

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RESEARCH DESIGNS AND STANDARDS ORGANISATION

NO EL/3.2.70/TMU

Manak Nagar, Lucknow
226 011 (UP)
th October 1982

SPECIAL MAINTENANCE INSTRUCTIONS NO RDSO/EL-PS/SMI /98

TITLE SPECIAL INSTRUCTIONS FOR REWINDING AND REPAIRS TO
MECHANICAL COMPONENTS OF 3-PHASE AC AUXILIARY MOTORS

1. Scope

- 1.1 A large number of auxiliary motor failures have been reported by Railways on account of inter-turn shorts and earth faults. Detailed investigations have been conducted by RDSO in consultation with various motor manufacturers and Dr. Beck & Co. A series of tests on motorettes using indigenously available winding wires were conducted and the results evaluated. Similarly detailed investigations have also been undertaken to identify and suggest solutions to the problems encountered on auxiliary motor mechanical components e.g. bearing housing ovality, shaft wear and selection of bearing scheme suitable to meet with traction applications.
- 1.2 Based on the above investigations, it is considered that substantial improvement in reliability levels and freedom from failures can be achieved by paying particular attention to the following aspects during rewinding:
 - .1 Materials to be used.
 - .2 Rewinding methods and processes.
 - .3 Repairs/modifications to mechanical components.
 - .4 Tests during rewinding.
- 1.3 These Special Instructions highlight the details in regard to the above four aspects. Opportunity has been taken to uprate the insulation system to Class 155 so that better reserve in regard to temperature rise is available.

2. Materials

- 2.1 The materials to be used, the specifications and the recommended sources of supply, are indicated in Annexure I.
- 2.2 Alternative Materials for Rewinding
The following alternative materials may be used in case of non-availability of recommended materials:-

- .6 This supersedes draft code of practice issued vide EL/3.2.70 dt 27.4.77 and SMI NO SMI/E-10/001 issued vide EL/2.2.8.4 dt 16.11.77 for testing of enamel-led insulating wires.

3.1 Tests on other insulating materials

- 3.1.1 After procurement, Nomex-Mylar-Nomex/~~Nomex~~ Nomex 411 insulation may be tested for important tests, e.g. Dielectric strength, tensile strength, and these should be in agreement with the limits shown in manufacturers' catalogue.
- 3.1.2 Other materials may be inspected following established IS specifications wherever applicable. Checks may be made in the Shops/Sheds periodically on such aspects as viscosity, solid contents, dielectric strength, etc. applicable to establish conformity with the manufacturer's declared properties.

4. Processes

- 4.1 The guidelines issued by RDSO in SMI NO RDSO/ELRS/SMI/3 vide letter No EL/3.2.70 dated 16.11.78 shall be followed. Special care is necessary in respect of following:-
 - .1 Coil separator shall be of adequate width so as to ensure that about 40% of the total slot width is covered. Similarly wedge separator shall be of adequate width so as to cover about 40% of the total slot width. (Refer sketch No SKEL 3251 at Annexure IV).
 - .2 Slot insulation shall project 10 mm on beyond slot end in both sides of the slot.
 - .3 The coil connection for each phase shall be made by using Ruptam 14 silver alloy. Do not use fusion welding, tin solder for any connection in the auxiliary motor.
 - .4 The star point shall be adequately made inside the motor using Ruptam 14 silver alloy for brazing and insulating the joint adequately with Nomex 410 tap 2 mil, applying F-40 Varnish on each taping layer.
 - .5 In order to avoid vibration of end laminations, the stator end laminations should be treated with Araldite and made rigid and secure.
 - .6 The overhang shall be stagger-taped, to permit entrance of varnish in the overhang for consolidation.

- .7 Secure the leads in the passage to terminal block, by M-seal or by some other sealing & fixing compound to prevent vibration of flexible leads near terminal studs.
 - .8 Two cycles of flood impregnation of motors using Dr. Beck's Elmotharm F-40 varnish shall be done. The procedure is indicated in SMI NO RDSO/EL-RS/SMI/86 - which ~~ix~~ also gives the recommended arrangements such as tank, etc.
 - .9 It is essential to observe the correct procedure for impregnation/baking of the motor as incorrect procedure may lead to premature failure of motors due to inter-turn shorts as a consequence of hot spot developed in the winding and inadequate bond strength leading to vibrations of conductor, hence inter-turn shorts. Poor impregnation makes the motor winding susceptible to attacks from moisture, dust and dirt, etc.
 - .10 The Railways shall have separate ovens for pre-heating and curing. An oven should be exclusively reserved for baking components using Dr. Beck's Elmotharm F-40 varnish to avoid aggressive effects of the solvents of this varnish on motors using other type of varnishes.
- 4.2 This supersedes RDSO SMI No SMI/E-10/002 issued vide letter No EL/3.2.70/D4 dated 15/26.11.77.
5. Repairs/Modifications to Mechanical Components for Obtaining Good Performance:
- 5.1 Procurement of bearings:
- The bearings shall be directly procured from the following:
- .1 Skefko India Bearing Co Ltd
P Box No 2202, Mahatma Gandhi Memorial Building
Netaji Subhas Road, Bombay.
 - .2 M/s FAG, West Germany
thro' M/s Bearing Engineers Pvt Ltd
East Anglia House, 6th Floor
30th Camac Street, PB No 9246
Calcutta.
 - .3 M/s Precision Bearing Industries, Maneja, Baroda.
- 5.2 Tests on bearings:
- .1 All incoming bearing shall be examined with the

