



**BEML LIMITED  
BANGALORE**

DOC. No.	GR/TD/4966
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REV. No.	1
PAGE NO.	1 / 17

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**Procurement Technical Specification of  
Roof busbar conductors for MRS1  
Project**

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	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	3 / 17

## TABLE OF CONTENTS

<b>1. Introduction.....</b>	<b>5</b>
1.1 General .....	5
1.2 Climatic and environmental Conditions (ERTS clause 3.10).....	6
1.3 Track Structure Parameters (ERTS clause 3.14) .....	7
1.4 Current Collection System (ERTS clause 3.17).....	8
<b>2. Definitions and Abbreviations .....</b>	<b>9</b>
2.1 Definitions .....	9
2.2 Abbreviations .....	10
<b>3. Precedence of Documents .....</b>	<b>11</b>
<b>4. Standards .....</b>	<b>11</b>
<b>6. Scope of Supply.....</b>	<b>12</b>
6.3 Interface Responsibilities .....	13
6.4 Design Information .....	13
6.5 Spares, Special Tools and Testing Equipment .....	13
6.6 Storage, Packing Crating and Marking .....	13
6.9 Warranty .....	13
<b>7. Technical Requirements .....</b>	<b>14</b>
7.1 General .....	14
7.2 Technical.....	14
7.3 Quality.....	14
7.3.1 General: Quality Assurance Program .....	14
7.3.2 Quality Assurance Plan.....	14
7.4. Inspection and Test Plan (Herein After ITP).....	15

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	4 / 17

<b>7.5 Fire .....</b>	<b>15</b>
<b>7.6 Weight .....</b>	<b>16</b>
<b>7.9 Materials and workmanship .....</b>	<b>16</b>
<b>8. Testing .....</b>	<b>16</b>
<b>8.1 General .....</b>	<b>16</b>
<b>8.2. Dimensional Inspection .....</b>	<b>16</b>
<b>8.3 Routine Test .....</b>	<b>16</b>
<b>9. Submittals .....</b>	<b>17</b>
<b>10. Enclosures .....</b>	<b>17</b>

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	5 / 17

## 1. Introduction

### 1.1 General

This document, Procurement Technical Specification (PTS) describes the complete technical requirement of Roof busbar conductors to be supplied for cars under the 'MRS1' contract (hereafter MRS1). The Roof busbar conductors shall comply in all respects with MRS1 Employer's Requirements General Specification (ERGS) and Employer's Requirements Technical Specification (ERTS).

BEML shall carry out all required works and activities as contractor for MRS1 project while the subcontractor shall be responsible for all works required in this PTS with regard to supply of Roof busbar conductors and shall be responsible for supporting the BEML activities as contractor for MRS1 Project.

The scope of work shall include all items of work which may be required to meet the performance requirements, trouble free and efficient operation of trains and meeting the best international practices even if not specifically mentioned in the tender specifications as specified in ERTS 1.1.3 (i) to (ix) and ERTS 1.1.7.

The configuration of train formation is as follows.

- \*DMC – TC – MC – - 3 car unit formation
- \*DMC – TC – MC – MC – TC – DMC\* - 6 car train formation

for increase in quantity (if required)

- TC – MC – - 2 car unit formation
- \*DMC – TC – MC – TC – MC – MC – TC – DMC\* - 8 car train formation


- DMC: Driving Motor Car, MC: Motor Car, TC: Trailer Car

- \* : Front Automatic Coupler(FAC)
- : Semi-Permanent Coupler (SPC)

In case of 8 car formation (if required), the performance features of extra 2 Car unit (T-M) shall be suitably designed in line with ERTS sub-clause 3.22.10.

Each DMC shall be provided with Automatic couplers without electric head, at the front end of the train. The other end of DMC and either ends of TC & MC shall be equipped with semi-permanent couplers.

The design of Roof busbar conductors shall be suitable for 8 car formation in future. The design details and performance parameters of Roof busbar conductors for 8 car train shall be submitted by the subcontractor during design stage itself and got approved from the Engineer.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	6 / 17

## 1.2 Climatic and environmental Conditions (ERTS clause 3.10)


The MRS1 cars shall operate reliably and safely under Mumbai climatic and Environmental conditions as per ERTS 3.10 shown in the following Table-1. Accordingly the Roof busbar conductors shall be designed to operate with satisfactory performance under the following climatic and environmental conditions,

Description	Limiting Values
Maximum ambient temperature (Refer note1 below)	36 °C
Minimum temperature	14.3 °C
Humidity(Refer note 2 below)	≥95% RH
Rainfall	The annual precipitation is 2,078 mm with 34 % (709 mm) falling in the month of July
Atmosphere during hot season	Extremely dusty including bird feathers
Maximum wind Speed	150 km/h
Vibration & Shocks	The sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373 and IEC 60571.
S02 level in atmosphere	80— 120 mg/ m <sup>3</sup>
Suspended particulate matter in atmosphere	360 — 540 mg/m <sup>3</sup>
Flood Proofing	The traction sub-systems mounted on the under-frame will be designed to permit propulsion of the train at 10 kmph through water up to a depth of 50 mm above rail level. Traction sub-systems shall be made splash proof in accordance with International Standards.

**Table-1**

Note:


1. The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70 °C.
2. Any moisture condensation shall not lead to any malfunction or failure.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	7 / 17

### 1.3 Track Structure Parameters (ERTS clause 3.14)

The Track Structure Parameters for At-grade, Elevated and Underground Corridors are shown in Table-2.

Description	Elevated and At-grade Corridor		Underground
	Ballasted	Ballasted less (DFF)	Ballasted less (DFF)
Track Laying Gauge	1435 mm	1435 mm	1435 mm
Rail Type (Main line and depot)	60E1 (UIC 60) 880/HH	60E1 (UIC 60) 1080/HH	60E1 (UIC 60) 1080/HH
Rail profile	UIC 861-3	UIC 861-3	UIC 861-3
Indication of Rail	1 in 20	1 in 20	1 in 20
Sleeper Spacing (Main Line)	600mm±10mm	600mm±10	700mm±10m
Sleeper Spacing (Depot)	650mm±10mm	Not applicable	Not applicable
Ballast Cushion Depth (Main Line)	300mm	Not applicable	Not applicable
Ballast Cushion Depth (Depot)	250mm	Not applicable	Not applicable
Standard Rail length	13m and 18m	18m	18m
Rail panel lengths	Longer than 200m	Longer than 200m	Longer than 200m
Minimum Radius of curvature	200m-Underground, 110m- Elevated, 100m-Depot		
Minimum Turn Out Radius (Main Line)	1 in 9 -300m radius 1 in 7 -190m radius		
Minimum Turn Out Radius (Depot)	1 in 7 -190m radius		
Max. Cant Permissible	110 mm	110 mm	110 mm
Max. Cant Desirable	110 mm	110 mm	110 mm
Max. Cant Deficiency Permissible	85 mm	85 mm	85 mm
Max. Cant Deficiency Desirable	85 mm	85 mm	85 mm
Max. permissible Cant Gradient	1 in 440	1 in 440	1 in 440
Max. Desirable Cant Gradient	1 in 720	1 in 720	1 in 720
Turn-out Speed : Turnout (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed : Scissors (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed : In depots (1 in 7) R-190	35 km/h	35 km/h	25 km/h

