

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 2 580 11 30026

TOOL LIST		
ITEM	TOOL	DESCRIPTION
VAR.00	1486914	BENDER

STYLE LIST				
STYLE CODE NO.	IT. INCLUDED	DESCRIPTION OR REMARKS	RECORDED	
BP 9048500664	VAR.00	ASSEMBLY OF SHUNT	Sd/-	30.11.94

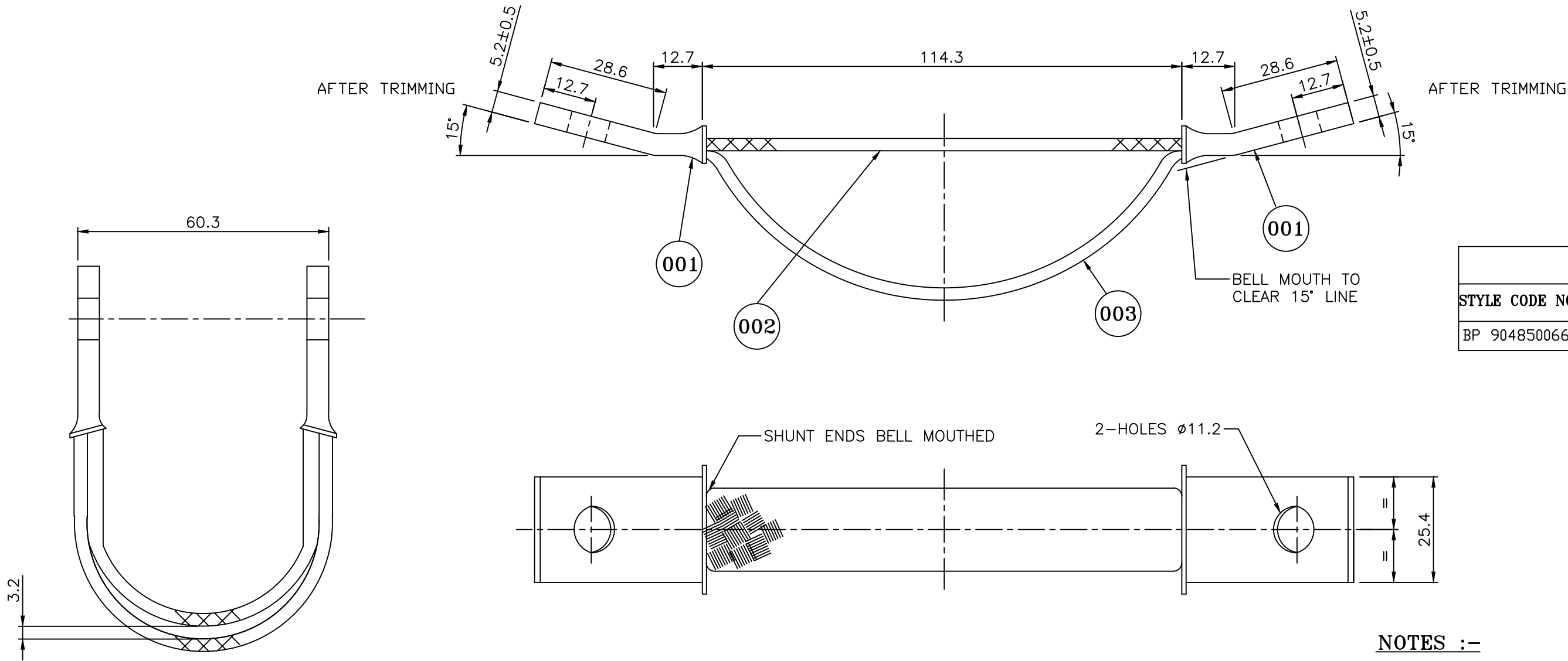


FIG. 1


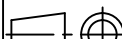
ON COMPLETION

THE SHUNT ENDS SHOULD BE HELD ONE IN EACH HAND & LIGHTLY PULLED WHEN RELEASED THE RESULTING EXTENSION OF ITEM 2 SHOULD, WHEN THE COMPLETED SHUNT IS FORMED IN TO A 'U' IN LINE WITH FIG. 1 GIVE A GAP OF 3.2 BETWEEN BRAIDS,AS SHOWN.

NOTES :-

- AFTER PRESSING SILVER PLATING THICKNESS ON SHUNT ENDS TO BE 0.004<sup>CR</sup> MINIMUM.
- PLATING THICKNESS IS CRITICAL TO QUALITY AND TO BE CHECKED AS FOLLOWING :  
A)- 5% RANDOMLY FOR THE SUPPLY LOT OF 1000 NUMBER OR BELOW.  
B)- 2% RANDOMLY FOR THE SUPPLY LOT OF MORE THAN 1000 NUMBER.

001		003	SHUNT FLEX CPR BRAID	4 580 11 30027	001			MM	229		
001		002	SHUNT FLEX CPR BRAID	4 580 11 30027	001			MM	203		
002		001	SHUNT END	3 580 11 30040	001						
VAR00	REMARKS	VAR. NO.	ITEM NO.	DESCRIPTION	STD	DRAWING NO.	IT.NO.	MATL. CODE	UNIT	UNIT WT.	ZONE
28	CARD TYPE-3	28	CARD TYPE-1	28	CARD TYPE-2						