help of shock pulse meter and measurements/checks etc ~~xxxxxx~~ shall be as per SMI NO RDSO EL.RS/SMI/79 issued vide letter No EL/2.2.43 dt 11.6.81.

- .2 During no load run test as per clause No 6.3.4 the maximum bearing temperature rise should not exceed 30°C. The bearing shall be checked for suitability of mounting etc. with the help of shock pulse meter.

5.3 Bearing arrangement

On a large number of present designs of auxiliary motors, both drive and non-drive end bearings are floating. No provision for preventing the rotation of bearings outer races in the housing has been made. Use of such design leads to

- .1 lateral shifting of rotor during vibration and hence causing excessive wear and tear of housing.
- .2 Under direct on line start condition, as adopted on auxiliary machines, /high voltage conditions /under heavy starting torques are developed which results in creepage of outer races in the housing. This phenomena leads to excessive wear and tear of the bearing housing and hence misalignment.

5.4 To overcome these problems, certain changes are proposed These are given in the following SMIs:

- .1 SMI No. -93 for HBB make MCP type K51 d2/H
- .2 SMI No. -94 for building up housing bore/shaft.
- .3 SMI No. -96 for NGEF/Siemen's make MVMTs
- .4 SMI N o. -99 for MPV, MCP, MVSL, MVSI

5.5 The modifications proposed in these SMIs are as follows:

- .1 In the final stages of modification, use of higher capacity bearings, i.e. cylindrical/spherical roller bearings, is proposed on the driving end to increase the bearing life and hence improve bearing performance.
- .2 As procurement of bearings recommended for various applications in para 5.4.1 and 5.4.2 may take considerable period, the performance of existing machines with ball bearings on both sides can be substantially improved by adopting modified design of bearing housing and proper interference fit. With above modifications for various applications mentioned in paras 5.4.1, 5.4.2 and 5.4.3, the creepage of bearing in the housing under direct on line start conditions, shall not exist. ...6

- 5.6 Grease outlet for exist of old grease during regreasing shall be provided on all the motors. Suitable 8 to 10 mm dia plug hole with a stud may be provided on all bearing housing cover in case the same is not provided. During greasing, relief plug shall be kept open in order to allow escape of old grease. After regreasing the motor shall be run for approximately 1-hour to allow excess grease in the bearing to overflow through relief plug, after which the relief plug may be closed. This is to ensure that excess grease, which leads to abnormal bearing performance, is not provided.

5.7 Repairs to worn out bearing housing and shafts:

.1 Hard chrome plating:

It is essential to build up the bearing housing and shafts to the specified tolerances to obtain good alignment between motor and the load.

- .2 To ensure good bearing performance, the recommended alternative method which may be adopted besides chrome plating, are: (Dia more than 30mm) may be suitably

.i) Worn out shafts/build up by welding using low 'mach-heat input special electrodes suitable for the 'ined EN-8 steels as per recommended procedure of M/s Larsen & Toubro.

.ii) Provision of suitable mild steel sleeves in the bearing housing shall be provided as per guidelines indicated in Drg.No. RDSO-SKEL-3520 enclosed. Suitable holes if necessary may be provided in the sleeve to avoid any blockage of existing grease path. The housing bore shall be concentric with bearing cover fixing hole centres.

5.8 Balancing of rotors:

All rotors should be balanced dynamically during IOH or whenever major repairs are done on the rotors. After balancing, the residual unbalance should not exceed 2 gm.meter.

6. TESTS TO BE DONE DURING REWINDING:

- 6.1 Every Rewinding Shop shall be equipped with facilities required for tests of enamelled winding wire as per IS:4800. On the winding wire in-process, samples shall be periodically taken and tested for properties. At least one sample in each size from each manufacturer shall be tested every month, the tests to be performed being the same as detailed in Annexure-II.

