



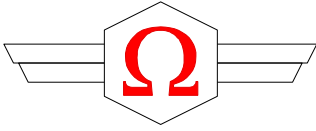
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## *Installation & Maintenance Manual*

### *Damping Resistors*

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		<i>Operation Manual (DA).Doc</i>			
Rev.	Date	File	Written	Checked	Approved



## **Section 1: GENERAL RECOMMENDATIONS**

### **1.1. LOADING, UNLOADING, HANDLING**

Resistors are placed in their mounting position into wooden packing or on Palettes and securely fastened to the bottom with bolts

Lifting lugs are provided to facilitate handling, loading or unloading

It is the responsibility of carrier & client to provide proper care in shipping and handling

Resistors are heavy & require proper equipment & procedures for safe & reliable handling. Safety of personnel and properties is important.

***Handling, unloading, loading erection & remittance of electrical connections should be supervised by qualified person, experienced tradesmen using proper lifting techniques & crane of right capacity to unload the units and move them to their location***

***Warning: when Handling, Loading, Unloading or Erecting the Resistors, Rear And Front Panels of Cubicles should be Securely Fastened***

### **1.2. RECEIVING**

Once received, the units should be unloaded and moved using proper handling and lifting equipment (Forklift or Crane). A preliminary inspection should be made to ensure proper handling was practiced during shipment

***Do not remove resistors units from their wooden palette or skid until they reach the job site***

### **1.3. STORAGE**

Resistors units should be stored as shipped using their wooden case or Palette

***NEVER store the cases Lying on the side, up-side-down or stacked as this could damage bushings, indoor post insulators or resistor banks.***

## **Section 2: INSPECTION & INSTALLATION**

### **2.1. VISUAL INSPECTION**

Once at job site:

- ✘ Remove all packing (wooden case) & remove the bolts which fasten resistors units to the palette or skid

***Warning: All packing should be removed within the enclosure before energizing. Failure to remove this material may result in fire hazard***

- ✘ Remove the rear & front panels using proper tools to unscrew the bolts
- ✘ Check the resistor banks to ensure that they are free from foreign bodies
- ✘ Check porcelain indoor insulators. Broken insulators must be replaced
- ✘ If porcelain indoor insulators have been contaminated during transportation or storage, they have to be cleaned (refer to maintenance section)
- ✘ Check the tightening of internal connections and bolts (Bolts can be unscrewed during transportation and shipping due to vibration)

### **2.2. INSTALLATION**

#### **2.2.1. FOUNDATION**

Foundations for electrical equipment such as Damping Resistors are laid as simple concrete foundations or simply as a steel skid depending on the size.

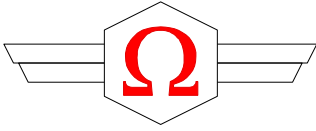
Besides the static loading, they must also withstand the stresses occurring in operation, such as short-circuit temperature rise, wind and ice load, seismic vibration and loads

The foundations are laid according to the layout of electrical equipment and steel structures.

The underside of the foundations must be free from frost, i.e. at a depth of 0,8 to 1,2m.

Dimensions of Foundation Area should be appropriate to ensure clearance purpose between each equipment.

Please refer to attached table for minimum clearances



### 2.2.2. UNITS PREPARATION BEFORE

#### INSTALLATION

- ✗ IN Bushings should be mounted, tightened & secured
- ✗ Internal connections between bushings & resistor banks should be mounted tightened & secured

**Care should be taken during the fixation of connections with resistor banks**

**Warning: Terminals are for electrical purpose only. They should not be used as mechanical supports**

#### ELECTRICAL VERIFICATION

Once all electrical connections, bushings & components have been tightened & checked, proceed with electrical verification

- ✗ Insulation verification: please refer to Procedure N° PC 113
- ✗ Measurement of resistance value: Refer to final routine test certificate for proper-recorded resistance value for each unit. Measured resistance value at site should not exceed 2% of recorded resistance value. Measurement should be done using a 4-wires apparatus with appropriate accuracy class. If ambient temperature is different from Test Ambient Temperature, following resistance value correction formula should be used:

$$R_{\theta} = R_{\theta a} \cdot (1 + \alpha \cdot (\theta - \theta_a))$$

with

$R_{\theta}$ : Measured resistance value at site

$R_{\theta a}$ : Recorded resistance value

$\alpha$ : Temperature coefficient

$\theta$ : Ambient temperature at site

$\theta a$ : Recorded Ambient temperature

The dimensions of the foundations area must be appropriate to ensure clearance purpose between the equipments (Please refer to enclosed table for minimum clearance)

### 2.2.3. ERECTION

Once foundations are made, clearances Distances have been checked, electrical verifications have been done & front & rear panels have been mounted & secured, proceed with the erection of units.

