

ALL DIMENSIONS ARE IN mm



NOTES :-

1. VAR.00 – INSERT ITEM 005 & 006 ON ITEM 001 AND FLATTEN TO DIMENSION GIVEN. BRAZE ITEM 008 TO ITEM 006 USING BRAZING PIECE ITEM 009. ASSEMBLY WEIGHT 0.865 KG.
- VAR.01 – INSERT ITEM 005 & 007 ON ITEM 002 AND FLATTEN TO DIMENSION GIVEN. BEND ITEM 007 AS SHOWN. ASSEMBLY WEIGHT 1.375 KG.
- VAR.02 – INSERT ITEM 005 ON ITEM 003 AND FLATTEN TO DIMENSION GIVEN. ASSEMBLY WEIGHT 1.360 KG.
- VAR.03 – INSERT ITEM 005 & 006 ON ITEM 004 AND FLATTEN TO DIMENSION GIVEN. BEND ITEM 006 AS SHOWN. ASSEMBLY WEIGHT 0.640 KG.
- VAR.04 – INSERT ITEM 005 & 006 ON ITEM 011 AND FLATTEN TO DIMENSION GIVEN. BRAZE ITEM 008 TO ITEM 006 USING BRAZING PIECE ITEM 009. ASSEMBLY WEIGHT 1.000 KG.
- VAR.05 – INSERT ITEM 005 & 006 ON ITEM 012 AND FLATTEN TO DIMENSION GIVEN. BRAZE ITEM 008 TO ITEM 006 USING BRAZING PIECE ITEM-009. ASSEMBLY WEIGHT 0.740KG.
2. TERMINALS SHOULD BE ELECTRO PLATED WITH TIN TO PR.S. AA0673602 OR DIP TIN WITH A PLATING THICKNESS OF 0.005 TO 0.008MM.
3. ALTERNATIVELY COPPER TERMINAL SIZE 2.0Tk x 22 O/D x 50LG. MAY BE USED FOR ITEM 005, COPPER TERMINAL SIZE 2.0Tk x 22 O/D x 60LG. MAY BE USED FOR ITEM 006 & COPPER TERMINAL SIZE 2.0Tk x 22 O/D x 75LG. MAY BE USED FOR ITEM 007.
4. 150 mm² FLAME RETARDANT FLUORELASTOMER INSULATED CABLE SHOULD BE AS PER RDSO SPECIFICATION NO. MP.0.52.00.08 & CONFIRM TO BHEL SPEC. NO. TM08393. [RESTRICTION OF RDSO VENDOR LIST IS NOT APPLICABLE FOR OM4903].
5. TOLERANCE ON LENGTH OF CABLE ±5MM.
6. TOLERANCE ON UNTOLERATED DIMNS. ±0.5MM.
7. THIN WALLED ADHESIVE LINED TUBE (AS PER TABLE:1 OF SPECIFICATION TM98255).
7. A) FOR TM4906, TM4907, OM4903(RH), BRUSH GEAR LEADS CONSIST OF ONE NO. EACH OF VAR00, VAR01, VAR02 & VAR03.
- B) FOR OM4903(LH), BRUSH GEAR LEADS CONSIST OF ONE NO. EACH OF VAR04, VAR05 & TWO NO. OF VAR02.

BRUSH GEAR LEADS

2 439 30 13 006

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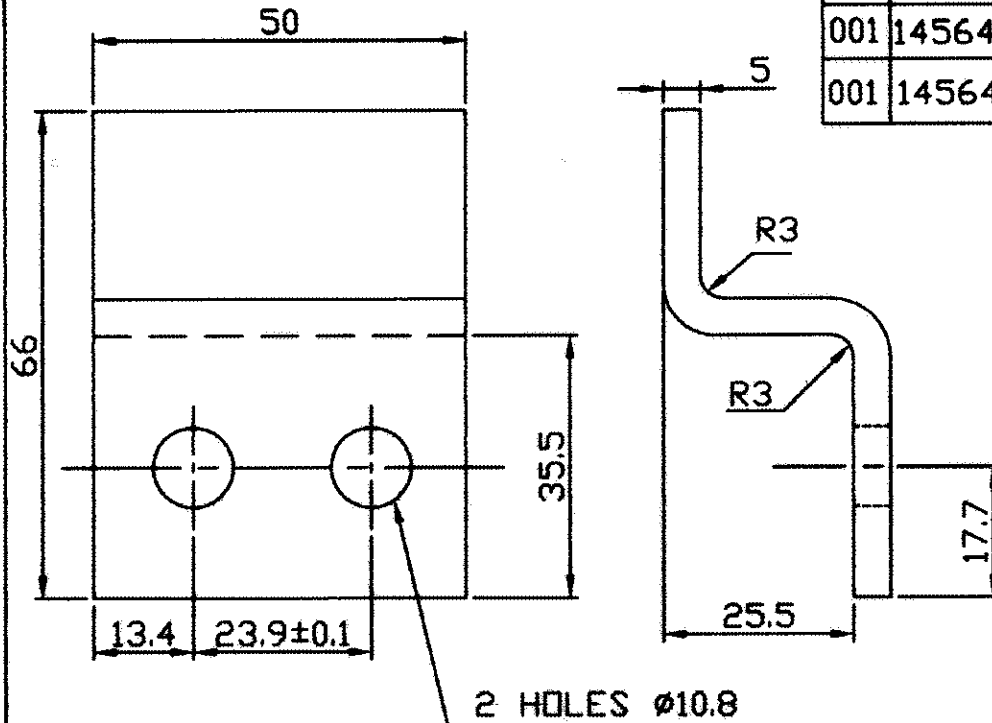
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FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

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REV.	DATE	ALTERED	REV.	DATE	ALTERED	CZ	ADDITIONAL INFORMATION
		CHECKED	01	09.04.09	CHECKED	me	
		APPROVED			APPROVED		
				DRG. UPDATED & DIGITIZED.		STATUS OF DRAWING	
						DISTRIBUTION OF PRINTS	
						TME - 1 TIX - 1 TXM - 3 CIM - 4	



TOOL LIST		
IT.	TOOL NO.	DESCRIPTION
001	1456494	'U'FORMING TOOL
001	1456497	DRILL JIG

NOTES:-

1. MATERIAL CALLED IN B.O.M. IS FOR TWO COMPONENTS.
2. FOR UNTOLERATED DIMNS TOLERANCE ± 0.5MM

REF. DRG. NO.	SEE NOTE-1		001	TERMINAL PLATE 5X50X182		AA12007	KG	0.200
	REMARKS	ITEM NO.	DESCRIPTION	STD	MATL. CODE	MATL. SPCN.	UNIT	UNIT WT. KG.
	28 — CARD TYPE-3		28 — CARD TYPE-1	28 — CARD TYPE-2				
	28 — CARD TYPE-3		28 — CARD TYPE-1	28 — CARD TYPE-2				
SIGN & DATE	 BHARAT HEAVY ELECTRICALS LTD. BHOPAL				NAME	SSN	DATE	NO. OF VRL
					R.K.SONI	Sd/-	16.5.97	-
					SGD.	Sd/-	16.5.97	
					KDG.	Sd/-	20.5.97	
INVENTORY NO.	DEPT TME	UNTL. SING. GR.	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF ITEM	
	CODE 405	'M'	NTS	0.200	34393013003	005	001	
	TITLE				DRAWING NO.	REV.		
	TERMINAL PLATE ₃				44393013001	02		
				SHT. No. 01	NO. OF SHT. 01			

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

000 01 03 634 2 ON 'GRD

2

3

4

5

6

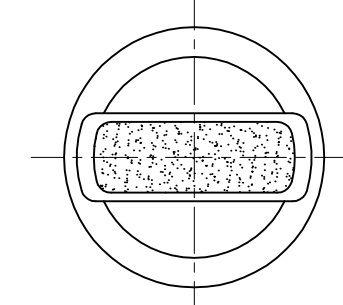
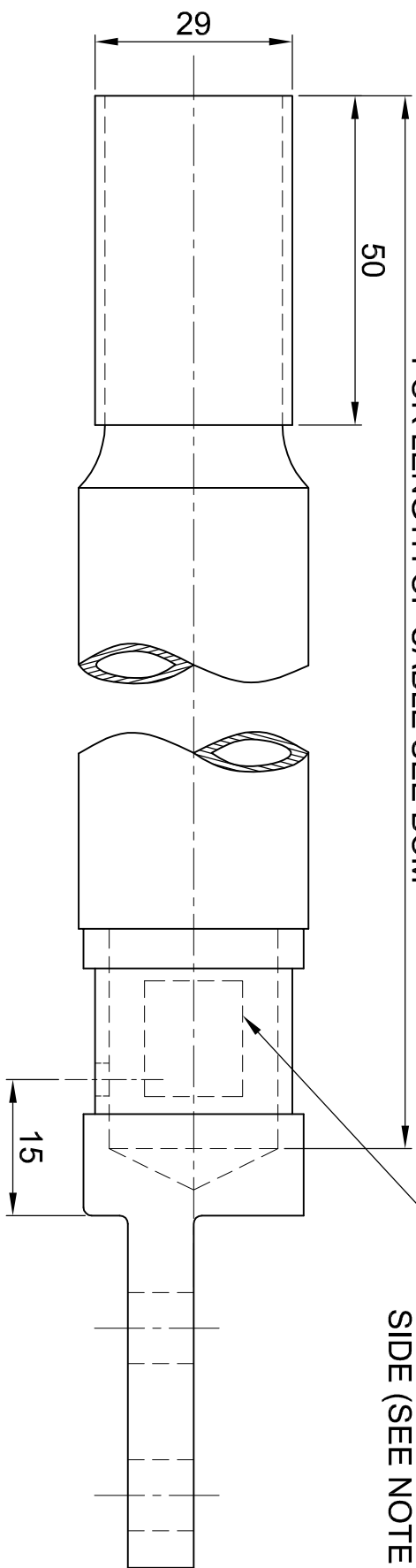
7

8

TOOL LIST		
ITEM	TOOL	DESCRIPTION
006	1402132	CRIMPING TOOL
005	1402133	CRIMPING DIE

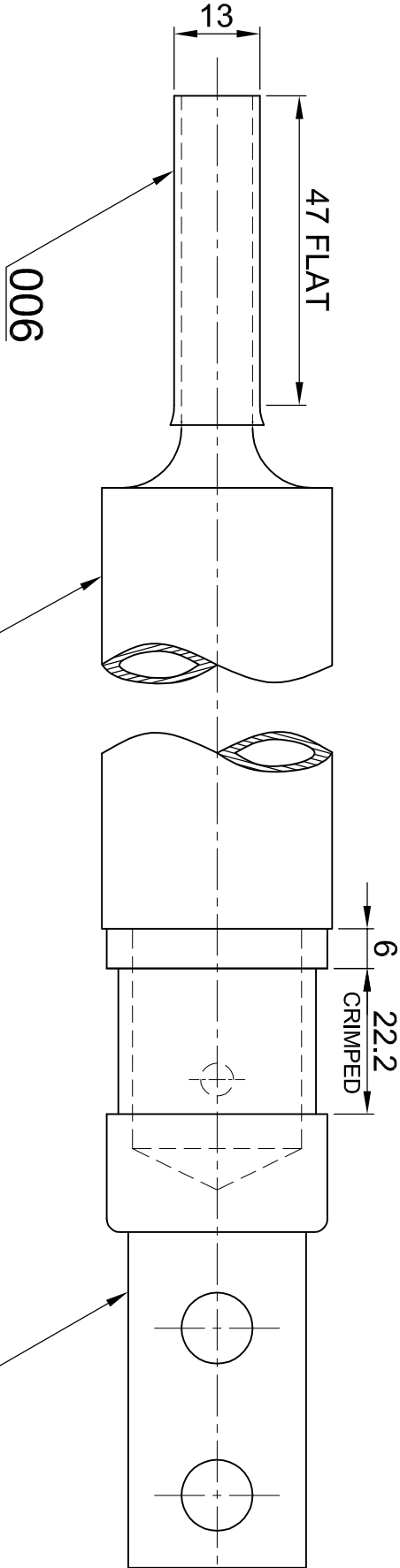
FOR LENGTH OF CABLE SEE BOM

SPACE FOR MARKING
LETTERS ON OPPOSITE
SIDE (SEE NOTE 2)