ADDITIONAL INFORMATION				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT				A.C. EMU INDIAN RAILWAYS						
STATUS OF DRAWING				M										
DISTRIBUTION OF PRINTS OFFICE COPY- 1, SWM -4 TCX(SWM) 1				भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल BHARAT HEAVY ELECTRICALS LTD. BHOPAL				बनाया DRN.	नाम /NAME	हस्ता /SIGN.	दि./DATE	वैरि की संख्या		
								जांचा CKD.	MANI	-SD-	2.1.82	NO. OF VAR.		
								स्वीकृत APPD.	V.P.A.	-SD-	11.3.83	00		
REV.	DATE	ALTERED CHECKED	KLJ KSA	-Sd- -Sd-	विभाग DEPT.	अन. टाल. नाप की श्रेणी UNTOL. DIMS. GR.		अनुपात SCALE	भार कि या WEIGHT (K.G.)	असे. ड्राइंग का संदर्भ REF. TO ASSY.	मद संख्या ITEM NO.	मद संख्या NO. OF ITEM		
04	03.03.97	APPROVED	MSQ	-Sd-	कोड CODE.	407	REF.C.G.06503	1:1	0.160	2 580 11 30024	004	003		
ZONE				NOTE-1 ADDED.				शीर्षक/TITLE				ड्राइंग क्र. /DRAWING NO.		पुन./ REV.
								ASSEMBLY OF SHUNT				2 580 11 30026	06	
												प्रश्न क्र./SHT NO. 01	प्रश्नों की संख्या / No.OF SHT	01

(ALL DIMENSIONS ARE IN mm.)

FIRST ANGLE PROJECTION

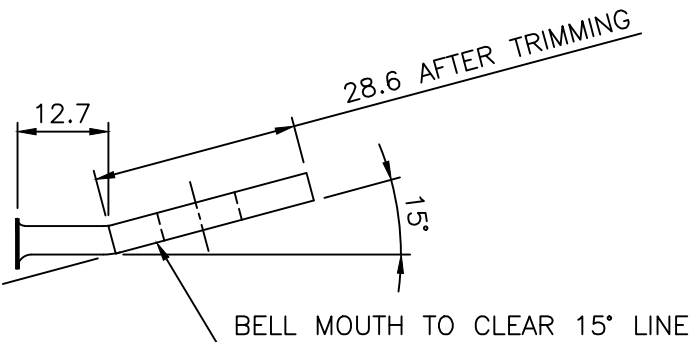
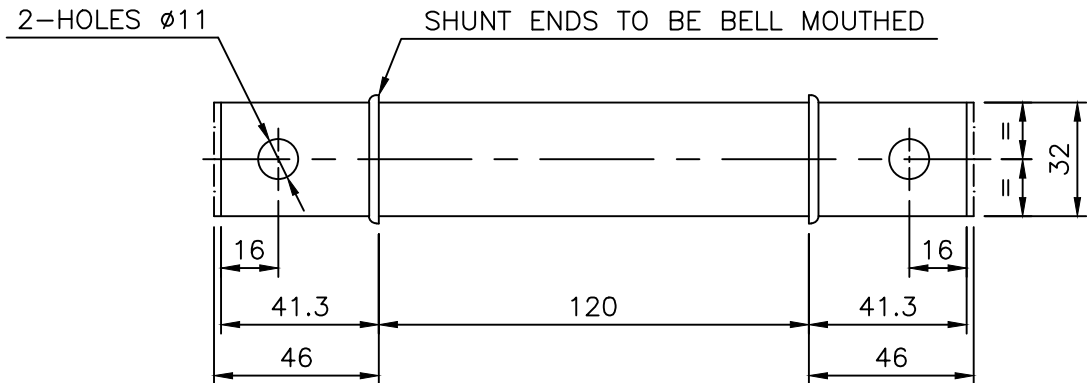
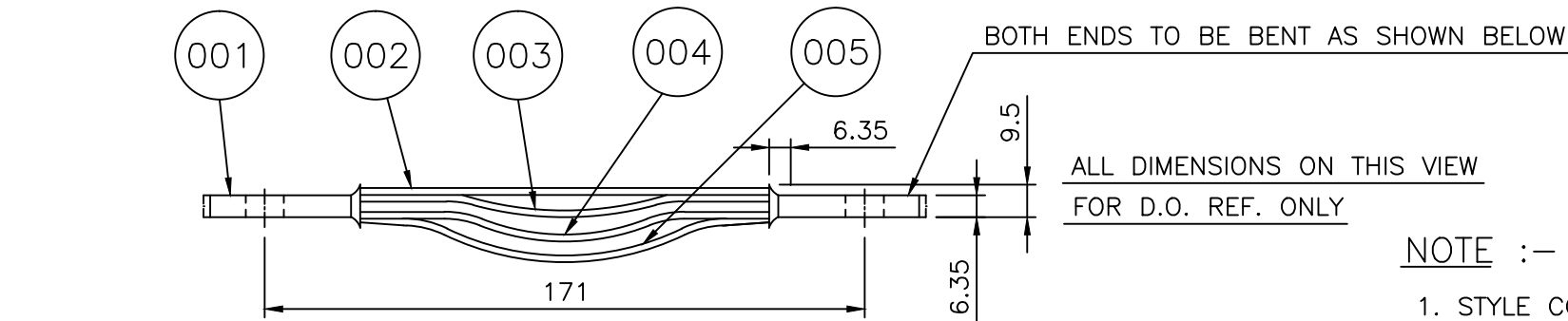
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D 8638475, COL.-D  
REF. DRG. NO.

SIGN. & DATE

INVENTORY No.

3 580 11 3 0047  
ड्राइंग क्र./DRAWING NO.



NOTE :-

1. STYLE CODE NO. FOR VAR.00, BP 9048548756.
2. AFTER PRESSING SILVER PLATING THICKNESS ON FERRULES TO BE 0.004<sup>CR</sup> MINIMUM.
3. PLATING THICKNESS IS CRITICAL TO QUALITY AND TO BE CHECKED AS FOLLOWING :  
A)- 5% RANDOMLY FOR THE SUPPLY LOT OF 1000 NUMBER OR BELOW.  
B)- 2% RANDOMLY FOR THE SUPPLY LOT OF MORE THAN 1000 NUMBER.