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	8 / 17

Turn-out Speed : Turnout (1 in 7) R-190	35 km/h	35 km/h	25 km/h
Turn-out Speed : Turnout (1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout (1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout (1 in 8.5) R-218	30 km/h	30 km/h	30 km/h
Turn-out Speed : Turnout (1 in 8.5) R-218	30 km/h	30 km/h	30 km/h
Maximum gradient main line	4%	4%	4%
Maximum gradient main Depot connection	4%	4%	4%
Minimum vertical radius of curvature	1500m	1500m	1500m

**Table-2**


Note: For detailed Track Tolerance details refer ERTS section 3.15.1 Table 3.3 and principle details Platform Interfaces refer ERTS section 3.16.1 Table 3.4.

#### **1.4 Current Collection System (ERTS clause 3.17)**

<b>System particulars</b>	<b>For all sections and depots</b>
Supply Voltage System	25kV ac Single phase 50Hz
Type of OHE	a. Auto tensioned flexible catenary for elevated and at-grade sections. b. Rigid catenary for underground sections. c. Flexible catenary for depot.
Current Collector	Through Pantograph
Height of Contact wire from rail level	a. 4800mm min. and 5500mm max. for elevated, at-grade and depot sections. b. 4318mm min. for underground sections.
Stagger	±200mm for Rigid Catenary; ±300mm for Flexible Catenary
Nominal Voltage	25.0 kV AC
Minimum Voltage	19.0 kV AC
Maximum Voltage	27.5 kV AC
Instantaneous min Voltage	17.5 kV AC
Occasional max Voltage	31.0 kV AC
Voltage for guaranteed performance	22.5 kV AC
Variation in frequency	48 to 52 Hertz

**Table-3**



	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	9 / 17

## 2. Definitions and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

### 2.1 Definitions

**“Employer”** means Delhi Metro Rail Corporation Limited (DMRC), its legal Successors and assignees.

**“BEML”** means the Contractor to procure the Roof busbar conductors for MRS1 Project.

**“Subcontractor”** means the supplier of Roof busbar conductors to BEML for MRS1 Project. Subcontractor shall carry out the works in accordance with ERTS and ERGS with regard to Roof busbar conductors.


**“Contractor”** means the persons or person appointed by the Employer to undertake the execution of the works for MRS1 project. In order to avoid misunderstanding of the roles of the Contractor in ERTS and ERGS, the term “Contractor” shall be read as “Subcontractor” in ERTS/ERGS for those ERTS/ERGS clauses referred to in this PTS.

**“Contract”** means the contract between Subcontractor and BEML in relation to the supply of Roof busbar conductors for MRS1 project.

**“NA”** means Not Applicable

**“Engineer”** means any person nominated or appointed from time to time by the Employer to act as the Engineer for the purposes of the Contract and notified as such in writing to the Contractor.


**“Engineer’s Representative”** means any Assistant of the Engineer appointed from time to time by the Employer.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	10 / 17

## 2.2 Abbreviations

ATC:	Automatic Train Control
DMRC:	Delhi Metro Rail Corporation
EMC:	Electro-Magnetic Compatibility
EMI:	Electro-Magnetic Interference
FAI:	First Article Inspection
ERTS:	Employer's Requirement Technical Specification
ERGS:	Employer's Requirement General Specification
GCC:	General Condition of Contract
GTC:	General Terms and Conditions.
LRU:	Line Replaceable Unit
MDBF:	Mean Distance Between Failures
MDBCF:	Mean Distance Between Component Failures
MDBSF:	Mean Distance Between Service Failures
MTTR:	Mean Time To Repair
PIS:	Passenger Information System
PTS:	Procurement Technical Specification
SCC:	Special Condition of Contract
SOD:	Schedule of Dimension
TCMS:	Train Integrated Management System
N/A:	Not Applicable
TBD:	To Be Determined
PDR:	Preliminary Design
FDR:	Final Design
GoA:	Grade of Automation
UTO:	Unattended Train Operation

For further abbreviations, please refer to ERTS APPENDIX TC

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	11 / 17

### 3. Precedence of Documents

**The PTS shall be read in conjunction with the General Terms and Conditions (GTC) of tender, ERGS and ERTS.**

The PTS shall be read in conjunction with the General Terms & Conditions (GTC) of the tender, ERGS and ERTS.

To the extent that any provision of the PTS is inconsistent with any provision of the Commercial Specification, the provisions of the General Terms and Conditions (GTC) shall prevail.

To the extent that any provision of GTC is inconsistent with any provisions of the ERGS and ERTS, the provisions of GTC shall prevail.

This PTS shall in no way relieve the subcontractor from any requirements specified in the ERTS and ERGS.

In the event of any conflict between requirements of particular parts of this PTS, the Subcontractor shall seek clarification from BEML.

In case of conflict among contract documents, the following order of priority shall govern:

Order of Precedence	Document title
1	DMRC ERTS
2	DMRC ERGS
3	GTC
4	PTS

**Table-4**


The complete requirements are those found in the above documents. It shall be the subcontractor's responsibility to ensure that equipment, documentation, and services furnished against this PTS are in full compliance with all the above documents.

Also, in the event of any conflict among the requirements of particular parts of the PTS, ERTS and ERGS, the subcontractor shall seek clarification with BEML prior to making a contract. After making a contract, the subcontractor shall comply with BEML's Interpretation for any discrepancies.

### 4. Standards

The design, manufacture and testing of the work and the materials shall conform to the latest editions of internationally recognized North American, European, Japanese standards. The standards to be used shall be as per Appendix TA of ERTS.

- General Standards: IEC, UIC, EN, BS, JIS, NF, NFPA, ASTM etc.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	12 / 17

- EN 45545(Part 1 to 7) Railway applications – Fire protection on railway vehicles – Part 1-7


## 6. Scope of Supply

The following is the scope of Roof busbar conductors required for MRS1 project.

Sl. no.	Part. no.	Description	Qty/ T car	Unit
1	525-21275	Roof busbar 1 (Pantograph to PT)	1	No.
2	525-21276	Roof busbar 2 (PT to VCB)	1	No.
3	525-21277	Roof busbar 3 (VCB to Arrestor1)	1	No.
4	525-21278	Roof busbar 4 (VCB to Cable head)	1	No.
5	525-21279	Roof busbar 5 (Cable head to Arrestor 2)	1	No.

