
MAINTENANCE AND INSPECTION OF TRANSFORMER

1. Remarks on making maintenance and inspection

Since the following inspection may be accompanied with somewhat dangerous work, careful and detailed programs should be established in advance for the security of workers and the preservation of equipment by maintaining sufficient communications between associated organizations.

1.1 Inspection under service interruption

When intending to perform inspection under service interruption, it is absolutely necessary to examine pilot lamps and indicating plates of various disconnecting switches, circuit-breakers, moulded-core circuit-breakers, etc. to confirm whether the equipment under inspection is exactly separated from live circuits. In order to prevent careless reclosure, on the other hand, it is essential to lock the equipment by switching off the control power supply or evacuating the compressed air if equipment is of pneumatically operated type. Successively, the condition of no voltage must be checked by means of a voltage detector which is suitable for the system voltage. For the prevention of voltage induction and the enhancement of safety, terminals should be connected to earthing conductors prior to starting the inspection work.

It must be borne in mind that careless noticing of service interruption will result in a serious accident.

1.2 Internal inspection

Internal inspection can be carried out by several methods. The object may be examined through a handhole or inspection window, or by entering the transformer inside through a manhole. In some cases, the core and coils assembly may be lifted above the tank for inspection. In any case the transformer interior is exposed to the external air and it is therefore necessary to finish the work within the shortest possible time to prevent absorption of moisture. Inspection programs should have been established in advance and no mistakes must be involved in the procurement of working materials. Inspectors are required to be careful for their clothing and handling of goods in order not to drop foreign materials into the transformer interior. Even a single piece of pencil, for example, must not be put in a pocket, etc..

When entering the transformer tank while the outside temperature is high, inspectors should wear clothes which easily absorb sweat so that sweat cannot be scattered inside the transformer.

- (1) Arrangements must have been finished in advance so that inspection can be completed in one day. This program will be effective in reducing the time period in which the core and coils assembly is exposed to air.
- (2) Inspection should be carried out on a day when relative humidity is low so that insulating materials cannot absorb too much moisture. If the core and coils assembly has to be inspected at a high humidity for unavoidable reasons by draining the insulating oil, inspection can be forwarded while dry and fresh air is led into the inside of tank at all times.

- (3) When entering the transformer tank, each inspector must confirm whether the tank inside is full of fresh air.
- (4) In order to prevent each inspector from leaving tools carelessly behind the tank interior after inspection, it is necessary to confirm the number of tools carried in and those taken out.
- (5) In order to prevent dropping out of tools and belongings during inspection, such tools should be provided with strings and belongings unnecessary for inspection should not be carried into the tank inside.
- (6) The lamps to be used for inspection should be provided with protective nets to avoid destruction. The lamp cords should be of oil-resisting type.

1.3 In case of daily maintenance and inspection

Try to find out any abnormal indications of trouble on the transformer as early as possible, by comparing such indication with the operation records carefully.

2. Daily maintenance and inspection

2.1 Temperature of insulating oil and winding

Since the temperature of insulating oil and winding is limited as stated in the specification, first make certain of it being less than the limited value. Second, calculate the anticipated temperature rise of the oil and winding on the actual loading, referring to Meidensha's test report. Third, compare the actual rise with the calculated rise of the oil and winding. It must be confirmed whether the temperature is proper or not.

2.2 Inspection of oil level

Check whether the oil level is in the proper position.

2.3 Noise

In order to find out faults at their early stage pay attention to any abnormal noises having generally high frequency during the daily inspection. These noises are likely to be produced as a result of faults in the transformer.

2.4 Looseness on locking or binding points

In case any looseness is found on various binding bolts along the outside surface, tighten it again directly

2.5 Oil leakage

Any oil leakage may lead the deterioration of oil and will spoil the outside appearance of transformer very much. Check carefully the parts which gaskets are applied.

2.6 Dehumidifying breather

The breathing action of the breather can be observed exactly at its oil cup, even while running, whenever either the ambient temperature or oil temperature changes. Check whether the breathing action is going on normally or not.

Silicagel is adopted as the standard dehumidifying agent, which looks blue in dry condition by mixing cobalt chloride, and it will become light-pink when it has absorbed moisture, so that special attention should be paid to the change of colour. The pink-coloured dehumidifying agent may be used again by drying it to turn its colour into blue. However it will be fouled by with dirt or dust and it is desirable to replace it with new one at a suitable opportunity.

