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सत्यमेव जयते

भारत सरकार – रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ – 226011
Government of India – Ministry of Railways
Research, Designs & Standards Organization
LUCKNOW – 226011

No. EL/3.2.176/1 Dated 08.09.2006

CEE CLW CR NR ECR NCR ER WR WCR SER SECR SR SCR ECoR
(Addresses as per mailing list enclosed)

Special Maintenance Instruction No. RDSO/2006/EL/SMI/0239 , Rev. '0'

1. **TITLE :**

Winding Scheme for Oil Cooling Blower Motors of different makes used on 3-Phase Drive Locomotives.

2. **BRIEF HISTORY :**

The reliability of Oil Cooling Blower motors (OCBs) of WAG9/WAP5/WAP7 class of 3-phase Locomotives has been a cause of concern. The investigations have shown that failures are mainly attributable to inter turn shorts and other winding failures caused by voltage surges present in Auxiliary Converter output. It is also observed that the failures on the motors repaired by the manufacturers through warranty or through other sources are very high. The quality of rewinding done through trade on these motors has not been up to the mark.

3. **OBJECT :**

3.1 The winding schemes of different makes of OCBs are different. This SMI consolidates the winding schemes of different makes to facilitate easy reference and use by rewinding workshops and other agencies carrying out rewinding of these motors.

3.2 Input supply of OCBs is from Auxiliary Converter with PWM output having very high harmonic distortion. Further, there are switching voltage surges present in the output. The insulation of the motors is subjected to additional stresses due to this as compared to conventional sinusoidal supply. This makes use of additional measures necessary while rewinding the motors. The quality of rewinding also plays very important role due to this factor. Therefore a check list of additional measures to be ensured by the rewinding agencies is provided in this SMI to ensure proper quality of workmanship.

4. **WINDING SCHEMES OF DIFFERENT MAKES OF OILING COOLING BLOWERS (OCB) :**

		Landert	BBL	CGL	Siemens
1.	Type of Winding	1. Layer	Double layer concentric	Double layer concentric	1 layer concentric
2.	Connection	Star	Star	Star	Star
3.	No. of Coils used	18	36	48	18
4.	No. of turns/coil	9	4	8	8
5.	No. of coil group	6	12	6 (4+4 coil/group)	12
6.	No. of coil group in parellel	1	-	2	1
7.	Coil Pitch	1:14/1:16/ 1:18	1-17, 2-16, 3-15	1-21, 2-20, 3-19, 4-18	18/18
8.	Conductor Size	Bare 2 x 1.12 + 10 x 1.19	Bare 1.423 Ins. 1.515	Bare: 4x1.18+1x1.12 Ins:4x1.285+1 x1.163	Bare -1.06 x (4) 1.12 x (6)
9.	No of Cond./ Slot	9	8	16	8
10.	No. of wires/Slot	108	80	80	80
11.	No. of Slots	36	36	48	36
12.	No. of wires in parallel	12	10	5	10
13.	Weight of Copper	--	24 kg	22 kg	

5. **WINDING PROCEDURE :**

Winding procedure should be adopted as already enlisted in RDSO Guidelines No. ELRS/PR/0094 of April- 2000 "Guidelines for Firms doing rewinding of Auxiliary Motors used on Electric Locomotives/EMUs". A copy of these guidelines is enclosed as Annexure-I for reference. **However the additional points mentioned in the following paras must be kept in mind.**

6. **MATERIAL USED :**

6.1 **Corona resistant wire**

6.1.1 The capability of the winding to withstand the surge environment can be improved by using Corona resistant winding wire. With this objective, the use of Corona resistance winding wire in lieu of dual coated enameled winding wire to IS13730 Part 13 (as stipulated at para 2.5.2 of RDSO's guidelines mentioned at para 5 above) should be made for winding of these motors.

6.1.2 So far, the wire is available from M/s Pearl Insulations Pvt Ltd, 505, Peenya Industrial Area, Bangalore 560058 as per following description:-

"Thermax 200CR type round enamelled winding wire" of appropriate size.