**Table 1: Roof busbar conductors**

- 6.1.2.1.** The subcontractor shall submit material test certificate for the copper as per grade: Cu ETP (Half hard condition-HB) to Spec IS: 191-80 (PART-5) for roof busbar Conductors. The bus bar shall not bend easily by external forces after installation.
- 6.1.2.2.** The subcontractor shall confirm physical properties as per IS: 250 1-95.
- 6.1.2.3.** The subcontractor shall provide the hardware and if any supporting clamps/brackets as required during installation.
- 6.1.2.4.** The firm to provide the relevant check sheets for tin plating thickness as per IS: 1359-92 service grade no.3 (severe).
- 6.1.2.5.** The subcontractor shall submit clause wise compliance for the procurement technical specification (PTS) and complete technical proposal with technical details, drawings, calculations & catalogues.
- 6.1.2.6.** The subcontractor shall conduct all Type test for Roof busbar insulator and relevant test reports to be submitted.
- 6.1.2.7.** The subcontractor shall install roof busbars in Proto train-set and to be ensured for correct installation and if required, to be modified accordingly for proper installation. Before mass production, sample should be approved.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	13 / 17

### **6.3 Interface Responsibilities**

The necessary conditions of installation for Roof busbar conductors shall be defined by the subcontractor and approved by BEML in order to avoid the problems when the Roof bus conductors will be installed in the vehicle.

Subcontractor shall be responsible for defining the technical requirements and the design constraints for Roof bus conductor's installation.

The subcontractor shall be responsible for the design of the Roof bus conductors and submission of design information and the performance of testing activities and rectification of the Roof bus conductors during the defects liability period.

Subcontractor shall recommend the required Roof busbar conductors termination/ cable joining procedures along with tools and equipments for connection.

### **6.4 Design Information**

The Subcontractor shall provide BEML with all necessary documents, drawings, reports, calculations, technical data and similar documents of design, system assurance, quality assurance, manufacturing and testing with respect to PTS according to the time schedule defined by BEML.

The documents shall be written in English with data format of respectively, Document – MS word, Spread sheet – MS excel, Data base files – MS Access, Presentation file – MS Power point.

Three sets of test procedures, manuals and documents shall be submitted to BEML for the preliminary, pre-final and final design submissions, the final contract document, and all other submission both in the hard copies and soft copy. The subcontractor shall comply with the requirements specified in ERGS & ERTS.

### **6.5 Spares, Special Tools and Testing Equipment**


The Subcontractor shall provide the special tool and equipments required for installation of Roof bus conductors.

### **6.6 Storage, Packing Crating and Marking**

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in ERGS 9. The subcontractor shall make and provide the document for proper storage, handling and logistics of Roof bus conductors.

### **6.9 Warranty**

Refer General Terms and Conditions (GTC) of the tender.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	14 / 17

## 7. Technical Requirements

### 7.1 General

The subcontractor shall be responsible for meeting all the general and technical requirements of the Roof busbar conductors as specified in ERGS & ERTS. The General and Technical Requirements comply but not be limited to the following:

- 1) Interface Activities
- 2) Quality Assurance
- 3) System Safety Assurance
- 4) Hazard Analysis
- 5) Fail safe design
- 6) Reliability , Availability & Maintainability
- 7) Fire performance and Toxicity Standards
- 8) International standards

### 7.2 Technical

The subcontractor shall submit material test certificate for the copper as per grade: Cu ETP (Half hard condition-HB) to Spec IS: 191-80 (PART-5) for roof busbar Conductors. The bus bar shall not bend easily by external forces after installation.

### 7.3 Quality

#### 7.3.1 General: Quality Assurance Program

This section describes quality assurance program required to assure the quality of products supplied from the Subcontractor to BEML. The Subcontractor shall assure the quality of product and maintain quality system to achieve high quality of the product.


#### 7.3.2 Quality Assurance Plan

The Subcontractor shall develop and submit to BEML QC team for review and approval a Quality Assurance Plan (QAP) based on ISO 9001 standard and GS 2.5. The subcontractor shall have the following

- a) Organization chart
- b) Certification of Personnel
- c) Evidence of Compliance
- d) Certificates of compliance
- e) Calibration of measurement equipment and tools

#### 7.3.3. Quality Assurance Activities

The Subcontractor shall address, as a minimum, the following activities and shall provide a means of self-correcting any shortcomings in his Quality Assurance Plan (QAP) as per GS 2.5.

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	15 / 17

- a) Procurement
- b) Manufacturing Inspection
- c) Production Conformance Testing
- d) Receiving Inspection
- e) Shipping Inspection
- f) Ensure inspection with latest Revision/Changes.
- g) Identification of items using tags etc.
- h) Handling (storing, preserving, packaging, marking and shipping).
- i) Non-conformance Control.

### 7.3.4 Quality Audit

The Subcontractor shall permit Quality Audit by BEML and/or the Customer of BEML. The scope of the audit will be only the field related with the implementation of this project and the Subcontractor's QAP. If any Nonconformity is detected during the audit, Corrective Action request will be issued to the Subcontractor. For the Corrective Action Request, the Subcontractor shall prepare and submit appropriate action plan within 10 (ten) days, perform the action plan and reply the result to BEML QC team.

### 7.4. Inspection and Test Plan (Herein After ITP)


ITP shall be submitted to BEML for review and approval as following no later than 30 days after purchase order by BEML. Subcontractor shall comply to ERTS 15.

- A) The ITP shall include all the major inspection and test activities planned prior and during the design, procurement and installation phases.
- B) Witness/Hold point of Inspection/Test  
After review of the ITP received from the Subcontractor, BEML will designate witness/hold point (if required) of BEML and/or the Customer of BEML and notify them to the Subcontractor.
- C) Inspection/Test Notification of Witness/Hold point  
After receiving of ITP, BEML will inform Notification schedule and procedure to the Subcontractor according to the Main contract between BEML and the Customer of BEML.

### 7.5 Fire

The Fire requirements shall be met, but not be limited to, the following sections in ERGS and ERTS:

- (a) Fire Performance - ERTS 2.19
- (b) Material and Workmanship Requirements - ERTS 14

	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	16 / 17

## 7.6 Weight

The weight of Roof busbar conductors shall be verified and controlled by the subcontractor in accordance with the requirements defined by BEML. The Subcontractor shall comply with all weight reductions judged necessary by BEML. Any unit exceeding the permissible weight shall be rejected. Overweight tolerance is not permitted.

## 7.9 Materials and workmanship

The Subcontractor shall be responsible for meeting the requirement of constructional details, material and workmanship of Roof busbar conductors. All materials and workmanship shall be in every respect in accordance with the proven up-to- date best practice. The requirements for material and workmanship of Roof busbar conductors shall meet the requirements as per ERTS 14.

## 8. Testing

### 8.1 General

The Subcontractor shall perform the tests in accordance with the approved Test Specification. BEML and MRS1 have the right to witness any of these tests at any stage of test progress. All test procedures, reports including all maintenance activities and checklists shall be submitted and approved by BEML and MRS1.

The test requirements shall meet, but not be limited to, the following sections in the ERGS and ERTS:

Refer Inspection, Tests & Commissioning- ERGS7 & ERTS15.

