

Fax : 91-0522-458500
Telephone : 1455109 & 451200
e-mail : edse.rdso@gmail.com



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/3.2.1/3-phase

Dated: 01.10.2019

प्रमुख विद्युत अभियंता, 1. मध्य रेलवे, मुम्बई सीएसटी-400 001 2. पूर्व मध्य रेलवे, हाजीपुर-844 101 3. पूर्व तटीय रेलवे, चन्द्रशेखरपुर, भुवनेश्वर-751 017 4. पूर्व रेलवे, फेयर्लीप्लेस, कोलकाता-700 001 5. उत्तर मध्य रेलवे, ब्लाक ए-2, सुबेदार गंज इलाहाबाद- 211 033 6. उत्तर रेलवे, बड़ौदा हाऊस, नई दिल्ली-110 001 7. उत्तर पश्चिम रेलवे जयपुर- 302006 8. उत्तर पूर्व रेलवे गोरखपुर- 273001 9. उत्तर पूर्व फ्रेन्टीयर रेलवे मालीगाँव गुवाहाटी-781011 10. दक्षिण मध्य रेलवे, रेल निलायम, सिकंदराबाद-500 371 11. दक्षिण पूर्व मध्य रेलवे, बिलासपुर- 495 004 12. दक्षिण पूर्व रेलवे, गार्डेनरीच, कोलकाता-700 043 13. दक्षिण रेलवे, पार्क टाउन, चेन्नई-600 003 14. दक्षिण पश्चिम रेलवे हुबली-580020 15. पश्चिम मध्य रेलवे, जबलपुर-482 001 16. पश्चिम रेलवे, चर्चगेट, मुम्बई- 400 020 17. चित्तरंजन रेल इंजन कारखाना, चित्तरंजन- 713 331 18. डीजल रेल इंजन कारखाना, वाराणसी-221004 19. डीजल लोको मोडर्निजेशन वर्क्स पटियाला- 147 001	Principal Chief Electrical Engineers, 1. Central Railway, Mumbai, CST-400 001. 2. East Central Railway, Hazipur-844 101. 3. East Coast Railway, Chandrashekharpur, Bhubaneswar -751 017 4. Eastern Railway, Fairlie Place, Calcutta-700 001. 5. North Central Railway, Block-A, Subedarganj, Allahabad- 211 033. 6. Northern Railway, Baroda House, New Delhi-110 001. 7. North Western Railway, Jaipur- 302 006 8. North Eastern Railway, Gorakhpur-273001 9. North East Frontier Railway, Maligaon, Guwahati- 781011 10. South Central Railway, Secunderabad-500 071. 11. South East Central Railway, Bilaspur-495 004. 12. South Eastern Railway, Garden Reach, Kolkata- 700 043. 13. Southern Railway, Park Town, Chennai-600 003. 14. South Western Railway, Hubli- 580020 15. West Central Railway, Jabalpur-482 001. 16. Western Railway, Churchgate, Mumbai-400 020 17. Chittaranjan Locomotive Works, Chittaranjan-713 331 18. Diesel Locomotive Works, Varanasi-221 004. 19. Diesel Loco Modernisation Works Patiala -147 001
--	--

TECHNICAL CIRCULAR No. ELRS/TC/0076, Rev. 2

**OIL LEAKAGE FROM THE TRANSFORMER BUSHINGS
AND COVERS IN 3-PHASE LOCOMOTIVES**

1.0 Background

Initially, 33 Nos. of 3-phase drive (11-WAP5, 22-WAG9) locomotives were imported from the then ABB/Switzerland (now M/s. Bombardier Transportation) with transfer of technology. These locomotives had Secheron make main 7500 / 6500 KVA transformers. When these locomotives were taken up for indigenous production at CLW, main transformer was developed through ToT to M/s. BHEL, CGL, BT/India, NGEF & EMCO. Later on, a few more sources have

obtained TOT from CLW. So far, CLW have manufactured about 41 WAP-5, 336 WAG-9 and 129 WAP-7 (passenger version of WAG9) locomotives majority of which have been provided with indigenously manufactured traction transformers from ToT partners.

While the traction transformers imported from OEM had given satisfactory service, the indigenous transformers supplied by ToT partners have been giving problem of oil leakage from the transformer bushings and cover.

