DRAFT FUNCTIONAL REQUIREMENT SPECIFICATION (FRS)
NUMBER: TI/SPC/OHE/MCA/0230

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

DRAFT FUNCTIONAL REQUIREMENT SPECIFICATION (FRS) FOR MODULAR CANTILEVER ASSEMBLY (MCA) FOR 25 KV AC TRACTION

(For official use only)

ISSUED BY

TRACTION INSTALLATION DIRECTORATE
RESEARCH DESIGN AND STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW 226 011
(INDIA)

INDEX

DRAFT FUNCTIONAL REQUIREMENT SPECIFICATION (FRS)
FOR
MODULAR CANTILEVER ASSEMBLY (MCA)
FOR
25 kV A.C.TRACTION

1.0 SCOPE:

1.1 In 25kV Over Head Traction System, **Modular Cantilever Assembly** supports both the main conductors and is more or less pivoted to the structures, capable of swivelling along the track as well as adjustable in transverse direction. This assembly holds the following OHE configurations: -

(a) Type- I: OHE configuration of 65 mm² Cd-Cu catenary wire/65 mm² Mg-Cu catenary wire & 107mm² Hard Drawn Grooved Copper Contact Wire/Hard Drawn Grooved Silver Bearing Copper Contact Wire with maximum **1200** kgf in each conductor (catenary wire/contact wire).
(b) Type- II: OHE configuration of 125 mm² Cd-Cu catenary wire/125 mm² Mg-Cu Catenary Wire & 150 mm² HDGC Contact Wire with maximum tension of Maximum **1500** kgf in each conductor (catenary wire/contact wire).

Simple polygonal design/profile of contact wire shown in drawing attached as **Annexure-I** & a schematic diagram of bracket assembly is placed at **Annexure-II**. Similar design of Modular Cantilever Assembly (**triangular type**) as shown in **Annexure-II** with less number components, light in weight and easy to install shall be accepted only.

1.2 This specification covers the requirement of "Modular Cantilever Assembly" (henceforth referred as MCA)" to suit the foot print dimensions on OHE masts/portals and insulator end fittings (mast/portal side) that exists on Indian Railway's 25kV ac traction network. Drawings of assembly and its components of Existing Cantilever Assembly are given in **Annexure-III.**

1.3 MCA shall consist of **cantilever tubes**, suitable **mast attachment fittings**, 25kV **porcelain** bracket & stay insulators with CD 1050mm and **composite** insulators with CD 1600mm, catenary wire suspension system, steady arm and other components & assemblies essentially required to support the overhead conductors for smooth current collection, without hard spots.

1.4 This FRS covers the requirement of field trials of MCA on the nominated section of Indian Railways at a maximum operational speed up to 200kmph & design speed up to 220 kmph/maximum available speed in IR for that section for minimum six months period. The device shall be put for field trial of Modular Cantilever System including the overlap, crossover and turn out in one tension length to observe its performance.

1.5 As the requirements are defined for development of the Modular Cantilever Assembly, better specification/parameters may be accepted for trial/testing by Indian Railways. Deviation in the specified parameters may also be considered by Indian Railways on merit and mutual agreement basis. However, manufacturers must note that once the product is developed and stabilized, Indian Railways reserve the right to freeze/ standardize any particular design or may provide its own design which shall be binding on all the manufacturers.

2.0 GOVERNING SPECIFICATIONS: In preparation of this specification, reference has been made to the following specification:

1.	IS **:** 1285**-**2002	Specification for wrought aluminium and aluminium alloys, extruded round tube and hollow sections (of general engineering purposes) **.**
2.	IS **:** 2673-2002	Specification for Dimensions for wrought aluminium and aluminium alloys, extruded tube (round) **.**
3.	IS:4711-2008	Methods for sampling of pipes, tubes and fittings.
4.	IS :504-1963	Methods of Chemical Analysis and its alloy
5.	IS:1608-2005	Mechanical Testing of Metals-Tensile Testing
6.	IS:5052-1993	Aluminium & its Alloy - Temper Designation
7.	IS: 6051-1970	Code for Designation of Aluminium & its Alloy
8.	ASTM B221M	Standard Specification for Aluminum-Alloy Extruded Bar, Rod, wire, Profiles and Tube (Metric)
9.	ASTM B317/B317M – 07	Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)
10.	ASTM B557	Tension testing of wrought and cast aluminum & magnesium alloy products
11.	ASTM E-155-00 (2005)/DIN EN VDE 0216	Reference for Radiographs for inspection of Aluminum & Magnesium castings.
12.	TI/SPC/OHE/INS /0071	Specification for solid core porcelain insulators for 25kV, a.c. 50Hz Over head traction lines.
13.	TI/SPC/OHE/INS COM/1072	Specification for composite insulator for 25kV, a.c. 50Hz Over head traction lines.
14.	TI/SPC/OHE/FA STNERS/0120 (Rev.01)	Specification for Steel Fasteners & Stainless Steel Fasteners for 25 kV A.C. Traction Overhead Equipment
15.	TI/SPC/OHE/FITT- INGS/0130, Rev1	Technical specification for 25 kV AC OHE Fittings
16.	EN 12165/ ASTM B124	Specification for Copper and Copper Alloy Forging Rod, Bar & Shapes
17.	EN 1706/ASTM B 85	Specification for Aluminium Alloy Die Castings