6.2 Testing on other insulating materials:

After procurement, Nomex-Mylar-Nomex/Nomex 411 insulation may be tested for important tests, e.g., Dielectric strength, tensile strength and these should be in agreement with the limits shown in manufacturers' catalogue.

6.3 Tests on motor after assembly:

The following tests shall be conducted :-

- .1 Continuity of winding and insulation resistance.
- .2 Measurement of winding resistance.
- .3 Surge voltage test at 5 Kv surge.
- .4 No load run for one hour at 460V, 50H.

Check that these results are in conformity with SMI No. RDSO/EL.RS/SMI/77 vide EL/3.2.70 dt. 22.4.81.

- .5 Dielectric strength at 2 KV for 1 minute.

7. A list of Modification sheets/SMI's is enclosed . Railway may ensure that during rewinding/repairs the instructions and modifications given are incorporated.

8.0 PERIODICITY: Whenever rewinding/repairs of induction motor is done.

9.0 APPLICATION OF CLASS OF LOCOMOTIVE:

All WAM4/WCAM1/WAP1/WAG4 class of electric locomotives.

10.0 INSTRUCTION DRAWING:

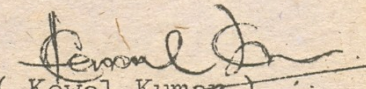
RDSO SKEL No. 3520, 3251. 3521

11.0 AGENCY OF IMPLEMENTATION:

All electric loco sheds and Repair shops of Railways.

12.0 DISTRIBUTION:

As per list attached.


(Kewal Kumar)
for Director General (Elect.)

ANNEXURE-I

MATERIALS FOR REWINDING OF 3-PHASE AUXILIARY MOTORS

(Ref. Para 2 of Spl. Maintenance Instructions
No. RDSO/EL-RS/SMI/98 dt. Oct'1982)

1. ENAMELLED WINDING WIRES:

1.1 Material specification:

Enamelled round copper wire as per IS:4800 Pt-V with medium covering. The enamel covering shall be with Dr. Beck & Co's Terebec 101 enamel.

1.2 Recommended suppliers:

- .1 Mysore Wire and Metal Industries, Post Box 7301, 14th Tunkur Road, Bangalore.
- .2 Atlas Wires Pvt. Ltd, National Highway No.8, P.O. Palej, Distt: Bharuch.
- .3 Jyoti Wire Industries, 23A, Shah Industrial Estate, Veera Desai Road, Andheri (West), Bombay.
- .4 Baroda Cables Pvt., Ltd, 18 Anand Nagar Society, Jetalpur Road, Baroda.
- .5 Premier Cables Co. Ltd, Karukutty, Distt: Ernakulam, KERLA.

1.3 Acceptance Tests:

As per guidelines at Annexure-II.

2. IMPREGNATING VARNISH:

Dr. Beck & Co's Elmothem F-40.

3. INSULATION FOR SLOT AND OVERHANG:

- i) SLOT LINER.
- ii) COIL SEPARATOR.
- iii) WEDGE SEPARATOR.
- iv) OVERHANG INTER-PHASE SEPARATOR.

3.1 Material specification:

- Nomex 410 - Mylar - Nomex 410 (0.25 mm thick) for items (i), (ii), & (iii).
- Nomex - 411 (0.22 mm thick, i.e. 9 mil) for item (iv).

3.2 Recommended suppliers:

- .1 DU POINT Films Department,
WILMINGTON ORDER Service Centre,
205, West, 14th Street Wilmington,
Delware 19898(302)774-3012, U.S.A.

Indian Agents:

- .2 INDMAG Private Limited,
201, Raheja Centre, 2nd Floor,
214, Nariman Point, Bombay-400021.

3.3 Acceptance tests:

As in manufacturer's certificate.

4. SLOT WEDGE:

4.1 Material specification:

Epoxy Fibre Glass.

4.2 Recommended suppliers:

- .1 M/s. Hatim & Co, 90 Rippon Street,
Calcutta.
- .2 M/s. Permali Wallace Limited,
Central India Flour Mill Estate,
Post Box No.38, Bhopal-8.
- .3 Tech-Invest(India)Ltd,
HEL Industrial Estate, Haridwar-249403.

5. CONNECTING LEAD:

- 5.1 Varnish Fibre Glass Flexible Connecting Lead Wire
(Varnish used shall preferably be Dr. Beck's
Elmothem F-40).

5.2 Recommended suppliers:

- .1 M/s. Devidayal Electronics & Wires
Gupta Mill Estate, Reay Road, Bombay-400010.
- .2 Indian Cable Co.
9, Hare Street Calcutta-700001.