6.1.3 The wire should be tested for all properties as per IS13730 Part 13 and in addition Voltage Endurance Test should be carried out as per details below.

Voltage Endurance Test
10 samples are prepared as per clause 13 of IS13730(part 0/Sec 1) and IS13778(Part 5) and subjected to voltage of 2 KV at 50 Hz at room temperature and maintained till break down occurs. Atleast 8 samples shall withstand for 75 hours without breakdown. The Breakdown Voltage shall be measured as per Clause 4 of IS13778 (Part 5):1993.

6.1.4 Efforts are being made for developing detailed specification and further sources for this wire. Railways shall be advised regarding the development in due course.

6.1.5 Type tests against first order from the Railways will be conducted by RDSO.

6.2 Other materials used for re-winding are listed in RDSO Guidelines No. ELRS/PR/0094 and SMI/185 and should be referred accordingly.

7.0 SPECIAL PRECAUTIONS TO BE TAKEN DURING WINDING OF PWM CONVERTER FED MOTORS:

7.1 Use of VPI process as per guidelines of varnish manufacturers must be ensured. Make sure that prescribed vacuum level and pressure level are maintained during impregnation. Also ensure following the correct baking cycle after VPI.

7.2 Phase separating layers of NKN sheet of sufficient area should be used for separation of phases adequately in the overhang.

7.3 Inter layer separating sheet of NKN of sufficient area must be used to separate layers of coils adequately in overhang.

7.4 While inserting coils into slots and shaping of the overhang, care should be taken that starting and end turn of coils are not placed very close to each other.

7.5 Ensure use of correct wire size for individual machines.

7.6 Brazing of the joints should be done properly. Special care should be taken while brazing joints having terminal connecting lead.

7.7 Cleaning of brazed joints must be ensured. No burrs should be left on the joints.

7.8 Ensure that the brazed joints are insulated adequately with sufficient insulation.

7.9 Presence of dust and dirt in the winding is highly injurious to the converter fed motors. It should, therefore, be ensured that the winding is done in dust free atmosphere. No activity spreading dust/ external particles should be carried out in the vicinity of winding worktable. Also make sure that the jobs in hand are adequately covered and protected when no work is being done on them.

7.10 Winding overhang should be tightened adequately with glass cord.

8. **APPLICATION :**
Oil Cooling Motors of 3-Phase Drive Locomotive i.e. WAG-9, WAP-7 & WAP-5.

9. **AGENCY OF IMPLEMENTATION:**
All rewinding workshops, motor manufacturers.

10. **PERIODICITY OF IMPLEMENTATION:**
During rewinding of OCB motors.

08/9/2006
(M.K.Singhal)
for Director General/Elect.

Encl: As above

Copy to:
1. Secretary (Electric Traction), Railway Board, Rail Bhawan, NEW DELHI 110001
For kind information please.
2. M/s Bharat Bijlee Ltd, M/s ABB, M/s Crompton Greaves Ltd, M/s Jyoti Ltd
(Addresses as per enclosed mailing list)
3. CWM KPA, CWM NKRD, SrDEE(TMS) CNB, SrDEE(TRS) TATA,
(Addresses as per enclosed mailing list)

08/9/2006.
(M.K.Singhal)
for Director General/Elect.

Encl: As above

Guide No. ELRS/PR/0094

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

GUIDELINES

FOR

FIRMS DOING REWINDING OF AUXILIARY MOTORS

USED IN ELECTRIC LOCOMOTIVES/EMU's

APRIL – 2000

Issued by

Electrical Directorate

Research Designs & Standards Organisation.

GENERAL

1.0 This guideline has been prepared for the guidance of rewinders of Auxiliary motors of Electric Locomotive and EMUs.

The guideline also provides information regarding minimum requirement of machinery and plant, test equipment, quality assurance plan for rewinding of the auxiliary motors.

2.0 It is observed that auxiliary motor manufacturers are normally not doing the rewinding of the motors failed under warranty in their works. It is being done by their authorised rewinders.

2.1 The performance of the rewound auxiliary motors by OEM's authorised rewinders is required to be improved. Therefore, it is essential to upgrade & streamline the facilities for rewinding & testing of the auxiliary motors with the authorised rewinders.

