Schedule of Technical Requirements for Periodic Repair, Rehabilitation of Motorized Bogie Frames for 3-Phase Electric Locomotives

Approved by
Sr. EDSE

ISSUED BY:-

Electrical Directorate
Research, Designs & Standards Organization,
Manak Nagar LUCKNOW – 226011
### Status of Revision

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Date of Revision</th>
<th>Page No.</th>
<th>Revision</th>
<th>Reason for Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared by

| SSE/C&S | DSE/TM | DSE/C&S |

Checked by

---

DRAFT
This document contains three sections, Section ‘A’, Section ‘B’ and Section “C”.

(i) Section ‘A’ deals with Schedule of Technical Requirements for periodic Repair, Rehabilitation of Bogie Frame for 3-phase Electric Locomotives.

(ii) Section ‘B’ deals with schedule of technical requirements for rewinding/repair/rehabilitation of traction motors for 3-phase Electric Locomotives.

(iii) Section ‘C’ deals with General Requirements for Repair, Rehabilitation of Bogie Frame and rewinding/repair/rehabilitation of traction motors for 3-phase Electric Locomotives.

NOTE : The firm can be RDSO/CLW approved source for repair/rehabilitation/manufacture of fabricated bogie and should comply the STR as specified in section ‘A’ and can get motor repaired/rehabilitated from RDSO/CLW approved source for repair/rehabilitation/manufacture of 3-phase traction motor.

OR

The firm can be RDSO/CLW approved source for repair/rehabilitation/manufacture of 3-phase traction motor and should comply the STR as specified in section ‘B’ and can get bogie repaired/rehabilitated from RDSO/CLW approved source for repair/rehabilitation/manufacture of fabricated bogie.

SECTION ‘A’

SCHEDULE OF TECHNICAL REQUIREMENTS FOR PERIODIC REPAIR, REHABILITATION OF BOGIE FRAMES FOR 3-PHASE ELECTRIC LOCOMOTIVES.

1.0 SCOPE:

This Schedule of Technical Requirements deals with the repair and rehabilitation of fabricated bogie frame of WAP-5, WAP-7 and WAG-9 of 3-phase electric locomotives.

The attention to the bogies in electric loco sheds and workshops are given due to cracks at various locations and deformation in bogie frames which leads to frequent breakages of components, like springs, brake rigging, abnormal wear of wheels, brake blocks etc. Therefore, to ensure safe and reliable working of bogies and its suspension arrangement in electric locos, the periodical attention and repairs of the bogie should be carried out. Moreover, after a considerable period in service and development of major defects, the major rehabilitation work is required which cannot be done in electric loco sheds and workshops to ensure safe and reliable working of the bogie, suspension and brake rigging.
2.0 SCOPE OF WORK:

2.1 The scope of work has taken care of the periodical as well as breakdown attention to be given to the bogies of electric locos during major schedules like IOH & POH. Considering the life of components, the need for replacement, the required attention has been incorporated for brake rigging, pins, bushes and brackets etc., along with the complete bogie frame.

2.2 The Schedule of Technical Requirements is given as eligibility criteria of vendors regarding their infrastructure, competence & capability to undertake the repair works.

2.3 The relevant instructions, guidelines issued from RDSO and practices being adopted by Zonal Railways have been incorporated and the references are indicated.

2.4 The details of work to be carried out during Repair/Rehabilitation of bogie are given as following.

3. Work to be carried out:

The activity of Repair/Rehabilitation of bogie consists of the following activities.

1. Repair/Rehabilitation of bogie frame and brake gear.
2. Repair/Rehabilitation of suspension arrangement.
3. Checking the condition and replacement of spheriblocks.
4. Repair/Rehabilitation of Traction link.
5. Repair/Rehabilitation of wheel set.
6. Repair/Rehabilitation of Axle and axle box.
7. Repair/Rehabilitation of Gear, pinion and gear case.

