GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

GUIDELINE
FOR
MAINTENANCE OF CAPACITORS
IN AC/DC DAMPING PANEL
IN
25 kv AC TAP CHANGER LOCOMOTIVE

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RESEARCH DESIGNS & STANDARD ORGANISATION
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CHAPTER 1- GENERAL

1.0 BACKGROUND:

Currently AC tap changer locomotives are provided with rectifier (RSI) blocks along with AC and DC damping panels. These damping panels are basically capacitor banks, which are provided for protection against high voltage transient and switching surges in input and output side.

1.1 It is found that there are a number of cases of capacitor failure on these panels and the suspected cause of failure being high voltage stress and high resistance across the capacitors. Moreover, the practice followed for failure investigation, measurement, removal and replacement of capacitors are inadequate.

1.2 This guideline is intended to define the procedure for capacitor inspection (visual), measurement, removal and replacement.

1.3 The AC damping panel, DC damping panel and the earthing capacitor panels are supplied as part of the RSI cubicle.

CHAPTER 2- PHYSICAL ARRANGEMENT

2.1 DC damping panel is supplied within the RSI block while ac damping panel and earthing capacitor panel is outside the cubicle. The external envelop size of ac damping panel and earthing panel are fixed. The physical arrangement of the capacitors is different for different makes of RSI cubicles supplied by different manufacturers. However, the electrical arrangement of capacitors are as follows:

I) AC damping panel:

Three (03) capacitors in series and six parallel legs. Each capacitor is rated 25 mfd and 500V. Total effective capacitance value is 50 mfd, 1500V. The bank is connected between cable Nos. 02 and 03. Total number of capacitors is 18.

II) DC damping panel:

Three (03) capacitors in series and three parallel legs. Each capacitor is rated 25 mfd and 500V. Total effective capacitance value is 25 mfd, 1500V. The bank is connected between cable Nos. 06 and 26. Total number of capacitors is 9.

III) AC earthing panel:

Twelve (12) capacitors in series and the mid point is earthed. So there are six (06) capacitors on either side of the earth. These are smaller capacitors as compared to capacitors in AC & DC damping panels. Each capacitor is rated 0.5 mfd and 500V. Total effective capacitance value is 0.078 mfd, 3960V. The bank is connected between cable Nos. 01 and 05. Total number of capacitors is 12.

2.2 The capacitors used by different suppliers are of different makes (e.g., ICAR, GE) and of different sizes. However, the electrical characteristics are comparable. Due to different mounting and routing of the cable adopted by different manufacturers, the method of maintenance of these capacitors are different and vendor specific. Thus guidelines is intended to standardise the maintenance procedure adopted by different loco sheds.

CHAPTER 3 - GUIDELINES FOR MAINTENANCE

3.0 Periodic maintenance:

The following jobs are required to be performed on the capacitors of the RSI cubicle during AOH.

1. Visual inspection
2. Measurement of capacitance
3. Identification of failed capacitor
4. Replacement of failed capacitor

3.1 Visual inspection

The capacitors are to be checked visually for the following occurrences.

- Flash over of terminals
- Terminal crack/breakage
- Bursting
- Bulging
- Leakage of electrolyte

In case any of the above occurrences found, the defective capacitor must be replaced with a new one of the same make. The replacement should be done in accordance with Para 3.4

3.2 Measurement of capacitance:

The capacitance should be measured with the help of a capacitance meter. The technical specification of the capacitance meter should be in accordance with Annexure-1.

3.2.1 AC damping panels:

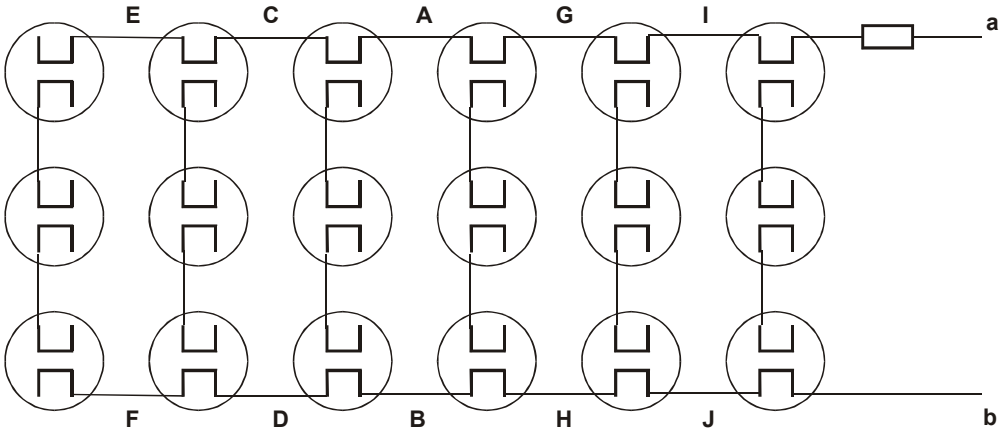

Fig. – 1

Step 1: Refer Fig- 1 above. Open connection ‘a’ or ‘b’ (not both).