001	-			005	BRAID ST. 854603 FLEX. COPPER BRAID	3 581 50 3 0009	001			MM	272	
001	001			004	BRAID ST. 854603 FLEX. COPPER BRAID	3 581 50 3 0009	001			MM	251	
001	001			003	BRAID ST. 854603 FLEX. COPPER BRAID	3 581 50 3 0009	001			MM	232	
001	001			002	BRAID ST. 854603 FLEX. COPPER BRAID	3 581 50 3 0009	001			MM	213	
002	002			001	FERRULE	4 580 11 3 0028	001					
VAR.01	VAR. 00	REMARKS	VAR NO.	ITEM NO.	DESCRIPTION	STD.	DRAWING NO.	IT. NO.	MATL. CODE.	A/C	UNIT	UNIT WT.
								VAR	MATL. SPCN.			QTY.

ADDITIONAL INFORMATION

STATUS OF DRAWING M

DISTRIBUTION OF PRINTS  
OFFICE COPY -1  
SWM -4  
TCX (SWM) -1

उत्पाद का प्रकार या ग्राहक/परियोजना का नाम AC EMU INDIAN RAILWAYS  
TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

बी.एच.ई.एल. भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल  
BHARAT HEAVY ELECTRICALS LTD. BHOPAL

बनाया DRN.	नाम/NAME	हस्ता/SIGN.	दिनांक/DATE	वेरि. की संख्या NO. OF VAR.
जांचा CKD.	L.M.O.	Sd/-	30.09.81	
अनुमोदित APPD.	MANI	Sd/-	22.01.82	01
	V.P.A.	Sd/-	10.03.83	

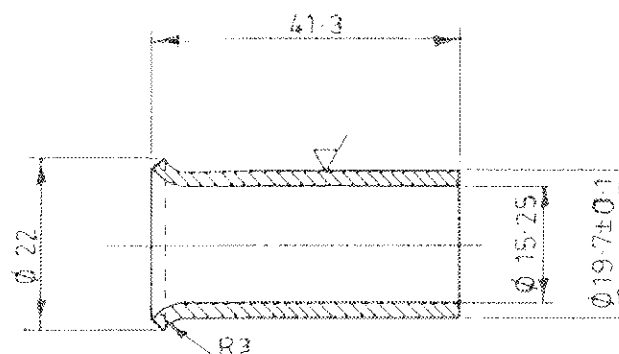
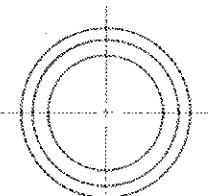
REV	DATE	ALTERED CHECKED APPROVED	REV	DATE	ALTERED BC CHECKED VJ APPROVED RKS	REV	DATE	ALTERED RCB CHECKED RKS APPROVED AG	विभाग DEPT. CEE	अन. टोल. नाप की श्रेणी UNTOL. DIMS. GR.	अनुपात SCALE	भार कि.ग्रा. WEIGHT (K.G.)	असे. ड्राइंग क्र. संदर्भ REF. TO ASSY.	मद क्र. ITEM NO.	मद. संख्या NO. OF ITEM
			04	18.03.14		03	08.11.05		कोड CODE. 407	REF CG 06503 CG 06503	1:2	-	VAR.00- 25801130033	001	005
					NOTE 3 ADDED FOR CTQ ON PLATING THICKNESS. IN NOTE PLATING THICKNESS WAS 0.008 MIN.			VAR.01 ADDED. DRG. COMPUTERISED & REDRAWN.	शीट / TITLE				ड्राइंग क्र./DRAWING NO.		पुन./REV.
									ASSEMBLY OF SHUNT				3 580 11 3 0047		04
													प्रष्ठ क्र./SHT.NO 01	प्रष्ठों की संख्या/ NO. OF.SHT.	01

## STYLE LIST

STYLE CODE NO.	ITEM INCLUDED	DESCRIPTION OR REMARKS	RECORDED
BP 9048575605	001	SHUNT END	SG. DATE John 7-10-81

## TOOL LIST

ITEM	TOOL	DESCRIPTION
001	1485503	PRE-FORM PRESS



FINISH:- SILVER PLATE (AFTER ANNEALING) 0.015 TO 0.020 TK.  
APPROXIMATELY TO PR.S. CG.03019 TO MAINTAIN  
MINIMUM THICKNESS CALLED ON ASSY.DRG.

NOTE:-  
1. ANNEAL BEFORE FINISH AS FOLLOWS  
A-HEAT THE FERRULES TO 500 TO 550 SOAK AT THIS TEMPERATURE THOROUGHLY.  
B-AFTER SOAKING THE FERRULES ARE TO BE QUENCHED IN WATER.  
AFTER THE ABOVE HEAT TREATMENT THE FERRULES SHOULD HAVE A HARDNESS OF 60 H V MAXIMUM.

59	64	65	75	78	79	25	27	29	58	59	60	77	23	31	34	45	50	56	58	85	72
VAR. NO.	REMARKS	VAR. NO.	ITEM NO.	DESCRIPTION	STD.	DRAWING NO.	IT. NO.	MATL. CODE	VAR.	MATL. SPECN.	QTY.	UNIT WT.	QTY.	UNIT WT.	QTY.	UNIT WT.	QTY.	UNIT WT.	QTY.	UNIT WT.	QTY.
001				20.8 O/DX 2.8 TK O <sub>2</sub> F HIGH CONDUIT CU TUBE				AA 12017													
28	CARD TYPE 3	28	CARD TYPE 1	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2	28	CARD TYPE 2

## ADDITIONAL INFORMATION

## STATUS OF DRAWING

M

DISTRIBUTION OF PRINTS  
OFFICE COPY 1  
SWM 1  
TCX (SWM) 1

TYPE OF PRODUCT A C EMU  
OR  
NAME OF CUSTOMER/PROJECT INDIAN RAILWAYS



BHARAT HEAVY ELECTRICALS LTD.  
BHOPAL

	NAME	SIGN	DATE	73 74
DRN	VINOD JOHN	✓ John	7-10-81	NO. OF
CHD	Mani	[Signature]	19/1/82	VAR.
APPD	V.P.A.	[Signature]	10/3/83	7


REV.	DATE	ALTERED	REV.	DATE	ALTERED
03	29-8-99	CHECKED DIS. J. 10/1/99	02	1-3-97	CKD. APPD.