4. List of typical M & P, required for repair/rehabilitation of bogie and wheel set is furnished in Annexure- I. The list is for general guidance only and actual manufacturing operations shall be submitted and got approved by the firm as a part of QAP.
SECTION ‘B’

SCHEDULE OF TECHNICAL REQUIREMENTS (STR) FOR REWINDING/REPIRING/REHABILITATION OF THREE PHASE TRACTION MOTORS TYPE 6FRA 6068 AND 6FXA 7059 FOR WAG9/WAP7/WAP5 ELECTRIC LOCOMOTIVES

1. **Scope:**

   Three phase Traction Motors type 6FRA 6068 and 6FXA 7059 are used on Three phase Electric Locomotives i.e. (WAG9/ WAP7/WAP5) on Indian Railways. The Schedule of Technical Requirement (STR) mentioned hereunder is issued to serve as a guide to repairers (called the “firm” hereafter) undertaking rewinding/repair and rehabilitation work of traction motors type 6FRA 6068 and 6FXA 7059. The firm should satisfy themselves having complied with the requirements of the respective drawings and STR.

2. **Work to be carried out:**

   The activity of rewinding of 3 phase traction motor stator mainly consists of the following activities.

   2.1 **Rewinding of stators:**

      Rewinding of stators mainly consist of the following main activities
      
      1. Removing old winding from stator,
      
      2. Cleaning of stator core
      
      3. Checking of core for any damage.
      
      4. Core loop loss test
      
      5. Implementation of stator modifications if any
      
      6. Manufacturing of stator coils
      
      7. Placement of coils in stator core.
      
      8. Placement of slot wedge
      
      9. Brazing of joints
      
      10. Bracing and final finish of overhangs
      
      11. VPI of stator

   2.2. **Repair of rotors**

      The activity of repair of 3 phase traction motor rotor mainly consists of the following activities.

      1. Removing of rotor bars and resistance ring from rotor core.
      
      2. Cleaning of rotor core
3. Core loss test
4. Checking of shaft dimensions
5. Modification of rotor core as per modified design if unmodified, e.g. Replacement of any mechanical component like end ring, stamping type resistance ring etc. as per design to be adopted.
6. Placement of rotor bars and resistance ring as per modified design to which rotor is to be repaired
7. Mechanized brazing of rotor bars and resistance ring
8. Swaging of rotor bars

2.3 Repair & rehabilitation of mechanical components

1. All mechanical assembly components e.g. stator chambers, end frames, bearing assembly components etc are not supposed to be repaired. It is to be procured in Kit from RDSO approved sources only.
2. All assembly components to be used as per latest drawings/ modification sheets.
3. List of typical M & P, required for repair/rehabilitation of traction motors is furnished in Annexure- II. The list is for general guidance only and actual manufacturing operations shall be submitted and got approved by the firm as a part of QAP.
4. The list of testing and measuring instruments are furnished in Annexure-III & IV respectively for general guidance only. However the specific Testing & measuring instruments, gauges used by the firm will also form part of QAP, which shall be submitted and got approved.
5. The firm should have additional Machinery and plants as mentioned in Annexure-V for assembling of bogie items.

2.4 Final Product Testing:

Firm should have the facilities to carry out the tests as per annexure-VI,( which is sample test schedule for traction motor type 6FRA6068) on repaired/rehabilitated traction motor on sinusoidal supply. The test bed and equipment should be of proper rating and capable of conducting these tests:
SECTION-C

GENERAL REQUIREMENT

3.1 General:
During undertaking repair or rehabilitation of Motorized bogie, all modifications with respect to the bogie frame and brake gear, suspension arrangement, Traction link, Axle and axle box, Gear, pinion, gear case, traction motor on stator, rotor or mechanical components to be carried out.

This schedule of technical requirements is meant to serve as guidelines only and is not exhaustive.

3.2 Drawings:
The CLW/RDSO drawings with latest version shall be applicable.

3.3 Materials:
All materials shall be as per RDSO/CLW Specifications. Procurement of all materials mechanical components etc shall be from RDSO/CLW approved vendors only.

3.4 General Requirements:

1. The firm should have currently valid ISO-9000 certification issued by an approved agency with the activity desired clearly mentioned in the scope of certification. The firm shall have a Quality Manual.
2. A system of regular submission of rejection details of material giving rejection rate, cause of rejection corrective action taken etc. on quarterly basis should be followed by the firm.
3. The firm shall have a system of documentation in respect of rejection at customer end, warranty replacement and failure of item supplied by them during service.
4. The firm shall have a system of recording the plant, machinery and control equipment's remaining out of service, nature of repairs done etc.
5. The testing and measuring equipment shall be duly calibrated and the validity of calibration should be current and verified by physically checking the calibration certificate issued by the Calibration Agency from whom it was calibrated.
6. The firm shall have a system of easy traceability of the product from manufacturing stage to finished product stage. Stamped identification marking with serial number of beam should be used for this purpose.