### 8.2. Dimensional Inspection

This inspection shall be done for picked the specimen by a lot of product. If the result is not proper all quantities of lot product shall be inspected to the approved drawing.


### 8.3 Routine Test

This test is required to verify that the Roof busbar conductors has been manufacture in such a way that it satisfies the requirements of the Approved Design Data as verified by the Type Test. Subcontractor shall perform routine test of Roof busbar conductors recorded in a log book and necessary alterations and adjustments shall be carried out.

Records from routine test shall be held by the subcontractor and made available timely for BEML and MRS1's inspection. Copies of the approved routine test results shall be submitted together with the associated log book.

This test basically shall include dimensional inspection but not be limited. The test shall be defined details by the subcontractor.



	<b>Procurement Technical specification of Roof busbar conductors</b>	DOC. NO.	GR/TD/4966
		DATE	07.05.2020
		REV. No.	1
		PAGE NO.	17 / 17

## 9. Submittals

The sub contractor shall provide the following as part of technical offer for technical evaluation:

- 1) **Technical offer for the Roof busbar conductors with complete technical details having the following:**
  - a) **Catalogues & data sheets of material used including the standards.**
  - b) **Submit quality test plan and test reports.**

- 2) **Clause wise compliance against,**

- a) **PTS - Doc no. GR/TD/4966.**

in the following format

- i. **Complied:** "Complied" shall be indicated by the supplier where the supplier is able to comply with the clause.
- ii. **Noted:** Where a clause merely provides information.
- iii. **"Complied with comments"** will be considered as fully complied for the clause with no additional commercial impact.
- iv. **Offers with Non-compliance and deviations to any of the ERTS, ERGS & PTS clauses with regard to Roof busbar conductors are liable for rejection.**

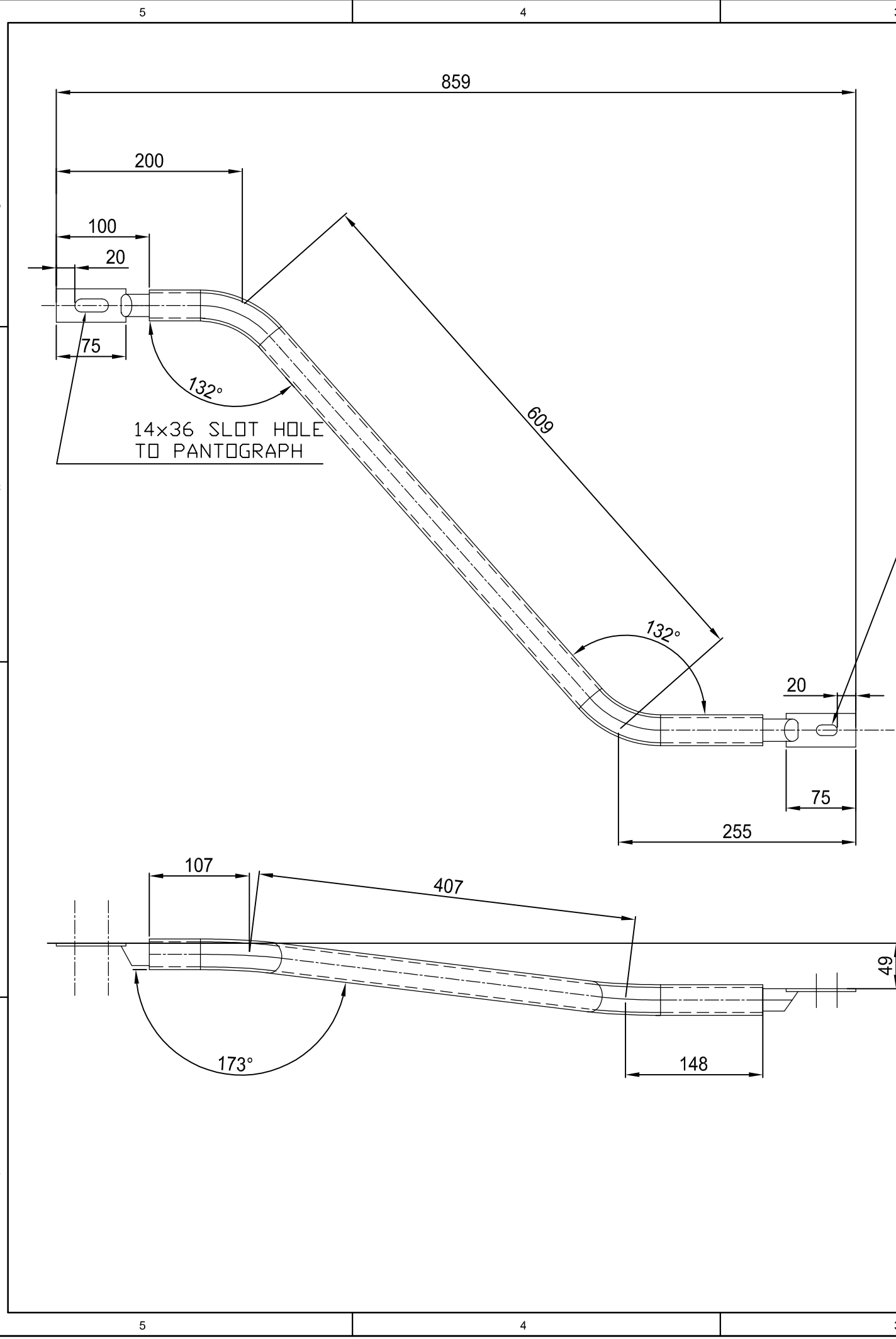
## 10. Enclosures

- 1) Attachment – 1: Roof busbar conductor drawings :

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GRADE No.	N1	0.025
VALUE	N2	0.05
SYMBOL	N3	0.1
	N4	0.2
	N5	0.4
	N6	0.8
	N7	1.6
	N8	3.2
	N9	6.3
	N10	12.5
	N11	25
	N12	50
SURFACE ROUGHNESS		



MACHINING DEVIATIONS FOR LINEAR DIMENSIONS	RANGE	0 - 6	6 - 30	30 - 120	120 - 315	315-1000	1000-2000	2000-4000	ABOVE 4000	RA
	TOLERANCE	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	~
FOR DIMENSIONAL TOLERANCES OF SHEET METAL PARTS AND WELDED STRUCTURES, REFER STD. RD-227										
UNSPECIFIED TOLERANCE FOR LINEAR AND ANGULAR DIMENSIONS REF. IS 2102 (PT-1) (MEDIUM)								QUALITY OF WELD JOINTS REF. RD 230 MEDIUM		
VALUES OF SURFACE TEXTURE SHALL BE AS PER COMPANY STD DS. 1012.C.										STATUS:
WELDING SHALL BE CARRIED OUT AS PER IS: 9595-96										