SILVER PLATE  
PR.S. CG.03019 WAS  
AA 0673613

FINISH MODIFIED.

REV.	DATE	ALTERED
1	8-5-32	CHECKED

TOOL NO. 1485503 ADDED.  
STYLE NO. WAS IN 6 DIGITS.  
LENGTH OF MAT. & WEIGHT  
ADDED IN B.O.M.

DEPT	GRADE OF UN		SCALE	WEIGHT(Kg)	REF. TO ASSY. DRG.	ITEM	75 77
CEE	TOL DIM				3 576 10 3 0007	NO. OF	
CODE	REFER		1:1		2 580 11 3 0026	ITEM	
407	CG.06503					001	77 78

TITLE

SHUNT END

CARD	DRAWING NO.	22 23 24
CODE	3 580 11 3 0040	REV
		03
SHEET NO.	01	NO. OF SHEETS 01

SIZE-A3

1508984/2023/HEP-SWM20915

DRG. NO. 3 580 11 3 0040

INVENTORY NO. D 8637572 (IT. 1) REF. DRG. NO. SIGN. & DATE

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6000 3 09 189 3 ON DRAWING

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D 8638311, IT-14&7  
REF. DRG. NO.

SIGN. & DATE

INVENTORY No.

ITEM	BRAID STYLE	NOMINAL		WIRE DIA.	STRANDING	TYPE	SWG. NO.	NO. OF PLAITS/ 10 Cm	PURCHASING SPECIFICATION	WEIGHT Kg/Km
		THICKNESS	WIDTH							
001	BP 9048546036	3	31	0.071	48/166	STOCKING WOVEN	45	20 TO 22	AA 12010	422.0
002	BP 9048543223	1.6	19.05	0.050	32/113	STOCKING WOVEN	47	36 TO 38	AA 12010	80.0

NOTE :-  
1. TOLERANCE ON NOMINAL WIDTH & THICKNESS ±5%.

कम्प्यूटर ड्राइंग  
क 35815030009

ADDITIONAL INFORMATION				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम				D.E. LOCO INDIAN RAILWAYS			
STATUS OF DRAWING M				TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT							
DISTRIBUTION OF PRINTS				भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल				क्याया DRN. ASE			
OFFICE COPY - 1				BHARAT HEAVY ELECTRICALS LTD. BHOPAL				जोया CHO. S.C.V.			
SWM - 4								स्वीकृत APPD. M.B.S.			
TCX (SWM) - 1								हस्ता/SIGN. दि./DATE			
				विभाग DEPT. CEE				भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल			
				कड कोड 407				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम			
				SEE NOTE-1				भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल			
				FOR IT. 002 WIRE DIA., STRANDING AND WEIGHT WERE 0.051,36/100 AND 98.0 Kg/Km RESP'Y. STYLE NO. WAS IN 6 DIGITS.				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम			
				STRANDING DETAILS FOR SHUNTS				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम			
				3 581 50 3 0009				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम			
				01				उत्पाद का प्रकार या ग्राहक/परियोजना का नाम			

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm) 19/175

1508984/2023-HEP-SWM-0915

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REV.	DATE	ALTERED	ADDITIONAL INFORMATION
01	13.12.08	CHECKED APPROVED	ACEMU
DRAWING COMPUTERISED & STYLE NO. WAS IN 6 DIGIT			STATUS OF DRAWING M
			DISTRIBUTION OF PRINTS O/C-1, TCX-1 SWM-4



ITEM	BRAID STYLE	NOMINAL		WIRE DIA	STRANDING	TYPE	SWG NO.	NO. OF PLAITS/10CM	PURCHASING SPECIFICATION	WEIGHT kg./km
		THICKNESS	WIDTH							
001	BP9048546028	3	25	0.071	48/126	STOCKING WOVEN	45	24 TO 26	AA12010	302.0

D 8638311 (IT.13)  
REF. DRG. NO.

REMARKS	ITEM NO.	DESCRIPTION	STD	MATL. CODE	A/C	UNIT	UNIT WT.
				MATL. SPECN.			QTY.

SIGN. &amp; DATE

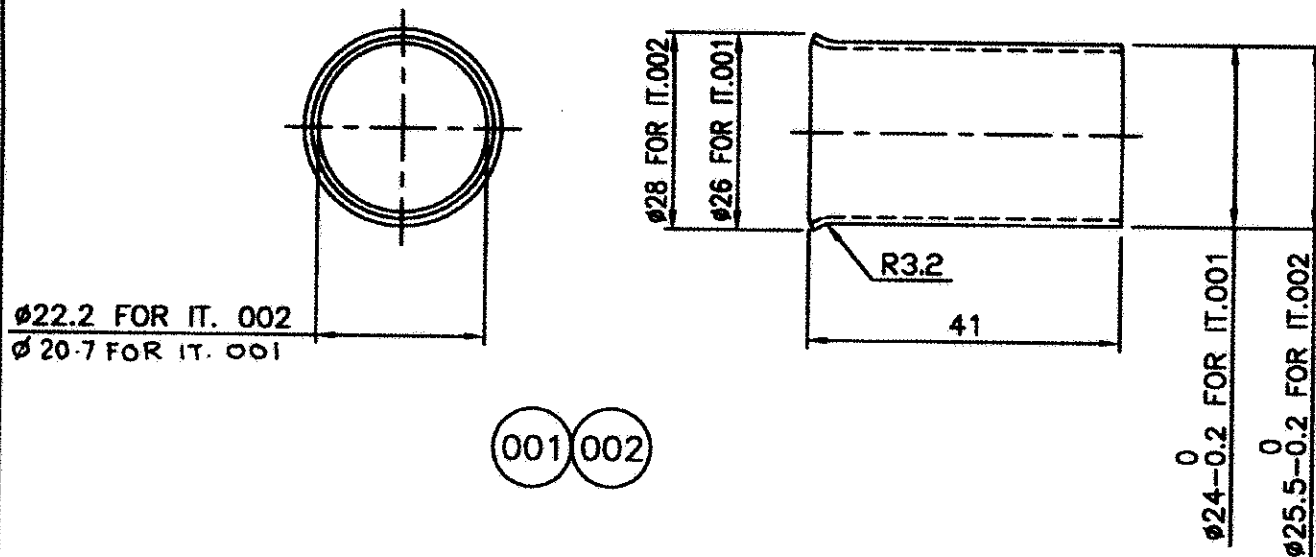
INVENTORY NO.