NOTES:-

1. FIT ITEM 005 & 006 ON CABLES ITEM NOS. 001 TO 004. ITEM 006 TO BE PRESSED TO DIMENSIONS GIVEN AND ITEM 005 TO BE CRIMPED ON.
2. LETTERS A, AA, F & FF SHOWN IN BOM FOR ITEMS 001 TO 004 SHOULD BE SUITABLY MARKED AT THE CRIMPED PORTION OF THE TERMINAL WITH 12 MM LETTERS AS SHOWN.
3. THE TERMINAL ITEM 006 TO BE BRIGHT ANNEALED AT 300° C FOR 45 MINUTES AND WATER QUENCHED AFTERWARDS. THE HARDNESS OF THE TERMINAL SHOULD NOT BE MORE THAN 60 HV.
4. TOLERANCES ON LENGTH OF CABLE ± 10 MM.
TOLERANCE ON OTHER UNTOLERATED DIMENSIONS ± 0.5 MM.
5. FROM EACH LOT, TWO MAIN CABLE LEADS PER 100 NOS. CABLE LEADS TO BE SUBJECTED TO TERMINAL PULL OUT TEST AT 900 KG LOAD. AFTER THE TEST, SAMPLE CABLE LEADS SHALL BE SENT BACK TO TXM FOR USE.
6. 200 MM² FLAME RETARDANT FLUOROELASTOMER INSULATED CABLE SHOULD BE AS PER RDSO SPECIFICATION NO. MP.0.52.00.08 & CONFIRM TO BHEL SPEC. NO. TM08393 (FOR ITEM NOS 001 TO 004).
7. ITEM 001 TO 004 (1 OF EACH) MAKE ONE SET OF CABLE LEADS FOR ONE MOTOR.



001, 002, 003, 004

005

001	001	001	001		006	TERMINAL 2.5 TK. X 26.40 O/D X 50 LG.			KG	0.090				
001	001	001	001		005	TERMINAL	3 439 30 13 001			BP 12082				
001								01						
001	-	-	-	SEE NOTE-6	004	LEAD WIRE 'FF' 1930 LG.			KG	4.210				
-	001	-	-	SEE NOTE-6	003	LEAD WIRE 'F' 2010 LG.			KG	4.390				
-	-	-	001	SEE NOTE-6	002	LEAD WIRE 'AA' 1930 LG.			KG	4.210				
-	-	-	001	SEE NOTE-6	001	LEAD WIRE 'A' 1960 LG.			KG	4.295				
VAR.03	VAR.02	VAR.01	VAR.00	59 64 65 75 76 79 25 27 29	REMARKS	VAR. NO.	DESCRIPTION	58 59 60 77 78 31 34 45 55 56 57 58 65 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	VAR. NO.	MATL. CODE	45 55 56 57 58 65 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	UNIT WT.	65 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	NO. OF

28 → CARD TYPE-3

28 → CARD TYPE-1

28 → CARD TYPE-2

ADDITIONAL INFORMATION
SIMILAR COMP. 2 439 30 13 002

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

TME - 1 TXM - 3



BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

DRN	VKD	SIGN	DATE
CKD	SGD	SD	1.5.99
APPD	KDG	SD	3.5.99

TM4906, TM4907BZ
TM5002BY

REF. TO ASSY. DRG.	ITEM NO.	NO. OF
1 439 30 13 001	010 TO	VAR.
1 439 30 27 002	013	006

REV.	DATE	ALTERED	CHECKED	APPD.
09	04.08.14	APPD.		

REV.	DATE	ALTERED	CHECKED	APPD.
08	26.04.13	APPD.		

REV.	DATE	ALTERED	CHECKED	APPD.
08	26.04.13	APPD.		

DEPT.	T.M.E	UNTD.	DIMS.	GR.	SCALE	NTS	WEIGHT(K.G.)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF
405	AA	0230208					VAR0104-78 VAR0204-78 VAR0304-78	1 439 30 13 001	010 TO	VAR.

DRN	VKD	SIGN	DATE
CKD	SGD	SD	1.5.99
APPD	KDG	SD	3.5.99

REV.	DATE	ALTERED	CHECKED	APPD.
09	04.08.14	APPD.		

REV.	DATE	ALTERED	CHECKED	APPD.
09	04.08.14	APPD.		

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INVENTORY NO.

SIGN. & DATE

REF. DRG. NO.

F

E

D

C

B

A

1

2

3

4

5

6

7

8

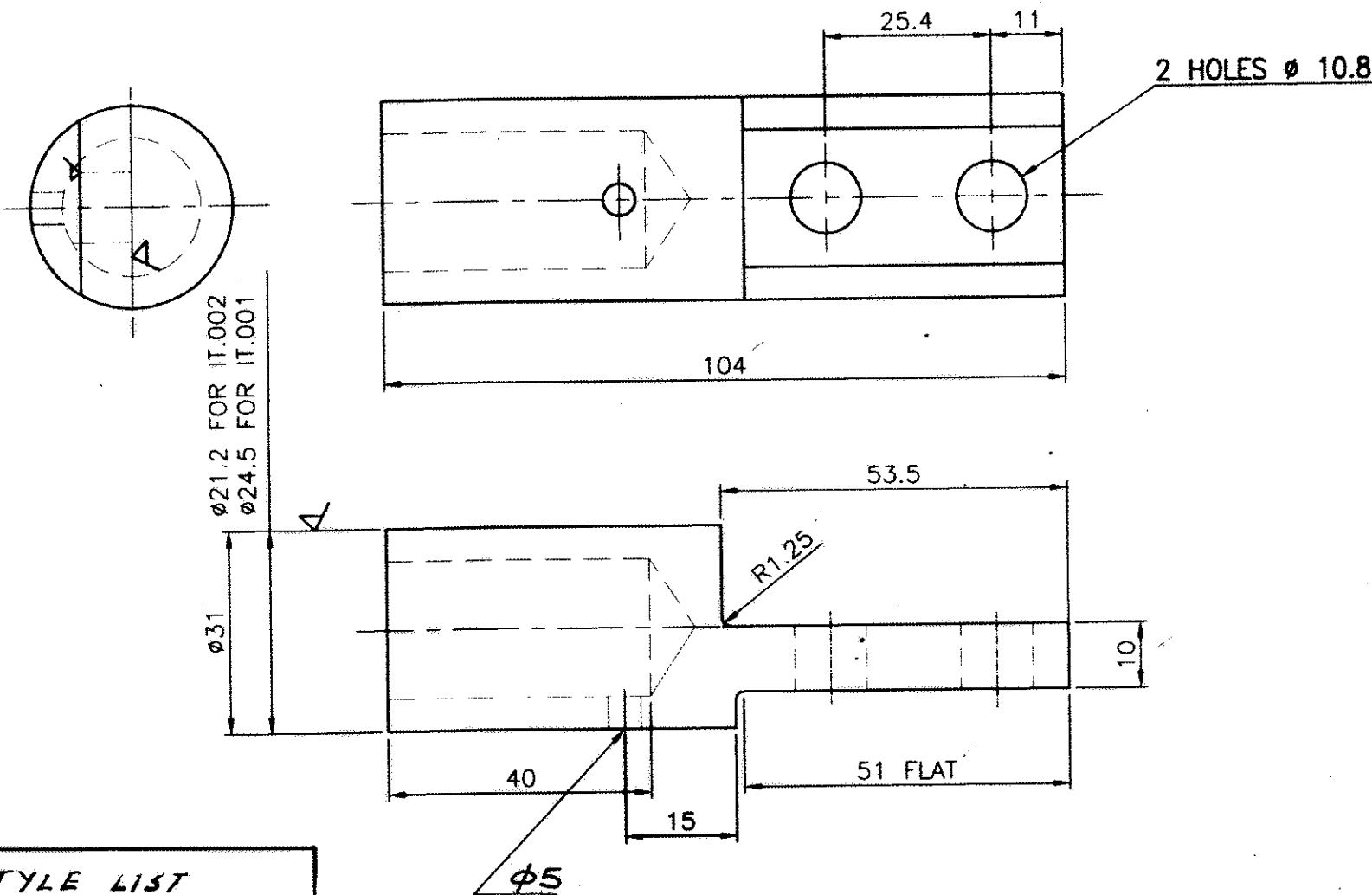
A2 SIZE

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FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

100 81 08 687 8 'ON 'DRG



NOTES:-

1. TERMINALS SHOULD BE ELECTROPLATED WITH TIN AS PER AA 0673602 WITH COATING TK.0.013.
2. THE TERMINALS ARE TO BE BRIGHT ANNEALED AT 550°C FOR 1(ONE)HOUR THE HARDNESS OF THE TERMINALS AFTER ANNEALING SHOULD BE BETWEEN 50 TO 65 HV.
3. HARDNESS OF THREE TERMINALS FROM EACH LOT TO BE TESTED.
4. DURING ANNEALING TERMINALS SHOULD BE KEPT SEPARATELY AND NOT IN A HEAP FORM.
5. SUITABLE CARE TO BE TAKEN TO AVOID DAMAGE TO THE MACHINED SURFACE OF THE TERMINAL DURING HANDLING.
6. VAR00 FOR 300 SQMM RADOX CABLE & 240SQ.MM. E-BEAM CABLE
VAR01 FOR 200 SQMM FLUONLEX CABLE.

STYLE LIST		
VAR	IT NO	ST. NO
00	-	BP 9044752278
01	-	BP 9044752952

001	-	R/WT 0.745		002	CABLE TERMINAL Ø32x104.			AA 12023			0.300		
-	001	R/WT 0.745		001	CABLE TERMINAL Ø32x104.			AA 12023			0.340		
VAR 01	VAR 00	REMARKS	VAR. NO.	ITEM NO	DESCRIPTION	STD.	DRAWING NO.	IT.NO	MATL. CODE	A	E	UNIT WT.	G.S.
								VAR	MATL. SPECN.	C	N	QTY.	ZONE

ADDITIONAL INFORMATION

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

TME-1 CIM-4
TIX-1 TXM-3

TYPE OF PRODUCT OR
NAME OF CUSTOMER/PROJECT

TM 4907AZ/BZ, TM4906AZ/BZ
TM 5002 AZ



BHARAT HEAVY ELECTRICALS LTD.
BHOPAL

NAME	SIGN	DATE	NO. OF
R.K.SONI	Sd	22.4.97	02
S.G.D	Sd	25.4.97	
KDG	Sd	28.4.97	

REV.	DATE	ALTERED	KANSARA
06	23.07.09	CHECKED	OK
		APPROVED	W

DEPT	TME	GRADE OF UN.TOL. DIM	SCALE	REF. TO ASSY. DRG.	ITEM NO.	NO. OF
CODE	405	frank	NTS	2 439 30 13 002	005	002
				2 439 30 13 003	005	
				2 439 30 13 004	005	

DRAWING UPDATED & DIGITIZED

TITLE	DRAWING NO.	REV
CABLE TERMINAL	3 439 30 13 001	06

SHT. No. 01 NO. OF SHT. 01



CORPORATE PURCHASING SPECIFICATION

AA 120 07

Rev. No. 04

PAGE 1 OF 5

COPPER STRIP – ANNEALED (CLOSE TOLERANCES)

1.0 GENERAL:

This specification governs the quality requirements of bright annealed bare Copper strip of thickness over 0.15 mm and upto 10 mm and widths upto 160 mm with radiused edges and close tolerances.