2.2 These guide-lines lay down a uniform standard procedure, so that a minimum quality of rewinding and improvement in reliability level of motors can be achieved.

2.3 Rewinders having ISO-9000 certification shall be preferred. However, it is a mandatory requirement.

3.0 PROCEDURE FOR REWINDING :

Inspect the stator winding carefully and investigate the probable cause of failure of the winding. Make a report for future reference.

2.4 i) Cut the stator winding overhangs.
ii) Remove the wedge and winding wires carefully so that stator slot portion should not get damaged.
iii) Clean the stator slots free of old insulation and file very lightly to remove any sharp corners and burrs. Wipe off all foreign material.
iv) Inspect the slot portion with the help of hand lamp for any damage.

2.5 Making of coils :

2.5.1 Use the enamelled winding wire from the RDSO approved source only.

2.5.2 Dual coated enamelled winding wires as per IS 13730 – Part 13 (Grade 2) Medium coating 1993 shall be used. Dual coat means that base coat with polyesterimide enamel MT 533.39 A/ TR543.38 and top coat with Allotherm 602L35A of Schenectady-Beck India only. The enamel thickness shall comply with IS 13730 Pt `0' Section M (I) and (II)mentioned above. Tan Delta bending point value will be 180-195 deg. C. Tan delta single point value will be 0.015 to 0.03 at 200 deg. C. The test on enamelled winding wires shall be conducted as per IS: 13778 Part 1 to 6 on each reel. Separate documentation for these tests shall be maintained by the rewinder, indicating the winding wire supply particulars.

2.5.3 Discard the first layer of winding wire from the beginning of the each reel so that scratches etc. if any, on the wire may not come in the winding portion.

2.5.4 Use the correct coil former as per specified drawing of OEM..

2.5.5 Form the coils using the specified wire size with the specified number of turns and parallel path, with the help of the correct former, taking care not to exert excessive tension. Lay the turns of the coils preferably in uniform layers to avoid excessive inter-turn voltage.

3.3 Slot/Interphase insulation :

3.3.1 Use the insulating materials from RDSO approved sources only.

3.3.2 Nomex 410- Kapton-Nomex 410 with calendered Nomex (NKN as per IEC 623-3) or Nomex 418 shall be used for slot liner and wedge separator. Uncalandered nomex 411- Kapton-Nomex 411 (NKN) shall be used for inter layer and interphase insulation.

3.3.3 Insert a `U' shaped slot liner, properly cuffed at the ends, with the overall length extending approximately 10 mm beyond slot ends.

3.4.0 Coil Insertion into slots:

3.4.1 Insert the coils in the insulated slot carefully, turn by turn, ensuring adequate protection to the insulating enamel. Lay the coils preferably in uniform layers to minimise interturn voltage. Use a revolving stand for the stator to facilitate insertion of the coil in the vertical position.

3.4.2 Insert the coil separator. Complete the insertion of coils in all slots. Insert interphase separator in the over hang region.

3.4.3 Consolidate the winding in slot and overhang portion using a light rubber faced mallet. (Preferably coil overhang shapers should be used.).

3.4.4 Insert the wedge separator and place the Epoxy bonded glass fibre laminates in the slot applying light mallet blow from the end slightly, lubricate the wedge by applying varnish before driving into the slots. Slot wedges may be suitably shamphered as per the OEM drawings.

3.5.0 Coil Connection :

3.5.1 Make the coil connections for each phase separately as per winding diagram after verifying the continuity and correct sequence of the coils. Make the joints by brazing, using Rupatam 14 silver alloy. Star point of the winding shall be formed inside the stator overhang.

The star point shall be adequately brazed and insulated ensuring best workmanship. On the brazed joint apply General Electric RTV Silicon sealent and overtape with two layers of half

lap "Fusa Flex" 76593 tape. Seal the joint with heat gun. Do not use tin or tin lead solder for any connection in auxiliary motors.

