GOVERNMENT OF INDIA
MINISTRY OF RAILWAY
RESEARCH DESIGN AND STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW- 11.

1. **Titles**

Periodic maintenance instructions and trouble shooting guidelines for capacitor banks provided on Indian Railways.

2. **Applicable to:**

All class of capacitor banks.

3. **Object of special maintenance instructions:**

To arrest the Maintenance failures of capacitor banks on Indian Railways due to maintenance problems and develop suitable guidelines suiting to all category of capacitor banks provided on Indian Railways.

To develop a suitable Guideline which shall assist the users for proper rectification of the capacitor banks failures by observing the schedule maintenance and taking suitable remedial action.

4. **Instructions:**

4.1 Three monthly schedule:

4.1.1 Clean the dust over the insulators with the help of a damp cloth. In case of oily deposits carbon tetrachloride or any other suitable solvent may be used for cleaning of the insulators.

4.1.2 Observe for any dielectric leakage/seepage, if any leakage/seepage is found, rectify it as given in Para 5.

4.1.3 Observe for any birdcages in and around the traction substations.

4.1.4 Observe physically for any abnormal temperature rise of the capacitor units.

4.2 Six monthly schedule

4.2.1 All the above items as mentioned in Three Monthly Schedule.

4.2.2 Check the excessive tension on any of the connectors. Ease out the tension on the bushings, if required.

4.2.3 Observe for any rust collection/corrosion marks on the metallic parts and clean them.

4.2.4 Observe the current and voltage variations for the capacitor bank for at least 24 hours (Hourly readings of voltage and current for the capacitor bank should be recorded. If continuous recording facility is available, the same may be used). Compare the records of measurements with last recorded readings. Measurements with Digital meters shall be ideal. Examine and execute the changes for the past few years.

4.3 Annual Maintenance Schedule.

4.3.1 All the above items as mentioned in 4.2.

4.3.2 Ensure proper tightening of the fasteners and the connectors.

4.3.3 Check for functioning of protective relays with the help of primary injection test kit & secondary injection test kit.

4.3.4 Measure temperature rise in 24 hours of the capacitor unit, which is innermost, by applying a suitable thermometer on the can of the capacitor bank. The temperature rise in no case should be 15 deg. C above the ambient temperature (Temperature of capacitor container can be measured by fixing a thermo-meter on the wall of the container, its bulb being at one fourth of the height of capacitor down from the top).

4.3.5 Check that the NCT settings are as per RDSO guidelines and note that the NCT relay settings have remained stable for last 5 years. Change in the NCT relay settings are required to be examined.

4.3.6 Measure the capacitance value and tan delta of the capacitor units at nearly the same ambient temperature. Compare with last measured values.

4.4 Trouble shooting Guidelines for Capacitor Bank on I.R.

S.No	TROUBLE	CAUSE	REMEDIAL ACTION
1.	Leakage of dielectric from capacior can	Minor transient damages. Dents etc.	a) Minor seepage may be attended by M-seal (fast drying type compound). b) Extent of leakage may be studied. Depending upon the extent of leakage, the same attended or units rejected. Original manufacturer can also be referred.

2	Seepage of dielectric.	a) Improper handling during transportation. b) Due to tension coming on bushings by terminal connectors. c) Overheating of capacitor bank.	a) Attend by using Araldite or M-seal (fast drying type compound) b) Ease out the tension by using proper size of terminal connectors. Arrest dielectric seepage by M- seal type fast drying compound. c) Eliminate overheating of capacitor banks by instructions at S. No. 3
3.	Overheating of the units (can temperatrature should not be more by15 deg. C above ambient).	a) Poor ventilation. Erection is near a hot body. b) Capacitor units values have changed over the last recorded values. c) Excessive oil seepage/leakage. d) Capacitor drawing high currents.	a) Change location. b) Capacitor unit elements inside the capacitor unit have failed. Replace capacitor unit with a new one if needed (Ref: Item 6 for details). c) The dielectric might have run the safe limit. The unit might fails. Replace unit. Measure capacitor value and decide. d) The dielectric medium aged. Refer to manufacturer and replace units. e) Refer Point No. 4 for details.
4.	Capacitor drawing high current	a) High system voltage. b) Harmonic current.	a) Reduce voltage by changing taps of the transformer. b) Harmonics in the system are on the increase. Conduct harmonic analysis.
5.	Capacitor drawing lower current	a) Less system voltage. b) A capacitor value of individual cell has changed due to blowing of internal fuses.	a) Correct voltage by transformer. b) Measure capacitance value and if changes are there. Replace the units. c) Check Neutral CT and associated protection for proper functioning.
6.	Abnormal bulging/ bursting of capacitor units.	a) Gas formation due to internal arching.	a) Replace unit. b) Check neutral CT and associated protection for proper functioning.