3. Periodical maintenance and inspection

The transformer being properly installed and maintained, it will need thorough inspections only at an interval of the definite period or when there are specific indications of troubles.

Most inspections, therefore, shall be carried out when the transformer is out of service.

3.1 Dial thermometer

Check whether the alarm contact is good, since this check may be unable to carry out on daily inspection. If the dial thermometer is out of order, replace it with a new one. The replacement does not require to drain the oil out, because the thermocouple is inserted in the pot on the tank cover, and is separated from the oil.

3.2 Bushings

Check whether the following damages or trouble is observed on the bushing:

- (1) Dirty spot, crack, and trace of discharge on porcelain insulator.
- (2) Loosened bolt, nut and irregular tightness on fixing terminals or studs.

3.3 Insulation resistance

Insulation resistance is a very useful guide to the condition of the insulation but is only an average value. Thus, it must be interpreted with care, i.e., it is subject to wide variation with temperature, humidity, and cleanliness of insulators. When the insulation resistance falls below the minimum permissible value, it can, in most cases of good design and where no defect exists, be brought up to the required standard by cleaning and drying the transformer. The insulation resistance of each winding to ground and of one winding to the other shall be measured on this test. In addition to the above, this test shall be made for all accessories such as cooling fan motors, Buchholz relay, bushing current transformer, etc..

3.4 Internal inspection

If nothing abnormal is found in the transformer especially, it is desirable for the operation to carry out the internal inspection once for 10 to 15 years.

3.5 On-load tap-changer

It is recommended a periodic inspection of the tap changer equipment to maintain a high reliability in service in accordance with the descriptions in the instructions attached separately.

4. Interval for the periodical inspection

It may be difficult to define the standard frequency of the periodical inspection clearly, because it is subject to the influence of many factors such as loading, ambient temperature, maintenance, and operating time etc.. The frequency of the inspection is given in the following schedule, when it is required for one of the tentative practice.

The schedule of the tentative frequency of the periodical inspection

No.	Inspection item	Frequency of the Periodical inspection	Remarks
1	Buchholz relay & dial thermometer	Every 3 years	Measure insulation resistance on each circuit.
2	Bushing	Every 3 years	Check only the appearance
3	Dehumidifying breather	When necessary	Replacement of dehumidifying agent and also of oil in oil cup.
4	Measurement of insulation resistance for each winding	Every 3 years	If special indication is found in comparison with annual records and with the test report at delivery time, it should be regarded as abnormal.
5	Measurement of breakdown voltage for insulating oil	Every 3years	Test five samples of adequate quantity of insulating oil taken out from tank.
6	Measurement of acid value for insulating oil	Every 3 years	
7	Internal inspection	Every 10years	
8	Cooling fans and / or oil pumps	Every 3 years	Measure insulation resistance. When abnormal noise or abnormal vibration occur, inspect them by removing and repair.
9	On-load tap-changer	It should refer to the instructions attached separately	
10	Gas-in-oil analysis	Every 1 year For the 1st 3,3 and 6month.	This test is particularly recommended for the important oil-immersed transformers.

5. The detailed data for maintenance and inspection

The outline on daily and periodical maintenance and inspection have been described up to the preceding paragraph. In this paragraph, several inspections which are essential and need the detailed data, are stated as follows:

5.1 Judgment of deterioration of insulating oil

It must be determined according to such procedures as below:

(1) Measurement of dielectric strength

(2) Measurement of oxidized degrees

Based upon the results of measurement as described in above paragraph, the standard values for judgment of deterioration will be determined in order to use them as the yardstick of maintenance.

(3) Dielectric strength

Transformer 40 kV/2.5 mm or more
On-load tap-changer It should refer to the instructions attached separately.

(4) Acid value

Standard acid value for oil will be tabulated as follows:

	Acid value	Standard treatment to be applied
Transformer	0.02 mg KOH/g or less	Fresh oil
	0.2 mg KOH/g or less	Normal
	0.2 - 0.5 mg KOH/g	Regeneration or replacement if circumstance allows
	0.5mg KOH/g or more	Regeneration or replacement is required urgently

5.2 Judgement of deterioration of transformer

Measurement of insulation resistance will be a guide for judgement of deterioration of transformer. The measured value obtained by use of megger tester does not always indicate that the insulation is damaged or that it is moist and dirty, but it indicates only a condition of the insulation. A tentative minimum value for operation is shown in Fig. 1.

