

**ANNEXURE – 1 (LIST OF DRAWINGS & DOCUMENTS)**

<b>Project :</b>	<b>Punatsangchhu-II Hydro-Electric Project (6x170 MW), Bhutan</b>  <b>400kV Pothead Yard</b>
<b>Customer :</b>	<b>Punatsanchhu Hydroelectric Project Authority</b>
<b>Consultant :</b>	<b>CEA &amp; Wapcos</b>

<b>Drawing/Doc No.</b>	<b>Drawing Title</b>
TB-1-365-316-001	LAYOUT PLAN AND SECTION FOR 400KV POTHEAD YARD
TB-4-365-318-006	400kV - EQUIPMENT EARTHING PHILOSOPHY & DETAILS
ANNEXURE-A	LIST OF MANDATORY SPARES
ANNEXURE-B	PROCEDURE FOR WELDING OF ALUMINIUM BUSES
ANNEXURE-E1	SPECIFICATION FOR CABLE GLANDS
ANNEXURE-E2	SPECIFICATION FOR AL. TUBE
ANNEXURE-E3	SPECIFICATION FOR GI PIPE & Accessories
ANNEXURE-E4	SPECIFICATION FOR ERECTION HARDWARE
ANNEXURE-E5	SPECIFICATION FOR GI FLAT
ANNEXURE-E6	SPECIFICATION FOR ACSR MOOSE CONDUCTOR
ANNEXURE-E7	SPECIFICATION FOR GI EARTH WIRE
ANNEXURE-E8	SPECIFICATION FOR CABLE TRENCH MATERIAL
ANNEXURE-C	PROJECT DETAILS

## LIST OF MANDATORY SPARES FOR PUNATSANGCHHU-II

## ANNEXURE - A

Sl.No.	Item Description	Unit	Quantity
<b>LIST OF MANDATORY SPARES</b>			
1a	Spares for 400kV, 2000A HDB Isolator: Main & auxiliary contactors for Isolators & Earth Switches	Set	1
1b	Spares for 400kV, 2000A HDB Isolator: Switches for Isolators & Earth Switches	Set	1
2	390kV, 10kA, Class-III, 1ph, 50 Hz, station type, heavy duty, metal oxide, gapless Lightning Arrestors without support structure but with terminal clamp/connector	Nos.	5
3	400kV, 2000-1000/ 1A, 1ph, oil immersed, self cooled hermetically sealed, 5 core CTs suitable for outdoor installation with terminal connectors but without support structure	Nos.	5
4	400kV, 1ph, oil immersed, self cooled hermetically sealed, CVTs suitable for outdoor installation with terminal connectors but without support structure	Nos.	5
5	400 kV, 6 kN Post Insulator without support structure & terminal clamp/connector		
a	- Insulators for Isolators (Without corona ring)	Nos	9
b	- Insulators for Wave trap (Without corona ring)	Nos	3
c	- Insulators for bus support (With corona ring)	Nos	3
6	400kV, 2000A, 1mH, 1ph, 50kA for 1 sec, 50 Hz pedestal type Wave trap without support structure & insulator but with terminal clamp/ connector.	Nos	3
7	Clamp & Connector for 400kV Pothead yard (of each type & rating)	Nos.	30
8	Disc & String Insulator Hardware		
a	Tension insulator string with double/single anchoring point , string comprising 2X25 nos. disc with hardware set with all accessories including tension clamp with/ without Turn Buckle set suitable for twin/quad conductor.	Set	3
b	Suspension insulator string comprising 1X25 nos. disc with hardware set with all accessories including drop/through type suspension clamp suitable for single/twin/quad conductor.	Set	3
c	Tension insulator string with double/single anchoring point , string comprising 1X25 nos. disc with hardware set with all accessories including tension clamp with/ without Turn Buckle set suitable for twin/quad conductor.	Set	3

## **2.0 SCOPE**

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Cable Glands. No deviation from the requirements specified in various clauses of this specification shall be allowed.

The actual cable data as guaranteed by the cable supplier will be furnished separately. However, for exact measurements, supplier should contact site for cable samples. The final supply shall be made based on actual cables supplied at site.

## **2.1 SPECIFIC TECHNICAL REQUIREMENT**

Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality.

Required number of packing glands to close unused openings in gland plates shall also be provided.

The glands shall be dust proof, screw on type, shrouded complete with necessary armour clamp and tapered washers etc.

**The glands shall have provision for securing armour of the cable separately and shall be provided with earthing tag.**

## **2.2 TEST**

All valid test reports as per relevant standard shall be furnished including Proof Torque Test, Tensile Test, Seal Test and Electrical Continuity Test as per BS 6121. Cable glands shall also be tested for dust proof and weather-proof termination. Bidders shall submit valid reports of type tests carried out within five years of bid opening. These reports should have been conducted on identical / similar equipment to those offered. In case less than five years old type test reports OR valid type tests are not furnished, the tests shall be conducted free of charge. No separate type test charges shall be paid.