12X22 SLOT HOLE TO PT

**NOTE:-**

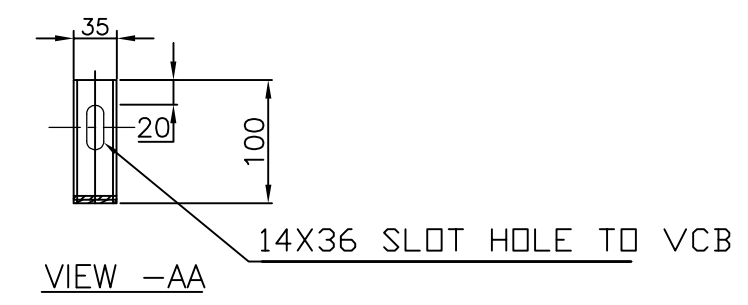
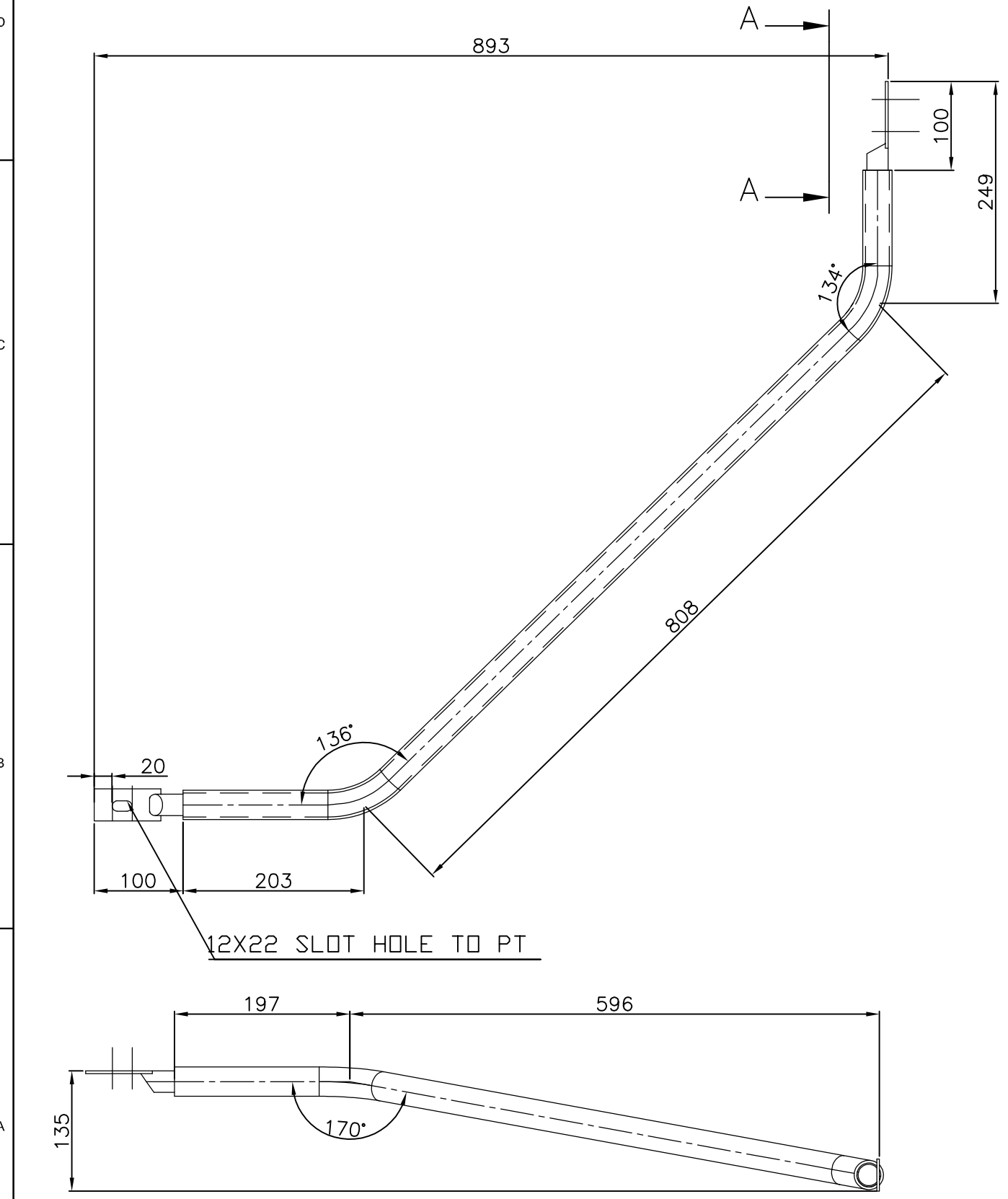
- ELECTROLYTIC TOUGH PITCH COPPER TUBE 25.4MM OD x 3 MM WALL THICKNESS, GRADE: CU-ETP (HALF HARD CONDITION-HB) TO SPEC IS: 2501-95 MATERIAL CONFIRMING TO GRADE ETP OF IS: 191-80 (PART 1)
- THE CONDUCTOR TO BE TIN PLATED TO IS-1359-92 SERVICE GRADE NO.3 (SEVERE)
- SUPPLIER SHALL SUBMIT THE TEST CERTIFICATE OF GRADE OF COPPER AS PER IS:191-80 (PART 5)
- ~~INSTALLATION AND HIGH VOLTAGE INSULATION SHOULD BE PROVIDED AS PER PTS GR/TD/4966 TECHNICAL REQUIREMENTS.~~

1	1	ETP GRADE COPPER TUBE	Dia 25.4x1100	SEE NOTE	
SL.No.	QTY	PART / STOCK No.	DESCRIPTION	SIZE	COMPANY STD./I.S MATERIAL
△			PRODUCT	MUMBAI METRO CARS-L2&L7	
△			REF DRG		
△			MATERIAL		
△			HEAT TREAT.	APPD	V SYLAJA 08.02.2020
△			SURFACE TREAT.	REVD	HARISH SN 08.02.2020
△			TITLE	CHKD	KIRAN A 08.02.2020
△				DRWN	AMBIKA HS 08.02.2020
△	REVISED & UPDATED	DATE 07.05.2020	BY AMBIKA	SCALE	1:1
△			CHKD NAGARAJ	SHEET	OF 0
△			APPD SYLAJA	DRG No.	525-21275
ALT.No.	ECN NO/CHANGES		<b>BEM LIMITED</b>		ALT
					1

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GRADE No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
VALUE	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
SYMBOL												
SURFACE ROUGHNESS												

MACHINING DEVIATIONS FOR LINEAR DIMENSIONS	RANGE	0 - 6	6 - 30	30 - 120	120 - 315	315-1000	1000-2000	2000-4000	ABOVE 4000	RA
	TOLERANCE	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	~
FOR DIMENSIONAL TOLERANCES OF SHEET METAL PARTS AND WELDED STRUCTURES, REFER STD. RD-227										
UNSPECIFIED TOLERANCE FOR LINEAR AND ANGULAR DIMENSIONS REF. IS 2102 (PT-1) (MEDIUM)								QUALITY OF WELD JOINTS REF. RD 230 MEDIUM		
VALUES OF SURFACE TEXTURE SHALL BE AS PER COMPANY STD DS. 1012.C.										STATUS:
WELDING SHALL BE CARRIED OUT AS PER IS: 9595-96										