कम्प्यूटर ड्राइंग पडल क्रमांक 45801130027	 <b>भारत हेवी इलेक्ट्रिकल्स लिमिटेड</b> <b>BHARAT HEAVY ELECTRICALS LTD.</b> <b>BHOPAL</b>		नाम / NAME VINOD JOHN हस्ता / SIGN sd/- दि./DATE 19.1.81	चेकि की संख्या NO. OF VAR. -	
	विभाग DEPT. कोड 407 CODE	उल.टल.माप की श्रेणी UNTOL. DIMS. GR.	 अनुपात SCALE NTS	भार (कि.ग्रा.) WEIGHT (KG) 2 580 11 30026	उल.ड्राइंग का संदर्भ REF. TO ASSY. DRG. 002 & 003
शीर्षक / TITLE <b>STRANDING DETAILS FOR SHUNT</b>			ड्राइंग क्र. / DRAWING NO. <b>4 580 11 30027</b>		पुन. / REV 01
			शीट क्र. / SHT. NO 01	शीटों की सं. / NO. OF SHT. 01	

1508984/2023/

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REV. 06	DATE 25.10.08	APPROVED KE	REV. 05	DATE 26.6.05	APPROVED RCB	ADDITIONAL INFORMATION
		CHECKED KSD			CHECKED RKS	AC EMU
		APPROVED SKR			APPROVED AG	STATUS OF DRAWING
IT.002 ADDED.			DRG. REDRAWN & COMPUTERISED.			M
F 992						DISTRIBUTION 0/C - 1, SWM - 4
						OF PRINTS TCX (SWM) - 1

**FINISH :-**

SILVER PLATE (AFTER ANNEALING) 0.010 TO 0.015TK APPROX. TO PR.S.  
CG 03019 TO MAINTAIN MIN. THICKNESS CALLED ON ASSY. DRAWING.

**NOTE :-**

1. ITEMS 001 & 002 TO BE ANNEALED BEFORE FINISH AS FOLLOWS :-
  - a. HEAT THE FERRULES TO 500°C TO 550°C. SOAK AT THIS TEMP. THOROUGHLY.
  - b. AFTER SOCKING THE FERRULES ARE TO BE QUENCHED IN WATER. AFTER THE ABOVE HEAT TREATMENT THE FERRULE SHOULD HAVE A HARDNESS OF 60 H.V. MAXIMUM.



	002	26 %x2.5TK. COPPER TUBE		AA 12016	MM	0.030
	001	25 O/D x 2.5TK COPPER TUBE		AA 12016	MM	0.071
						45.0
						45.0
REMARKS	ITEM NO.	DESCRIPTION	STD	MATL. CODE	A/C UNIT	UNIT WT.
				MATL. SPECN.		QTY.

SIGN &amp; DATE

INVENTORY NO.

कम्प्यूटर ड्राइंग

फर्कल क्रमांक 45801130028

		<b>BHARAT HEAVY ELECTRICALS LTD.</b> <b>BHOPAL</b>		NAME L.M.O.	SIGN Sd/-	DATE 30.09.81	NO. OF VAR.
				NAME MANI	SIGN Sd/-	DATE 16.01.82	
				NAME V.P.A.	SIGN Sd/-	DATE 16.09.82	
DEPT. CEE CODE 407	UNTIL. DIMS. GR. CG 06503		SCALE 1:1	WEIGHT(KG) -	REF. TO ASSY. DRG. ITS. 1&2 3 580 11 3 0036	ITEM NO. 002	NO. OF ITEM
/TITLE <b>FERRULE</b>					DRAWING NO. 4 580 11 3 0028	REV 06	
					SHT. NO 01	NO. OF SHT. 01	



## CORPORATE PURCHASING SPECIFICATION

AA 120 10

Rev. No. 03

PAGE 1 OF 4

### FLEXIBLE COPPER BRAID – ANNEALED, FLAT

#### 1.0 GENERAL:

This specification governs the quality requirements of flat flexible copper braid in annealed condition, manufactured from high conductivity copper wire, plaited in a tubular form.

#### 2.0 APPLICATION:

Used in the manufacture of flexible connections of electrical apparatus.

#### 3.0 CONDITION OF DELIVERY:

Copper braid shall be supplied in flat flexible annealed condition. The braid shall be of ordinary flexible quality or stretch wires refer Cl.6.3.

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

There is no Indian Standard covering this material.

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 Sizes:

The Copper braid shall be supplied with the width and thickness as specified in BHEL order. The stranding of the preferred sizes are given below:

Thickness mm	Width mm	No of strands	Wire dia mm	No of braids	Effective area, cm <sup>2</sup>
1.60	19.05	648	0.122	1	0.1174
3.20	25.40	1908	0.152	3	0.4355

The stranding of other sizes shall be as described in BHEL order

##### 5.2 Tolerances:

##### 5.2.1 Width & Thickness:

The tolerance on width and thickness shall be  $\pm 0.381$  mm measured on the braid under no compression or tension.

#### Revisions :

Clause:20.10.9 of MOM of MRC-NFCW+HE

#### APPROVED :

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE-MRC (NFCW+HE)

Rev. No. 03

Amd.No.