3.0 ENVIRONMENTAL REQUIREMENTS: The MCA shall be used in varying atmospheric and climatic conditions as tabulated below.

i)	Ambient air temperature	-15^0C to (+)65^0C
ii)	Maximum temperature of metallic object in sun.	70^0C
iii)	Minimum Temperature	(-) 15°C
iv)	Maximum relative humidity	100%
v)	Annual rainfall	Dry Arid regions and also heavy monsoon affected regions with rainfall ranging from 1750 to 6250 mm
vi)	Maximum number of Thunder storm days per annum	85
vii)	Maximum number of Dust storm days per annum	35
viii	Number of Rainy days per annum.	120
ix)	Basic wind pressure	216 kgf/m^2
x)	Altitude	1000m/above 1000m height from sea level. Note -The Electrical Parameters above 1000 meter altitude are increased due to changes in Environmental altitude, Insulators shall be designed considering altitude correction factor for Electrical parameters in line with the stipulations given in IEC: 60071-2.
xi)	Corrosion	Heavy corrosion prone areas, saline environment

4.0 GENERAL & TECHNICAL REQUIREMENTS:

4.1 GENERAL REQUIREMENTS:

(i) The design of Modular Cantilever Assembly shall be frozen based on proven design, FEA analysis, less number components, light in weight and easy to install.

(ii) All fittings and fasteners shall be suitable for connection to the existing OHE mast and portals.

(iii) Modular Cantilever Assembly shall be suitable for maximum span length of **72** m for maximum operational speed up to 200 kmph.

(iv) All components of MCA shall be freely inter-changeable with each other.

(v) MCA shall be able to take vibrations due to wind and passage of trains and at times to impact loading in case of breakage of OHE conductors/Insulators during their life span.

(vi) The MCA shall be suitable for maximum tension length 1500 m of overhead equipment. An anti-creep is provided at middle of the tension length.

(vii) MCA shall be corrosion resistant to withstand the polluting & corrosive atmosphere such as in the coastal areas, in the vicinity of chemical plants and diesel loco sheds etc. Material specification should fulfil these requirements.

(viii) Manufacturer's monogram and Identification Number shall be engraved on parts of MCA as per the relevant drawings.

4.2 TECHNICAL REQUIREMENTS:

(i) Design Validation: Safety of MCA to be validated through FEA analysis for maximum Basic Wind Pressure 216 kgf/m² & for maximum design speed 220 kmph. FEA analysis should be submitted by Vendors after finalization of drawings of MCA.

(ii) Drawings:

Drawings of MCA (Plan & Elevation) shall be finalized by RDSO after consultation with manufacturers/vendors . Draft drg. are attached as annexure IV.

(a) Stay & Bracket tubes
(b) Stay & Bracket Insulators with end fittings for Stay & Bracket tubes.
(c) Fittings
(d) Fasteners

(iii) RDSO's Specification:

(a) Stay & Bracket tubes: The testing of Stay & Bracket tubes shall meet the requirement of IS/EN as mentioned in RDSO approved drawings of MCA.
(b) Stay & Bracket Insulators: The material/testing of Insulators shall meet the requirement of RDSO specification No. TI/SPC/OHE/INS/0071 for porcelain insulator with minimum creepage distance 1050m and specification No. TI/SPC/OHE/INSCOM/1072 for Composite Insulators with minimum CD 1600 mm.
(c) MCA Fittings: The testing of fittings shall meet the requirement of requirement of IS/EN as mentioned in RDSO approved drawings of MCA.
(d) Fasteners: The material/testing of fasteners shall meet the requirement of IS/EN as mentioned in RDSO approved drawings of MCA.