2.0 APPLICATION: Used for general electrical purposes such as bus bars, connectors etc.

3.0 CONDITION OF DELIVERY:

Bright and Annealed.

The material shall be supplied in annealed condition, with close tolerances in coils or straight lengths as specified in BHEL order.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall in general comply with the requirements of the following national standard and also meet the requirements of this specification.

IS: 1897 – 2008: Copper strips for Electrical Purposes.

Gr: 'O' 'Annealed'

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes: Copper Strips shall be supplied to the dimensions specified in BHEL order:

5.2 Tolerances:

Tolerances on width, thickness, and length shall be as follows:

5.2.1 Width / Thickness:

Tolerance on thickness, width and length shall be as follows,

Width/Thickness, mm		Tolerance, $\pm$ mm
Over	Upto & including	
-	3.0	0.03
3.0	6.3	0.05
6.3	12.0	0.07
12.0	25.0	0.10
25.0	50.0	0.12
50.0	100.0	0.25
100.0	160.0	0.50

Revisions :

CI: 24.1 of MOM of MRC-NFCW+HE

APPROVED :

INTERPLANT MATERIAL RATIONALISATION
COMMITTEE-MRC (NFCW+HE)

Rev. No. 04

Amd.No.

Reaffirmed

Prepared

Issued

Dt. of 1st Issue

Dt: 06.06.2012

Dt :

Year :

BHOPAL

Corp. R&D

March, 1980

AA 120 07	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 04		
PAGE 2 OF 5		

5.2.2 Length:
Tolerance on fixed length, shall be as per the table given below:

Length, meter		Tolerance, $\pm$ mm
Over	up to & including	
-	0.2	1.0
0.2	1	2.0
1	2	3.0
2	4	6.0
4	6	10.0

5.3 Radius on Edges:
The strip shall be supplied with edge radiused as per IS:1897, reproduced below, reproduced below.

Thickness, mm		Nominal radius on edges, mm	Tolerance on radius, mm
Over	upto & incld.		
--	1.0	Semi circular	$\pm$ 0.06
1.0	1.6	0.60	$\pm$ 0.15
			- 0.10
1.6	2.25	0.80	$\pm$ 0.15
2.25	3.55	1.0	$\pm$ 0.20
3.55	10.00	1.25	$\pm$ 0.25

5.4 Straightness:
The edges of strips supplied in straight lengths shall not vary from a straight line by more than 20 mm in any 1000 mm length.

6.0 MANUFACTURE:
The strip shall be manufactured from copper of ETP grade conform to IS:191.
The conductor shall be manufactured from ETP grade copper conforming to BHEL specification: AA 12024: Electrolytic Tough Pitch Copper Wire/Bars/Ingots/Continuously cast wire rods.

NOTE: It is preferable to manufacture conductor from continuously cast copper rods provided all other parameters and conditions remain same.

7.0 FREEDOM FROM DEFECTS:
The strips shall be clean, bright, smooth and free from harmful defects.

	CORPORATE PURCHASING SPECIFICATION	AA 120 07 Rev. No. 04 PAGE 3 OF 5
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8.0 CHEMICAL COMPOSITION:

The analysis of copper when analyzed in accordance with IS:440 or any other conventional/instrumental methods shall be as follows:

Element	Percent, min.	Percent, max.
Copper and Silver	99.90	--
Bismuth*	--	0.001
Lead*	--	0.005
Total of all impurities excluding silver and oxygen excl. silver and oxygen	--	0.030

* These elements need not be determined when the material supplied conforms with mechanical and electrical properties specified in this specification. However, the supplier shall ensure that the composition of the material lies within the limits specified above.

9.0 TEST SAMPLES:

One sampling per size per melt per consignment of 3 tonnes or part thereof shall be taken for chemical, mechanical and electrical tests.

The sample shall be cut off cold and shall receive no further treatment before being tested.

10.0 MECHANICAL PROPERTIES:

10.1 Tensile strength (For sizes over 0.50 mm and upto & including 10mm thick):

The test samples, when tested in accordance with IS: 1608 shall show the following properties:

IS: 1608, shall show the following properties:

Tensile Strength: 205 N/mm² , minimum.

Elongation on 4√A or 50 mm gauge length: 35% Min

NOTE: Material upto and including 0.5mm shall be tested only for hardness.

10.2 Hardness (Vickers):

When tested in accordance with IS:1501, the strips shall have a Vickers hardness not exceeding 60 HV, min.

10.3 Bend Test:

The strip shall not be subjected to transverse bend test. where this is not possible, it shall be subjected to a longitudinal bend test. The strip when tested in accordance with IS: 1897 shall withstand a close bend test, through an angle of 180°, without showing any sign of cracks or failures upon the convex surface of the bend.

10.4 Edgewise Bending:

The material shall withstand without showing any sign of cracks or failure, when bent on edge through an angle of 180° over a former of radius equal to half the width of the strip.

AA 120 07	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 04		
PAGE 4 OF 5		

11.0 ELECTRICAL RESISTIVITY (AS RECEIVED):

When measured in accordance with IS: 3635, the electrical resistivity at 20⁰ shall not be greater than 0.01737 ohm-mm²/metre, which is equivalent to an electrical conductivity of 99.25%, minimum of IACS standard. (Refer Appendix B of IS: 613 for temperature correction factor).

Alternatively, the method of measurement employing eddy current probes as per ASTM E 1004 is also acceptable.

12.0 INSPECTION AT SUPPLIER'S WORKS:

Whenever specified, tests and inspection are to be conducted in the presence of BHEL'S representative.

The supplier shall offer BHEL'S representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his carrying out the prescribed tests elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL'S works and the final acceptance of the material shall be based on these test results.

13.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied along with each consignment.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA 120 07, Rev 04: Copper strip – Annealed, Close Tolerances

BHEL Order No,

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

Results of dimensional inspection, chemical analysis, mechanical and electrical tests as per this specification.



CORPORATE PURCHASING SPECIFICATION

AA 120 07

Rev. No. 04

PAGE 5 OF 5

14.0 PACKING AND MARKING:

The material shall be supplied in coils or drums or in straight length as ordered. The minimum eye of coil or barrel diameter of drums shall be 250 mm.

The material not supplied in drums shall be hessian wrapped and tied with string and not with wire and shall be suitably protected to with wire and shall be suitably protected to avoid damage in transit. Each coil or drum or bundle shall be legibly marked or labeled with the following information.

Each coil or drum or bundle shall be legibly marked or labeled with the following information:

AA 12007 : Copper strip – Annealed, (Close Tolerances)

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

15.0 REFERRED STADARDS (Latest Publications Including Amendments):

- | | | | |
|-------------|------------|------------|---------------|
| 1. IS:191 | 2. IS:440 | 3. IS:613 | 4. IS: 1501 |
| 5. IS:1897 | 6. IS:1608 | 7. IS:3635 | 8.ASTM E 1004 |
| 9. AA 12024 | | | |

	CORPORATE PURCHASING SPECIFICATION	AA77015 Rev No.03 PAGE 1 of 2																		
COPPER - PHOSPHORUS BRAZING ALLOY (BA Cu P5)																				
1 GENERAL This specification governs the quality of Copper Phosphorus, Brazing Alloy for general purposes.																				
2 APPLICATION Used for joining Copper and Copper alloys. These alloys are not recommended for ferrous and nickel bearing metals. Copper can be brazed without the use of the flux. However, for brazing copper alloys flux may be necessary.																				
3 CONDITION OF DELIVERY Forms and sizes shall be as per Purchase Order requirement.																				
4 COMPLIANCE WITH STANDARDS This specification is based on IS 2927 – 1975 : “Specification for Brazing Alloys” Grade BA Cu P5																				
5 DIMENSIONS AND TOLERANCES 5.1 Sizes All dimensions and forms shall be as per the purchase order. 5.2 Tolerances The variations in dimensions shall comply with table-11 of IS 2927.																				
6 MANUFACTURE The brazing alloys may be manufactured by any method that shall yield a product which will be of uniform quality and conform to the requirements of this specification.																				
7 FREEDOM FROM DEFECTS The brazing alloys shall be of uniform quality, clean and free from foreign matters. NOTE — The melting ranges of the filler metals given in IS 2927 are for general information only.																				
8 TEST SAMPLES A composite sample of 30 g from each lot of 50 kgs or fraction thereof shall be taken for chemical composition. The sample so selected shall be representative of the lot. 8.1 Samples from wire, strip, shall be taken by sawing or by any other mechanical means through their entire cross section and thoroughly mixed. No lubricant shall be used when sawing or machining. 8.2 Samples of powder or granulated brazing alloys shall contain the grains as supplied.																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="3" style="padding: 5px;"> Revisions: Brought upto date </td> <td colspan="3" style="text-align: center; padding: 5px;"> APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(W) </td> </tr> <tr> <td style="padding: 5px;">Rev No.03</td> <td style="padding: 5px;">Amd No.</td> <td style="padding: 5px;">Reaffirmed</td> <td style="padding: 5px;">Prepared</td> <td style="padding: 5px;">Issued</td> <td style="padding: 5px;">Dt. of 1st Issue</td> </tr> <tr> <td style="padding: 5px;">Dt:31-05-2017</td> <td style="padding: 5px;">Dt:</td> <td style="padding: 5px;">Year:</td> <td style="padding: 5px;">21HEP, Bhopal</td> <td style="padding: 5px;">Corp.R&D</td> <td style="padding: 5px;">01-01-1988</td> </tr> </table>			Revisions: Brought upto date			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(W)			Rev No.03	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue	Dt:31-05-2017	Dt:	Year:	21HEP, Bhopal	Corp.R&D	01-01-1988
Revisions: Brought upto date			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(W)																	
Rev No.03	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue															
Dt:31-05-2017	Dt:	Year:	21HEP, Bhopal	Corp.R&D	01-01-1988															

DRC-R5113

AA77015

Rev No.03

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CORPORATE PURCHASING SPECIFICATION



9 CHEMICAL COMPOSITION

	Min	Max
Silver	14.50	15.50
Phosphorus	4.50	5.00
Copper	Remainder	
Other Elements Total	-	0.15

10 PHYSICAL PROPERTIES

Melting Range (Approx.)

Solidus	Liquidus
643°C	802° C

11 TEST CERTIFICATE

The supplier shall submit 5 copies of test certificate giving the following information

BHEL Order No.

BHEL Spec No. AA77015

Supplier's Name

Chemical composition

Consignment/Identification No.

Size/Form

Cast/Lot No.

12 MARKING AND IDENTIFICATION

On each straight length of wire/strip/powder the classification/grade shall be embossed or stamped at one end for positive identification. Alternatively an adhesive label shall be affixed carrying the classification/grade at one end of each wire/strip/powder such that the label shall not get peeled off while handling or storage for at least one year.

13 PACKING

These brazing alloys shall be suitably wrapped & boxed in wooden crates before despatched to protect it against damage during transport or under normal dry storage conditions.

AA77015: COPPER - PHOSPHORUS BRAZING ALLOY (BA Cu P5)

BHEL Order No.

Manufacturer's Name & Trade Mark.

Size/Form.

Weight.

14 REFERRED STANDARDS (Latest Publications including Amendments)

Nil



PLANT PURCHASING SPECIFICATION BHOPAL

BP 12082

REV NO. 07

PAGE 1 of 3

SUPERSEDES
BP 12082 Rev 06

HIGH CONDUCTIVITY COPPER TUBES

1. GENERAL

This specification governs the quality requirements of high conductivity copper tube, up to 125mm outside diameter.

2. APPLICATION :

For use in Traction Motor /Current Transformers.

3. CONDITION OF DELIVERY:

The tube shall be supplied in solid drawn condition in straight lengths.

Ends shall be cut clean and square with the axis of the tube.