6. OVERHANG BINDING:

Glass Cord 1 mm (dia).

7. OVERHANG TAPING:

- 7.1 Varnished glass fibre tape 0.17 to 0.20 mm thick.

7.2 Recommended suppliers:

- .1 Hatim & Co., 90 Rippon Street, Calcutta.
- .2 Jhaveri Thanawalla,
17, Tamarine Lane, Bombay-400001.

8. SLEEVES:

8.1 Glass sleeve impregnated with Dr. Beck's Elmothem F-40, 0.25 mm- 0.7 mm thick and 4 mm to 8 mm dia, as required.

8.2 Recommended suppliers;

M/s. Jyoti Marketing & Projects Ltd,
Industrial Area, Baroda-3.

9. BRAZING MATERIAL FOR COIL AND LEAD CONNECTIONS:

9.1 Ruptan-14 Alloy.

9.2 Recommended suppliers:

Indian Oxygen Ltd,

10. OVERHANG PROTECTION:

10.1 Epoxy Gel Coat of Dr. Beck & Co.

11. INSULATION AT STAR POINT:

11.1 Material specification:

Nomex 410 type 2 mil thick.

11.2 Recommended suppliers:

.1 DU PONT Films Department,
WILMINGTON ORDER Service Centre,
205, West, 14th Street Wilmington,
Delaware 19898 (302) 774-3012, U.S.A.

Indian Agents:

.2 INDMAG Private Limited,
291, Rajeeva Centre, 2nd Floor,
214, Nariman Point, Bombay-400021.

12. TERMINAL JUG:

12.1 Material specification:

Copper Tubular Terminal Leg as per RDSO Drg. SKEL-3001.
(Refer also SMI No. RDSO/EL.RS/SMI/32 ~~issued~~ vide letter
EL/3.2.70/J2 dated 21.11.78).

12.2 Recommended suppliers:

M/s. Dowell's Electro, Werke
Satguru Estate, Office Aarey Road,
Goregaon East, Bombay-400063.

13. TERMINAL BLOCK:

13.1 Epoxy moulded terminal block to drawings
No.
(Ref.RDSO Modification Sheet No.WAM4/61 issued vide
EL/3.2.70/D4 dated 16.1.78).

13.2 Recommended suppliers:

M/s.SINCOS,
134,IDA Industrial Estate,
Okhla Phase-1, New Delhi-110020.

14. TERMINAL STUDS:

As per SMI for terminal blocks above.

NOTE: This supersedes insulating materials indicated in
Draft Code of Practice issued vide EL/3.2.70 dt.27.4.77.

Annex-II

TESTS FOR INSPECTION AND ACCEPTANCE OF ENAMELED
WINDING WIRES AS PER IS: 4800 Pt. III

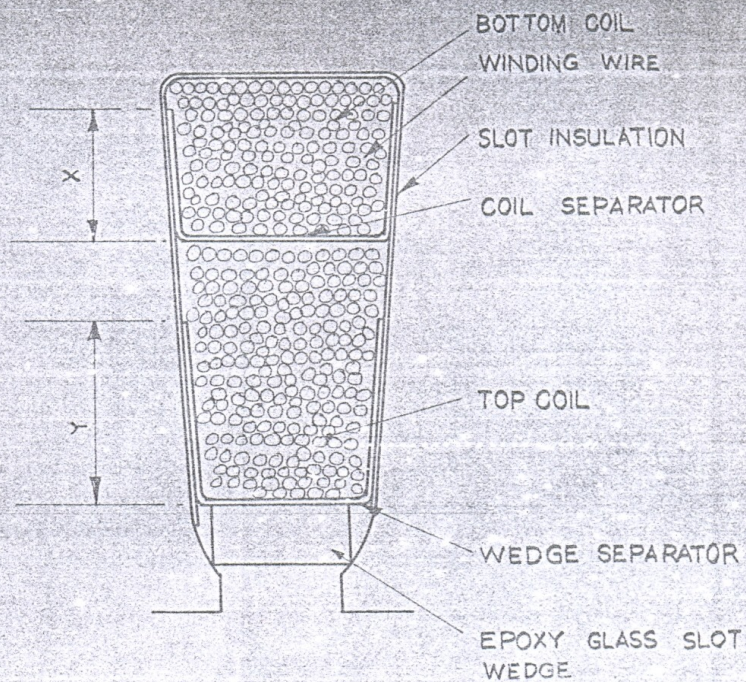
1. The following tests shall be conducted as per IS: 4800 Pt. III at the manufacturer's works before acceptance. In regard to quantities to be tested, the sampling plan laid-down in IS 4800 Pt. III shall be followed.