Step 2: Measure capacitance between terminals ‘a’ and ‘b’. The meter must read the value 50 µf ±10% (i.e. 45 – 55 µf). If the value is out of the range, then there are one or more failed capacitors in the bank.

Step 3: Open both the connections ‘a’ and ‘b’. Remove the panel from the loco and bring to the section where soldering/resoldering can be done.

3.2.2 DC damping panel

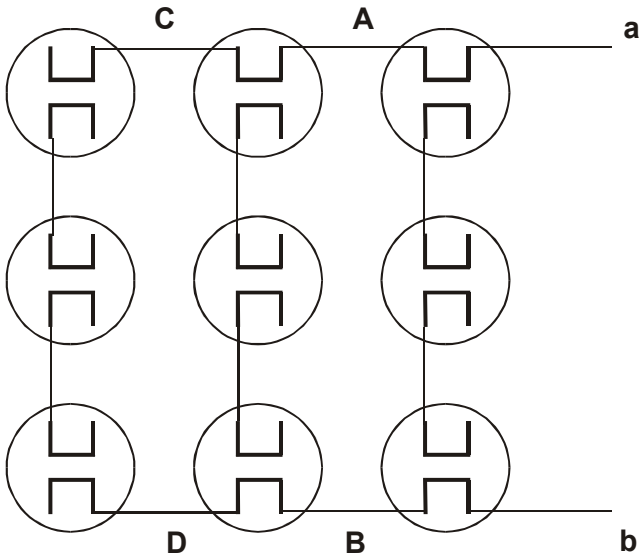

Fig. – 2

Step 1: Refer Fig- 2 above. Open connection ‘a’ or ‘b’ (not both).

Step 2: Measure capacitance between terminals ‘a’ and ‘b’. The meter should read the value 25 µfd ±10% (i.e. 22.5 – 27.5 µfd). If the value is out of the range, then there are one or more failed capacitors in the bank.

Step 3: Open both the connections ‘a’ and ‘b’. Remove the panel from the loco and bring to the section where soldering/resoldering can be done.

3.2.3 AC Earthing Panel

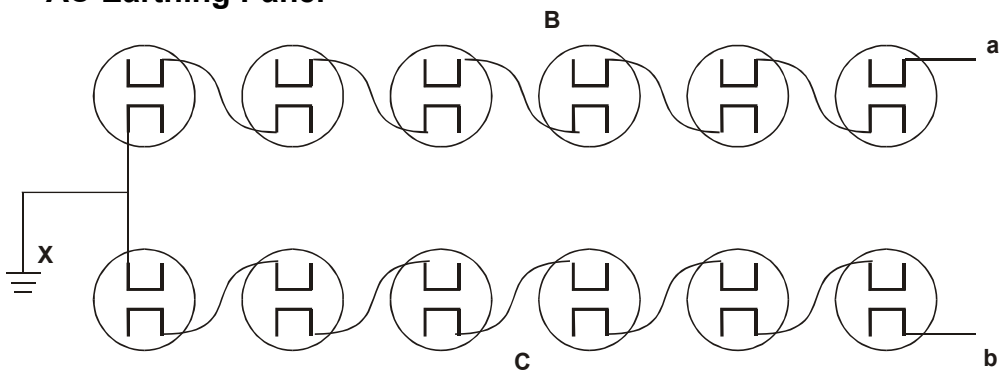

Fig. – 3

Step – 1: Refer Fig- 3 above. Open connections ‘a’ and ‘b’.

Step – 2: Measure capacitance between terminals a & x and b & x. The value should be 0.08 $\mu f \pm 10\%$). If the value is out of range, then one or more failed capacitors are in the bank.

Step – 3: Open connections a, b and X. Remove panel from the loco and bring to the section where soldering/desoldering can be done.

3.3 Identification of failed capacitors:

For identification of failed capacitors, proceed as per the following tables where reference values are given between selected pair of points. The selected points or nodes are marked in the Figures shown above. The tables should be referred in conjunction with respective Figures. Each node in the table is suffixed with the words either "left" or "right". It means once a node is opened/desoldered, the circuit in the left side of that node in the figure is "left" and the circuit in the right side of that node is "right".

Table – 1 (For ac damping panel each capacitor is 25μfd)
Refer Fig – 1

Measure between points		**Capacitance Value**
A	**B**	**50 μf**
Open A & B		
A_{left}	B_{left}	25 μf (left leg)
A_{right}	B_{right}	25 μf (Right leg)
Open C & D		
C_{left}	D_{left}	16.67 μf
C_{right}	D_{right}	8.33 μf
Open E & F		
E_{left}	F_{left}	8.33 μf
E_{right}	F_{right}	8.33 μf
Open G & H		
G_{left}	H_{left}	8.33 μf
G_{right}	H_{right}	16.67 μf
Open I & J		
I_{left}	J_{left}	8.33 μf
I_{right}	J_{right}	8.33 μf

Table – 2 (for DC damping panel each capacitor is 25μfd**)**
Refer Fig - 2

Measure between points		**Capacitance Value**
A	**b**	**25 μf**
Open A & B		
A_{left}	B_{left}	**16.67 μf**
A_{right}	B_{right}	**8.33 μf**
Open C & D		
C_{left}	D_{left}	**8.33 μf**
C_{right}	D_{right}	**8.33 μf**

Table – 3 (for AC Earthing panel 0.5µfd capacitor**)**
Refer Fig – 3.