3.5.2 Make the phase connections by brazing the connecting leads of specified size with the following specification "Flexible insulated fibre glass copper connecting lead wire with fire retardant silicon elastomer for temperature –50 deg C to 180 deg. C as per BSS 6195/1969 type 8`b' category C/D with BDV of 6 KV minimum. (Category `C' for 4 and 6 sq.mm sizes and category `D' for 10 sq.mm size of lead wire). Procure the connecting lead wire from the RDSO approved sources only.

3.5.3 Joints and flexible leads shall be covered with suitable flexible insulated fibre glass sleeve with coating of fire retardant silicon elastomer applied by extrusion or multi dip process having temperature index of 180 deg. C as per BS:2848 type 1/180 Tb having wall thickness of 0.9 mm and capable to withstand minimum BDV of 5 KV for one minute.

It should be assured that the sleeve not only cover the brazed portion but also cover well beyond the scratched insulated portion of the winding wire and connecting lead wire.

3.5.4 The lead wire should not be excessively long.

3.5.5 The leads and joints shall be tied rigidly on the overhang of the winding staggered using glass cord.

The leads shall be tied securely on the stator overhang of the winding at their exit from the winding to the terminal block.

3.5.6 The connecting lead wire from the phase connection should be brought to the terminal block.

3.5.7 A compression type (rubber) gland shall be used for securing the flexible leads at the entry of terminal block and rubber grommet should also be used.

3.5.8 Flexible cable shall be well gripped by the insulated socket tube while doing crimping.

3.5.9 The crimped socket and joint shall comply with BS:4579 Part 1.

3.5.10 The terminal sockets used shall be of annealed electrolytic copper. The minimum radius between palm and tube shall be 2 mm. Thickness of socket tube shall be at least 1 mm.

3.6.0 Impregnation

3.6.1 The winding shall be subjected to vacuum pressure impregnation (VPI) process with impregnating varnish Dobeckon FT2015/2005/500EK of Schenectady Beck India Ltd. During VPI process vacuum level should be 1 Torr and pressure 2 to 3 Kg/sq. cm. The VPI plant should be suitable for solventless resins and should have chilling plant installed on storage tank. The impregnation shall be done twice , i.e., double impregnation. While using impregnating varnish, viscosity should be checked. If viscosity is found more than specified ,

add diluent `V' and in case viscosity is found less than specified add inhibitor UPI of Schenectady Beck India.

4.0 RDSO Special Maintenance Instructions and Modification Sheets issued from time to time must be followed during rewinding of auxiliary motors. The copies of SMI/MS can be purchased from RDSO.

5.0 For more technical details, refer RDSO Specification No. SPEC/E-10/3/08 (Revised) of Sept.1995 with amendment No. 1 and SPEC/E-10/3/09 (Motor) of August, 1997 for auxiliary motors of conventional and 3-phase Electric Locomotives respectively.

SUMMARY OF INSULATING MATERIAL

. No.	Item	Material	Governing Specification	Manufacturer
1.	Winding Wire	Enamelled winding wire	IS:13730 Pt.13, Grade 2, 1993	RDSO approved
2.	Slot insulation	NKN (Nomex 410 Kapton Nomex 410) or Nomex 418	IEC 623-3	RDSO approved (Beico/Nasik PRS Permacel) Krempel, Germany.
3.	Interphase Separator	Nomex 411 Kapton Nomex 411 (NKN)		-do-
4.	Inter layer separator	-do-	-do-	-do-
5.	Connecting Lead wire	Flexible insulated fiber glass copper connecting lead wire with fire retardant silicon	BSS:6195/1969 type 8 `B', category C for 4 & 6 Sq.mm size and category	RDSO approved sources

		elastomer for temp –50 deg.C to 180 deg C and BDV of 6 KV minimum.	`D' for 10 sq.mm size	
6.	Sleeve	Fiber glass sleeve with coating of fire retardant silicon elastomer applied by extrusion or multidip processhaving temp. index of 180 deg C, type 1/180 Tb having wall thickness of 0.9 mm	BS:2848 and capable to withstand minimum BDV of 5KV for 1 min.	-do-
7.	Impregnating varnish	Dobeckon FT2015/2005/500EK	Manufacturers test data.	Schenectady Beck India Ltd.
8.	Wedge	Epoxy glass laminate	BDV 5 KV for 1 minute	-
OTHER MATERIAL				
9.	Bearing	Deep grooved ball bearing with C3- radial clearances.	Manufacturers test data.	SKF/France, Germany, FAG/Germany, NSK/Japan.
10.	Terminal Block	Epox moulded glass reinforced	BS3815	RDSO SKEL 2754A & 2784A
NOTE: For details Specification and approved sources, please refer RDSO SMI-185 with amendments 1-5.				