(iv) Material Specification:

Material specification of MCA components shall be as per RDSO's drawings. A list of RDSO drawings/components with material & standards are mentioned in **Annexure-IV.**

5.0 INSPECTION & TESTING:

5.1 MCA shall be inspected and tested by the Director General/TI [DG/TI]/RDSO, Lucknow or his authorized representative at the firm's work. All the proto type tests specified in clause 5.4 shall be carried out at the manufacturer's works. The firm shall arrange, without making any claim or charges, all the necessary machinery, apparatus, labour and assistance required to get the specified tests conducted in the presence of purchaser's representative. If certain facilities are not available for the tests, manufacturer may arrange these tests outside at Government approved Laboratories. The charges for these tests shall be borne by the manufacturer. After successful prototype Inspection & Testing, MCA shall be subjected to Field Trial **as per clause 1.4.**

5.2 Before giving call to RDSO for prototype testing of MCA, the manufacturer shall submit ITRs (Internal Test Reports of each part of MCA) for approval and detailed test schedule consisting of the details of each test and nature of the test, venue of the test and the duration of each test and the total number of days required to complete the test at one stretch. Once the test schedule is approved, the test shall invariably be done accordingly.

5.3 In case, any dispute or disagreement arises between the manufacturer and RDSO/Purchaser during the process of testing, as regards to the type test and /or the interpretation and acceptability of the type test results, it shall be brought to the notice of DG/TI/RDSO, whose decision shall be final and binding.

5.4 TESTS:

5.4.1 The following type tests shall be conducted on MCA:

SN	TEST	TYPE TEST	ACCEPTENCE TEST	ROUTINE TEST	Clause No. / Standard / Drawings
1.0	Visual examination	Y	Y	Y	Cl.6.1
2.0	Verification of dimensions	Y	Y	Y	As per RDSO Drawings
3.0	Chemical composition test	Y	Y	Y	As per relevant specification/ Standards
4.0	Radiographic Testing of fittings	Y	Y	Y	Cl.6.2
5.0	Inter-changeability test (fittings & tubes)	Y	Y	Y	Cl.6.3
6.0	Physical properties & failing load test for fittings & tubes	Y	Y	Y	Cl.6.4
7.0	Insulators testing	Y	Y	Y	Cl.4.2(iii)(b)
8.0	Test on Fasteners/fittings	Y	Y	Y	Cl. 4.2(iii)(c)&(d)
9.0	Peak and Short Time Withstand Current Test of Cantilever Components	Y	N	N	Cl.6.5

5.5 Sampling for type test:

a) Three set of each fitting & tubes used in MCA shall be produced by the manufacturer, on which test as per clause 5.4 shall be carried out for ascertaining their conformity to the requirements of this specification.

b) The lot which has been found satisfactory in visual examination shall be tested for dimensional characteristics. Any items failing to meet one or more dimensional requirements shall be considered unsatisfactory. All the samples in the lot may be inspected for dimensional characteristics and the defective ones be removed, if agreed by the purchaser. The lot shall then be tested for the remaining tests. Any item failing to meet the requirement of tests, shall be considered as defective.

5.6 ACCEPTANCE & ROUTINE TESTS: The manufacturer shall carry out the specified tests, during production, on the samples taken at regular intervals, to ensure conformity to relevant specifications as also to maintain proper control over the process of manufacture. The manufacturer shall maintain the frequency of the various tests and shall produce a certificate at the time of inspection, showing the frequencies of various inspections/tests which have been exercised during production.

6.0 TEST METHODS:

6.1 **Visual examination:-**All components of modular cantilever Assembly shall be visually examined as per RDSO's Specifications and Drawings. Components made by casting process shall have clean finish and free from cracks, surface flaws, harmful inclusions, blow holes etc. No repair shall be done to the castings to hide defects. MCA shall also be checked for identification nos. and firms monogram, as mentioned in the relevant drawings.

6.2 **Radiographic Test :** All cast components shall subjected to radiography as per ASTM E-155-00(2005)/DIN EN VDE 0216 or relevant standards and shall satisfy the RDSO Specification No. TI/SPC/OHE/Fittings/0130(10/13).

6.3 **Interchangeability test:** If the components (fittings/tubes) of one Modular cantilever are able to fit in place of components of other cantilever, randomly selected, without any further modifications for inter-changeability and ease in erection & maintenance and MCA

so made meet the requirements of clause 6.3, the requirement of this test shall be deemed to have been complied with.

6.4 **Physical properties and failing load test:** The tensile strength, yield stress and percentage elongation shall be determined in accordance with methods specified in ASTM B-557 or relevant standards and shall not be less than the values specified for the Grades given in RDSO drawings. Bending test shall be conducted in accordance with ASTM B 317 or relevant standards. Calculation for permissible stresses along with the copy of relevant standard shall be submitted.

6.5 **Peak and Short Time Withstand Current Test of Cantilever Components**: Peak and Short Time Withstand Current Test of Cantilever Components shall be conducted as per EN 50119 Standard.