Reaffirmed

Prepared

Issued

Dt. of 1st Issue

Dt :15.02.2006

Dt :

Year :2012

BHOPAL

Corp. R&amp;D

November, 1978

AA 120 10	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 03		
PAGE 2 OF 4		

**5.2.2 Wire:**

The tolerance on wire diameter shall be as follows:

Nominal Over	Diameter mm upto & incld.	Tolerance (±)
--	0.127	0.0025
0.127	0.190	0.0051

**6.0 MANUFACTURE:**

6.1 The wires for the braid shall be manufactured from copper of ETP grade conforming to IS:191.

6.2 **Braiding:** The stands shall be divided into groups of equal number and braided in tubular form. The braid shall then be flattened. The lay of the braid side shall, at the supplier's discretion, meet the flexibility and dimensional details specified.

For large number of strands the braids may be manufactured in two or more concentric tubular forms.

6.3 **Stretch wires:** Whenever specified in BHEL order, the braid shall be supplied with two parallel stretch wires of large diameter than the wire used in the braid running the whole length of the braid, to assist in controlling the width during manufacture and excessive stretching.

**7.0 FREEDOM FROM DEFECTS:**

The braid shall be clean, and free from harmful harmful defects.

**8.0 CHEMICAL ANALYSIS:**

The analysis of copper when analyzed in accordance with IS:440, shall as follows.

Element	Percent	
	Min.	Max
Copper and Silver	99.90	-----
Bismuth*	-----	0.001
Lead*	-----	0.005
Total of all impurities excl. silver and oxygen	-----	0.030
Silver present will be counted as copper.		





## CORPORATE PURCHASING SPECIFICATION

AA 120 10

Rev. No. 03

PAGE 3 OF 4

\*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 sample per size per melt per consignment of 3 tonnes or part thereof shall be taken for chemical and electrical tests.

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

### 10.0 ELECTRICAL RESISTIVITY (AS RECEIVED)

When measured in accordance with IS: 3635, the electrical resistivity at 20<sup>0</sup>.C shall not be greater than 0.01739 ohm-mm<sup>2</sup>/metre, which is equivalent to an electrical conductivity of 99.14%, minimum of IACS standard. (Refer Appendix B of IS: 613 for temperature correction factor).

### 11.0 INSPECTION AT SUPPLIER ' WORKS:

When ever 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 works, the supplier shall make Necessary arrangements for carrying out the prescribed test 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.

### 12.0 TEST CERTIFICATES:

Unless other wise stated, three copies of certificates shall be supplied along with each consignment.

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

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The test certificate shall bear the following information:

AA 12010 (Rev.03) : Flexible Copper Braid - Annealed, Flat

BHEL Order No.

Manufacturer 's/Supplier's Name:

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

The effective cross sectional area of the braid in square cm calculated from  $W/0.887$  where W is the weight of finished braid in kg per metre length.

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

### 13.0 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 12010 : Flexible Copper braid – Annealed, Flat

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

### 14.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. IS: 191

2. IS:440

3. IS: 613

4. IS: 3635



## CORPORATE PURCHASING SPECIFICATION

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## SOLID DRAWN COPPER TUBES AND PIPES

## 1.0 GENERAL:

This specification governs the quality requirements of solid drawn copper tubes and pipes.

## 2.0 APPLICATION:

General engineering purposes.

## 3.0 CONDITION OF DELIVERY: Half Hard (HB).

## 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

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

IS : 2501- 1995 : Solid drawn copper tubes for general engineering purposes  
Gr: Cu DHP

## 5.0 DIMENSIONS AND TOLERANCES:

## 5.1 Sizes:

The tubes and pipes shall be supplied as per the dimensions specified in BHEL order/drawing. Unless otherwise specified, tubes/ pipes shall be supplied in random lengths of 3 of 6 meters.

## 5.2 Tolerances:

The tolerances on out side diameter, wall Thickness, length, roundness and straightness of tubes/pipes shall be as per IS : 5493, given below:

## 5.2.1 Tolerance on mean outside diameter:

<u>Outside diameter, mm</u>		Tolerances, $\pm$ mm
Over	Upto and incl.	
-	10	0.08
10	18	0.10
18	32	0.12
32	50	0.15
50	80	0.20
80	125	0.25
125	200	0.50
200	250	0.80
250	315	1.00

## Revisions :

Cl: 19.10.15 of MOM of MRC-NFCW+HE

## APPROVED :

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE-MRC (NFCW+HE)

Rev. No. 05	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt: 15-10-04	Dt :	Year :	HARDWAR	Corp. R&D	01-03-78

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**5.2.2 Tolerance on wall 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.

**5.2.3 Tolerance on length:**

Length, meters		Tolerance on length, mm
Over	Upto and incl.	
-	5	+ 2.5
5	7	+ 3.0
7	-	+ 4.0

**5.2.4 Roundness Tolerance:**

The difference between major and minor diameters as determined at any one cross section expressed in terms of % of specified O.D of the tube shall be as follows:

t / D*, mm	Roundness Tolerance on O.D%
0.01 - 0.03	1.5
Over 0.03 - 0.05	1.1
Over 0.05 - 0.10	0.8 or 0.05 mm whichever is greater
Over 0.10	0.7

\* Where t is wall thickness and D is outside diameter (O.D).

**5.2.5 Tolerance on Straightness:**

Permissible maximum deflection shall be 3 mm on any one meter length,

**6.0 MANUFACTURE:**

The tubes shall be solid drawn and subsequently annealed. In no case tubes shall be redrawn from used tubes. The ends shall be cut clean and square with the axis of the tubes.