3.7.0 TESTS

Following tests must be carried out at the stages mentioned below :

Sl No.	Tests	Stage
1.	Dielectric test between phases and phases to earth at 2 KV for 15 Sec.	Before making phase connections.
2.	Continuity of winding	After completion of winding and before impregnation.
3.	Insulation resistance	-do-
4.	Measurement of winding resistance	-do-
5.	Surge voltage test at 5 KV P-P	-do-
6.	Insulation resistance	After assembly, on assembled motors..
7.	Resistance measurement	-do-
8.	Direction of rotation	-do-
9.	No load test at 415V and 500V balance voltage. (The ratio of no load current at 500V to that of at 415V shall not exceed the values achieved during type test.)	-do-
10.	Locked rotor test. A single test at any reduced voltage as per IS:4029 1991.	-do-
11.	One hr. temp. rise test at 415V (limit as per prototype test report).	-do-
12.	High voltage test at 2.64KV for 1 min.	-do-
13.	Vibration test as per IS 4729/IS12075 vibration level shall not exceed 15 micron P-P for MVMT and MVRH and 10 micron for other motors.	-do-
14..	S.P.M. measurement.	-do-

Part –2

(A) **Machinery and Plant**

1. Electric ovens (0-300 deg. C) with automatic cut in & cut off.
2. Crane/chain pulley.

3. Coiling machine with counter
4. Dynamic balancing machine for rotor balancing.
5. Wedge cutting machine
6. Vacuum impregnation plant.
7. Chilling plant for storage of varnish.
8. Brazing machine.
9. Air conditioned room size 4x4 mts.with minimum two air conditioner for keeping insulating material.
10. Spray painting facility.

(B) **Testing Facilities :-**

The minimum essential testing facilities which are required for rewinding of auxiliary -motors:

1. Dynamometer
2. Complete testing facility for testing dual coat enemelled winding wire as per IS:13730 Pt.13.
3. 3 phase voltage regulator (0-500V).
4. Resistance meter.
5. Watt meters]
6. Voltmeters] Accuracy class 0.5
7. Ammeters]
8. RPM measurement meter
9. Frequency meter
10. Vibration meter
11. `SPM' (Shock Pulse meter)
12. High voltage test set
13. Megger
14. Growler/EMC motor checker
15. Surge comparision tester
16. Multi meter
17. Miscellaneous tools e.g., rubber faced mallet, wire cutter and vernier callipers, etc.

S. No	COMPONENT/OPERATIONS	CHARACTERISTICS CHECKED	CLASSIFICATION	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	AGENCY
1.	Enamelled copper wire	(1)Dimensional conformance	Major	Measurement	Random	IS:13730 Pt-13		
		(2) Peel test	Major	Testing		-do-		
		(3)Thermal stability	Major	Heat shock test		-do-		