4. COMPLIANCE WITH NATIONAL STANDARDS

There is no Indian standard for this material. However assistance has been drawn from IS: 2501/BSEN 13600.

5. DIMENSIONS AND TOLERANCES:

5.1. Sizes

These tubes shall be designated by outside diameter and thickness. The material shall be supplied to the dimensions as specified in purchase order.

The sizes shall be selected from IS 5493.

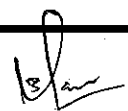
5.2. Tolerances

The tolerances shall comply with IS: 5493, as detailed below.

5.2.1 Diameter:-

The mean diameter of the tube shall not vary from the specified diameter by more than the amount of tolerance given below. The mean diameter is half the sum of two diameters measured at right angles at any section of the tube.

Revision : Reviewed & Brought up to date.

Issued by : 

**STANDARDS AND MATERIALS GROUP
TECHNICAL SERVICES DEPTMENT**

23

Rev. 07

Date : 12.03.2022

Date of first Issue: Feb. 1984



PLANT PURCHASING SPECIFICATION BHOPAL

BP 12082

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Outside Diameter Specified (mm)	Tolerances Nominal ($\pm$ mm)
Up to 10	0.08
Over 10 to 18	0.10
Over 18 to 32	0.12
Over 32 to 50	0.15
Over 50 to 80	0.20
Over 80 to 125	0.25

5.2.2 Thickness:

The mean thickness of the tube shall not vary from the specified thickness by more than $\pm 12.5\%$ of the specified wall thickness. However total weight of the tubes should not differ by more than $\pm 5\%$ from the nominal dimensions.

5.2.3 Length

The tube ordered in the specified length shall be within the tolerances as specified below:

Specified Length (metres)	Tolerances on Specified Length (mm)
Upto & including 3	+4
Over 3 upto 6	+6
Over 6 upto 10	+8

*Note: Minus tolerances are not permissible.

5.3 Straightness :

For the acceptable straightness of the tubes, the permissible max. deflection shall not exceed 2 mm per meter.

6. MANUFACTURE:

The tubes shall be solid drawn; temper annealed and in no case shall be redrawn from used tubes.

7. FREEDOM FROM DEFECTS:

The tubes shall be round, straight, smooth, clean, uniform in diameter and free from cracks, seams, slivers, scales, deleterious film in the bore and other harmful defects.

The ends shall be cut clean and square with the axis of the tube.

8. CHEMICAL COMPOSITION:

The chemical composition of the material shall be as follows :

Copper including silver : 99.9% Min. 24



PLANT PURCHASING SPECIFICATION BHOPAL

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Note: These elements need not be determined when the material supplied confirms with Electrical & Mechanical properties specified in this specification. However, the supplier shall ensure that the composition of material confirms the specified limits.

9. TEST SAMPLES:

One sample per size, per batch, per consignment, shall be selected for test.

10. MECHANICAL PROPERTIES:

10.1 Tensile :

Test pieces when tested in accordance with IS : 1608 shall show a tensile strength of 245N/mm², Min.

10.2 Hardness :

The material when tested in accordance with IS : 1501 shall show a vicker's hardness of 75-90 HV.

11. ELECTRICAL CONDUCTIVITY:

The electrical conductivity of the material when tested at 20°C in the "As Received" condition shall be 97% min. of IACS standard which is equivalent to resistivity of 0.01777 Ohm mm²/ meter max. The material shall be tested in accordance with IS 3635. Alternatively, the eddy current probe method as per ASTM E1004 is also acceptable. Refer Appendix B of IS: 613 for temperature correction factor.

12. TEST CERTIFICATE:

Unless otherwise stated on the order, three copies of the test certificate shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information :

BP 12082 (Rev. 07) : High conductivity Copper tubes.

BHEL Order No.

Manufacturer's / Supplier's Name.

Size and number of tubes.

Batch No.

Results of Tests: Test results obtained for Electrical and Mechanical Properties and Dimensional tolerances as per this specification.

13. PACKING AND MARKING

The tubes shall be suitably Hessian wrapped and packed to prevent damage during transit. Each package shall bear the following information

BP 12082: High conductivity Copper tubes.

Manufacture/Supplier's Name.

Size and weight of the material.



TME/2010

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL **TRACTION MACHINES ENGINEERING DIVISION**

PRODUCT STANDARD		CONCURRENT SHEET	
GENERAL INFORMATION		DATE : 04.04.2000	
PRODUCT STANDARD NO. : 98255			
DESCRIPTION : DUAL WALL CROSS LINKED POLYOLEFIN HEAT SHRINKABLE TUBE (3:1 SHRINK RATIO) (Thin walled and Medium walled)			
REVISION NO.	DETAILS OF REVISION		
01	Medium wall tube added as table 2. Tensile strength, Dielectric strength and specific gravity modified. Other clause revised accordingly.		
	NAME	SIGNATURE	DATE
PREPARED BY	S. P. SINGH		04.04.2000
AGREED BY	REMARK DEPTT./SEC.	SIGNATURE	DATE
A. P. Samal	TME / ELECTRICAL		4.4.2000
A. DANI	TME / ELECTRICAL		4.4.2000

COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company			PRODUCT STANDARD TME DIVISION, BHOPAL		TM 98255	
	TME/2011				PAGE 01 OF 05	
	DUAL WALL CROSS LINKED POLYOLEFIN HEAT SHRINKABLE TUBE (3:1 SHRINK RATIO) (Thin walled and Medium walled)					
1. GENERAL: This specification governs the quality of Dual Wall Cross Linked Polyolefin Heat Shrinkable Tube with a meltable adhesive inner liner which flows and seals when heated. The tube can be shrunk uniformly by application of heat at temperature of 120 deg.C and above. The material of the tube should be low density polyethylene or any other suitable material of the same type.						
2. APPLICATION: Used for covering exposed portion of flexible lead wires between the cable insulation and terminal as well as covering of connections in traction machines.						
3. COMPLIANCE WITH NATIONAL STANDARDS: There is no Indian Standard covering this material.						
4. DIMENSIONS AND TOLERANCES: Sizes and type of tube shall be as stated on the order/drawing preferably as given in table 1 / table 2 for thin walled and medium walled tube respectively. The length of the tube as supplied can vary from 1 to 1.5 mtr. or as given in order.						
Revision Details: As per revision sheet			Distribution	Qty.	Approved	
Rev. No.	Date of Rev	Reaffirmed Year			S. P. Singh Sr.DGM/TME	<i>ts2</i>
01	03.04.2000	Feb 2022	TME TXM TNX QMX	1 1 1 2	Prepared P. Telang Dy. Mgr/ TME	Checked V.Rawtiya DGM/TME
						Dt. of 1 st Issue 03.04.2000

 PRODUCT STANDARD TME DIVISION ,BHOPAL		TM 98255		
		PAGE 02 OF 05		
TME /2011				
Table 1 (Thin walled adhesive lined tube)				
Item No.	Before Heat Shrinking (As Recd.-Nom) I.D. (mm)	After Heat Shrinking Without Cable		
		I.D. (mm)	Wall Thickness	
			Total (mm)	Melttable (mm)
1.	6.0	2.0	1.0	0.5
2.	9.0	3.0	1.4	0.6
3.	12.0	4.0	1.75	0.7
4.	19.0	6.0	2.25	0.8
5.	24.0	8.0	2.5	0.8
6.	39.0	13.0	2.5	1.0
7.	50.0	16.0	2.6	1.0
Table 2 (Medium walled adhesive lined tube)				
Item No.	Before Heat Shrinking (As Recd.-Nom) I.D. (mm)	After Heat Shrinking Without Cable		
		I.D. (mm)	Wall Thickness	
			Total (mm)	Melttable (mm)
1.	12.0	4.0	2.0	0.5
2.	20.0	6.0	2.5	0.6
3.	30.0	8.0	3.0	0.7
4.	34.0	9.0	3.0	0.8
5.	40.0	12.0	3.0	0.8
6.	45.0	13.0	3.0	0.9
7.	50.0	17.0	3.5	1.0
5. FREEDOM FROM DEFECTS: The tube shall be smooth and free from porosity, breaks and other visible defects.				

		 PRODUCT STANDARD TME DIVISION ,BHOPAL	TM 98255
		TME /2011	PAGE 03 OF 05
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company		6. IDENTIFICATION: The material, when identified by infra-red spectrometer or by any other convenient method shall be low density polyethelene.	
		7. TEST SAMPLE: 5 meter long sample of the tube shall be supplied for testing & approval.	
		8. PROPERTIES:	
		8.1 Temperature Rnage: -55 deg.C to 135 deg.C	
		8.2 Tensile strength (Test Method : ISO 37 or DIN 53455) 10 Mpa, Min.	
		8.3 Elongation (Test Method : ISO 37 or DIN 53455) 300%, Min.	
		8.4 Dielectric Strength (Test Method : IEC 243 or DIN 53481) 12 Kv/mm, Min.	
		8.5 Longitudinal Change (Test Method : ASTM D2671) 5%, Max.	
		8.6 Water Absorption (Test Method : ISO 62/ASTM D570/DIN0570) 0.5% Max.	
		8.7 Flammability (Test Method: ISO 2671/ASTM D876) Shall not propagate flame and should be generally flame retardant.	
		8.8 Resistance to Acid & Alkali (Test Method: ISO 1817/ISO 37) Good to excellent	

		 PRODUCT STANDARD TME DIVISION ,BHOPAL TME /2011	TM 98255 PAGE 04 OF 05
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company		8.9 Resistance to Corrosion (Test Method : ASTM D2671) Non Corrosive 8.10 Specific gravity (By any conventional method) 1.2 +/- 0.1 gm/ cubic-cm. 8.11 Colour : Black 9.0 STORAGE PROPERTIES: When stored properly under normal storage condition, the material shall not show any sign of deterioration like hair line cracks ,swelling, porosity ,flow lines ,etc. and there should not be any change in dimension of tube. 10. INSPECTION AT SUPPLIER'S WORK: Whenever specified, tests and inspections are to be conducted in the presence of BHEL's representative. The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the later that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his works, the supplier shall make necessary arrangements for carrying out the prescribed tests elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing. 11. TEST CERTIFICATE: Unless otherwise stated, three copies of test certificates shall be supplied. Further the supplier shall ensure that one copy of Test Certificate is enclosed alongwith the dispatch documents to facilitate quick clearance of the material. Test certificate shall bear the following information :- TM98255: Dual Wall Cross Linked Polyolefin Heat Shrinkable Tube (3:1 Shrink ratio, Thin walled/Medium walled) BHEL Order No. Supplier's Name & Trade Mark, if any. Date of Manufacture	

		 PRODUCT STANDARD TME DIVISION ,BHOPAL	TM 9 8 2 5 5
		TME /2011	PAGE 05 OF 05
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company		12. PACKING AND MARKING: Material shall be suitably packed to prevent damage from contamination or handling during transit. Each package shall be legibly marked with the following information. BHEL Order No.: Manufacturer's /Supplier's Name & Trade Mark, if any. TM 98255 : Dual Wall Cross Linked Polyolefin Heat Shrinkable Tube (3:1 Shrink ratio, Thin walled/Medium walled) Date of manufacture Batch No. Size Quantity. 13. REJECTION AND REPLACEMENT: If the material does not comply with the requirements of this specification during receipt inspection at BHEL or if any defect is found during further processing of the material, BHEL reserves the right to reject the whole consignment notwithstanding any previous certification of satisfactory testing and/or inspection. The supplier shall undertake to replace the rejected material at his own cost & the rejected material shall be taken back by the supplier after fulfilling the commercial terms and conditions.	

COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company	 PRODUCT STANDARD TME DIVISION, BHOPAL		TM 08393													
	TME/2011		PAGE 01 OF 02													
	<u>GUIDELINES FOR PROCUREMENT OF FLUONLEX/FLUOROELASTOMERIC CABLE BY CABLE LEAD MANUFACTURES</u>															
1.0 Scope																
1.1 This specification covers the guidelines for procurement of Fluonlex/Fluoroelastomeric cable from cable manufacturers by cable lead vendors for traction machines cable leads & brush gear connectors.																
1.2 This specification is being issued because cable is a critical item and due control shall be exercised by cable lead manufacturers in procuring cable from cable manufactures and documents in this respect shall be submitted to BHEL. Cable should have cable manufacturer's identification mark alongwith size and manufacturing date of cable after every 500-800mm length.																
2.0 Instructions for cable procurement :																
Vendors of cable leads must comply with the following instructions while procuring the Fluonlex/Fluoroelastomeric cable from original cable manufacturers :																
2.1 Cable shall be as per specification called in enquiry / drawing.																
2.2 Cable shall be purchased from RDSO / BHEL approved sources only and copy of approval of RDSO / BHEL shall be submitted in offer itself.																
2.3 Name of cable manufacturer should be clearly mentioned in offer itself.																
2.4 Complete type test results of the tests conducted at original cable manufacturer's works witnessed by BHEL representative. Alternatively test certificate by NABL approved lab shall be submitted with first supply.																
2.5 For acceptance of regular lots:																
a. Cable lead supplier shall submit complete test results or acceptance test results mentioned in the respective specification mentioned in the drg/enquiry from original cable manufacturer's works.																
b. After receipt of lot in BHEL, 2 nos. of cable leads will be subjected to following tests for acceptance of lot:																
<table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Tests</th> <th>Requirement</th> <th>Test Method</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Insulation Resistance</td> <td>30GΩ (Min.)</td> <td>As per Appendix-1</td> </tr> <tr> <td>2</td> <td>Dielectric Strength Test</td> <td>Should pass at 80% of value mentioned in the reference specification</td> <td>As per Appendix-2</td> </tr> </tbody> </table>					Sl. No.	Tests	Requirement	Test Method	1	Insulation Resistance	30GΩ (Min.)	As per Appendix-1	2	Dielectric Strength Test	Should pass at 80% of value mentioned in the reference specification	As per Appendix-2
Sl. No.	Tests	Requirement	Test Method													
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Revision Details: As per revision sheet			Distribution	Qty.	Approved											
					S. P. Singh Sr.DGM/TME											
Rev. No.	Date of Rev	Reaffirmed Year	TME TXM TNX QMX	1 1 1 2	Prepared P. Telang Dy. Mgr/ TME	Dt. of 1 st Issue										
04	31.12.12	Feb 2022			Checked V.Rawtiya DGM/TME											

		 PRODUCT STANDARD TME DIVISION, BHOPAL	TM 08393 PAGE 02 OF 02
		TME /2012	
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company		Note: Sample Cable leads sent for tests (above) shall be taken back for assembly in traction machines after passing the above tests. Appendix-1 Finished cable lead shall be immersed in tap water at bath temperature less than 30°C for a period of 6 hours. The ends of cable lead during immersion shall be kept above water level. Following this condition period, the insulation resistance shall be measured with 1000V Megger. Appendix-2 Specimen of cable lead should be immersed in tap water keeping both ends above water level at bath temperature less than 30°C for a period of 16 hours. Following this condition period, apply test voltage between copper conductor and water. 3.0 Packing and Marking : ➤ All cable leads shall have their ends sealed with non-hygroscopic sealing materials. ➤ The label /stenciling on the packing shall contain the following information: • Reference specification number with revision • Manufacturer's name, brand name or trade mark • Types of cables and voltage grade • Number of cores • Nominal cross-sectional area of the conductor • Approx. gross weight • Month and Year of manufacture • Purchase Order Number 4.0 Revision Record: Rev 01: Length of cable sample has been reduced from 6 meter to 1.5 meter and table-1 added. Rev02: In table-1 requirement and test method against Insulation Resistance has been revised. Instead of "as per specification", IR value of Minimum 30GΩ for 1.5 meter cable sample has been called. Rev03: Cable sample called in clause no. 2.5, has been removed as per guidelines of RDSO (refer RDSO letter SD.DFM.Cable.1 dated 23.04.2012). Rev04: a) Title has been changed from "Guidelines for procurement of Cable by cable lead manufacturers" to "Guidelines for procurement of Fluonlex/Fluoroelastomeric Cable by cable lead manufacturers. b) In clause no. 2.5 i.e. For acceptance of regular lots, witnessing of test results from BHEL representative has been withdrawn. c) Conductor Resistance test called in table for acceptance of regular lot has been withdrawn. d) Appendix-2 added.	

	CORPORATE STANDARD			AA0673602																				
				Rev. No. 03																				
				PAGE 1 of 5																				
PROCESS FOR ELECTROPLATING TIN FROM ALKALINE BATH ON FERROUS AND NON-FERROUS METAL PARTS																								
1 GENERAL This standard details the process for Tin plating by Vat and Barrel process from an alkaline tin solution on articles of steel, copper and copper alloys to protect them against corrosion, to provide surface for soldering of electrical contacts & terminals and for masking during nitriding. Barrel process for smaller components and tank process for larger components shall be followed.																								
2 APPLICATION Used for bus-bar connections, spout connections, cable sockets, etc., of switchgear; hardware like nuts, bolts, connection cams of transformer; brush holder, cable glands, etc., of traction motors; clamp plates, support plates, etc., of capacitors; clamps, brackets, etc., of electronics.																								
3 COMPLIANCE WITH NATIONAL STANDARDS This Standard has reference to IS 1359 : 1992: Electroplated coating Tin-Specification.																								
4 MATERIALS <table border="1" style="width: 100%;"> <thead> <tr> <th>Materials</th> <th>Available from</th> </tr> </thead> <tbody> <tr> <td>Satin Tin Salt-721</td> <td>M/S Platewel Processes & Chemicals Ltd., Baroda</td> </tr> <tr> <td>Satin Tin Salt</td> <td>M/S Grauer & Weil (I) Ltd., Mumbai</td> </tr> <tr> <td>Mutton Tallow (Optional)</td> <td>Having acid neutralization value of 2.3 to 6.6 mg of KOH/g of mutton tallow</td> </tr> <tr> <td>Sodium Perborate</td> <td>IS 3598</td> </tr> <tr> <td>Hydrogen Peroxide -20 volume</td> <td></td> </tr> <tr> <td>Caustic Soda</td> <td>AA54201</td> </tr> <tr> <td>Tin Anodes</td> <td>IS 2384</td> </tr> <tr> <td>Sodium Stannate</td> <td>IS 3026</td> </tr> </tbody> </table>							Materials	Available from	Satin Tin Salt-721	M/S Platewel Processes & Chemicals Ltd., Baroda	Satin Tin Salt	M/S Grauer & Weil (I) Ltd., Mumbai	Mutton Tallow (Optional)	Having acid neutralization value of 2.3 to 6.6 mg of KOH/g of mutton tallow	Sodium Perborate	IS 3598	Hydrogen Peroxide -20 volume		Caustic Soda	AA54201	Tin Anodes	IS 2384	Sodium Stannate	IS 3026
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5 EQUIPMENT 5.1 Plating Tank / Vat The Tank/vat shall be made of mild steel. The vat shall be provided with an insulated frame on top fitted with insulators for holding the anode and cathode rods. The solution shall be heated by steam, gas or electrical heater. 5.2 Barrel The plating barrel shall be constructed of hard rubber, polypropylene, etc., and shall be so driven as to rotate at 10 to 15 rpm. 5.3 Cold Water Rinsing Tank Mild steel tank. 5.4 Hot Water Rinsing Tank Mild steel tank with heating arrangements.																								
Revisions: As per Clause 31.11.5 of MOM of MRC-CPO				APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC (CPO&NM)																				
Rev. No. 03	Amd. No.	Reaffirmed	Prepared HEP, Bhopal	Issued Corp. R&D	Dt. of 1 st Issue 01-01-1985																			
Dt: 15-10-2002	Dt:	Year: 2021 34																						

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CORPORATE STANDARD**6 COMPOSITION OF ELECTROLYTE AND OPERATING INSTRUCTIONS****6.1 Electrolyte (Bath Solution) And Operating Conditions**

The electrolyte shall be of the following compositions and operating conditions as specified below:

	SATIN TIN SALT-721	SATIN TIN SALT
Salt for Vat Plating	150 g/l	110 g/l
Salt for Barrel Plating	250 g/l	200 g/l
Temperature	60 - 70°C	60 - 80°C
Ratio of Anode to Cathode Area (Approximately)	1:1	1:1
Current density (for information only and not a controlling parameter)	1.5-2 A/dm ² (15-20 A/sq.ft)	1.5-2 A/dm ² (15-20 sq/ft)
Voltage for Vat	2-6 V	2-6 V
Voltage for Barrel	10±2 V	10±2 V

6.2 Preparation of Electrolyte

The vat/barrel shall be filled with water to about 2/3rd capacity and then heated to nearly 50°C.

The required amount of tin salt shall be added to the water in small quantities with stirring.

After complete dissolution, the electrolyte shall be brought upto the working level by adding water and subsequently stirred thoroughly and heated to the operating temperature.

6.3 Analysis of the Electrolyte

The electrolyte shall be analysed after initial make-up and subsequently at suitable intervals.

The concentration of the electrolyte shall be maintained at the following limits:

Tin (Metal) For vat plating : 30 - 40 g/litre

For barrel plating : 50 - 60 g/litre

Free Caustic Soda (NaOH) For vat plating : 8 - 16 g/litre

For barrel plating : 20 - 30 g/litre

6.4 Temperature and voltage shall be recorded during plating.

7 PROCESS OF PLATING**7.1 Cleaning**

All articles shall be properly cleaned as described in BHEL Standard AA0673601:

Process for cleaning and preparation of metal surfaces prior to electroplating, except passivation. If required electrolytic cleaning can also be carried out additionally.

7.2 Rinsing

All articles shall be rinsed thoroughly after cleaning to avoid contamination of the plating solution.

7.3 Pre-heating (Optional)

Before dipping in the plating bath all articles should be dipped in a hot water (80-90°C) bath for pre-heating purpose.

7.4 Plating

All articles shall be plated at the specified current density for a duration which will depend on the thickness of the deposit required.

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Note: It shall be ensured that the anodes are never put in the solution before the vat/barrel is loaded and the current switched on. Likewise the anodes shall be removed before switching off the current after the plating is done.

7.5 Cold Rinsing

After removal from the plating bath, all articles shall be rinsed thoroughly in cold running water till any trace of tin solution is removed.

7.6 Hot Rinsing

Finally, all articles shall be rinsed in clean hot water at 80-90°C and dried.

7.7 Reflowing of Tin Deposit (Optional)

Castings having surface impurities like cavities and blow holes, where removal of entrapped alkaline tin solution is not possible, shall be immersed in a mutton tallow bath maintained at 260±10°C for 2 to 10 seconds. After flow melting, the articles are quenched in a bath containing kerosene oil at the top and water at the bottom. The residual oil from the flow melted surface shall be removed by vapour degreasing or by dipping in trichloroethylene. The thickness range of coating that can be flow melted is 2.5 to 7.5 microns.

8 HEAT TREATMENT

8.1 Stress Relieving Before Plating

Severely cold-worked steels or parts made from steel of tensile strength of 100 kgf/mm² or greater which have been ground or subjected to severe machining after tempering, shall normally be stress relieved by maintaining them at 200 ± 10°C, for not less than one hour or, preferably, for 30 minutes at the highest temperature within the limits imposed by the tempering temperature.

8.1.1 Some steels which have been carburized, flame-hardened or induction-hardened and subsequently ground would be impaired by the above treatment and shall instead be stress relieved at 140 ± 10°C for not less than five hours.