7.0 CRITERIA FOR ACCEPTANCE OF FINISHED PRODUCT:

a) Lot shall be made **from** the same production batch. Three modular assemblies from each batch shall be selected at random from the offered lot (not more than 100 nos.) for tests. Samples from three selected units shall be subjected to the tests as specified above.

b) If any sample fails to comply with any test(s) specified in this specification, test(s) shall be repeated on three samples, taken from the same batch but limited to the test(s) in which failure occurred. If in the retest(s) any sample fails, the batch represented by the sample shall be deemed not to comply with specification and the complete batch shall be rejected.

c) Only after clear written approval of the results of tests on the prototype is communicated by the DG/TI/RDSO to the manufacturer, he shall take up bulk manufacture of MCAs which shall be strictly with the same material and process as adopted for the prototype.

8.0 PACKING AND MARKING: Part identification No., Manufacturers monogram and month/year of manufacture shall be marked on each part of the MCA. The modular cantilever system complying with this specification shall be properly packed, duly assembled, in strong wooden boxes so as to avoid damage during transit. The box shall carry on its outer face the following information.

a)	Manufacturer's name	b)	Content details (Part Name, Part No. & Quantity)
c)	Net and gross weight	d)	Production batch number
e)	Contract number and consignee	f)	Any other particulars specified by the purchaser.
g)	Inspector's stamp and seal on components & box	h)	Date of inspection

9.0 RELIABILITY:

a) MODULAR CANTILEVER ASSEMBLY as a unit is expected to provide reliable service for at least 40 years irrespective of polluting & corrosive atmosphere such as in the coastal areas, in the vicinity of chemical plants and diesel loco sheds etc.

b) The manufacture shall, therefore, ensure that the system supplied including all parts and components etc. used are free from manufacturing defect. MCA shall be of highest quality and in conformity with the specification.

10.0 MAINTAINABILITY:

10.1 Manufacturer will submit to RDSO the requirements of maintenance.

10.2 The manufacturer shall provide the services of competent engineers at own expense during the warranty period for any manufacturing and design defects and also to impart instructions for regular service and maintenance.

10.3 The manufacturer shall furnish list of recommended spares, tool & plants for proper

upkeep and trouble free service of MCAs.

10.4 An undertaking that spares shall be made available during the service life (40years) of MCAs.

11.0 WARRANTEE: The manufacturer shall provide warrantee for satisfactory performance of MCA for a period of 30 months from date of supply & 24 months from the date of commissioning, whichever is earlier or IRS term & conditions.

12.0 All the provisions contained in RDSO's ISO procedures laid down in document No.-QO-D-8.1-11, Version 2.6 dated 07.07.2023 (Titled " Vendor- changes in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor//vendors in the contracts floated by Railways to maintain quality of products supplied to Railways"

13.0 Modular cantilever should be compatible with Pantographs used in India Railways as given in **Annexure-V.**

14.0 The "Make in India" policy of Government of India shall be applicable.

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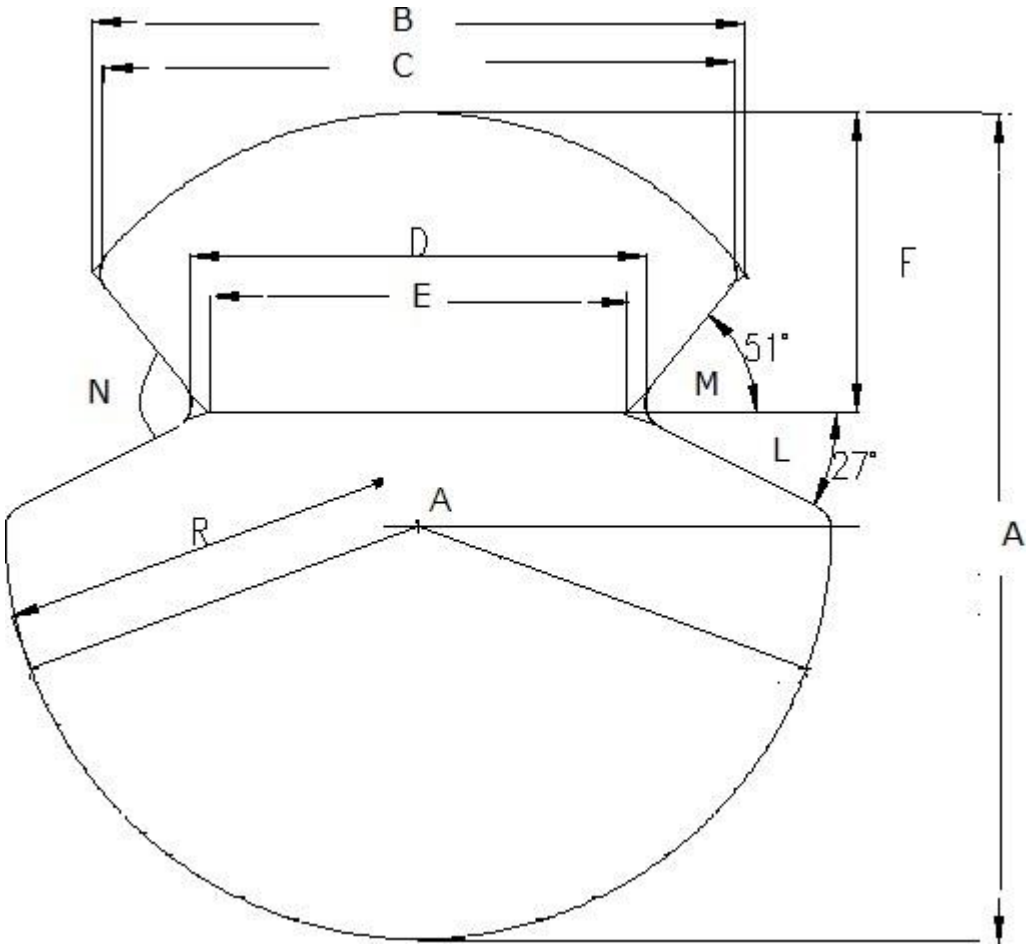
Annexure-I