7.	Black marks on bushing of the capacitor banks.	a) External fault between terminal and container. b) High voltage surge due to lightning or restriking of circuit breakers.	a) Clean bushing and check installation for external short circuits ,presence of bird cages etc. b) Check for effectiveness of the lighting arrestor and its proper rating. c) Consult original manufacturer, if situation persists.
8.	Terminals overheated or melted.	a) Loose terminal connectors or corrosion is taking place.	b) Properly tighten connectors. c) Clean for rust/ corrosion. If required, change the connector.
9.	Capacitor bank tripping on unbalanced protection.	a) Capacitor unit rating has changed. b) Neutral C.T. connections not proper or setting wrong.	a) Replace unit, if value has changed (Ref. Item 6 for details)

5. **Arresting leakage**

Take out the defective unit having leakage/seepage and put it in a position so that the leakage/seepage point is topmost. The capacitor unit is filled with dielectric but on the top some nitrogen is present. The can should be placed such that the dielectric does not ooze out from the cracked location. Clean the seepage point by carbon tetrachloride or a similar oil removing solvent, so that it is perfectly dried. Apply fast drying type M-seal compound (or equivalent) for arresting the leakage of the can. For arresting the leakage near the insulator bushings, araldite (or equivalent) may be used. Allow it to dry for 6-8 hrs. or as recommended by the adhesive supplier. Re-erect the unit after making a red cross mark with the paint, which is visible from down below so as to identity the capacitor unit from the ground level. Continue to monitor the capacitor bank for its performance.

This exercise is applicable for attention of minor leakage of the capacitor units only. For major leakage from the bushings or otherwise where the dielectric might have already reduced to a level where the internal elements are getting exposed the capacitor unit may be replaced.

6. **Bird Electrocution Problem:**

To avoid the bird electrocution leading to capacitor failure problem, provide bird caps made of polypropylene on the capacitor's terminal bushings and PVC sleeves on the bus-bars. These caps and sleeves should be procured from RDSO approved H.T. capacitor vendors and should have a minimum 15 kV, AC voltage withstand value continuously.

7. **Measurement of capacitance**:

Use a digital multimeter capable of recording reading in microfarad upto first decimal place. The range of the capacitance meter should be 2 to 100 microfarad minimum. Measure the readings of the capacitance upto the first decimal value. Also note the ambient temperatures. Reading of the capacitor values is likely to change (within 0 to –5%) in the initial 3 to 12 months. These may be recorded for reference only. Any changes in values beyond this period from 0 to 3% per unit suggest starting of the deterioration cycle of the capacitor units. Such capacitor banks should be measured for the values more often. Changes in values beyond –6% indicates that the capacitor bank is likely to fail and should be removed from service.

8. **Measurement of Tan Delta (Dielectric loss angle)**:

The tan delta measurements should be done annually with the help of a standard shearing bridge. Abrupt changes in the dielectric constants shall be the indicators of deterioration of the capacitor. The measured value of the dielectric loss angle shall not exceed 0.0005.

8 **References:**

i) UNISTAR Installation, operation and Maintenance of High voltage Power capacitors.
ii) Rough Metallized PP for AC Applications by Denis Pallemand & Lucien Tamic.
iii) Performance assessment and field Experience by S.A Backer & P.R.B.Nair.
iv) The Effect of water content of the impregnation Liquid on Agening of All Film Capacitor Windings by H. Suonppa, T. Martinmaki & V. Rasanen.

9. Suggestion for improvement upon these instructions are most welcome and may be addressed to Executive Director/TI, R.D.S.O., Manak Nagar,Lucknow-226 011

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