8.2 Heat Treatment after Plating (Optional)

8.2.1 Components subjected to critical fatigue or sustained loading stressed in service and made from severely cold-worked steels or from steels exceeding 100 kgf/mm² tensile strength shall be heat treated at 185 ± 5°C for not less than two hours.

8.2.2 Where the temperature of heat treatment in 8.2.1 would be harmful, for example, for some surface-hardened parts, a lower temperature for a longer time may be required.

NOTE:

When tin is plated on the article for soft soldering purposes, it may be flow melted at a temperature of 250 to 260°C to overcome difficulties in soldering during long periods of storage.

9 MAINTAINANCE OF ELECTROLYTE

9.1 If the electrolyte is low in tin and caustic soda, then add tin salt according to the requirement

9.2 To increase the tin content without affecting the caustic soda content, and addition of sodium stannate should be made.

9.3 If the bath works sluggishly and the anodes are coated with a thick encrustation, it is an indication that the solution is deficient in free caustic soda. The deficiency shall be corrected by maintaining free caustic soda as per clause 6.3.

9.4 If the deposit is rough, dark spongy, sodium perborate shall be added to the solution at the rate of 0.4 g/l of solution. Alternatively, 20 volume Hydrogen Peroxide to the extent of 1.5 ml/litre of solution may be added.

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10 CARE OF ANODES

When working correctly the anodes are covered with a greenish yellow film the continuous maintenance of which is most important.

To obtain this film in the first instance, the vat/barrel shall be loaded with dummy cathodes (e.g. steel sheets). The current switched on and then the tin anodes shall be introduced on the one as each becomes filmed over. This is known as polarisation of anode. The current density necessary for this operation is about twice that normally used for plating. The formation of the film shall be at once apparent by the pale yellow brassy appearance of the anodes and shall also be indicated by a rapid fall in amperage and increase in voltage. As soon as the anodes are properly polarised in this manner, the current shall be reduced to normal and dummy cathodes replaced, one by one, with the articles to be plated. The batch shall be operated continuously for several hours, if possible, removing a number of articles at a time and replacing them with others before further unloading. In this way there will always be sufficient current passing to keep the anodes filmed the whole time they are in the vat/barrel.

At the end of day's work, anodes shall be taken out, current switched off and finally plated articles shall be removed. On commencing work again, the vat/barrel shall be loaded with articles current switched on and then anodes shall be introduced. If for any reason, the anodes lose their greenish yellow surface film and become a normal tin color they must be 'worked in' again as directed at the beginning of this clause until properly filmed over. It is important that the current be kept flowing continuously the whole time the anodes are in the vat/barrel in order to maintain the necessary film upon them. Failure to observe this precaution and keeping the anodes polarised will give rise to the formation of stannite (i.e. stannous tin) in solution and cause the plating to be dark and rough in texture.

11 PRECAUTIONS

Solution shall be kept covered when not in use.

Any chemical that may be necessary to be added shall be dissolved in a part of the original solution before adding it to the vat/barrel. It shall be poured through a filter.

Any metal that may be deposited on any part of the vat/barrel shall be removed

Any article that becomes lodged in any part of the vat / barrel shall be removed.

12 INSPECTION AND QUALITY OF DEPOSIT

12.1 Sampling

A sample from each batch of tank/barrel load shall be tested.

12.2 Condition of Surface

The plated surface shall appear as a smooth and continuous film over the base metal and shall be free from defects such as pits, stains, cracks, blisters, unplated areas and other superficial blemishes visible to the unaided eye. The plated surface shall be matt white and free from nodules.

12.3 Thickness of Deposit

Thickness of deposit shall be as per Appendix A of IS 1359.

12.4 Adhesion Type Test (CI 9.3, Appendix- C of IS 1359)

The flaking and blistering of the coating shall be taken as evidence of unsatisfactory adhesion.

12.5 Solderability test (CI 9.5, Appendix-D of IS 1359)

This test shall be carried out whenever specified on BHEL order.

The samples shall be considered solderable, if they show a uniform coating free from discontinuities of breaks visible to the unaided eye.

Samples of tin coating on copper and copper alloys shall be subjected to preliminary artificial ageing treatment as per clause D-3.1.

PAGE 5 of 5

- 1) IS 1359
- 2) IS 2384
- 3) IS 3026
- 4) IS 3598
- 5) AA54201
- 6) AA0673601

	CORPORATE PURCHASING SPECIFICATION		AA 120 23		
			Rev. No. 08		
			PAGE 1 OF 5		
COPPER RODS AND SECTIONS - HARD					
1.0 GENERAL: This specification governs the quality requirements of copper rods/bars and sections. 2.0 APPLICATION: Used for general electrical purposes in Transformers, switch gears, Bus - bars, HT/MT caps and control equipment. 3.0 CONDITION OF DELIVERY: The copper rods shall be supplied in hard condition in straight lengths. Rectangular rods shall be supplied with radiused edges to clause 5.3. 4.0 COMPLIANCE WITH NATIONAL STANDARDS: The copper rods and bars shall comply with the requirements of the following national standard and also meet the requirements of this specification. IS: 613- 2000 : Copper Rods and Bars For Condition : Hard Electrical purposes - specification. 5.0 DIMENSIONS AND TOLERANCES: 5.1 Sizes. Copper rods and sections shall be supplied to the dimensions specified in BHEL order / drawing. 5.2 Tolerances: 5.2.1 The tolerances for round, square, rectangular and hexagonal rods / bars shall be as given below : [Table - 2 of IS: 613] 5.2.2 Sections: Shall be as per BHEL drawing accompanying the order.					
Revisions : CI: 24.1 of MOM of MRC-NFCW+HE			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (NFCW+HE)		
Rev. No.08	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:06.06.2012	Dt :	Year :	BHOPAL	Corp. R&D	Nov, 1978

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5.2.3 Length - Rod/Sections:

Tolerance on length shall be as follows:

Length, mm		Tolerances, ± mm
Over	Upto & incl.	
-	150	1.2
150	1200	1.5
1200	2400	2.5
2400	-	5.0

5.2.4 Straightness:

The straightness and/or edgewise curvature (edge bow) shall not exceed 3 mm for every 1000 mm length.

5.2.5 Radius on Edges - Rectangular & Squares:

Thickness, mm		Edges Radius, mm	Tolerance in Radius ± mm
Over	Upto and incl		
6	25	2.5	0.25
25	50	3.2	0.25
50	-	as agreed to between BHEL & manufacturer.	

6.0 MANUFACTURE:

The copper rods shall be manufactured from copper of ETP grade conforming to IS: 191. The conductor shall be manufactured from ETP grade copper conforming to BHEL specification AA 120 24:: Electrolytic Tough Pitch Copper Wire/Bars/Ingots/Continuously cast wire rods.

Note: It is preferable to manufacture conductor from continuously cast copper rods provided all other parameters and conditions remain same."

7.0 FREEDOM FROM DEFECTS:

The copper rods shall be clean, bright, smooth and free from fins, spills, scaling, blisters, cracks and other defects.

8.0 CHEMICAL COMPOSITION:

The analysis of copper when analyzed in accordance with IS 440 or by any other Conventional/ Instrumental method shall be as follows:

Element	Percent, min.	Percent, max.
Copper and Silver	99.90	-
*Bismuth	-	0.001
*Lead	-	0.005
*Total of all impurities excl. silver and oxygen.	-	0.030



CORPORATE PURCHASING SPECIFICATION

AA 120 23

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- These elements need not be determined when the material supplied conforms with the mechanical and electrical properties specified in this specification. However, the supplier shall ensure that the composition of the material lies within the limits specified above.

9.0 TEST SAMPLES:

9.1 Tests shall be conducted as follows:

Rods and bars : Mechanical and Electrical.
Sections : Hardness and Electrical.

9.2 One sample per size per melt per consignment of 3 tonnes or part thereof shall be taken for chemical, mechanical and electrical tests.
The sample shall be cut off cold and shall receive no further treatment before being tested .

10.0 MECHANICAL PROPERTIES:

10.1 Tensile Strength:

The test samples, when tested in accordance with IS: 1608 shall show the following properties and hardness as per IS:1501.

10.1.1 Round: TABLE FOR HD

Dia., Width, Across flats or Thickness, mm		Tensile strength, N/mm ² ,min.			Elongation on 5.65√So of gauge length, % min.			Hardness for all shapes
Over	Upto & incl.	Round	Square/ Hexagonal	Rect- angular	Round	Square/ Hexagonal	Rect- angular	HV, min.
6.0	10.0	330	-	-	-	-	-	90
10.0	12.0	320	310	270	6	6	8	
12.0	25.0	290	280	260	8	8	8	
25.0	90.0	260	250	250	12	12	10	
> 90.0	As agreed between BHEL and manufacturer.							

10.1.2 Rods /Bars other than rectangular:

For material over 30 mm dia, thickness or width a cross flats, the test piece shall be turned with its centre 14mm from the surface of the material for material of smaller dia or width, which may not be tested in the condition as manufacture of the test pieces shall be turned from the centre of the material.

10.1.3 Rectangular Bars/Rods:

The test piece shall be taken from the centre of the rod/bar.

10.2 Bend Test:

The material shall be tested for bend test in accordance with IS:1599, if specified in BHEL order.

11.0 ELECTRICAL RESISTIVITY (As Received):

When measured in accordance with IS: 3635, the electrical resistivity of the sample in as received condition at 20⁰ C shall not be greater than 0.0177 ohm. mm² / metre, which is equivalent to an electrical conductivity of 97% minimum of IACS standard. (Refer Appendix B of IS: 613 for temperature correction factor.) Alternatively, the method of measurement employing eddy current probes as per ASTM E 1004 is also acceptable.

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12.0 CHECK LIST:

The supplier shall fill up the enclosed checklist as per Annexure-A and submit the same alongwith each batch.

13.0 INSPECTION AT SUPPLIER'S WORKS:

Whenever specified, tests and inspection are to be conducted in the presence of BHEL'S representative .

The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his carrying out the prescribed tests elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL'S works and the final acceptance of the material shall be based on these test results.

14.0 TEST CERTIFICATES:

Unless otherwise stated, three copies of test certificates shall be supplied along with each consignment.

In addition, the supplier shall ensure to send one copy of test certificates along with the despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:
 AA 12023 (Rev. No. 08) : Copper Rods and sections - Hard
 BHEL Order No.
 Manufacturer 's / Supplier 's Name
 Lot /Identification / Batch /Melt No.
 Sizes and Quantity Supplied
 Results of dimensional inspection, Chemical analysis,
 Mechanical and electrical tests as per this specification.

15.0 PACKING AND MARKING:

The material shall be suitably packed to prevent damage during transit.
 Each package shall be legibly marked or labeled with the following information.
 AA 12023 : Copper Rod and sections - Hard
 BHEL Order No
 Manufacturer's/ supplier's Name
 Lot/Identification/ Batch /Melt No.
 Size and Quantity supplied.