**7.0 FREEDOM FROM DEFECTS:**

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



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**8.0 CHEMICAL COMPOSITION:**

The chemical composition of the material. When analyzed in accordance with IS:440 (Methods for chemical analysis of copper ) or any other conventional/ instrumental method shall be as follows:

Element	Percent	
	min	max
Copper (any silver to be counted as copper )	99.80	-
*Antimony	-	0.005
*Arsenic	-	0.05
*Bismuth	-	0.003
*Iron	-	0.03
*Lead	-	0.01
*Nickel	-	0.10
*Selenium and Tellurium	-	0.02
*Tellurium	-	0.01
*Tin	-	0.01
Phosphorus	0.015	0.10
*Total impurities excluding Silver, Nickel, Arsenic and Phosphorus	-	0.06

**\*Note:** These elements need not be determined when the material supplied conforms with the mechanical 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 The chemical analysis shall be performed on each heat.

9.2 Tubes of one size and thickness shall be grouped in batches of 300 tubes or 1000kg or part thereof and one tube from each batch shall be selected at random for mechanical testing.

**Note:** For tubes with wall thickness <1 mm, lot will be of 2000 tubes or part thereof.

9.3 For embrittlement , one tube shall be selected from a lot of 100 tubes or part thereof.

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**10.0 MECHANICAL PROPERTIES:****10.1 Tensile test:**

A piece of tube selected for test, suitably plugged or flattened sufficiently for gripping, when tested in accordance with IS:1608 shall show the following tensile properties.

Condition	Tensile strength, N/mm <sup>2</sup> , min.	Elongation on 5.65 $\sqrt{S_0}$ gauge length, percent, minimum
As such	235	25
Strip cut from tube	225	25

**10.2 Flattening And Doubling Over Test:**

The test pieces shall not show any crack, when tested in accordance with clause 10.2 of IS: 2501.

**10.3 Drift Expanding Test (For tubes not exceeding 100 mm in O.D):**

The tubes, when tested as per Cl. 10.3 of IS: 2501, shall be capable of undergoing drifting without showing either crack or flaw.

**11.0 NON DESTRUCTIVE TEST:**


All tubes shall meet the requirement of eddy current or by hydraulic / pneumatic test as per Clause No. 4 of IS: 2501.

**12.0 OPTIONAL TEST:****12.1 HYDROGEN EMBRITTLEMENT TEST:**

Test specimen of tubes shall be capable of meeting the requirements of hydrogen embrittlement test as per IS: 6243 (Method of hydrogen and embrittlement test of copper)

**13.0 RETESTS:**

Should any of the test pieces first selected, fail to pass the prescribed tests mentioned under various clauses in this specification, two further samples from the same batch shall be selected for testing, one of which shall be from the same component from which the original test sample was taken, unless that component has been withdrawn by the supplier.

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Should the test pieces from both these additional samples pass the batch represented by the test sample shall be accepted. Should the test pieces from either of these additional samples fail, the batch represented by the test sample shall be rejected.

Should any specimen fail under above tests, all the tubes referred by the sample shall stand rejected. However, they may be resubmitted for inspection after stress relief treatment.

**14.0 TEST CERTIFICATES:**

Unless otherwise specified on order, three copies of test certificates shall be supplied. In addition, supplier shall sure to enclose one copy of test certificate alongwith despatch documents to facilitate quick clearance of material.

The test certificate shall bear the following information:

BHEL Order No.  
AA 12016, Rev. No. 05: Solid Drawn Copper Tubes / Pipes  
Batch No.  
Identification Mark / No.  
Weight  
Supplier's Reference and Name  
Results of Chemical, mechanical, hydraulic and all other tests called for.

**15.0 PACKING AND MARKING:**

The material shall be suitably packed in wooden crates to prevent corrosion and damage during transit.

Each crate shall be legibly marked with the following information.

BHEL Order No.  
AA 12016  
Batch No.  
Identification Mark /No.  
Weight  
Supplier's Reference and Name

**16.0 REFERRED STANDARDS (Latest Publications Including Amendments):**

1) IS: 440    2) IS: 2501    3) IS: 1608    4) IS: 5493    5) IS: 6243.

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## ANNEXURE - A

**CHECK LIST FOR AA 120 16: SOLID DRAWN COPPER TUBES / PIPES**  
(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 : Yes/No
  3. Straightness as per specification : Yes/No
  4. Chemical composition as per specification : Yes/No
  5. Mechanical properties as per specification : Yes/No
  6. Tests :
    - (1) Drift expanding : Yes/No
    - (2) Flattening : Yes/No
    - (3) Mercurous Nitrate test : Yes/No
  7. NDT tests offered :
    - (1) Hydraulic test :Yes/No
    - (2) Eddy Current test :Yes/No
    - (3) Pneumatic. :Yes/No
    - (4) Hydrogen Embrittlement :Yes/No
  8. Quality plan on BHEL format enclosed :Yes/No
  9. Details of previous experience enclosed (For New suppliers only) :Yes/No.
  10. Lifting Beam offered :Yes/No
  11. Packing box drg. Enclosed :Yes/No
  12. End guides included (Both ends) :Yes/No
  13. Deviations taken (Please specify clearly, if any ) :Yes/No.
    - 1
    - 2
    - 3

Date:


Place:

