**Gapless Metal Oxide Lightning Arresters**

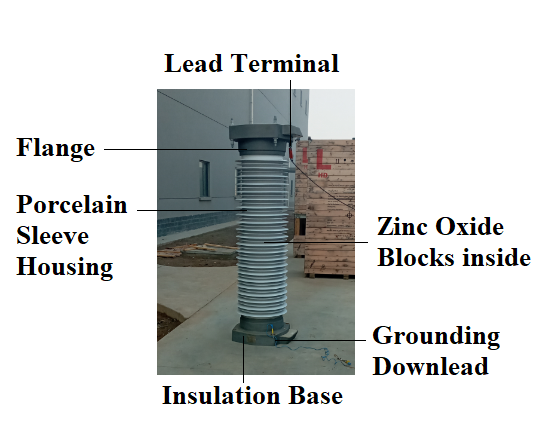
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**Introduction**

Lightning arresters play an important role in the protection of power system insulation against damage by surge voltages. The lightning arrester limits overvoltage, protects insulation of electrical installation, prevents disturbance of normal system state and realizes automatic recovery when the peak value of the overvoltage caused by the lightning or the circuit switch exceeds the rated system value.

Gapless Zinc oxide arresters are connected between the phase and ground terminal to limit the voltage level below the withstand voltage Level of system Electrical equipment. Lightning overvoltage have a time range of few microseconds and the magnitude of the overvoltage can reach several per unit if the lightning arrester is not installed.

Zinc oxide provides nonlinear voltage-current characteristics for the protection from over voltages. Hence it acts like a nonlinear resistor. When the system voltage is applied on the lightning arrester at continuous operating voltage, about 80% of the rated voltage, the arrester experiences some leakage current which depends on the condition of the arrester. The current consists of capacitive and resistive components. The leakage current generates heat hence proper thermal design is needed for the arrester housing. During lightning surge, Zinc oxide resistance decreases heavily and the current reaches the range of kA. This discharges the voltage surge to the ground.



Lightning Arrester

**Lightning Arrester Protection System**

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| **Type** | **Arrester Name** | **Arrester Model** |
| CBH | 660kV Valve Hall DC Pole Arrester | YH2WCBH1-709/1416  (Matiari and Lahore) |
| M | 6-pulse Bridge Arrester | YH2WM1-384/754  (Matiari and Lahore) |
| CBN1 | Valve Hall Neutral Bus Arrester | YH2WCBN1-230/451  (Matiari and Lahore) |
| DB | 660kV outdoor DC Pole Arrester | YH20WDB1-680/1448  (Matiari and Lahore) |
| DL | 660kV outdoor DC Pole Arrester | YH20WDL1-680/1448  (Matiari and Lahore) |
| CBN2 | Neutral Bus Arrester | YH2WCBN1-207/392  (Matiari and Lahore) |
| E | Neutral Bus Arrester | YH5WE1-163/369 (Lahore), YH5WE1-207/453 (Matiari) |
| EL | Grounding Pole Arrester | YH10WEL1-131/277  (Matiari and Lahore) |
| EM | Metal Return Transfer Bus Arrester | YH20WEM1-163/412 (Lahore), YH20WEM1-194/395 (Matiari) |
| F50 | Arrester for Power Frequency Blocking Filter | YH10WF1-60/140 (Matiari) |