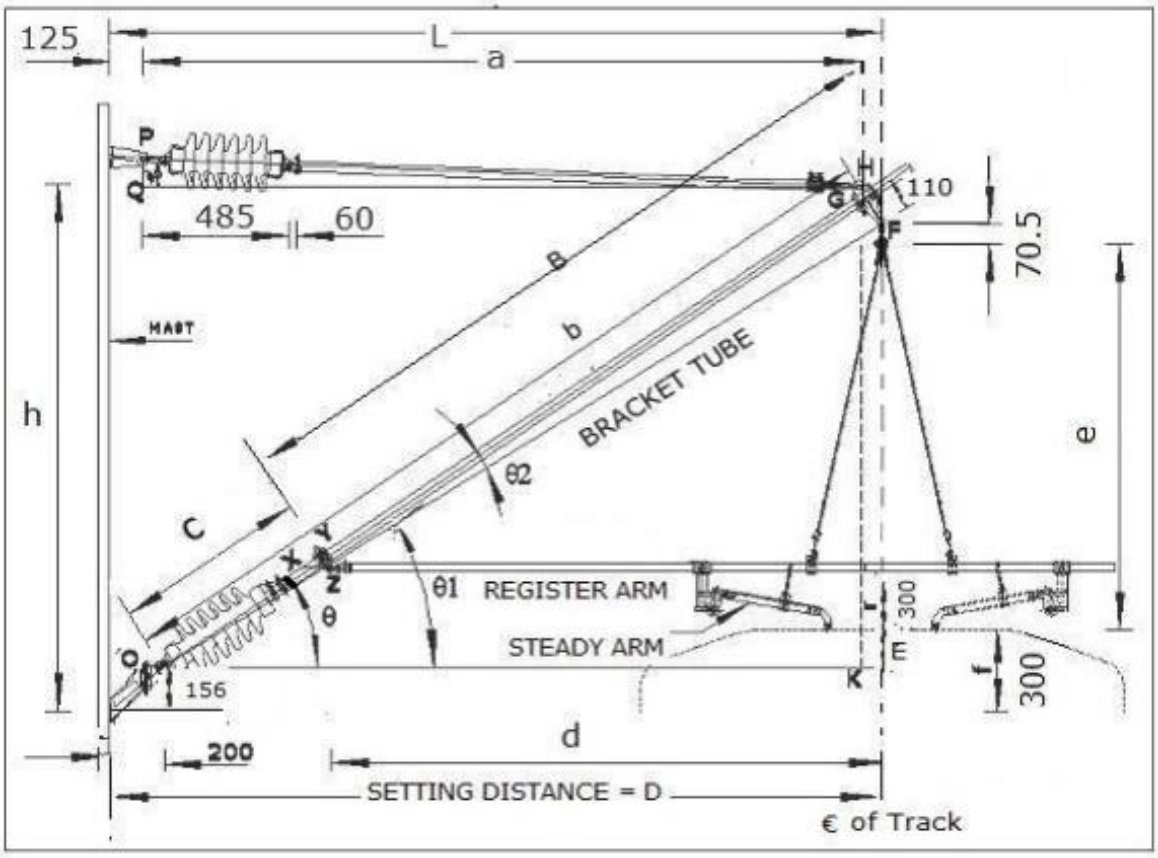
Contact wire profile



Cross Section of Contact Wire (mm^2)	Dimensions (mm)						Dimensions (Degree)		
	A	B	C	D	E	F	L	M	N
107	12.24±0.16	-	-	6.92±0.15	6.50	4.43	27(+1,-0)	51(+1,-0)	78(+2,-0)
150	14.50±0.20	-		6.92±0.15	6.50	4.00	27(+1,-0)	51(+1,-0)	78(+2,-0)
161	15.00±0.15	12.2	12.0 ±0.25	8.50(+0.18-0.30)	8.10	5.75	27(+2,-0)	51(+2,-0)	78(+3,-0)
193	16.40±0.15	12.2	12.0±0.25	8.50(+0.18-0.30)	8.10	5.3	27(+2,-0)	51(+2,-0)	78(+3,-0)

Annexure-II

EXISTING CANTILEVERASSEMBLY



a Distance between the Mast Stay Arm Fitting (Top Attachment) and the centre of Hook of Catenary Suspension Bracket.

b Distance between the Vertical Axis of the Mast Bracket Swivel and the axis of the Catenary Suspension Bracket.

c Distance from the bottom Cap of Bracket Insulator to the axis of the Register Arm Hook.

d Horizontal distance between the centre of the Register Arm Hook and the vertical axis of Catenary Suspension.

e Encumbrance

Distance between the axis of Catenary and Contact wires. It is normally kept 1400 mm.

f Distance between Contact Plane and Mast Bracket Fitting. It is normally 300 mm.

L Suspension Distance

Horizontal distance from the extreme face of Mast Stay-Arm Fitting to the Suspension point of Catenary wire. This is different from Setting Distance to the extent of stagger of Catenary Clamp and thickness of Multiple Cantilever Cross Arm or Extension Chairs, if provided.

r Distance between the Contact Plane and the Register Arm axis (including Raised Register Arm) - which is assumed to be horizontal. It is normally 300 mm for the running Contact Plane.

θ Inclination of Bracket tube to the horizontal (as indicated) $\theta = \theta_1 + \theta_2$. It is generally 38°. Thus the Mast Bracket Fitting axis has an inclination of 38° to horizontal.

Annexure-III

Details of existing Cantilever assembly vis-a-vis Modular cantilever system components:

SN	Existing components			MCA components		
	Name of fitting	**Part No.**	**Material**	**Name of fitting**	**Material**	**Standard**
1	Tube, Standard(29.9/38)/ Large(40/49)		Hot Dip Galv. Steel	Support tube	Aluminum alloy	IS:1285 or its Equivalent Specification (EN/IEC/BS etc.)
2	Contact wire swivel clip	1220	Al. Bronze	Contact wire clamp complete	CuNi2Si (Copper Nickel Silicon)	EN 12165 or its Equivalent specification (EN/IEC/BS etc.)
3	Suspension clamp	1160	-do-	Suspension clamp	Aluminium alloy/Al. Bronze	TI/SPC/OHE/Fittings/0130(10/13) or its equivalent specification. (EN/IEC/BS etc.)
4	Double suspension clamp	1170	-do-			
5	Standard catenary suspension bracket.	2110-1	-do-	Standard catenary suspension bracket		
6	Standard catenary suspension bracket bottom.	2111	-do-			
7	Standard catenary suspension bracket top	2112	-do-			
8	Large catenary suspension bracket.	2130	-do-	Large catenary suspension bracket		
9	Large catenary suspension bracket top.	2131	-do-			
10	Large catenary suspension bracket bottom.	2132	-do-			
11	Large catenary suspension bracket.	2130-1	MCI			
12	25mm steady arm clamp	2490-2	MCI	Steady arm clamp	Aluminium Alloy	TI/SPC/OHE/Fittings/0130(10/13) or its equivalent specification. (EN/IEC/BS etc.)
13	Steady rod piece	2341	Steel Galv.	Steady arm single bended		
14	Steady rod eye piece	2345	Al. Bronze			
15	Tubular stay adjuster.	2402	Steel Galv.			
16	Raised register arm adjuster 25 mm	2432	Steel Galv.			
17	BFB steady arm assembly	2390	Arm-Alu Hook-MCI/Swivel-Steel Galv. MCI			
18	25mm drop bracket assembly	2360		Drop bracket assembly	Aluminum alloy Stainless steel (pipe)	TI/SPC/OHE/Fittings/0130(10/13) or its equivalent specification. (EN/IEC/BS etc.)
19	Mast fitting for hook insulator.	3021	-do-	Mast fitting assembly	Aluminium Alloy	TI/SPC/OHE/Fittings/0130(10/13) or its equivalent specification. (EN/IEC/BS etc.)