<table>
<thead>
<tr>
<th>Prepared by</th>
<th>Checked by</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE/C&amp;S</td>
<td>DSE/TM</td>
</tr>
</tbody>
</table>
3.5 Quality Assurance Plan (QAP)

The firm shall prepare quality Assurance plan (QAP) before approval is sought and submit the same as part of compliance of this STR. The QAP shall be a comprehensive document covering the following aspects:

i) Details of Quality Control Organisation of the firm along with key personnel engaged in the QC function.

ii) Quality Assurance Process of incoming materials used for the subject items.

iii) Process Flow Chart indicating process of manufacture for an individual product or for a family of products if the process is same.

iv) Quality Assurance System – Inspection & Testing Plan including the stage inspection.

v) Calibration scheme and status of calibration of equipments used in the quality process.

3.6 Incoming Material

1. A complete Bill of Material indicating all input material items required for manufacturing of the product, governing specification and their sources of supplies should be furnished.

2. Test results of incoming raw material with reference to Test Certificate issued by the supplier and the results of internal tests carried out by the firm for verification may be submitted as part of QAP.

3.7 Process of Repair

1. Complete Process Flow Chart covering all steps of process for repair/rehabilitation of an individual product (or for a family of products if the process is same) shall be clearly enlisted as a part of QAP.

2. The following details of machines used for all the steps of machining operations should be included.
   a) Make and model of the machine
   b) Accuracy
   c) Details of machining operations

3. Details of Jigs and fixtures used during repair/rehabilitation should be furnished along with the repair/rehabilitation process wherever used.

4. List of typical M & P, required for repair/rehabilitation of bogie is furnished in Annexure- I. The list is for general guidance only and actual manufacturing operations shall be submitted and got approved by the firm as a part of QAP.

<table>
<thead>
<tr>
<th>Prepared by</th>
<th>Checked by</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE/C&amp;S</td>
<td>DSE/TM</td>
</tr>
</tbody>
</table>
5. The list of testing and measuring instruments are furnished in Annexeure-III & IV respectively for general guidance only. However the specific Testing & measuring instruments, gauges used by the firm will also form part of QAP, which shall be submitted and got approved.

3.8 Sub-vendors:

Sub vendors for critical items shall comply respective RDSO/CLW STR & Specification.

3.8 Final Product Testing:

Firm should have the facilities to carry out the tests as per annexure-VI, (which is sample test schedule for motor). The test bed and equipment should be of proper rating and capable of conducting these tests.

3.10 Calibration of testing /Measuring Equipment:

a. Calibration of the Testing/measuring Equipment should be done at least once in a year unless stated otherwise.

b. Inspection staff conducting non-destructive testing shall be adequately trained and qualified by recognized agency and shall have adequate experience.

c. Staff conducting tests likes chemical Analysis and mechanical properties shall have adequate skill & components and shall have undergone sufficient training. Skill of such staff shall periodically be qualified by making them carry out tests in blind samples.
ANNEXURE-I

MACHINERIES & PLANT (M&P) REQUIRED FOR REPAIR / RHBILITATION OF BOGIE ITEMS

The following is the minimum indicative list of facilities to be available with the firm:-

1. Heat treatment furnace for carrying out heat treatment on the bogie before and after repair.
2. Bogie washing plant for washing the bogie before taking up repair.
3. Spring testing machine for testing of springs.
4. Spheribloc testing machine for checking serviceability of spheriblocs.
5. MIG welding machine for repairing of cracks in the bogie frame.
6. Light run testing facility for testing motor and wheels after assembly.
7. Fixture to check squareness of bogie.
8. Axle box cleaning plant
10. EOT crane facility (2 nos.) of min 25 t capacity for handling the bogie frame/Motorized bogie
11. MPT & Dye penetrant test equipment's.
12. Radiographic facilities for detection of cracks before rehabilitation and checking of soundness of weld cracks after the work.