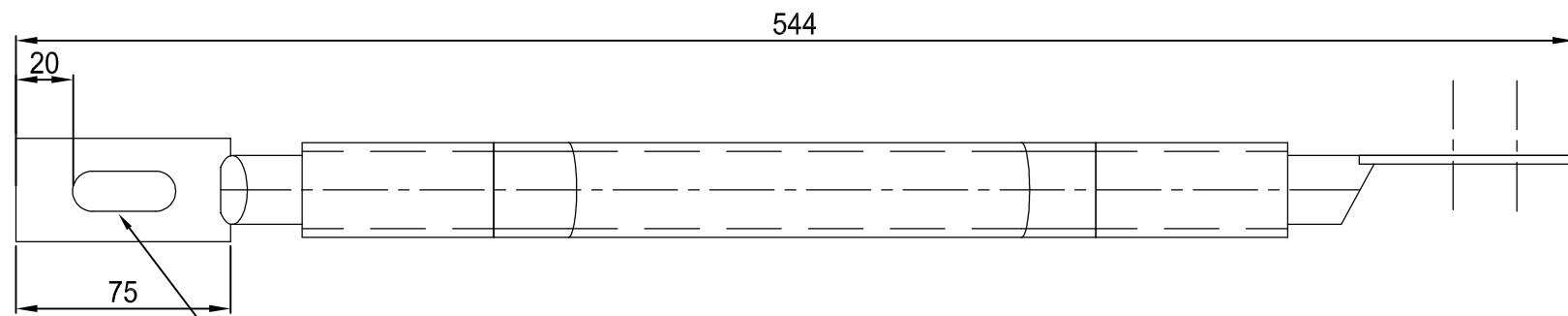
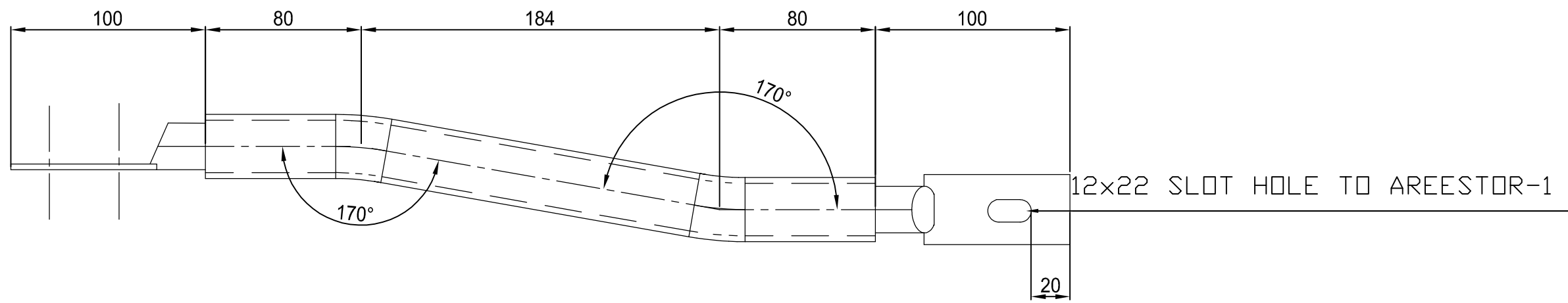
- NOTE:-**
- ELECTROLYTIC TOUGH PITCH COPPER TUBE 25.4MM OD x 3 MM WALL THICKNESS, GRADE: CU-ETP (HALF HARD CONDITION-HB) TO SPEC IS: 2501-95 MATERIAL CONFIRMING TO GRADE ETP OF IS: 191-80 (PART 1)
  - THE CONDUCTOR TO BE TIN PLATED TO IS-1359-92 SERVICE GRADE NO.3 (SEVERE)
  - SUPPLIER SHALL SUBMIT THE TEST CERTIFICATE OF GRADE OF COPPER AS PER IS:191-80 (PART 5)
  - ~~INSTALLATION AND HIGH VOLTAGE INSULATION SHOULD BE PROVIDED AS PER PTS-GR/TD/4966 TECHNICAL REQUIREMENTS.~~

1	1		ETP GRADE COPPER TUBE	Dia 25.4x1400	SEE NOTE	
SL.No.	QTY	PART / STOCK No.	DESCRIPTION	SIZE	COMPANY STD./I.S	Wt. (Kg)
					MATERIAL	
			PRODUCT	MUMBAI METRO CARS-L2&L7		
			REF DRG			
			MATERIAL			
			HEAT TREAT.	APPD	V SYLAJA	08.02.2020
			SURFACE TREAT.	REVD	HARISH SN	08.02.2020
			TITLE	CHKD	KIRAN A	08.02.2020
				DRWN	AMBIKA HS	08.02.2020
	REVISED & UPDATED	DATE 07.05.2020	BY AMBIKA	SCALE		SHEET
ALT.No.	ECN NO/CHANGES	DATE	BY	1:5	1 OF 1	Wt.(Kg)
			CHKD NAGARAJ			-
			APPD SYLAJA	DRG No.		ALT
			<b>BEML LIMITED</b>			525-21276

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GRADE No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	ROUGHNESS
VALUE	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50	
SYMBOL													

MACHINING DEVIATIONS FOR LINEAR DIMENSIONS	RANGE	0 - 6	6 - 30	30 - 120	120 - 315	315-1000	1000-2000	2000-4000	ABOVE 4000	RA
	TOLERANCE	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	~
FOR DIMENSIONAL TOLERANCES OF SHEET METAL PARTS AND WELDED STRUCTURES, REFER STD. RD-227										
UNSPECIFIED TOLERANCE FOR LINEAR AND ANGULAR DIMENSIONS REF. IS 2102 (PT-1) (MEDIUM)								QUALITY OF WELD JOINTS REF. RD 230 MEDIUM		
VALUES OF SURFACE TEXTURE SHALL BE AS PER COMPANY STD DS. 1012.C.										STATUS:
WELDING SHALL BE CARRIED OUT AS PER IS: 9595-96										



**NOTE:-**

- ELECTROLYTIC TOUGH PITCH COPPER TUBE 25.4MM OD x 3 MM WALL THICKNESS, GRADE: CU-ETP (HALF HARD CONDITION-HB) TO SPEC IS: 2501-95 MATERIAL CONFIRMING TO GRADE ETP OF IS: 191-80 (PART 1)
- THE CONDUCTOR TO BE TIN PLATED TO IS-1359-92 SERVICE GRADE NO.3 (SEVERE)
- SUPPLIER SHALL SUBMIT THE TEST CERTIFICATE OF GRADE OF COPPER AS PER IS:191-80 (PART 5)
- ~~INSTALLATION AND HIGH VOLTAGE INSULATION SHOULD BE PROVIDED AS PER PTS 4966 TECHNICAL REQUIREMENTS.~~