For each test, the winding wires should meet respective minimum acceptable values as is dictated in IS: 4800 Pt. V.

Tests,

1. Diameter Test,
2. Electrical Resistance test,
3. Elongation test,
4. Springiness test,
5. Flexibility and adherence test,
6. Resistance to abrasion test,
7. Heat shock test,
8. Cut through test,
9. Cure test,
10. Solvent Tests*,
11. Break down voltage test,

*
Solvent Tests:- First test shall be conducted using standard solvent as per IS: 4800 Pt, III and in the second test Thinners F-40 of Dr. Beck & Co., shall be used as solvent for tests as per IS: 4800 Pt, III.



NOTE: COIL AND WEDGE SEPARATOR SHALL BE OF SUFFICIENT WIDTH TO COVER MAX. POSSIBLE SLOT DEPTH AS SHOWN.

REF:

SCALE: NTS

APPROVED: *[Signature]*

SCHEMATIC DIAGRAM OF SLOT OF THREE PHASE INDUCTION MOTOR.

R. D. S.O., ELEC. DTE.

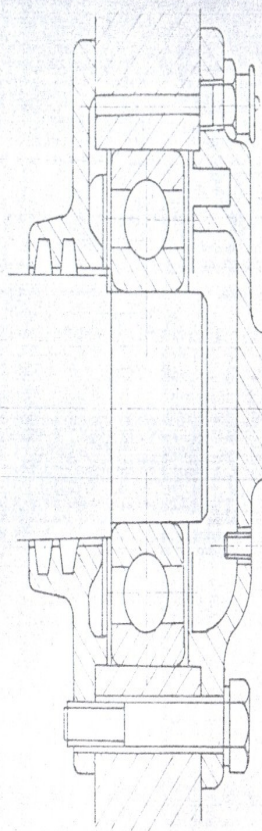
SKEL- 3521.

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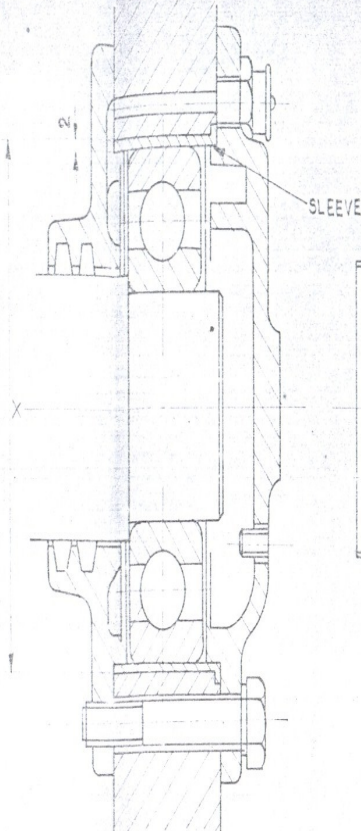
Clough

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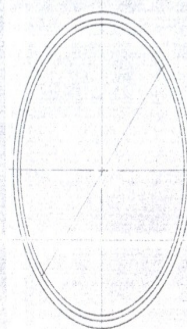
82



ORIGINAL



MODIFIED



DETAIL OF SLEEVE

PROCEDURE:

1. MACHINE THE HOUSING BORE BY 2 mm. MEASURE OD \approx X
2. PROVIDE SLEEVE ON 2T PRESS. SLEEVE OD SHALL BE ADJUSTED SO AS TO OBTAIN M7 INTERFERENCE FIT W.R.T. HOUSING BORE.
3. SLEEVE ID SHALL BE AS PER ORIGINAL DIA OF HOUSING BORE.
4. FIND THE RANGE AND PROVIDE TOLERANCE ON DIMENSION 'X' FOR BEARING HOUSING AND SLEEVE AS PER TABLE-1. IF DIA OF BEARING HOUSING 'X' FALLS IN THE RANGE OF 120-150, THE TOLERANCE SHALL BE TAKEN AS PER COLUMN REMARK.
5. BEFORE PRESS FITTING APPLY 'LOCTITE' ON OUTER SURFACE AND HOUSING BORE.

TABLE -1.

BEARING HOUSING DIA RANGE	80-120	120-150 (X)	150-180	REMARK.
TOLERANCE ON SLEEVE OD	0 -15	0 -18	0 -25	X X - 40 μ .
TOLERANCE ON HOUSING BORE	-35 0	-40 0	-40 0	X X - 18 μ .

REF:

SCALE: NTS.

APPROVED:

PROVISION OF SLEEVES ON WORNOUT HOUSINGS OF AUX. MOTORS.