16.0 REFERRED STANDARDS(LATEST PUBLICATION INCLUDING AMENDMENTS):

1) IS:191	2) IS:440	3) IS:613	4) IS:1501	
5) IS:1599	6) IS:1608	7) IS: 2826	8) IS: 3635	9) ASTM E 1004

	CORPORATE PURCHASING SPECIFICATION	AA 120 23 Rev. No. 08 PAGE 5 OF 5
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ANNEXURE - A (Clause 12.0)

CHECK LIST FOR AA 120 23: COPPER RODS AND SECTIONS - HARD
(To be filled by Supplier)

A. Name of Principal Supplier :

B. Name of Indian Agent :

1. Grade of material as per specification : Yes/No

2. Tolerance on diameter/ Width/thickness/ length and flatness as per specification and drawing : Yes/No

3. Chemical composition as per specification : Yes/No

4. Mechanical properties as per specification : Yes/No

5. Electrical Resistivity : Yes/No

6. Tests : (1) Bend

7. Details of previous experience enclosed : Yes/No.
(For New suppliers only)

C. Deviations taken (Please specify clearly, if any) : Yes/No.

1
2
3

Date: _____

Place: _____

Signature &
Seal of Supplier

रेल मंत्रालय

डीजल इलेक्ट्रिक लोको के

कर्षण मोटरों में प्रयुक्त लपट प्रतिरोधी 200°C फ्लुरोइलास्टोमर कुचालित
मेन लीड एवं ब्रशगियर केबिलों
के लिए तकनीकी विशिष्टि

***TECHNICAL SPECIFICATION
FOR
FLAME RETARDANT 200°C FLUOROELASTOMER INSULATED
MAIN LEAD & BRUSH GEAR CABLES USED IN TRACTION MOTORS
OF
DIESEL ELECTRIC LOCOMOTIVES***

विशिष्ट संख्या चा.श. ०.५२.००.०८(संशोधन - ०३)
मार्च, २००८

SPECIFICATION NO. MP. 0. 52.00.08 (REV.- 03)
MARCH, 2008

अनुसंधान अभिकल्प एवं मानक संगठन
मानक नगर, लखनऊ - २२६०११
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW - 226011.

1.0 SCOPE

- 1.1 This specification covers the performance and test requirements for 200°C Fluoro-Elastomeric 1500V grade flame-retardant (equivalent to 1500V flame-retardant FLUONLEX insulated wire-WFM2 of M/s Hitachi Cables Ltd.) flexible Traction Motor Lead Cables & Brush Gear Connector Cables for use on Diesel Electric Locomotives. The cables shall be oil and grease resistant and resistant to moisture.
- 1.2 The cable is expected to have a minimum useful life of 25 years when applied at an appropriate duty cycle and environment.

- 2.1 The copper conductor shall be multi-stranded. The strands of the conductor shall consist of tinned, annealed, high conductivity circular copper wire conforming to JIS C 3152.
- 2.2 The direction of the lay should preferably be uni-directional (unilay) such that a compact conductor is obtained with smooth outside surface. The direction of the lay for all bunches shall be left hand.
- 2.3 Only brazed or welded joints of individual strands are permitted.

A suitable separator between conductor and insulation is required, the same shall be offered giving the details of this separator.

- 4.1 The insulation shall be an extruded layer of black modified ETFE (copolymer of tetrafluoroethylene and olefine) compound.
- 4.2 The cable shall be suitable for operation at 200°C. The manufacturer shall establish the Infra Red Spectrograph of the material and furnish the same to RDSO before type test and it should match with the Infra Red Spectrograph given at **Annexure - 1**.
- 4.3 The covering of the conductor shall be uniform over the entire length of the cable. The average thickness of the covering shall not be less than 90% and the minimum thickness at any point shall not be less than 80% of the value given in **Table-1**.
- 4.4 The insulation shall be so applied by extrusion that it fits closely with conductor and it can be strip off the conductor.

The conductor formation (cross sectional area, diameter of wires in conductor, number of wires, diameter of conductor, thickness of covering, overall dimension of the cable and maximum resistance of conductor at 20°C) of fluoroelastomeric cables to be used on diesel electric locomotives for Indian Railways are as per **Table – 1**. If the manufacturer proposes different conductor formation, which equals or excels **Table – 1**, RDSO's approval shall be obtained before adoption.

Unless specifically indicated the colour of the insulation shall be black.

Tests on cables shall be carried out as per Table – 2 of this specification.

- Type Tests
- Acceptance Tests

- The manufacturer shall submit internal test results as per all the tests specified in **Table – 2** along with Infra Red Spectrograph of the polymer. If the results of internal test found satisfactory, the manufacturer shall be called for type test of the cable. And as a part of type test, the manufacturer shall also be asked to supply cables with end fittings for twelve traction motors for fitment trials at DLW / DMW / BHEL. The manufacturer shall notify in advance about readiness of the cable for type testing.
- The type test schedule shall be constituted of all the tests specified in **Table - 2**. Successful completion of type test is mandatory for final approval of fluoroelastomeric cables for application on diesel-electric locomotives. RDSO representatives at the cost and premises of the manufacturer shall witness type test. Type tests shall be repeated every three years as a part of quality audit. In case of any change in the material or design of the cable complete type tests shall be repeated.
- If the testing facilities for any test are not available at the manufacturer's premises, the manufacturer shall make necessary arrangements for carrying out that test at outside laboratories, either reputed or government approved.

- These tests are to be carried out on samples selected randomly from a lot ready for despatch, for the purpose of acceptance of the lot by the purchaser or any other inspecting agency nominated by the purchaser as per the tests marked as Acceptance Tests in **Table–2**. Acceptance tests shall not be carried out on a particular size from the lot on which type tests have already been conducted. The acceptance test schedule shall be constituted of all those tests marked as Acceptance Tests in **Table–2**.
- If any of the test results does not meet the requirements, the whole tests shall be repeated on other samples selected again.
- If the results of the repeated tests are not found within acceptable limits, the entire offered lot shall be rejected.
- If the results of the repeated tests are found within acceptable limits, the offered lots shall be considered to be acceptable.

The following details shall be printed on the covering of the cable in contrasting colour within 1000mm:

- Manufacturer's Name / Trade Mark
- Rated voltage
- Year of manufacture
- Indication of Type of cable and Thermal Index.
- Cross Sectional area of the conductor.

9.0 PACKING & MARKING

- All cables shall have their ends sealed with non-hygroscopic sealing materials.
- The cables shall be supplied on reels / drums and labelled. Standard length per reel / drum = 100 ± 5 meters in one piece.
- The label/stencilling on the drum shall contain the following information:
 - Reference specification number
 - Manufacturer's name, brand name or trade mark
 - Types of cables and voltage grade
 - Number of cores
 - Nominal cross-sectional area of the conductor
 - Length of the cable on the drum / reel
 - Number of lengths of the reel / drum (if more than one)
 - Direction of rotation of drum (by means of arrow)
 - Approx. gross weight
 - Year of manufacture
 - Purchase Order Number

TABLE - 1

Nom. Sectional Area (mm ²)	Conductor		Thick. of Insulation (mm)	Dia. of finished cable (mm)	Tolerance of overall dia. (mm)	Conductor Resistance At 20°C Max (Ω/Km)	AC Test Voltage (V/1 min.)	Min. Insulation Resistance at 20°C (MΩ/Km)	Min. Surface Leakage Resistance (MΩ)
	Construction No. (Typical Value) / Dia. of Wire (max.) (mm)	Dia of conductor or (mm)							
250	61/77/0.26	22.6	3.0	28.8	+1.2	0.0804	5,400	900	50
200	37/102/0.26	20.2	3.0	26.4	+1.1	0.0991	5,400	1,000	60
150	37/76/0.26	17.5	2.5	22.7	+1.0	0.133	5,400	900	70
100	37/51/0.26	14.4	2.5	19.6	+0.9	0.198	5,400	1,000	80
80	19/79/0.26	12.7	2.5	17.9	+0.9	0.249	5,400	1,000	90
50	19/50/0.26	10.2	2.5	15.4	+0.8	0.394	5,400	1,000	100

APPENDIX-1**COMPOSITION OF CONDUCTOR**

Tin-plating of the wires shall be visually examined. There should be no blistering or colour change of the wires. All wires must be of the same nominal diameter. The diameter of the wires must not differ from the nominal diameter beyond the tolerance ± 0.01 mm.

The diameter of the wire shall be measured by means of a ratchet micrometer or a dial micrometer, between smooth faces circular in shape and with a diameter of at least 5 mm. The average of the readings of the two measurements taken at right angles to each other shall be accepted as the value of the diameter.

APPENDIX-2**SLIPPAGE TEST**

A sample of length approximately 350 mm is taken and bent to a radius of 100 mm. The relative displacement of the conductor with insulation shall not be more than 5 mm for cables up to 25 mm dia. and 10 mm for cables over 25 mm dia. from each end of the cable.

APPENDIX-3**ABRASION RESISTANCE****Applicable Cable Size - 150 mm²**

The test shall be conducted as per UL Standard 719 (non-metallic sheathed cables) or TDE 76/P/16.

As per **UL Standard 719** (non-metallic sheathed cables) :-

Abrasion resistance shall be 2500 cycles (averages of 3 tests). The abrading blade shall be General Electric carbolloy tool blanks – Blank order no. 1330, Group II-370.

Three wire specimens shall be cut from unaged samples each having a length of approximately 14 inches. The test specimens are laid flat and parallel on a horizontal reciprocating table positioned beneath steel plungers. Each plunger is provided with three abrading blades of the type described above. The pressure applied to each plunger shall be according to 8 pounds and the motion of the table shall be 30 cycles per minute.

APPENDIX-4**FLEXIBILITY****TABLE - A**

S. No.	Conductor Size (mm ²)	Dia. of mandrel (in.)	Maximum Weight (pounds)
1.0	100	3	17
2.0	150	4	24
3.0	200	4-1/2	26
4.0	250	5	35

At a temperature maintained between 20 and 25° C, one end of a 45 inch test specimen shall be secured to the mandrel and the other end to the load weight specified in TABLE - A. The

APPENDIX-5

CRUSH RESISTANCE

APPENDIX-6

VOLTAGE WITHSTAND (DIELECTRIC TEST) & INSULATION RESISTANT TEST

TABLE - B

SI No.	Conductor Size (mm2)	AC test voltage (KV)	DC test voltage (KV)	Insulation resistance (MΩ/Km)
1.0	100	5.4	24.0	1000
2.0	150	5.4	28.5	900
3.0	200	5.4	28.5	1000
4.0	250	5.4	31.5	900

A) Voltage Withstand (dielectric test)

The insulated conductors shall withstand AC voltages for 1 minute and DC voltages for 5 minutes as given in TABLE - B and ICEA S-66-524 after a 6-hour immersion in water. The water bath temperature shall not exceed 30°C.

B) Insulation Resistance

The manufacturer shall guarantee that any 25 foot sample, chosen at random from production, shall pass the **dielectric test** given as above and shall have an insulation resistance in excess of 900 – 1000 **MΩ/Km** when tested as given below:

Finished cable shall be immersed in tap water at a bath temperature less than 30°C for a period of 6 hours. Following this conditioning period, the insulation resistance shall be measured per paragraph 6.25 of ICEA S-19-81 and the results calculated in **MΩ/Km**.

APPENDIX-7***CURRENT CARRYING CAPACITY***

Take suitable length of cable fitted with lugs at both ends. Pass the cable through the current transformer of capacity of more than 2000 Amps. Make a loop of the cable by bolting the lugs and place it in draft free room at ambient temperature. Support the cable with wooden block so as to lift it in air in horizontal position. Insert thermocouple between the insulation and conductor and wrap tightly the area with glass tape to make good contact of the thermocouple with the conductor. Increase the current of the transformer intermittently allowing the conductor to attain the maximum temperature at each setting and continue until the rated temperature i.e. 200°C of the conductor is attained at a steady state and keep the cable at $200 \pm 10^{\circ}\text{C}$ for min. 480 hours. Measure the current by inserting the probes around the cable. From the reading of the probes, current carrying capacity of the cable can be determined. After the conditioning period i.e. min. 480 hours, stop the current supply, unbolt the lugs and immediately wrap the cable in hot condition (within / around 1 min.), minimum three loops around the mandrel having a diameter equal to two times the overall diameter of the cable being tested. There shall be no cracks or splits in the cable covering (s) after bending and the sample shall also pass the dielectric test as per Appendix-6.

This method will give the current carrying capacity of the cable in free air at ambient temperature.