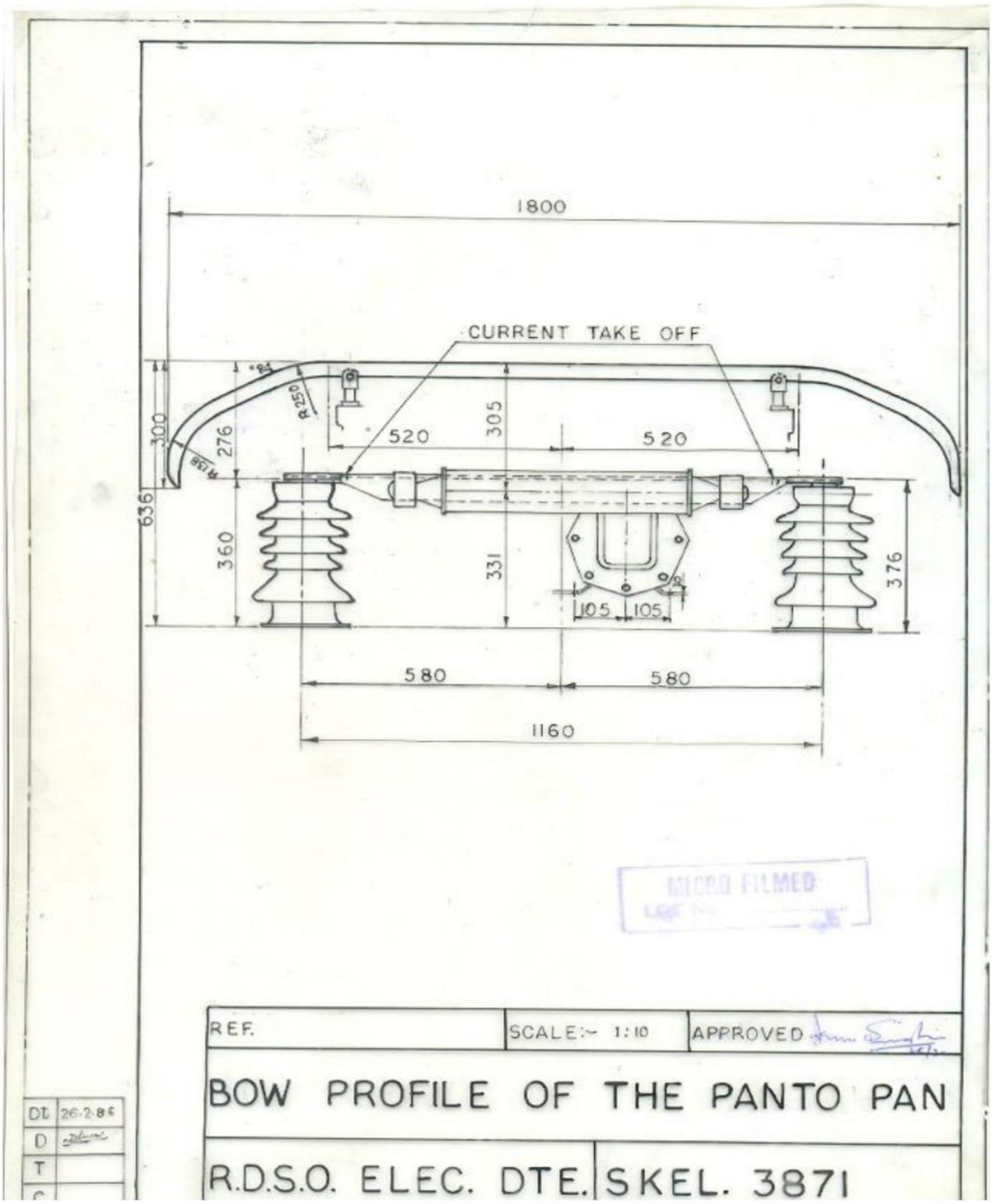
Annexure-IV

LIST OF ASSEMBLY DRAWINGS & COMPONENTS FOR MCA

SN	Drawing Name	Type	Drawing No
Assembly Drawings:			
1	MCA PULLOFF - PUSH OFF (TANGENT/CURVED TRACK) (BFB TYPE)	Assembly	TI/DRG/OHE/MCA/000X1/23/0
	MCA ASSEMBLY ON CURVED TRACK PULL OFF - PUSH OFF ~~(ON OUT SIDE CURVED)~~(TUBLER TYPE)	Assembly	TI/DRG/OHE/MCA/000X2/23/0
	MCA OUT OF RUNNING ASSEMBLY	Assembly	TI/DRG/OHE/MCA/000X3/23/0
	MCA ASSEMBLY ON OVERLAP FOR SINGLE CANTILEVER	Assembly	TI/DRG/OHE/MCA/000X4/23/0
	MCA ASSEMBLY ON OVERLAP PULL OFF - PUSH OFF (MULTIPLE TRIPLE CANTILEVER)	Assembly	TI/DRG/OHE/MCA/000X5/23/0
	MCA ASSEMBLY ON RAIL LEVEL PLATFORM PULL OFF - PUSH OFF	Assembly	TI/DRG/OHE/MCA/000X6/23/0
	MCA ASSEMBLY ON HIGH LEVEL OR LOW LEVEL PLATFORM (PULL OFF - PUSH OFF)	Assembly	TI/DRG/OHE/MCA/000X7/23/0
	MCA ASSEMBLY ON TRAMWAY TYPE	Assembly	TI/DRG/OHE/MCA/000X8/23/0
	MCA ASSEMBLY FOR BOX TYPE ARRANGEMENTS	Assembly	TI/DRG/OHE/MCA/000X9/23/0
Components Drawings:			
I	MAST BRACKET ASSEMBLY	Sub Assembly	TI/DRG/OHE/MCA/000X10/23/0
II	REGISTER ARM CLEVIS	Sub Assembly	TI/DRG/OHE/MCA/000X11/23/0
III	DOUBLE TUBE HOLDER	Sub Assembly	TI/DRG/OHE/MCA/000X12/23/0
IV	CATENARY WIRE HOLDER CLAMP	Sub Assembly	TI/DRG/OHE/MCA/000X13/23/0
V	HOOK EYE FOR 70 MM TUBE	Sub Assembly	TI/DRG/OHE/MCA/000X14/23/0
VI	THREADED CLEVIS ASSEMBLY FOR 42 MM TUBE	Sub Assembly	TI/DRG/OHE/MCA/000X15/23/0