MACHINERIES & PLANT (M&P) REQUIRED FOR REPAIR / REHABILITATION OF WHEEL SET

1. Axle turning lathe (CNC) with grinding and polishing facilities of sufficient capacity.
2. Axle Journal turning and burnishing (AJTB) lathe.
3. Wheel disc boring machine/ vertical turret lathe.
5. Surface wheel lathe and/ or CNC milling machine.
6. EOT crane 5t and 1 t capacity.
7. Induction heater/oil bathe heater for fitment of bearing.
8. Proper jigs and fixtures for handling wheel disc, suspension tube and wheel set.
9. Measuring instrument for checking dimension/clearances and wheel profile, surface finish etc.
10. Material handling facilities like fork lifter, mobile crane of adequate capacity.
11. Testing facilities like ultrasonography of axle, wheel disc.
12. Dust free environment/cover space for bearing storage and handling.
13. Sufficient covered space for assembly of wheel set.

**NOTE:-** In case Indian Railways decides to supply wheel sets, then machineries & plant required for repair / rehabilitation of wheel set is not required. However facility for handling, storage and testing of wheel set is required.
ANNEXURE-II

MACHINERIES & PLANT (M&P) REQUIRED FOR REWINDING/REPAIR OF TRACTION MOTOR

The following is the minimum indicative list of facilities to be available with the firm:-

1. Mechanized brazing Plant for joining Rotor bars & Resistance ring
2. Swaging machine for swaging of rotor bars
3. Dynamic Balancing Machine
4. CNC turning lathe machine for rotor shaft and rotor complete.
5. Hydraulic System for pinion Extraction & Mounting & Hydraulic jack of 50 T
6. Crane ≥ 05 Ton
7. Baking Ovens with automatic temperature control and recording (Temperature range 0 ºC - 400 ºC) with facility of rotary curing.
8. Hydraulic Press Machine ≥ 350 Ton
9. VPI Plant (Min. Pressure Capacity 7 ± 0.5 Bar, min vacuum capacity 0.07m Bar) with chilling plant.
10. Coil winding Machine, Coil Spreading machine, Coil Molding Press Machine, Automatic coil forming, looping facility
11. Induction Heater with temperature control for bearings fitment
13. Induction brazing Machine for leads connection.
15. Dust free room for insulation of coils.
16. Air conditioned store for storage of insulating materials
17. Varnish/paint Spray Booth

Prepared by  
SSE/C&S

Checked by  
DSE/TM 
DSE/C&S
ANNEXURE-III

LIST OF TESTING FACILITIES FOR STAGE & FINAL TESTING OF 3 PHASE TRACTION MOTOR

1. Test bed with control panel, of capacity greater than 1500 KVA, 3 Phase, 3000 V suitable for carrying out tests mentioned in annexure-VI. Power analyzer should be part of the control panel or there should be an arrangement to connect it in parallel
2. DE testing machine ≥ 0-10 KV and 0-100mA
3. Surge comparison tester.
4. Power analyzer (If not provided in test bed control panel)
5. Facility for carrying out over speed test by increasing frequency
6. Digital Multi meter
7. Digital thermometer
8. Digital anemometer (air velocity meter)
9. Digital Tachometer
10. Digital Vibration meter
11. Digital Noise meter
12. Megger 500 V & 1000V
13. Micro Ohm meter
14. Core loop tester
ANNEXURE-IV

LIST OF MEASURING INSTRUMENTS

i. Micrometer outside up to ≥700mm with accuracy 0.001 mm
ii. Bore Micrometer (one meter inside) with accuracy 0.001 mm
iii. Bore dial Gauge ≥700mm with accuracy 0.001 mm.
iv. Venire Height Gauge one meter
v. Surface table of minimum 2 meter x 1.5 meter
vi. Infrared thermometer for checking temperature.
 vii. Dial indicator snap gauge for measurement of shaft diameter.
     viii. Ovality gauge
     ix. Feeler gauges

ANNEXURE – V

ADDITIONAL MACHINERIES & PLANT (M&P) REQUIRED FOR ASSEMBLING OF BOGIE ITEMS

1. spring testing machine
2. Spheribloc testing machine
3. Light run testing facility
4. Axle box cleaning plant
5. Fixture for checking of brake rigging
6. EOT crane facility (2 nos ) of min 25 t capacity
7. MPT & Dye penetrant test equipment’s
8. Induction heater for mounting and removing bearing

<table>
<thead>
<tr>
<th>Prepared by</th>
<th>Checked by</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE/C&amp;S</td>
<td>DSE/TM</td>
</tr>
<tr>
<td>DSE/C&amp;S</td>
<td>DSE/C&amp;S</td>
</tr>
</tbody>
</table>
SAMPLE TESTS SCHEDULE FOR 3 PHASE TRACTION MOTOR TYPE 6FRA6068
(Based on CLW approved test schedule for TM with brazed rotor)

The CLW approved test schedule being followed at present for traction motor type 6FRA6068 is given below for better appreciation & guidance to firms of facility required for testing AC traction motors.
Tests shall be carried out on sinusoidal supply at 50 Hz only in one direction of rotation.