TABLE – 2

Specification No. MP.0.52.00.08 (Rev.-03)

S.No	TESTS	Type Test	Acceptance Test	REQUIREMENTS	TEST METHODS
CONSTRUCTION & DIMENSIONS					
1.	(a) Composition of conductor (b) Tin Plating of copper wire	✓	✓	(a) Table – 1 of this specification, (b) No blistering, no colour change	Appendix – 1 For thickness of insulation : IEC-60811-1-1 For resistance: JIS C 3005 For tin plating: IJC 895 OR cl. 5.1.3
2.	a) Persulphate test(for Cu) b) Annealing test (for Cu)	✓	✓	a) 6.1.1 of IS: 8130:1984 b) 6.1.2 of IS: 8130:1984	a) Part 4 of IS: 10810:1984 b) Part 1 of IS: 10810:1984
MECHANICAL PROPERTIES					
3.	Mechanical Properties of Insulation: ➤ Tensile Strength as received ➤ Elongation at break as received ➤ Retention of tensile strength & elongation at break after heat ageing for 96 hrs. at 250°C	✓	✓	≥ 1.0 Kg /mm ² ≥ 250% ≥ 80% of the value before ageing	JIS C 3005, cl. 18 JIS C 3005, cl. 19
4.	Slippage test	✓	✓	The relevant displacement of the conductor with insulation shall not be more than 5mm for cables up to 25mm dia and 10mm for cables more than 25mm dia.	Appendix - 2
5.	Abrasion Resistance	✓	✓	The finished wire shall show a resistance to abrasion of no less than 2500 cycles (5000 strokes) when tested according to Appendix – 3	Appendix – 3 OR TDE/76/P/16
6.	Impact at - 40±2 °C (for Power Cable)	✓		No cracks, no break down when tested as SI. No. 13 of this table.	IEC-811-1-4, cl. 8.5 Test specimen as received & after ageing in air oven for 10days at 250°C

TABLE – 2

Specification No. MP.0.52.00.08 (Rev.-03)

S.No	TESTS	Type Test	Acceptance Test	REQUIREMENTS	TEST METHODS
7.	Windability - bending at - 40±2 °C	✓	✓	No cracks, no breakdown when tested according to Sl. No. 13 of this Table.	IEC-811-1-4, cl. 8.1
8.	Windability (bending) after ageing	✓	✓	250°C, 10 days, No cracks, no break down when tested according to Sl.No. 13 of this Table.	UIC 895 OR cl. 5.3.2
9.	Cross-linking degree test by Gel Fraction method	✓	✓	Gel Fraction 85% min. For uniformity, cut covering from the cross-section of a cable & cut 4 samples at 90° each from the cut cross section & do the test. Average of 4 pieces must meet ≥ 85%	JIS C 3005, cl. 27
10.	Flexibility	✓	✓	Any specimen exhibiting a continuous separation of adjacent turns for more than 90° shall not meet the test requirement.	Appendix - 4
11.	Crush Resistance	✓	✓	At room temperature, the finished cable shall exhibit a resistance of crushing of greater than 4000 lbs (average of 10 tests).	Appendix - 5
12.	Tests for identification of polymers	✓	✓	Infra Red Spectrograph results of polymer should match the spectrograph attached with this specification.	ASTM – D – 3677 - 83
ELECTRICAL PROPERTIES					
13.	Voltage withstand (dielectric test) & Insulation Resistance test	✓	✓	The insulated conductors shall withstand the r.m.s & DC voltages as given in Appendix - 6.	Appendix – 6 OR JIS C 3005, cl. 8 (1) & 9.1
14.	Current Carrying capacity	✓	✓	At 200°C, rated current shall pass through the cable for 480 hrs and there should be no crack, no breakdown when tested according to Sl. No. 13 of this Table.	Appendix – 7
15.	Surface leakage resistance	✓	✓	Not less than the value given in the Table-1	JIS C 3005, cl. 16

TABLE – 2

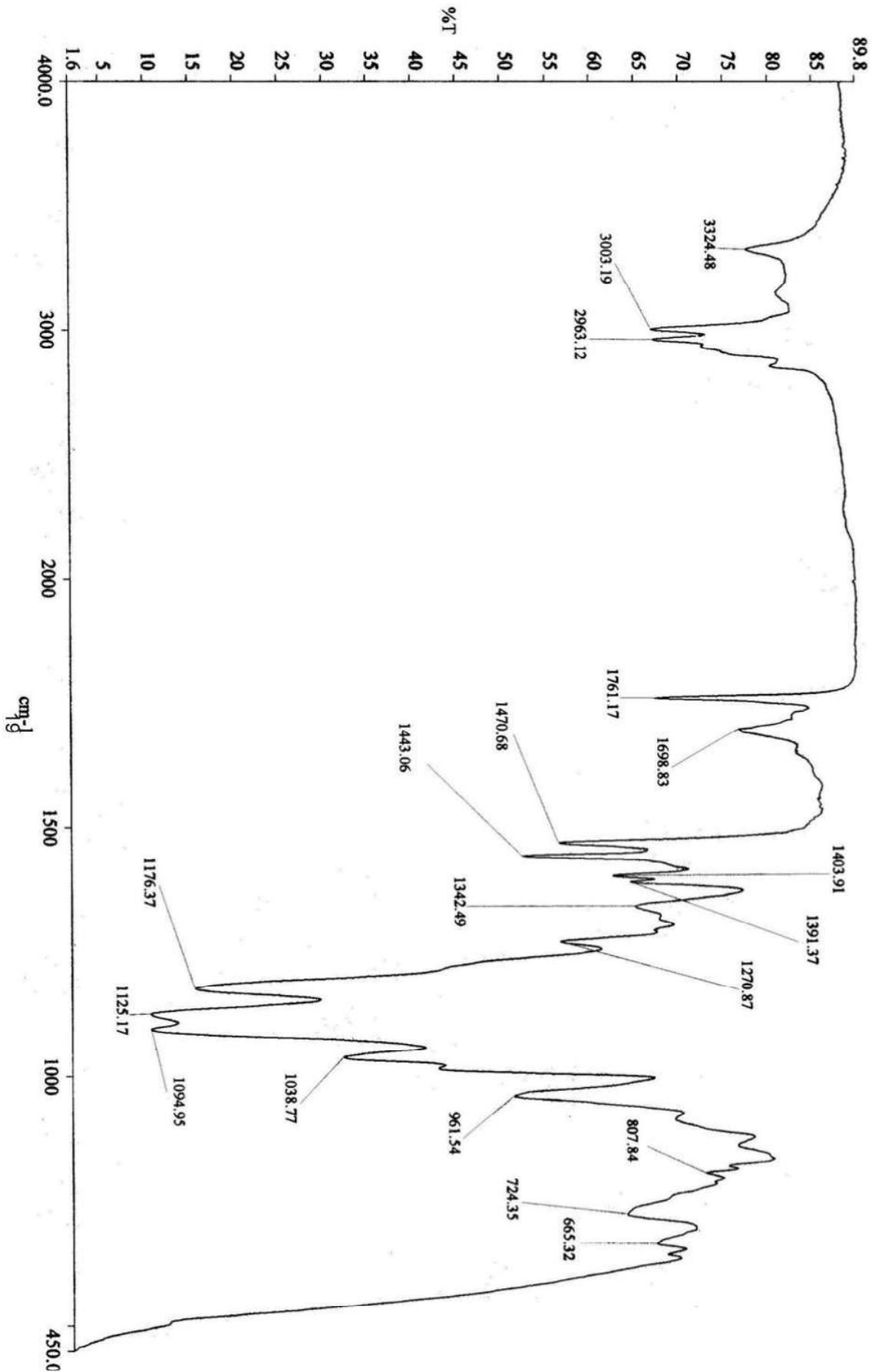
Specification No. MP.0.52.00.08 (Rev.-03)

S.No	TESTS	Type Test	Acceptance Test	REQUIREMENTS	TEST METHODS
16.	➤ Thermal Test & endurance of usability. ➤ Elongation at break absolute.	✓	✓	Arrhenius Plot ≥ 50% after 20,000 h at 200°C	IEC-216
17.	Flame Retardance	✓	✓	To be naturally extinguished within 30 seconds.	JIS C 3005, cl. 28(b) Horizontal method) OR, IEC-332-Part-1
18.	Hot set test	✓	✓	200°C, 20 N/ Cm ² : Max. elongation: • under load ≤ 100% • after cooling ≤ 25%	IEC 811-2-1, cl. 9
19.	Oil resistance test	✓	✓	➤ <u>Hot oil resistance test I</u> : No cracks or other deterioration in the covering. No break down when tested according to SI. No. 13 of this Table. The cable dia. increase shall not exceed 40 %. OR ➤ <u>Hot oil resistance test II</u> : Minimum values for Tensile Strength & Elongation measured shall be as follows: • % of original tensile strength : 60 • % of original elongation : 60 <u>Fuel Oil test</u> : Cable dia. increase shall not exceed the value specified below: High Speed Diesel oil <u>Dia. increase</u> 20%	<u>Hot oil resistance test I</u> : The central 1 foot section of a 2 ft. sample should be immersed in a U-shape in ASTM No. 1, 2 & 3 oil for 100 hrs. at 150 ± 2° C. OR <u>Hot oil resistance test II</u> : As per JIS C 3005, clause 20 and class C of Table 6.
20.	Ozone resistance test	✓	✓	275 ± 25 ppm, 96h at room temp.. No cracks in insulation. No breakdown when tested according to S. NO. 13 of this table.	IS: 10810, Part - 13
21.	Moisture Absorption	✓	✓	According to IEC 60811-1-3 § 9.2 After 168 hrs at 70° C in water Max. weight increase ≤ 8 mg/inch ² (1.24 mg/cm ²)	IEC 60811-1-3 § 9.2

Specification No. MP.0.52.00.08 (Rev.-03)

Annexure - 1

INFRARED SPECTROGRAPH OF MODIFIED ETFE





BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
QUALITY ASSURANCE PLAN FOR CABLE LEAD ASSEMBLY TO BHEL ORDERING SPECIFICATION/DRAWING AS PER PO

QUALITY PLAN NO. – QAP/QTm/VENDORQAP/2024-25/ CABLE LEAD ASSEMBLY DTD 16.03.2025 REV 00
Reference Document- PO DRAWING/SPECIFICATION

SL. NO	COMPONENT	CHARACTERISTICS	TYPE OF CHECK	QUANTAM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	INSPECTION AGENCY	REMARKS
				TP	TPIA					
1)	Raw material 1. Flexible cable 2. Ferrule	All tests as per specification	TC verification	100%	100%	As per PO drawing & specification	As per PO drawing & specification	MTC	BHEL/TPIA	TEST LAB NABL/EQUIVALENT ACCREDITED/SOURCE MILL /Supplier to get the raw material TC correlated with material TC. All Test certificate (type & routine) of copper wire, insulation & final cable to be reviewed as per HITACHI SPEC0028 by TPJA and submitted to BHEL OR each batch. Batch No. to be related with verified by TPJA

Prepared By

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BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
QUALITY ASSURANCE PLAN FOR CABLE LEAD ASSEMBLY TO BHEL ORDERING SPECIFICATION/DRAWING AS PER PO

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SL. NO	COMPONENT	CHARACTERISTICS	TYPE OF CHECK	QUANTAM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	INSPECTION AGENCY	REMARKS
				TP	TP/A					
2)	Testing	Routine test	TC verification & test	100%	1% or min 2 nos cable	As per drawing & specification	As per drawing & Specification	Supplier record	BHEL/TP/A	100 % RR & 1% Witness
3)	Dimension	Dimension	measurement	100%	5%	As per drawing & specification	As per drawing & Specification	Supplier record	BHEL/TP/A	100 % RR & 5% Witness
4)	Identification vendor name, PO & job serial no.	Verification	Visual	100%	10%	As per drawing & specification	As per drawing & Specification	Supplier record	BHEL/TP/A	
5)	Packing suitable for transit and storage	Visual	visual	100%	-	As per drawing & specification	As per drawing & specification			Packing shall be such that there should no damage during transit

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