- ✗ If Resistor is to be installed on Steel Structure (Pedestal), Install the Steel Structure on flat concrete using appropriate bolts (expansion type anchors for concrete pad mounting)

**Lifting lugs are provided on each unit for easy hoisting and placement of unit by crane**

#### CASE OF STACKED LIVE UNITS

##### 2.2.3.1 ERECTION OF BOTTOM UNITS

- ✗ Install the bottom porcelain outdoor post insulators on the metallic structure or steel bottom plate using appropriate bolts. Please refer to components list for type of insulators for each unit
- ✗ Install & mount the unit on the bottom porcelain outdoor insulators.

**Unit Should Not Be Earthed**

##### 2.2.3.2 ERECTION OF MIDDLE / TOP UNITS

- ✗ Install the middle / Top porcelain outdoor insulators on insulators Support provided with each unit
- ✗ Install the middle / Top unit on the middle / Top Porcelain Outdoor Insulators

#### CASE OF SIDE BY SIDE LIVE UNITS

- ✗ For each unit proceed as for bottom units

#### CASE OF GROUNDED UNITS

- ✗ Proceed as for Live units without Outdoor post Station Insulator

**Unit should always be securely grounded.**

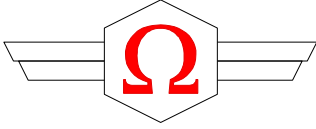
### 2.2.4. ELECTRICAL CONNECTION

**Electrical Terminals Should Not Be Used As Mechanical Support**

- ✗ Proceed to the IN connection
- ✗ Proceed to OUT connection
- ✗ Proceed to Intermediate connections for Multi-cubicle Systems

**Check That All Connections Are Tightened**

**DO NOT TOUCH ACTIVE PART DURING ERECTION, INSTALLATION OR MAINTENANCE**



### **Section 3: COMMISSIONING**

Once all connection has been checked, foreign bodies & all packing material have been removed clearance has been checked,

#### **UNITS ARE READY TO OPERATE**

Before energizing please check that all safety instruction have been observed

**NOTE: During first energizing a smoke may exhaust from resistors, Smoke will not affect the resistors**

### **Section 4: SERVICING & MAINTENANCE**

Users of electrical systems agree that servicing and maintenance are obvious measures for ensuring that products and installations operate over long periods.

Maintenance activities may be divided into

- ✘ Corrective maintenance
- ✘ Preventive maintenance

#### **4.1. TYPES OF MAINTENANCE**

##### **4.1.1. PREVENTIVE MAINTENANCE**

Means scheduled maintenance to prevent breakdowns and to detect faults before damage is caused.

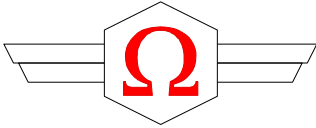
- ✘ Preventive maintenance may be divided into direct and indirect maintenance.
- ✘ Direct preventive maintenance includes cleaning, scheduled replacement or rehabilitation.
- ✘ Indirect preventive maintenance includes scheduled testing.

##### **4.1.2. CORRECTIVE MAINTENANCE**

Consists in repairing when material breaks down

##### **4.1.3. CLEANING RESISTORS:**

- ✘ Check the cleanness of insulators, bushings.
- ✘ They must be wiped off, using duster and a rapidly evaporating thinner. (DO NOT USE WATER)
- ✘ Contamination must be removed.
- ✘ Broken, Cracked insulators or Bushings must be replaced.
- ✘ Live parts or banks must be blown by air (care must be taken in order not to destroy or bend the live parts and the pressure or the blower air speed).
- ✘ Air inlet and outlet of the housing must be cleaned.



#### 4.2. PREVENTIVE MAINTENANCE SCHEDULE

Stainless steel resistors are designed to operate with free maintenance, but minimum maintenance visits are required in accordance with pollution classification area.

##### 4.2.1. LOW AND MEDIUM POLLUTION AREAS

- ✦ First preventive maintenance visit: usually after 6 months operation.
- ✦ Scheduled preventive maintenance: One visit every 18 months.

##### 4.2.2. HIGH AND SEVERE POLLUTION AREAS

- ✦ First preventive maintenance visit: after 3 months operation.
- ✦ Scheduled preventive maintenance: Once a year.