1. Measurement of cold resistance
2. No load characteristics
   The motor is to run at no load. Measurement of current, power input at 2360 V, 1817 V and 545 V correspondingly.
   Measurement of current symmetry at 1817 V, current balance ± 2%

3. Half Hour heat run test (No load over fluxing):
   The motor is to be run at U1 = 2890 V, (established after trial) on No Load without ventilation and with the air inlet closed. The duration of the test shall be 30 minutes. The following parameters shall be measured after every 5 minute.
   • Voltage
   • Current
   • Frequency
   • Power factor
   • Speed
   • Power Input
   • Housing (Frame) Temperature
   • Bearing Temperature (DE/NDE)
   • Temperature by temperature sensors 1&2
   • Ambient temperature.

After half hour heat run test, the motor shall be stopped and the winding temperature (by resistance measurement) shall be measured. The winding temperature shall be calculated from cold and hot resistance

Power factor will be calculated from measurement of KW and KVAR, measured at every interval of 5 minutes, for accurate measurement of low power factor at no load (or directly measured by meter)

\[ \text{Power factor} = \cos \left( \tan^{-1}(\text{KVAR/KW}) \right) \]
4. **Short circuit characteristics:**
   In this case rotor is to be blocked up. The supply is to be given so that the current flow in stator is 390 A, 270 A and 80 A. The voltage, current & power is to be measured.

5. **Impedance Measurement:**
   Measurement of impedance by using regulated single phase AC supply and injecting the current approx. 5A, 10A and 15 A between two phase U-V, V-W and W-U and measure the voltage drop between phase and current injected. Average Impedance shall be calculated from 3 values obtained from different phase and current.

6. **Over speed test:**
   For 2 minutes, at around 3250 rpm

7. **Polarization Index test:**
   Polarization Index shall be carried out by the ratio of insulation resistance value after 10 minutes to Insulation resistance value after 1 Minute.

8. **Ventilation calibration measurement:**
   At 0, 1283 and 2583 rpm for different static head at air inlet.

9. **Dielectric test:**
   - HV test between phases t earth at 8300 V for 1 Minute.
   - Measure Insulation Resistance of winding at 1000 V DC

10. **Direction of rotation:**
    L1, L2 L3 to U1, V1 & W1, rotation clockwise as seen from DE side (verification of rotation)

11. **Check on temperature sensors:**
    Check the temperature sensors assembly as per ABB doc. No HTAT 620468

12. **Check on speed sensor assembly:**
    Functional check of speed indicator assembly in both direction of rotation as installed on traction motor.
    - Measurement of dielectric strength as per IEC- 60571
    - Measurement of no of pulses.

13. **Core loop test for stator:**
    This test to be carried out to find out healthiness of stamping for 30 min at 4 points at top, bottom, left & right side core. Difference between Max & Min temperature should not be more than 15 °C.
14. Vibration test & Noise Test:
These tests to be carried out as per IEC-60349-2

15. Measurement of Ovality of Rotors:
Specified DE side 0.001 to 0.015 mm & NDE side 0.001 to 0.020 mm

16. Color matching test of rotor (rotor shaft & Pinion) & Taper draw.
Specified limit ≥ 90% & 1.0 ±0.3 mm

17. Dynamic balancing test of rotor

18. Dimensional check
As per ABB/CLW/Firm’s approved drawing

19. Record of general data:
Record the following data:
- Rotor diameter
- Stator Diameter
- Type of bearing used on DE/NDE with make
- Radial clearance of bearing
- Axial play of bearing

NOTE:- (1) Above test schedule is essentially Type test schedule of 6FRA6068 Traction motor.
(2) Routine test schedule normally comprises of tests mentioned at SL. No. 1, 2, 3, 4, 9, 10, 11 and 19.