- 1.1 Problem was studied and it was noted to be due to non-standard type of gaskets / 'O' rings used by manufacturers in assembly. To prevent the problem, a Technical Circular no. ELRS/TC/0076, Rev'O' was issued vide file of even no. dated 17.09.2002 specifying the type of gaskets and manufactures to be provided on bushings, top cover and bushing plates of transformers. This problem was accordingly investigated after issue of Rev.'O' of this Technical Circular.
- 1.2 However, the problem of oil leakage has again been reported by Railways in the recent past. The matter has been investigated and the majority cases of oil leakage reported are due to use of non specified gaskets/'O' rings by the manufactures. Quality of gasket / 'O' ring is important and therefore specification of these have been examined and reconciled position in respect to specification is being issued through Rev '1' of this Technical Circular for guidance of Railways, Production Units and Transformer manufacturers.
- 1.3 Oil leakage cases of LOT 6500/7500 KVA transformers reported by Railways were analyzed and it has been observed that mainly oil leakage cases are on account of bushing gaskets at location 'B' & 'C'(SKEL-4663) which is of NEBAR and supplied by M/s James Walker, UK. NEBAR gaskets are made of a blend of rubber and cork material. Equivalent material of NEBAR developed by M/s Nu-Cork and supplied by M/s CGL has also reported to be failed by Central Railway.
- 1.4 On the subject issue, RDSO has interacted with ABB and M/s ABB Secheron, the OEM of these transformers who have conducted a quality audit of their unit at Vadodara. Based on their global experience, ABB Secheron have recommended the use of NBR(Nitrile) gaskets at location B & C (SKEL-4663, Alt.1) in place of NEBAR gaskets. RDSO, has further discussed the matter with all the transformer manufacturers including ABB and it has been considered to use NBR(Nitrile) gasket for bushing gaskets at location 'B' and HNBR gasket for bushing gaskets at location 'C' with high temperature withstand capacity in place of existing NEBAR gaskets. Accordingly, the requisite changes have been incorporated in this Technical Circular.

2.0 Bushings

- 2.1 The type of bushings used for different applications in the transformers for 3-phase drive locomotives are given in Table-1 as under:-

TABLE-1

TYPE OF BUSHING	APPLICATION	TERMINALS
DT 3/2000	Traction Bushings SOD Bushings	2u1-2v1, 2u2-2v2, 2u3-2v3, 2u4-2v4, X11-X12, X21-X22
DT 1/250	GOD Bushings	XB11-XB12, XB13-XB14, XB21-XB22, XB23-XB24, XB31-XB32, XB33-XB34.
DT 3/630	Filter/Burr/Earth Bushings	2UF-2VF, 2UB-2VB, 1V
DT 1/2000	Hotel Load Bushings	2UH -2VH

- 2.2** In order to prevent oil leakage from the bushing gaskets, it is necessary to use gaskets at different locations in the bushings as per details given in the following Table- 2 below :-

TABLE -2

Bushing Type	Location				
	A	B	C	D	E
DT 1/250	NITRILE Ø 22/12x11	NITRILE Ø 29/14x3	HNBR Ø 50/28x4	NBC Ø 50/28x2	NBC Ø 45/25x2
DT 1/2000	NITRILE Ø 59/42x18	NITRILE Ø 76/44x3	HNBR Ø 104/70x4	NBC Ø 104/70x3	NBC Ø 90/63x3
DT 3/630	NITRILE Ø 32/20x13	NITRILE Ø 41/22x3	HNBR Ø 70/45x4	NBC Ø 70/45x2	NBC Ø 63/40x2
DT 3/2000	NITRILE Ø 59/42x18	NITRILE Ø 76/44x3	HNBR Ø 104/70x4	NBC Ø 104/70x3	NBC Ø 90/63x3

The Locations **A,B,C,D & E** of the gaskets are indicated in the RDSO drawing **SKEL No.4663, Alt.1** (Enclosed)

The details of the above gasket material and the governing Specifications are given in the Table -3 below:-

TABLE-3

Material	DISCRIPTION	Reference IS/BS
NITRILE	Nitrile Rubber Vulcanized Butadiene	BS : 2751 - 2001 Grade - BA 80
HNBR	Hydrogenated Nitrile Butadiene Rubber	See Note-1 below
NBC	Nitrile bonded cork Gasket	IS:4253 (Part 2): 2008 See Note-2 below

Note1- H-NBR is a hydrogenated nitrile compound of standard quality for use in the transformer gaskets. This exhibits good chemical and mechanical properties at high temperature. The salient parameters of HNBR components are as given below along with test method:

S.No.	CHARACTERISTICS	VALUE	TEST METHOD
1.	Chemical composition	Acrylonitrile/ Butadiene Rubber, ACN % is 34%, 99.5% hydrogenated. Polymer content should be minimum 45% .	
2.	Specific weight (gm/ cc)	Typically 1.24	ISO 2781
3.	Hardness(IRHD)(Shore A)	66 to 74	ISO 868
4.	Tensile Strength at break (Mpa)	Min. 15	ISO 37
5.	Elongation at break (%)	Min. 350%	ISO 37
6.	Compression set (%) 22h/ 150 °C, on slab	Max. 25%	ISO 815
7.	Heat ageing 70h/ 150 °C i) Hardness change, Shore A ii) Tensile strength change(%) iii) Elongation change(%)	+ 10 Pts. - 10% max. - 20% max.	ISO 188
8.	Immersion in IEC:60296/ IS:12463 oil 70h/ 150 °C i) Hardness change, Shore A ii) Tensile strength change(%) iii) Elongation change(%)	- 10 Pts. - 10% max. - 30% max.	ISO 1817

Note-2 : The size of cork granules used shall be of 'Fine' category as mentioned in the Clause No. 3.2 of IS:4253(Part-2):2008. The NBC gasket shall be of type RC70-C as per Table-1 of IS 4253(part-2):2008. The characteristics of type RC70-C and their values are given below:

S.No.	CHARACTERISTICS	VALUE	TEST METHOD
1.	Hardness(IRHD) Shore A	70 ± 5	IS 3400(part-2):1995
2.	Dimensional changes, Percent, Max	1.5	
3.	Tensile Strength , kPa, Min	1550	
4.	Compressibility (%) (at 2800 kPa) percentage	25-35	
5.	Recovery, percent, Min	80	

6.	Compression set Percent, Max	85	IS 4253(part 2):2008
7.	Chemical test on water extract: a) pH, where applicable	5.0 – 8.5	
	b) Chloride content(as chloride ion)	0.2 percent, Max	
	c) Sulphate content(as sulphate ion)	0.2 percent, Max	
9.	Volume change in transformer oil as per IEC:60296 , 70 h/ 100 °C	Max. 8	

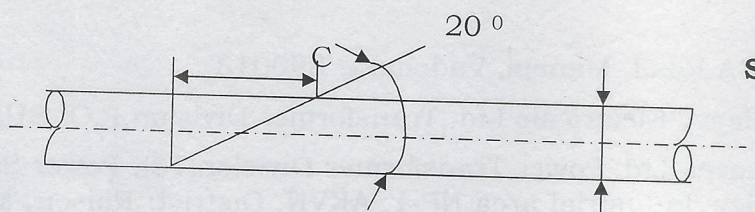
3. Covers

In order to prevent oil leakage from transformer cover gaskets as well as from the two bushing plate gaskets, it is necessary to use joint less gaskets as per details given in Table-4 below :-

TABLE-4

Location	Qty	Material	Single piece	With overlap joint ☐	Dia. 'S'	Ref. IS / BS
Tank Cover	01	Nitrile (nitrile rubber vulcanized butadiene)	8035 ± 10 mm	8035 ± 10 + 'C' (44) mm = 8079 ± 10 mm	16mm	BS : 2751-2001
Bushing Covers	02	Nitrile (nitrile rubber vulcanized butadiene)	3930 ± 10 mm	3930 ± 10 + 'C' (20) mm = 3950 ± 10 mm	07mm	BS : 2751-2001

In case of use of open ended gasket (generally, it should not be permitted), the procedure to be followed for vulcanizing the overlap joint I is as under :-



Cut the gasket ends at an angle of 20°. Apply rubber adhesives on both the cut edges and press it in a template. Heat the template at 155 deg.C for about 21 min. (Max. 26 min.) for gasket of dia. 16mm and for about 12 min. (Max.17 min.) for gasket of dia 7.0 mm.

1.0 Oil Compartment gaskets

The oil compartment gaskets for 3-ph locomotive transformers shall be used as per details given in Table-5 below:-

TABLE-5

SN	Description of gasket	Drg. No.	Ref. IS/BS/ Material	Unit	Qty Per set
1.	450 x 1744 x 6	HSTN104275P0001	FPM(Viton)	No.	4
2.	80 x 421 x 6	HSTN424015P0001		No.	4
3.	100 x 290 x 6	HSTN423988P0001	Ref.	No.	4
4.	80 x 409 x 6	HSTN423987P0001	IS:3400	No.	4
5.	80 x 414 x 6	HSTN423986P0001	See Note-3	No.	4
6.	10 Dia. Round cord	HSTN003296P0010	below *	mm	8150

Note-3 :

Typical FPM(VITON) 75 Characteristics

S.No.	CHARACTERISTICS	VALUE
1.	Colour	BLACK
2.	Hardness	75 ± 5 SHORE A
3.	Specific Gravity(gm/cc)	1.85 ±0.1
4.	Tensile Strength , Min (Kg F/cm ²)	110
5.	Elongation at break (Min)	165%
6.	Compression set [24 Hr/ 200 °C] Percent, Max	20%
7.	Temperature Range	-10°C / + 270 °C
8.	Volume change in transformer oil as per IEC:60296 , 70 h/ 100 °C	Max. 8

A. Pandey 01.10.19
(Arvind Pandey)
for Director General (Elect.)

Encl: As above.