Measure between points		Capacitance Value
A	**X**	**0.08 µf**
B	**X**	**0.08 µf**
Open X		
A	**B**	**0.04 µf**
Open A & B		
A	**B_{right}**	**0.167 µf**
A	**B_{left}**	**0.167 µf**
Open C		
B	**C_{right}**	**0.167 µf**
A	**C_{left}**	**0.167 µf**

Once the capacitance value specified in Tables is not observed between two specified terminals, check further in that leg and Zero-is on the failed capacitor. It is not required to desolder on the side where the capacitance value is within the range.

Opening of connections will be through desoldering (Refer procedure for soldering/resoldering Annexure – 2).

3.4 Replacement of the capacitor:

Step 1: Once faulty capacitors are identified, remove the capacitor from the bank and replace it with a new one. Do not mix different makes of capacitors in a single panel.

Step 2: Complete all the tasks as per in table -1 further in that section. There may be more than one-failed capacitors in the bank.

Step 3: Solder back all connections as per respective figures.

Step 4: Repeat step 2. The value should read as per specified range.

Step 5: Connect the panel back into the loco. Re-establish the original connections.

ANNEXURE - 1

Technical details of capacitance meter

Accuracy level:	0.5%
Range:	20 pf – 200µf
Resolution:	0.1 pf (for 200pf range)
Test frequency:	100f (for 200pf range)
Overload protection:	0.25 A fuse
Operating principle:	Dual slope integration
Zero adjustment:	± 20pf
Power source:	DC – 5V, AC – 230 V
Measurement voltage:	5V (max)
Accessories:	Test clip spares fuses, battery, adopter and instruction manual

ANNEXURE – 2

Soldering/Desoldering Procedure

1. The capacitor terminals have the following heat resistance limits. Adequate care should be followed while soldering/resoldering so that in no case the following limit is exceeded.

   Max. temp. : 350°C
   Duration : 5 Seconds with max temp.

   Good soldering is evident by free flowing of the solder with wetting of the terminations and the solder should flow within 2±0.5 sec (IEC 384 -1). The soldering station should be set for a nominal temperature of 275°C ±10°C.

2. Faulty solder joints remain one of the major causes of capacitor failure and thus the importance of high standards of workmanship in soldering is required. Solder joints should have a smooth appearance. The joints should be free from scratches, sharp edges.

3. Solders 60/40 type only to be used. With this type of solder combination, melting does not take place all at once. Solder begins to melt at 183°C (361°F), but it's not fully melted until the temperature reaches 216°C (420°F). Between these two temperatures, the solder exists in a plastic or semi-liquid state.

   No movement of any element should be done during the cool down period. Movement may cause what is known as disturbed joint. A disturbed joint has a rough and irregular appearance. A disturbed solder joint may be unreliable and may require rework.

4. **Flux:** Although the surfaces to be soldered may look clean, there is always a thin film of oxide covering it. For a good solder bond, surface oxides must be removed during the soldering process using flux.

   Flux must melt at a temperature lower than solder so that it can do its job prior to the soldering action. It will volatilise very rapidly; thus it is mandatory that flux be melted to flow onto the work surface and not be simply volatilised by the hot iron tip to provide the full benefit of the fluxing action.

5. **SOLDERING IRON:** A continuously tinned surface must be maintained on the soldering iron tip's working surface to ensure proper heat transfer and to avoid transfer of impurities to the solder connection.

Before using the soldering iron the tip should be cleaned by wiping it on a wet sponge. When not in use the iron should be kept in a holder, with its tip clean and coated with a small amount of solder

6. **APPLYING SOLDER:** The soldering iron tip should be applied to the maximum mass point of the joint. This will permit the rapid thermal elevation of the parts to be soldered. Molten solder always flows from the cooler area toward the hotter one.

7. **Before solder is applied:** the surface temperature of the parts being soldered must be elevated above the solder melting point.

8. Never melt the solder against the iron tip and allow it to flow onto a surface cooler than the solder melting temperature. Solder applied to a cleaned, fluxed and properly heated surface will melt and flow without direct contact with the heat source and provide a smooth, even surface.

9. Please ensure that cables used should not be more than 1.5mm^2 dia. Higher cable dia. requires more heat to be soldered which in turn will damage the capacitor. So it is better to clip the higher sized cable leads (if used any) with the capacitor terminals.