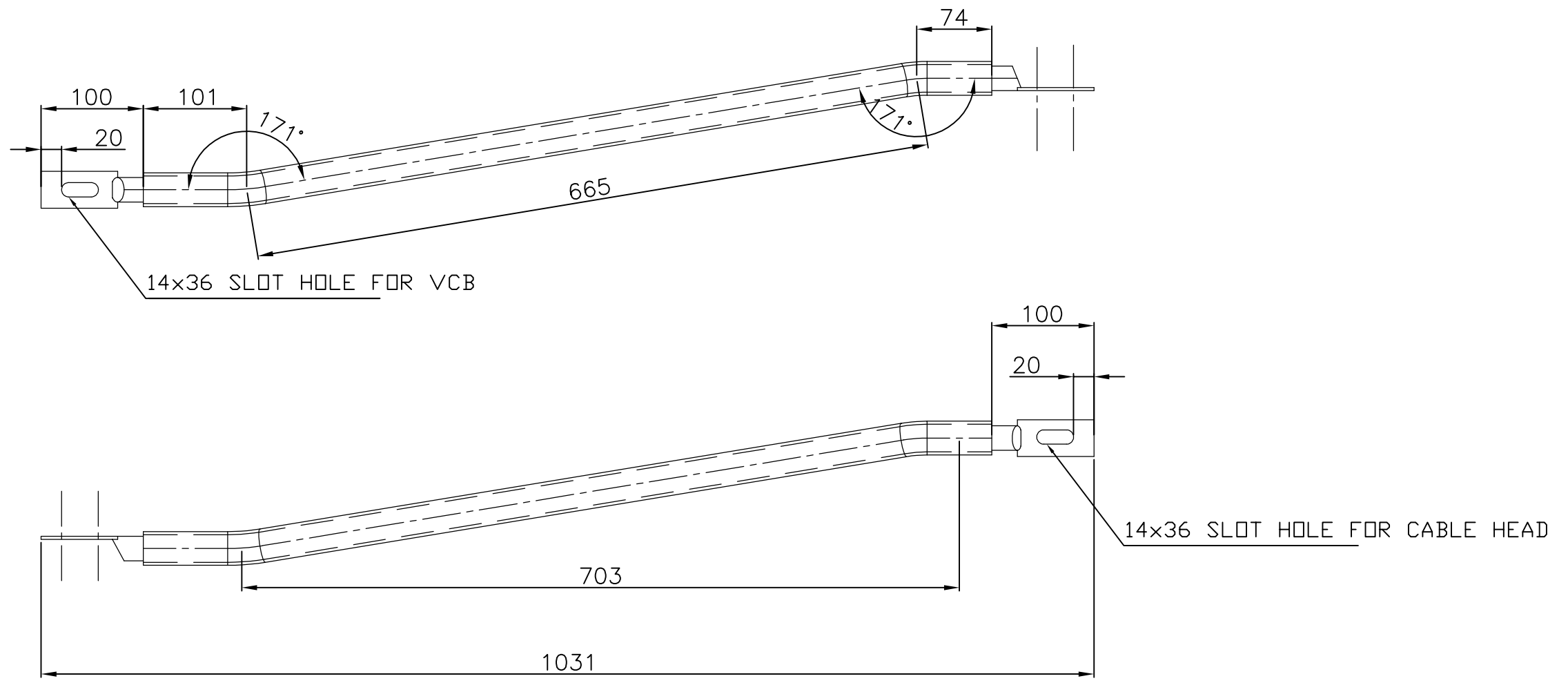
1	1		ETP GRADE COPPER TUBE	Dia 25.4x550	SEE NOTE	
SL.No.	QTY	PART / STOCK No.	DESCRIPTION	SIZE	COMPANY STD./I.S	Wt. (Kg)
					MATERIAL	
			PRODUCT	MUMBAI METRO CARS-L2&L7		
			REF DRG			
			MATERIAL			
			HEAT TREAT.	APPD	V SYLAJA	08.02.2020
			SURFACE TREAT.	REVD	HARISH SN	08.02.2020
			TITLE	CHKD	KIRAN A	08.02.2020
			BUS BAR-3 VCB TO ARRES-1	DRWN	AMBIKA HS	08.02.2020
				SCALE		SHEET
1	REVISED & UPDATED	DATE 07.05.2020	BY AMBIKA	1:2.5	1 OF 1	-
			CHKD NAGARAJ			
			APPD SYLAJA			
ALT.No.	ECN NO/CHANGES		DRG No.		ALT	
			BEM BEML LIMITED		525-21277	

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N1	0.025
N2	0.05
N3	0.1
N4	0.2
N5	0.4
N6	0.8
N7	1.6
N8	3.2
N9	6.3
N10	12.5
N11	25
N12	50

GRADE No. VALUE SYMBOL  
 SURFACE ROUGHNESS

MACHINING DEVIATIONS FOR LINEAR DIMENSIONS	RANGE	0 - 6	6 - 30	30 - 120	120 - 315	315-1000	1000-2000	2000-4000	ABOVE 4000	RA
	TOLERANCE	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	~
FOR DIMENSIONAL TOLERANCES OF SHEET METAL PARTS AND WELDED STRUCTURES, REFER STD. RD-227										
UNSPECIFIED TOLERANCE FOR LINEAR AND ANGULAR DIMENSIONS REF. IS 2102 (PT-1) (MEDIUM)								QUALITY OF WELD JOINTS REF. RD 230 MEDIUM		
VALUES OF SURFACE TEXTURE SHALL BE AS PER COMPANY STD DS. 1012.C.										STATUS:
WELDING SHALL BE CARRIED OUT AS PER IS: 9595-96										



**NOTE:—**

- ELECTROLYTIC TOUGH PITCH COPPER TUBE 25.4MM OD x 3 MM WALL THICKNESS, GRADE: CU-ETP (HALF HARD CONDITION-HB) TO SPEC IS: 2501-95 MATERIAL CONFIRMING TO GRADE ETP OF IS: 191-80 (PART 1)
- THE CONDUCTOR TO BE TIN PLATED TO IS-1359-92 SERVICE GRADE NO.3 (SEVERE)
- SUPPLIER SHALL SUBMIT THE TEST CERTIFICATE OF GRADE OF COPPER AS PER IS:191-80 (PART 5)
- ~~INSTALLATION AND HIGH VOLTAGE INSULATION SHOULD BE PROVIDED AS PER PTS GR/TD/4966 TECHNICAL REQUIREMENTS.~~