#### IMPORTANT NOTICE

***Before any maintenance operation, make sure that resistors are not under voltage and that they are disconnected. After disconnecting resistors, wait one hour before approaching resistors because housing is hot.***

#### Section 5: TECHNICAL & ELECTRICAL ADDITIONAL INFORMATION'S

##### 5.1. MINIMUM CLEARANCES, PROTECTIVE BARRIER CLEARANCES AND WIDTHS OF GANGWAYS

###### Key to symbols used:

$U_m$	[kV] Maximum voltage for apparatus
$U_n$	[kV] Nominal voltage
$U_{rb}$	[kV] Rated lightning impulse withstand voltage
$U_{rs}$	[kV] Rated switching impulse withstand voltage
N	[mm] Minimum clearance, non-reduced values
S	[mm] Minimum clearance, reduced values

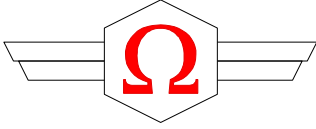
###### ***Minimum clearances and protective barrier clearances in power installations with rated voltages above 1 kV:***

The clearances between live parts of a system and earthed components must be at least equal to those shown below. This table lists the minimum clearances for the maximum apparatus voltages and the respective insulation levels as per IEC 71.

***Note: This table has been updated in order to comply with the state of international European standardization as of January 1993.***

###### ***Minimum clearances between live parts of a system and from earth as per IEC 71.***

For  $U_m$  between 1 kV and < 300 kV the criterion is the rated lightning impulse withstand voltage.



## INSTALLATION & MAINTENANCE MANUAL

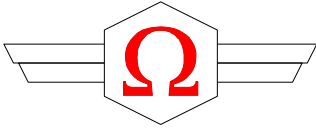
### DAMPING RESISTORS

For voltage range I:  $1 \text{ kV} < U_m < 52 \text{ kV}$

Nominal Voltage	Maximum voltage for apparatus	Non-reduced values			Reduced values		
		Rated lightning impulse withstand voltage	Minimum clearances phase-to-phase phase-to-earth		Rated lightning impulse withstand voltage	Minimum clearances phase-to-phase phase-to-earth	
$U_n$ kV	$U_m$ kV		$U_{rB}$ kV	Indoor N mm		Outdoor N mm	$U_{rB}$ kV
3	3.6	40	60	120	20	60	120
6	7.2	60	90	120	40	60	120
10	12	75	120	150	60	90	150
20	24	125	220		95	160	
30	36	170	320		145	270	

For voltage range I:  $52 \text{ kV} \leq U_m < 300 \text{ kV}$

Nominal voltage	Maximum voltage for apparatus	Earth-fault factor greater than 1.4		Earth-fault factor less than 1.4	
		Rated lightning impulse withstand voltage $U_{rB}$ kV	Minimum clearances phase-to-phase phase-to-earth N mm	Rated lightning impulse withstand voltage $U_{rB}$ kV	Minimum clearances phase-to-phase phase-to-earth S mm
$U_n$ kV	$U_m$ kV	$U_{rB}$ kV	N mm	$U_{rB}$ kV	S mm
45	52	250	480	-	-
60	72.5	325	630	-	-
110	123	550	1100	450	900
150	170	750	1500	650	1300
220	245	1050	2100	950	1900
				850	1700



**5.2. POLLUTION SEVERITY LEVELS OR CLASSIFICATION**

<i>Pollution level</i>	<i>Examples of typical environments</i>	<i>Minimum creepage distance mm/kV</i>
<b><i>I Light</i></b>	<ul style="list-style-type: none"> <li>- Areas without industries and with low density of houses equipped with heating plants</li> <li>- Areas with low density of industries or houses but subjected to frequent winds and/or rainfall</li> <li>- Agricultural areas</li> <li>- Mountainous areas</li> </ul> <p>All these areas shall be situated at least 10 to 20 Km from the sea and shall not be exposed to winds directly from the sea.</p>	16
<b><i>II Medium</i></b>	<ul style="list-style-type: none"> <li>- Areas with industries not producing particularly polluting smoke and/or with average density of houses equipped with heating plants.</li> <li>- Areas with high density of houses and/or industries but subjected to frequent winds and/or rainfall.</li> <li>- Areas exposed to wind from the sea but not too close to the coast (at least several kilometres distant).</li> </ul>	20
<b><i>III Heavy</i></b>	<ul style="list-style-type: none"> <li>- Areas with high density of industries and suburbs of large cities with high density of heating plants producing pollution.</li> <li>- Areas close to the sea or in any case exposed to relatively strong winds from the sea.</li> </ul>	25
<b><i>IV Very Heavy</i></b>	<ul style="list-style-type: none"> <li>- Areas generally of moderate extent, subjected to conductive dusts and to industrial smoke producing particularly thick conductive deposits.</li> <li>- Areas generally of moderate extent, very close to the coast and exposed to sea-spray or to very strong and polluting winds from the sea.</li> <li>- Desert areas, characterized by no rain for long periods, exposed to strong winds carrying sand and salt, and subjected to regular condensation.</li> </ul>	31

**Applicable Standards: IEC 815, 71-2**