

## Tests on Insulator (solid)

### Type tests:

- To prove design features and the quality to be done on samples.
- To be done on samples.

### Routine Tests:

- To check quality of individual test piece.
- To ensure the reliability of objects, quality and consistency of materials.

## Test objects

- Insulators
- Bushings
- Cables
- Transformer
- Surge Arrester

## Transmission line insulators



## Insulators: Power Frequency Test

- Dry flashover test
- Wet flashover test

## Power Frequency test: Transmission line Insulators

Test	Procedure	Results/Remarks
Dry Power Frequency Test	<ul style="list-style-type: none"> <li>AC power frequency is applied across the insulators under <u>dry condition (without rain and precipitation)</u></li> <li>It is increased at a uniform rate of <b>2% per second of 75 % of the estimated test voltage (if 100 kV is the estimated voltage, the voltage should be increase at 1.5 kV/sec.)</b> to such a value that a breakdown occurs along the surface of the insulator.</li> </ul>	a <b>breakdown occurs</b> along the surface of the insulator.

## Power Frequency test: Transmission line Insulators

Test	Procedure	Results/Remarks
Wet Power Frequency Test	<ul style="list-style-type: none"> <li>AC power frequency is applied across the insulators under wet conditions</li> <li>It is increased at a uniform rate of <b>2% per second of 75 % of the estimated test voltage (if 100 kV is the estimated voltage, the voltage should be increase at 1.5 kV/sec.)</b> to such a value that a breakdown occurs along the surface of the insulator.</li> <li>The insulator is subjected to a spray of water by means of nozzles at an inclination of 45° to the vertical.</li> <li>The spraying is continued for at least 1 minute before the voltage application and is continued during the test.</li> </ul>	<b>15 minutes voltage is applied. (2 flash over are allowed.)</b>

## Impulse test: Transmission line Insulators

Test	Procedure	Results/Remarks
Impulse withstand voltage	<ul style="list-style-type: none"> <li>Standard impulse voltage is given with +ve and -ve polarity for 5 consecutive times.</li> </ul>	<b>If not flashed over or punctured-pass the test.</b>
Impulse flash over test	<ul style="list-style-type: none"> <li>Specified voltage is applied.</li> <li>Probability of failure is determined for 40-60% failure value or 20-80% failure value since it is difficult to set exact 50% flash over values.</li> </ul>	The average of upper and lower (front and tail) is taken. Surface should not be damaged but some markings are allowed.
Pollution test (salt-fog test)	<ul style="list-style-type: none"> <li>Maximum normal withstand voltage is given and artificial salt-fog is created and compressed air.</li> <li>If the flashover occurs within an hour, test is repeated with fog of lower salinity or otherwise with higher salinity.</li> </ul>	The maximum salinity at which insulator withstands 3 out of 4 flash over is taken as passed.

## Types of pollutions

Type	Pollutants
Micro-bio pollution	Dust, microorganisms, bird secretions, flies etc.
Industrial pollution	Smoke, petroleum vapors, dust and other deposits
Coastal pollution	Corrosive and hygroscopic salt layers
Desert pollution	Sand storms
Ice and fog deposits	Corrosion, nonuniform gradients along the surface of the insulators

# Transformer Bushing



## Testing of bushings

Test	Procedure	Results/Remarks
Power frequency test- power factor test	<ul style="list-style-type: none"> <li>Bushing is connected one side at HV terminal and ground is connected to Schering bridge.</li> <li>Voltage is increased in steps and then reduced.</li> </ul>	<b>The capacitance and power factor are recorded at each step.</b>
Internal or partial discharge	<ul style="list-style-type: none"> <li>-----do-----</li> </ul>	-----do-----
Momentary withstand test at power frequency	<ul style="list-style-type: none"> <li>The bushing has to withstand without flashover or puncture for 1 minute or 30 seconds to measure the voltage</li> </ul>	At present this test is replaced by the impulse withstand test.
One minute wet withstand test at power frequency	<ul style="list-style-type: none"> <li>Specified voltage is applied to the bushing with the rain arrangement as described earlier</li> </ul>	Bushing has to withstand the voltage without flashover for one minute but it does not give any information for its satisfactory performance.

## Testing of bushings

Test	Procedure	Results/Remarks
Impulse voltage test- full wave withstand test	<ul style="list-style-type: none"> <li>5-consecutive full waves of standard wave form are applied</li> </ul>	if 2 flashover are observed, test is failed.
Chopped wave withstand and switching surge tests	<ul style="list-style-type: none"> <li>Chopped wave form is applied similar to full wave withstand tests</li> </ul>	-----do-----
Thermal test/ temperature stability test (performed only for >= 132 kV transformer bushing	<ul style="list-style-type: none"> <li>In the free air below 40° C power frequency, the test is carried out till temperature sustains at constant value, i.e., increase in temperature &lt; 1° C / hour.</li> <li>Bushing along with transformer is applied 86@ of nominal system voltage is applied</li> </ul>	Any part of bushing should not exceed 45° C.