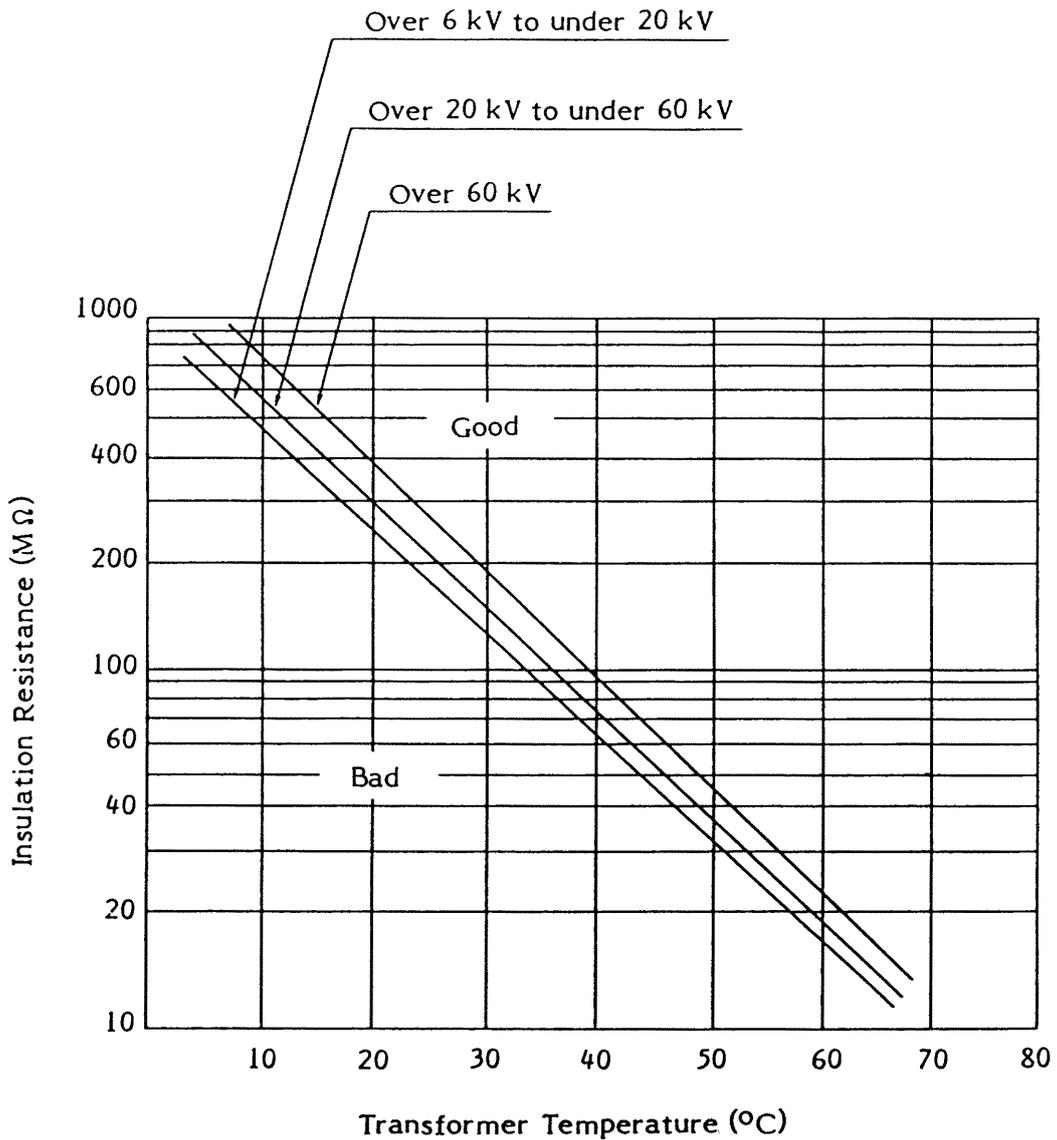


Fig.1 Judgement guide for insulation resistance