**Nameplate Parameters**

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| Model Name | Y | H | 2 | W | V | 1- | 344/ | 660.7 |
| Metal Oxide Arrester | Polymeric Housed Type | Matching Current (kA) | Gapless | Arrester Type | Design Number | Rated Voltage (kV) | Residual Voltage (kV) |
| Uref | Reference DC voltage at 1mA current conduction. It is the voltage when the arrester begins to act: 348.1 kVrms. | | | | | | | |
| PCOV: | Peak value of continuous operating voltage: 492.2 kV. It should be higher than the maximum operating system voltage. | | | | | | | |
| CCOV | Crest value of the continuous operating voltage: 413.6 kV. It should be higher than the maximum operating system voltage. | | | | | | | |
| LIPL | Lightning impulse protection Level. Maximum residual voltage peak value under lightning impulse current. It is expresses Residual Voltage at Coordination Current: 660.7 kV/ 2 kA. | | | | | | | |
| SIPL | Switching Impulse Protection Level. Maximum residual voltage peak value under operating Impulse current 683.2 kV/ 4 kA. | | | | | | | |
| ISC | Rated Short Circuit Withstand Current: 65 kA. | | | | | | | |
| Energy | Maximum energy absorption capability: 9.2. | | | | | | | |

**High Voltage Insulation Test**

The High Voltage Megger Test is used to measure the Insulation Resistance of the Lightning Arrester.

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| KEW3125A High Voltage Insulation Tester was used to measure the insulation resistance of the Lightning Arrester. The 2500V setting was used for neutral point Lightning arrestor. The 5000V setting was used for other Lightning arrestors. | High Voltage Insulation Tester |
| The insulation resistance was measured by connecting the black probe to the grounding terminal and the red probe to the High Voltage terminal.  The Insulation resistance test or Megger Test is a non-destructive test because the voltage levels used are at or below the rating of the Lightning Arrester.  The Neutral Point Lightning arrester insulation resistance should not be less than 2000MOhm. The insulation resistance of other lightning arresters should not be less than 2000MOhm. |  |

**Leakage Current Measurement Test**

The DC Hipot Test is used to test the High Voltage withstand capability of the Lightning Arrester.

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| The Portable DC High Voltage Hipot Tester Control Box consisted of a High Voltage DC Generator, High Voltage Digital micro-ammeter and a High Voltage Digital Voltmeter. The input power was provided by 220V AC power supply. The output connections included the Lightning Arrester High Voltage Terminal and the common Lightning Arrester Ground Terminal. The Control box was provided with on/off switch, power supply protection, status LED indicators and a knob for Voltage variation. | High Voltage DC Tester Control Box |
| The High Voltage Multiplying Cylinder was used to multiply the output voltage of the High Voltage DC Generator. This is used in Hipot Test to generate voltage levels that are near to or higher than the rated Lightning Arrester Voltage. Unlike Megger Insulation Test, Hipot Test is destructive in nature. Hence, special protection is needed while carrying out the test. In the case of 200kV+ tests, testers must wear insulated shoes and stand in a safety area. | Voltage Multiplying Cylinder |
| The 220V AC Power Supply was connected using power cables. A Grounding Electrode was used to ground the test equipment and the Lightning Arrester. The ambient temperature, relative humidity and operating voltage during measurement should be recorded. The live measurement should be carried out when the surface of the arrester housing is dry. Attention should be paid to the inter phase interference. Lightning arresters with full current on line detection devices cannot replace the test of this project. The readings should be recorded regularly. If an abnormality is found, the live or power cut resistive current test should be conducted in time. | Power Cable    Grounding Electrode |
| The full current, resistive current or power loss under the operating voltage was measured. The measured value should not change significantly from the initial value. The measured value was compared with the initial value. When the resistive current increases by 50%, the reason should be analyzed and the monitoring should be strengthened to shorten the detection period appropriately. When the resistive current doubles, the power should be cut off for Inspection. |  |
| The test voltage was slowly increased by turning the knob until the current reached 4mA. The test voltage was recorded and compared with standard value. This should be higher than the voltage when the arrester starts to conduct U1mA.  The Leakage current at U1mA and 0.75U1mA.  must not be less than the value required by the equipment specifications. The measured value of U1mA must be compared with its initial value and the value specified by the manufacturer. The difference should not be greater than +/- 5%. The leakage current at 0.75U1mA should not be greater than 50uA.  After the tests were completed, the equipment was discharged by touching the High Voltage Terminal with a discharging rod metal tip. After that, the ground lead was directly connected to the test terminal. |  |