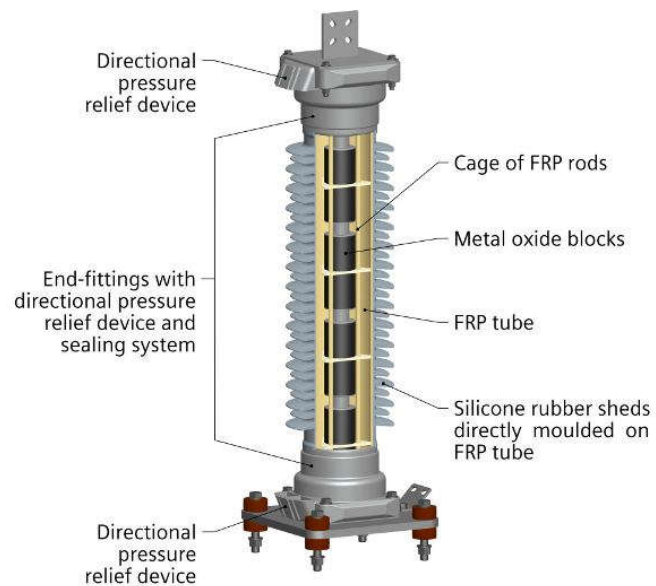
## Tests on Transformers

Test	Procedure	Results/Remarks
Induced Overvoltage test	<ul style="list-style-type: none"> <li>Excite the secondary of transformer from a high frequency AC source (100-400 Hz) at about twice the rated voltage. This reduces core saturation (<math>V \propto I \propto</math>) and also limits the charging current.</li> </ul>	Insulation withstand strength can be checked.
Impulse testing	<ul style="list-style-type: none"> <li>Full wave and chopped wave of standard impulse with a chopping time of 3-6 <math>\mu</math>S.</li> <li>Windings are short circuited to prevent large over voltage being induced in the winding and connected to ground.</li> <li>Apply impulse voltage of magnitude of 75% of BIL of transformer.</li> <li>One full wave of 100% BIL</li> <li>Two chopped wave of 100% BIL</li> <li>One full wave of 100% BIL</li> <li>One full wave of chopped 75% BIL</li> </ul>	<ul style="list-style-type: none"> <li>To determine the ability of insulation, verification, dielectric strength against impulses.</li> <li>Short circuit reduces impedance of transfer and reduces the sensitivity of detection.</li> </ul>

## Tests on Transformers

Test	Procedure	Results/Remarks
Switching Impulse test	<ul style="list-style-type: none"><li>Long duration impulses with rise time 0.1-0.3 ms and total duration time-1ms.</li><li>Switch impulse voltage is applied as per standards (SIL) to winding.</li></ul>	To check the insulation ability to carry switching over voltages.

## Surge Arrester



## Tests on surge arrester

Test	Procedure	Results/Remarks
Power Frequency sparkover test	<ul style="list-style-type: none"> <li>The surge arrester has to withstand at least 1.5 times the residual voltage for 5 successive applications for dry and wet conditions</li> </ul>	To withstand power frequency over voltage.
Residual voltage test	<ul style="list-style-type: none"> <li>For a particular discharge class (10kA, 20kA, 5 or so.), the arrester should not incur voltage drop more than residual voltage</li> </ul>	To determine the V-I characteristic and stresses or deterioration of ZnO block.

## Tests on surge arrester

Test	Procedure	Results/Remarks
100% impulse spark over test (impulse voltage withstand capacity test)	<ul style="list-style-type: none"> <li>Standard impulse voltage is given for 15 consecutive times (1.3 times the impulse voltage withstand or impulse voltage for a discharge current whichever is lower)</li> </ul>	The surge arrester should not show any flashover over its insulation.
Front of wave spark over test	<ul style="list-style-type: none"> <li>As per the std. specifications, the time to spark over is measured. The V-T characteristics of arrester is plotted.</li> </ul>	To ensure that the surge arrester flashes over for very steep fronted waves of high values.
Short circuit test	<ul style="list-style-type: none"> <li>Before the application of Short circuit, the surge arrester has to undergo for pre-failing phase where it gives low resistance in order to maintain conductivity.</li> </ul>	The surge arrester should not thermally run-away.



## Tests on Cables

Test	Procedure	Results/Remarks
Dielectric power factor test.	<ul style="list-style-type: none"> <li>High Voltage Schering Bridge is used to perform dielectric power factor test on the cable sample. The power factor is measured for different values of voltages <i>e.g.</i> 0.5, 1.0, 1.5 and 2.0 times the rated operating voltages.</li> <li>The maximum value of power factor at normal working voltage does not exceed a specified value (usually 0.01) at a series of temperatures ranging from 15°C to 65°C.</li> <li>The difference in the power factor between rated voltage and 1.5 times the rated voltage and the rated voltage and twice the rated voltage does not exceed a specified value</li> </ul>	

Test	Procedure	Results/Remarks
Impulse withstand voltage test.	<ul style="list-style-type: none"> <li>The test cable is subjected to 10 positive and 10 negative impulse voltage of magnitude as specified in specification, the cable should withstand 5 applications without any damage</li> <li>Usually after the impulse test, the power frequency dielectric power factor test is carried out to ensure that no failure occurred during the impulse test</li> </ul>	no failure occurred during the impulse test
Partial discharge test	<ul style="list-style-type: none"> <li>Partial discharge measurement of cables is very important as it gives an indication of expected life of the cable and it gives location of fault, if any, in the cable.</li> </ul>	