VII	DROP BRACKET	Sub Assembly	TI/DRG/OHE/MCA/000X16/23/0
VIII	ASSEMBLY EYE JOINT	Sub Assembly	TI/DRG/OHE/MCA/000X17/23/0
IX	BFB STEADY ARM	Sub Assembly	TI/DRG/OHE/MCA/000X18/23/0
	NORMAL BENT STEADY ARM	Sub Assembly	TI/DRG/OHE/MCA/000X18-1/23/0
X	ANTI WIND STAY CALMP ASSEMBLY	Sub Assembly	TI/DRG/OHE/MCA/000X19/23/0
XI	ASSEMBLY SUPPORT FOR REGISTRATION TUBE	Sub Assembly	TI/DRG/OHE/MCA/000X20/23/0
XII	HOOK CLIP ASSEMBLY	Sub Assembly	TI/DRG/OHE/MCA/000X21/23/0
XIII	REGISTER ARM DROPPER	Sub Assembly	TI/DRG/OHE/MCA/000X22/23/0
XIV	ANTIWIND STAY WIRE	Sub Assembly	TI/DRG/OHE/MCA/000X23/23/0
XV	BRACKET AND SWIVEL WITH CLEVIS ASSEMBLY	Sub Assembly	TI/DRG/OHE/MCA/000X24/23/0
XVI	MCA TUBES	Component	TI/DRG/OHE/MCA/000X25/23/0
XVII	STAGGER SUPPORTASSEMBLY (OOR)	Sub Assembly	TI/DRG/OHE/MCA/000X26/23/0
XVIII	TUBE CAP FOR 55 MM TUBE	Component	TI/DRG/OHE/MCA/000X27/23/0
XIX	TUBE CAP FOR 70 MM TUBE	Component	TI/DRG/OHE/MCA/000X28/23/0
XX	STAY INSULATOR (Porcelain)	Sub Assembly	TI/DRG/OHE/MCA/000X29/23/0
	STAY INSULATOR (Composite)	Sub Assembly	TI/DRG/OHE/MCA/000X29-1/23/0
XXI	BRACKET INSULATO(Porcelain/Composite)	Sub Assembly	TI/DRG/OHE/MCA/000X30/23/0
	BRACKET INSULATO(Porcelain/Composite)	Sub Assembly	TI/DRG/OHE/MCA/000X30-1/23/0

BOW PROFILE OF P**ANTO PAN 1800MM WIDE**

Annexure-V



PANTO PAN PROFILE OF 2030MM WIDE BOW