Copy to:

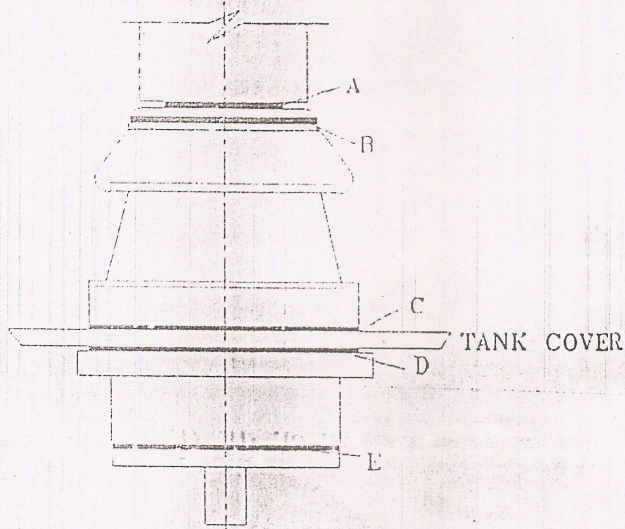
1. M/s ABB,ERDA Road, Maneja, Vadodara- 390013
2. M/s. Bharat Heavy Electricals Ltd.,Transformer Division,P.O. BHEL, Jhansi
3. Crompton Greaves Ltd.,Power Transformer Division(T3), Power Systems,Plot No. 29,31 & 32, New Industrial area NP-1, AKVN, District: Raisen, Mandideep- 462 046
4. M/s. EMCO Limited,Plot No. F-5, Road No.-28,Waghle Industrial Estate,Thane- 400 604
5. M/s. High Volt Electricals, 203, Saurabh, Above Andhra Bank, 116 Andheri-Kurla Road,Chakala,Mumbai-400 093

6. M/s Stesalit Limited, Park Plaza(N),71, Park Street, Kolkata-700016.
7. Bombay Oil Seal Company, Sanghavi house, Unico Industrial Park, BLDG. No. 4, Gala No. 101 & 102, Tungar Phata , Tungareshwar Road, Sativali, Vasai(East), Thane.
8. NU-Cork Products (P) Ltd., E-370, Phase-I, RIICO Indl. Area, Bhiwadi-301019.
9. Cortica Mfg.(I) Pvt.Ltd., Plot No. 105, Sidco Inds Estate, Thirumazhisai. Madras
10. Talbros Pvt. Ltd., Plot No. 60, Sector 6, Faridabad,
11. Bharat Corrub Industries LLP, 749/8 GIDC Industrial Estate, Makarpur, Baroda 390010
12. Indian Cork Industries, Khasara No. 33A, Modern Indistrial Estate, opp, Bahadurgarh Chamber of Commerce, Delhi Rohtak Road, Distt-Jhajjar(Haryana)

Encl: As above.

A. Pandey 01.10.19
(Arvind Pandey)
for Director General (Elect.)

STATUS	REF. NO.	DESCRIPTION	APP. BY	DATE
1	ABB'S AUDIT REPORT DT. 22.10.11	MATERIAL OF GASKET 'B' CHANGED FROM NEBAR TO NITRILE AND MATERIAL OF GASKET 'C' CHANGED FROM NEBAR TO HNBR	<i>[Signature]</i>	12/2/13



LOCATION	GASKET MATERIAL
A	NITRILE
B	NITRILE
C	HNBR
D	NBC
E	NBC

REF. NO.	PART NO.	DESCRIPTION	DETAIL Dwg. NO.	NO.	DATE	SPEC
PEP-			SCALE:-	APPROVED BY:-		
LOCATION OF GASKET ON BUSHING ASSEMBLY OF LOT 6500/7500KVA TRANSFORMER				FIRST ISSUE		
RDSO ELEC DTE, SKEL-4663				SUPERSEDED		

03220032

AJA

[Signature]