		(4) Resistance to abrasion	Major			-do-		
		(5) Insulation strength	Major	BDV test at room temp.		-do-		
		(6) Conductivity	Major	Resistance measurement		-do-		
		(7) Mandrel winding	Major	Testing		-do-		
		(8) Continuity of covering	Major	Measurement		-do-		
		(9) Solvent test (10) Tan delta test & all left over tests conforming to IS 13778 Pt.1-6		Chemical		-do-		
2.	Insulating paper nomex 410/411	(1) Dimensional conformance. (2) Weight per unit area (3) BDV Test (4) Tensile strength (5) Elongation a- Lengthwise b- Cross wise c- Folded d- Unfolded (For BDV, Elongation and Tensile strength a, b,c,d should be tested.	Major Major Major Major	Measurement. Measurement Testing Testing	1) lot 1) lot 1) lot 1) lot			
3.	Impregnating resin	a) Viscosity b) Curing test c) Solid content d) Gel time e) Shelf life	Major Major Major	Measurement Curing Non-volatile matter Chemical Chemical	250 ml/lot -do- -do-			
4.	Terminal Lead Cable	a) Dimensional conformance b) Electrical strength	Major Major	Measurement. Testing	1/lot 100%	BSS 6195-1969		
5.	Sleeves	a) HV Test 5 KV for one min. b) Width, thickness c) Bending test	Major Major	Testing Measurement	100% Random	BSS-2848		
6.	Brazing alloy	a) Chemical composition	Major	Chemical analysis	One/lot	IS:2927		

7.	Bearing	a) Dimensional conformance	Major	Measurement	100%	Manufacture catalogue		
		b) Manufacturer's type & designation	Major	Visual verification	100%	-do-		
		c) Physical condition	Major	Visual Inspection	100%			
		d) Make	Major	Visual	100%	Imported SKF/FAG make bearings of European origin and NSK/Japan make bearings shall be used.		
		e) Tolerance between inner race bore and shaft.	Major	K5	100%			
		f) Tolerance between outer race & end shield bore.	Major	J6	100%			
8.	Terminal Block	a) Dimensional conference	Major	Measure-ment	100%	SKEL 2784A & SKEL 2754A		
		b) HV Test	Major	Testing	100%			
9.	Stator coil	a) Size & Grade of wire.	Major	Verification	1for each motor	Drawing from OEM	Drawing from OEM	
		b) No. of turns	Major	-do-	-do-			
		c) Former size	Major	-do-	-do-			

10.	Stator winding	a) Cleanliness & Smoothness of slot surface. b) Dimensional conformance of stator winding. c) Correctness of group & phase connections. d) Soundness of winding insulation. e) Test of winding wire is must	Major Major Major Major	Visual inspection Measurement & visual inspection. Polarity test and winding resistance. IR & HV test.	100% 100% 100% 100%	 IS-325	No projection of stamping in slot. T.Test IS:325	
11.	Grease Servogem RR-3	Verification of material by drop point test.	Major	Testing	Gm/lot	IS:7623	IS:7623	
12.	Rotor & Stator material		Major	-	Per lot	M-45 grade	IS:648	
13.	Rotor	a) Discontinuity in rotor bars and end rings. b) Growler test c) Inductance test			100% 100% 100%			
14.	Balancing of rotor		Major	-	100%	G 2.5	ISO 1940-1973	
15.	Cable Glands	a) Dimensional b) Physical condition. c) Type and designation	Major Major Major	Measurement Vusual inspection Visual verification	Random 100% 100%			

16.	Impregnation of winding	a) Pre-heating b) Vacuum and pressure cycle. c) Drying & Baking d) Viscosity of resin	Major Major Major Major	Verification for temp. & duration Verification. Temp. and duration of heating. Measurement.	100%			
17.	Motor assembly	a) Correctness of bearing assembly b) Completeness and correctness of motor assembly. c) Free Rotation of rotor d) Concentricity of stator & rotor.	Major Major Major Major	Visual inspection Visual inspection Verification by hand rotation Air gap measurement	100% 100% 100% 100%	Assembly Drg. Assembly Drg. - Assembly Drg.	Assembly Drg. Assembly drg. -	
18.	Routine Test	a) Physical verification of name plate. b) Inspection resistance. c) Winding resistance d) SC Test e) H.V.Test f) Phase sequence check g) Direction of rotation. h) No load running test i) Load test j) Vibration test. k) Surge test. l) One hr. temp. rise test at rated voltage and rated load	Major Major Major Major Major Major Major Major Major Major Major Major	Verification Measurement -do- -do- Testing Verification -do- Testing Testing Testing Testing	100% 100% 100% 100% 100% 100% 100% 100% 100% 100% 100% 100%			
19.	Painting	a) Appearance & Finish	Major	Visual Inspection	100%			