Signature  
and  
Seal of Supplier



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<b>OXYGEN FREE HIGH CONDUCTIVITY COPPER TUBES - MEDIUM HARD</b>					
<b>1.0 GENERAL:</b> This specification governs the quality requirements of oxygen free high conductivity copper tube, solid drawn Square/ Rectangular/Circular/ in medium hard condition.					
<b>2.0 APPLICATION:</b> Used in switchgear, transformers and traction motors.					
<b>3.0 CONDITION OF DELIVERY:</b> The material shall be supplied in medium hard condition in straight lengths as specified in BHEL order. Ends shall be cut clean and square with the axis of the tube.					
<b>4.0 COMPLIANCE WITH NATIONAL STANDARDS:</b> There is no Indian Standard covering this material. However, assistance has been drawn from the following national standard. BS: 1977-1976 : Specification for High Conductivity Gr : C 103 Copper Tubes for Electrical Purposes. Medium hard					
<b>5.0 DIMENSIONS AND TOLERANCES:</b>					
<b>5.1 Sizes:</b> The tubes shall be supplied to the dimensions as specified in BHEL order.					
<b>5.2 Tolerances:</b>					
<b>5.2.1 Thickness:</b> Tolerance on thickness shall be as follows:					
-----					
Thickness, mm		Tolerance, + mm			
-----					
Over	upto & incl.				
-----					
0.75	1.60	0.15			
1.60	2.25	0.20			
2.25	4.30	0.35			
4.80	7.00	0.45			
7.00	9.50	0.60			
9.50	15.00	0.80			
15.00	25.00	1.00			
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<b>Revisions: Ref: Cl.31.2.1 of MOM of MRC –E &amp; 15.27 of MRC-NFCW+HE</b>			<b>APPROVED:</b> INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (NFCW +HE)		
Rev. No. 02	Amd.No. 01	Reaffirmed	Prepared HYDERABAD	Issued Corp. R&D	Dt. Of 1 <sup>st</sup> Issue 01-11-78
Dt.: 01-02-97	Dt: 01-05-99	Year:			



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**5.2.2 Length:**

Tolerance on length of the tubes ordered in specified length shall be as follows:

Length, metre	:	Tolerance, ± mm
over      upto & incl.      :		
--              3.0		1.5
3.0            6.0		3.0

For sizes not included in this specification, tolerance shall be as stated in BHEL order.

**5.2.3 Circular Tubes Diameters:**

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.

Nominal Diameter mm		Tolerance mm	
over	up to & incl.	plus	minus
15	15	0.0	0.13
50	50	0.0	0.20
100	100	0.0	0.25

**5.2.4 Square & Rectangular Tubes:**

The tolerances on square and Rectangular tubes shall be as agreed between BHEL and the suppliers.

**6.0 MANUFACTURE:**

The tubes shall be manufactured from copper of ETP grade conform to IS:191, except that oxygen content shall not exceed 0.001% .


**7.0 FREEDOM FROM DEFECTS:**

The material shall be clean, bright, smooth and free from spills, sealing, blisters, cracks, lappings, shaving, splinters, metal dust, oxidation and other harmful defects. However, such surface marks caused during drawing or rolling that are barely noticeable to the naked eye are allowed

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

**8.0 CHEMICAL COMPOSITION:**

The analysis of copper when analysed in accordance with IS: 440, shall be as follows.

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Element	Percent	
	Min	Max
Copper and Silver	99.90	
Bismuth *	-	0.001
Lead *	-	0.005
Oxygen	-	0.001
Total of all impurities excl.silver and oxygen	-	0.040
Silver present will be counted as Copper.		

\* 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 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 material when tested in accordance with IS: 1608 shall show a tensile strength of 245 N/mm<sup>2</sup> Minimum.

**10.2 Hardness(Vickers):**  
When tested in accordance with IS: 1501,(Part 1), the material shall have a vickers hardness in the range of 75 - 90 HV.

**10.3 Hydraulic Test:**  
The tubes shall withstand, when hydraulically tested to a test pressure of 20 kg/cm<sup>2</sup> for one hour in water, and shall not show any sign of leakage or sweating or permanent increase in diameter at any point.

**11.0 ELECTRICAL RESISTIVITY(AS RECEIVED):**  
When measured in accordance with IS:3635, the electrical resistivity at 20° c shall not be greater than 0.01777 ohm mm<sup>2</sup>/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 shall also be acceptable

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**12.0 OPTIONAL TESTS:**  
Whenever specified in BHEL order the following tests shall be conducted on the norms of acceptance shall be as specified there in.


**12.1 Hydrogen Embrittlement Test:**  
The test pieces cut from the tube(either full section or strips from the tubes) is exposed to hydrogen atmosphere at 825°C - 875°C for 30 minutes. After cooling down to room temperature the pieces are tested. In case of full section sample, the tube shall be flattened to close. In case of a strip cut from the tube, it shall be bent 180°. In no case the copper shall exhibit any crack.

**12.2 Metallographic Examination:**  
After subjecting the material to the hydrogen embrittlement test, the test pieces shall be examined under an optical microscope at a magnification of at least 200. Test pieces shall show no fissures or cracks and inclusions, particularly cuprous oxide shall be absent.

**12.3 Hydrogen Resistance-Round Tubes:**  
Tube specimens of 10 to 20 mm length are annealed for 30 minutes at 800 to 850° C in a reduced atmosphere (hydrogen or fuel gas) cooled and then compressed between two parallel platens until the specimen shall not show any incipient cracks or fracture at the bend. In case of thick-walled tubes or tubes of larger cross-section, a strip of about 10 mm wide can be taken as test specimen.

**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 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. 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 certificates shall be supplied along with each consignment.

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<p>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.</p> <p>The test certificate shall bear the following information:</p> <p>AA 12017 (Rev.No.02) : Oxygen Free High Conductivity Copper Tube - Medium Hard.</p> <p>BHEL Order No</p> <p>Manufacturer's/Suppliers's Name</p> <p>Lot/Identification/Batch/Melt No. Sizes and</p> <p>Quantity supplied</p> <p>Results of dimensional inspection, chemical analysis, mechanical and electrical tests as per this specification.</p> <p><b>15.0 PACKING AND MARKING:</b></p> <p>The material supplied shall be suitable packed to avoid damage during transit.</p> <p>Each package shall be legibly marked or labelled with the following information.</p> <p>AA 12017 : Oxygen Free High Conductivity Copper Tube - Medium Hard.</p> <p>BHEL Order No</p> <p>Manufacturer's/Supplier's Name</p> <p>Lot/Idetification/Batch/Melt No. Size and Quantity supplied</p> <p><b>16.0 REFERRED STANDARDS (Latest Publications Including Amendments)</b></p> <p>1) IS: 191    2) IS:440    3) IS: 613    4) IS: 1501 (Part 1) 5) IS: 1608 6) IS: 3635    7) BS: 1977    8) ASTM E 1004.</p>		