

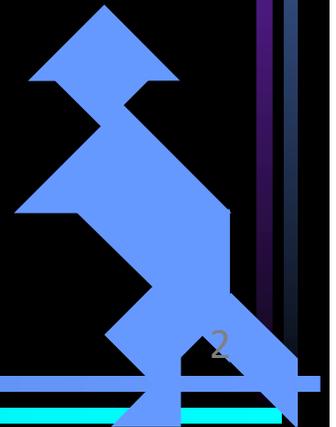
UNIT V

High Voltage Testing & Insulation Coordination

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Introduction

- Insulators and Bushings
- Isolators and Circuit Breakers
- Cables
- Transformers
- Surge Diverters
- Radio Interference
- Insulation Coordination



General Terminology

- Disruptive Discharge Voltage
 - Voltage produces loss of dielectric strength of an insulation
- Withstand Voltage
 - Applied to a test object under specified conditions in a withstand test
- 50% Flashover Voltage
- 100% Flashover Voltage
- Creepage Distance
 - Shortest distance on the contour of the external surface of the insulation unit or between two metal fittings on the insulator

Contd.,

- AC Test Voltages
 - Frequency 40 to 60, sinusoidal,
 - Deviation permissible 7%
- Impulse Voltage
 - Polarity
 - Peak value
 - Time to front(t_f)-1.67 times time bet` 30% to 90% of the peak value – rising portion
 - Time to half the peak value after peak
 - Standard:- $t_f = 1.2 \mu\text{s}$, $t_t = 50 \mu\text{s}$,
 - Tolerance $\pm 3\%$ on Peak, $\pm 30\%$ front time, and $\pm 20\%$ tail time.

Reference Atmospheric Conditions

- IS; Temp = 27⁰C, Pressure = 1013 mB (760 torr), Abs Humidity = 17 gm/m³
- British Standard; Temp = 20⁰C, Abs Humidity = 11 g/m³ (65% relative)

$$V_s = V_a \times h/d$$

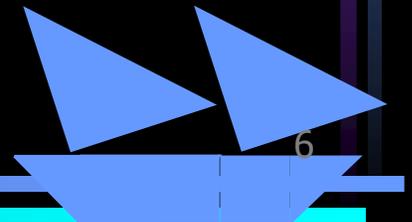
Where, h=humidity correction factor, d
air density correction factor

$$d = 0.289b / (273 + t) \text{ for } 20^{\circ}\text{C}$$

$$= 0.296b / (273 + t) \text{ for } 20^{\circ}\text{C}$$

Testing of Insulators: Power Frequency Tests

- Dry and Wet Flash over test
 - Power frequency Voltage is applied at 2% per second upto 75% of estimate voltage
- Characteristics of spray
 - Precipitation Rate : $3 \pm 10\%$ (mm/min)
 - Direction : 45° Vertical
 - Conductivity of water: 100μ siemens $\pm 10\%$
 - Water Temperature: Ambient $\pm 15\%$



Contd.,

- IEC Standards:

- Vertical Component : 1 to 1.5 mm/min
- Horizontal Component : 1 to 1.5 mm/min
- Limits for individual measurements : 0.5 to 2 mm/min
- Temperature of water : Ambient $\pm 15\%$
- Conductivity (20°C) : 100 $\pm 15\%$ $\mu\text{S/cm}$

Wet and Dry Withstand Tests (One Minute)

- Same test is applied for a period of one minute

Impulse Tests of Insulator

- Impulse Withstand Voltage Tests
 - Testing 5 consecutive waves for flashover
- Impulse Flashover test
 - Probability of failure 40% to 60%
 - Probability of failure 20% to 80%
- Pollution Testing
 - Dust, Micro-organisms, Bird Secretions, flies
 - Industrial Pollutions like smoke, petroleum vapours, dusts and other deposits
 - Coastal Pollution – Corrosive and hydrosopic salt layers
 - Desert Pollution
 - Ice and fog deposits

Testing of Bushings

- Power frequency test
 - Power factor Voltage test
 - Internal or partial discharge test
 - Momentary Withstand test
 - One minute wet withstand test
 - Visible discharge test
- Impulse Tests
 - Full wave withstand
 - Chopped wave withstand and Switching Surge Test

Thermal tests

- Thermal runaway
- Carried at free air with temperature below 40°C and rated power frequency
- Temperature rise less than 1°C/hr
- Applied voltage is 86% nominal system voltage

Testing of Isolators and Circuit Breakers

- Isolators/Disconnectors – mechanical switching device, which provides in the open position, an isolating distance in accordance with special requirements
- Characteristics:
 - Electrical : Arcing voltage, current chopping, residual current, rate of decrease of conductance of arc space and plasma, and shunting effects
 - Physical: media, pressure, speed of contact , number of breaks, size of arcing chamber, and materials and configuration of CB
 - Degree of electrical loading, Applied voltage, type of fault, time of interruption, time constant, natural frequency and power factor, rate of rise of recovery voltage, restriking voltage, decrease in ac component in SC current, degree of symmetry and DC component of SC current

Main tests

- Dielectric or Overvoltage tests
- Temperature rise tests
- Mechanical tests
- Short Circuit Tests
 - Direct tests
 - SC generator as source
 - Power utility system or network
 - Synthetic Tests
 - Direct tests in the network or in the fields
 - Direct Testing in SC laboratories
 - Synthetic Tests of CBs
 - Composite testing
 - Unit testing
 - Testing Procedure
 - Asymmetrical Tests

Testing of Cables

- Mechanical tests like bending, dripping and drainage, fire resistance and corrosion
- Thermal duty
- Dielectric Power factor
- Power frequency Withstand Voltage
- Impulse Withstand Voltage
- Partial Discharge
- Life expectancy

Testing of Transformers

- Induced Overvoltage tests
- Partial Discharge tests
- Impulse Testing of Transformer

Testing of Surge Diverters: Ratings

Div Class	Diverter Rating Volts	Impulse 8/20 μ s Amp	High Ct 4/10 μ s Amp	Long Duration
A	LV (230-600)	1500 2500	10000 25000	50 A 500 μ s
B	Distribution Voltage 400V - 33kV	5000	65000	75 A 1000 μ s
C	Station type LA >11kV	10000	100000	150 A 2000 μ s

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Tests:

- Power Frequency Sparkover Test
- 100% Standard Impulse Sparkover Test
- Front of wave sparkover test
- Residual Voltage test

High Current Impulse Test on SD

- Long Duration Impulse Current test
- Operating Duty cycle Test
- Other Tests
 - Mechanical tests like Porosity, temperature cycle, etc
 - Pressure Relief Test
 - Voltage withstand test on insulator housing of diverter
 - Switching surge flashover test
 - Pollution test