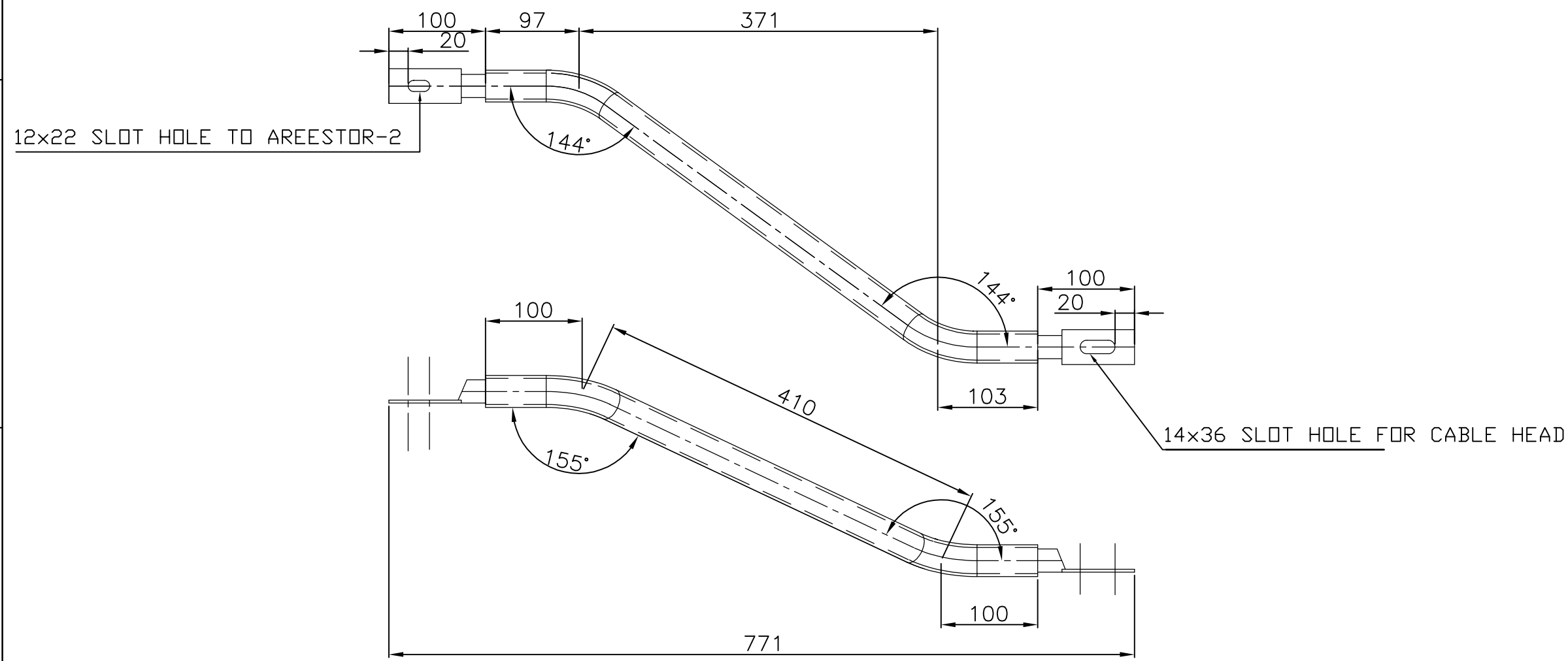
1	1		ETP GRADE COPPER TUBE	Dia 25.4x1100	SEE NOTE	
SL.No.	QTY	PART / STOCK No.	DESCRIPTION	SIZE	COMPANY STD./I.S	Wt. (Kg)
					MATERIAL	
△			PRODUCT	MUMBAI METRO CARS-L2&L7		
△			REF DRG			
△			MATERIAL			
△			HEAT TREAT.	APPD	V SYLAJA	08.02.2020
△			SURFACE TREAT.	REVD	HARISH SN	08.02.2020
△			TITLE	CHKD	KIRAN A	08.02.2020
△			BUS BAR-4 VCB TO CABLE HEAD	DRWN	AMBIKA HS	08.02.2020
1	REVISED & UPDATED	DATE 07.05.2020		SCALE	1:5	SHEET 1 OF 1
ALT.No.	ECN NO/CHANGES	BY AMBIKA	CHKD NAGARAJ	APPD SYLAJA	DRG No.	ALT 1
				<b>BEML LIMITED</b> NEW PRODUCTS - NEW DREAMS		525-21278

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N1	0.025
N2	0.05
N3	0.1
N4	0.2
N5	0.4
N6	0.8
N7	1.6
N8	3.2
N9	6.3
N10	12.5
N11	25
N12	50

GRADE No. VALUE SYMBOL  
 SURFACE ROUGHNESS

MACHINING DEVIATIONS FOR LINEAR DIMENSIONS	RANGE	0 - 6	6 - 30	30 - 120	120 - 315	315-1000	1000-2000	2000-4000	ABOVE 4000	RA
	TOLERANCE	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	~
FOR DIMENSIONAL TOLERANCES OF SHEET METAL PARTS AND WELDED STRUCTURES, REFER STD. RD-227										
UNSPECIFIED TOLERANCE FOR LINEAR AND ANGULAR DIMENSIONS REF. IS 2102 (PT-1) (MEDIUM)								QUALITY OF WELD JOINTS REF, RD 230 MEDIUM		
VALUES OF SURFACE TEXTURE SHALL BE AS PER COMPANY STD DS. 1012.C.										STATUS:
WELDING SHALL BE CARRIED OUT AS PER IS: 9595-96										



**NOTE:—**

- ELECTROLYTIC TOUGH PITCH COPPER TUBE 25.4MM OD x 3 MM WALL THICKNESS, GRADE: CU-ETP (HALF HARD CONDITION-HB) TO SPEC IS: 2501-95 MATERIAL CONFIRMING TO GRADE ETP OF IS: 191-80 (PART 1)
- THE CONDUCTOR TO BE TIN PLATED TO IS-1359-92 SERVICE GRADE NO.3 (SEVERE)
- SUPPLIER SHALL SUBMIT THE TEST CERTIFICATE OF GRADE OF COPPER AS PER IS:191-80 (PART 5)
- INSTALLATION AND HIGH VOLTAGE INSULATION SHOULD BE PROVIDED AS PER PTS GR/TD/4966 TECHNICAL REQUIREMENTS.

1	1		ETP GRADE COPPER TUBE	Dia 25.4x900	SEE NOTE	
SL.No.	QTY	PART / STOCK No.	DESCRIPTION	SIZE	COMPANY STD./I.S	Wt. (Kg)
					MATERIAL	
			PRODUCT	MUMBAI METRO CARS-L2&L7		
			REF DRG			
			MATERIAL			
			HEAT TREAT.	APPD	V SYLAJA	08.02.2020
			SURFACE TREAT.	REVD	HARISH SN	08.02.2020
			TITLE	CHKD	KIRAN A	08.02.2020
			BUS BAR-5_CABLE HEAD TO ARRESTOR-2	DRWN	AMBIKA HS	08.02.2020
				SCALE	1:5	SHEET 1 OF 1
1	REVISED & UPDATED	DATE 07.05.2020	BY AMBIKA	CHKD NAGARAJ	APPD SYLAJA	
ALT.No.	ECN NO/CHANGES					
<b>BEML LIMITED</b> <small>NEW PROGRESS - NEW DREAMS</small>				<b>525-21279</b>		