or gas or liquid filled capillary tubes linked to an indicating needle.

4.1.2 Locations of sensors and indicators

The location of sensors near power transformers requires care. The sensor should never be installed directly in sunlight or in close proximity of the transformer tank. Also, care should be taken to ensure that the sensor is shielded from strong air movement and always be mounted away from cooling fan inlets or outlets. The recommended mounting locations may be on the underneath of the transformer's control cabinet or on the lower side of the control cabinet, shielded from influences of the sun and wind.

4.1.3 Purpose of ambient temperature Measurement

Ambient temperature is an important measurable value, and is the "base reference" temperature to determine the thermal performance of a transformer, including top oil temperature rise and winding hottest spot temperature rise. IEEE Std C57.12.00 states that the temperature of the cooling air (ambient temperature) shall not exceed 40 °C above ambient temperature, and the average temperature of the cooling air (ambient temperature) for any 24 h period shall not exceed 30 °C. It also states that the average winding temperature rise above ambient temperature shall not exceed 65 °C. Also, maximum (hottest-spot) winding temperature rise above ambient temperature shall not exceed 80 °C above ambient.

In addition, IEEE Std C57.91 provides guidance on the influence of ambient temperature to transformer loading. IEEE Std C57.91 also states ambient temperature is an important factor in determining the load capability of a transformer, since temperature rises for any load must be added to the ambient temperature to determine maximum operating temperatures.

4.2 Insulating liquid temperature measurement

There are two different insulating liquid temperature measurements important to transformers: top oil temperature and bottom oil temperature.

4.2.1 Types of equipment

Users have many choices for instruments to measure insulating liquid temperature. These include:

- Substation hardened Electronic Temperature Monitors
- Mechanical temperature indicating devices using bi-metallic strip or gas or liquid filled capillary tubes linked to an indicating needle
- Standalone RTD, thermocouple, or thermistor sensor interfaces

4.2.2 Locations of sensors and indicators

4.2.2.1 Top oil temperature sensor locations

Top oil sensors should be mounted on the side of the transformer, in Segment 1 as per IEEE Std C57.12.10 and IEEE Std C57.12.36. The thermal sensing element shall be mounted on the tank wall, in a closed well at a suitable level to indicate the top-liquid temperature. The well shall be positioned so that it is covered by at least 2.5 cm (1 inch) of insulating liquid at the lowest permissible insulating liquid level. For dimensions of the well, see Figure 4 of IEEE Std C57.12.00–2015.

For transformers with conservators, with approval of the user, the manufacturer may install the top oil sensor in a closed well on the tank cover.

4.2.2.2 Bottom oil temperature sensor locations

Bottom oil sensors should be mounted on the side of the transformer in Segment 1 as per IEEE Std C57.12.10 and IEEE Std C57.12.36. The thermal sensing element shall be mounted on the tank wall in a closed well at a level of no less than 15.0 cm (6 inch) above the tank drain valve.

4.2.3 Special Measurement Conditions

Precautions should be taken when applying magnetic surface mount temperature probes for top or bottom oil temperatures. First, sensors mounted on the tank wall, if not designed to thermally isolate the sensing element from the housing, should be mounted side of the tank, not exposed to direct sunlight. Also, since the sensor is mounted on the tank wall will be lower by 3 to 5 °C inside insulating liquid temperature and should be factored into temperature set point settings.