# BHARAT HEAVY ELECTRICALS LIMITED

## TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-xxx-316-055	Rev no.-00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	MLK	SKS	RS
TITLE <b>RATE CONTRACT FOR ALUMINIUM TUBE</b>		SIGN	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
		DATE	22/09/14	22/09/14	23/9/14
		GROUP	TBEM	W.O. No	
CUSTOMER/ CONSULTANT					
PROJECT					

### CONTENTS

Sec. No.	Description	No. of Sheets
1.	Scope, Specific Technical Requirement and Quantities	2
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3.	Project Details & General Specifications	8
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5.	Check list ( To be filled during tender stage)	1
6.	Quality Plan	1

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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS
Distribution			To Copies		TBQM TBCM
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**SECTION – I**

**SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES**

**1.0 SCOPE**

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of ALUMINIUM TUBE.

The equipment is required for the following project.

Name of the customer :

Name of the Project :

The specification comprise of following sections:

Section-1 Scope, Specific Technical Requirements & quantities.

Section-2 Equipment Specification

Section-3 Project Details & General Specifications

Section-4 Guaranteed & Technical Particulars.

Section-5 Checklist (to be filled during tender stage)

Section-6 Quality Plan

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

**1.1 (A) BILL OF QUANTITY**

Sl. No.	Description	Quantity
1	ALUMINIUM TUBE 4" IPS (EH type)	450 m

**Note:-** 5% of the above mentioned quantities of every type & size of Aluminum Tube shall be considered for Export Projects. Export-worthy packing for the Export Projects has to be provided by the vendor.

**1.2 (B) TECHNICAL SPECIFICATION REQUIREMENT FOR PRE-QUALIFICATION CRITERIA**

- 1) The manufacturer should have manufactured & supplied at least 60MT of Aluminium Tube of **3 inch or higher size** in India in any one year during the last five years from the date of technical bid opening.
- 2) The manufacturer should have manufactured and supplied Al. tube upto 4.5” size.
- 3) Bidder shall be manufacturer of Aluminium Tube.

**1.3 (C) TYPE TEST CHARGES (OPTIONAL)**

The bidder has to quote type test charges for the following type tests. Conduction of these type test is optional and shall be as per the requirement of particular contract. If required, then these should have been conducted in NABL accredited Laboratory. The sample used for type testing shall be in the scope of bidder.

- 1) RIV Test.
- 2) Corona Inception/Extinction Test.

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**SECTION – II**

**EQUIPMENT SPECIFICATION**

**TECHNICAL SPECIFICATIONS FOR ALUMINIUM TUBE**

**1.0 TECHNICAL DATA OF ALUMINIUM TUBE**

S. No.	PARTICULARS	DATA
1	Applicable Grade & Standard	Grade 63401 WP (Range 2) as per IS 5082: 1981
2	Manufacturing Process	a) Hot extrusion process through die and mandrel (Solid billet process). Heat treatment shall be done after hot extrusion of the tube; or b) Bridge extrusion process and then cold drawn. Heat treatment shall be done after hot extrusion of the tube.
3	Chemical Composition	Copper- 0.05% Max Magnesium- 0.4 to 0.9% Silicon- 0.3 to 0.7% Iron- 0.5% Max Manganese- 0.03 Max. Aluminium - Balance
4	Min. 0.2% proof Stress	170 MPa
5	Min. UTS	200 MPa
6	Min. Elongation on 50 mm	10%
7	Max. Electrical Resistivity at 20°C	0.03135 $\Omega$ -mm/ mm <sup>2</sup>
8	Min. Electrical Conductivity	55% of IACS
9	Temp. Coefficient of resistance	0.00364/°C
10	Temp. Coefficient of Linear Expansion over 20°C to 200°C	0.000023/°C
11	Thermal Conductivity at 100°C	0.43 Cal/s/mm <sup>2</sup> /cm/°C

TECHNICAL SPECIFICATIONS  
ALUMINIUM TUBE

DOC. NO.TB-xxx-316-055

12	Nominal Size, IPS (EH type)	3 Inch	4 Inch	4.5 Inch
13	Minimum Outside Diameter in mm ( <i>no negative tolerance permitted</i> )	88.90 +2.2	114.2 +2.2	120 +1.5
14	Modulus of elasticity (kg/mm <sup>2</sup> )	6700	6700	6700
15	Minimum Thickness in mm ( <i>no negative tolerance permitted</i> )	7.62 +2.2	8.51 +2.2	12 +1.0
16	Nominal Cross Section Area, in Sqmm	1946	2826	4071.5
17	Nominal Weight, kg/m (Maximum positive tolerance allowed is 8%, no negative tolerance is allowed.)	5.25	7.7	10.993
18	Packing	HDPE covering		
19	<b>Required Length</b>	As per individual PI.		

*No deviation on above-indicated parameters shall be accepted. The indicated quantity of individual type of Aluminum Tubes as mentioned in Section-I may vary by up to  $\pm 30\%$ . However overall quantity may vary by  $\pm 20\%$ . The tube shall be supplied in cut lengths minimum of 4m & maximum of 7m respectively. The negative/positive tolerance on the length of the section shall not exceed 10 mm. The maximum positive tolerance allowed on nominal weight (Kg/m) is 8%, however during tender stage, if the vendor exceeds the tolerance as a deviation, then the additional prices shall be loaded on the offer of bidder.*

- a) All tubes shall be supplied straightened & reasonably free from twist.
- b) The surface of the Aluminium tubes shall have a bright smooth finish, free from seams, cracks & other imperfections. Special attention shall be given to avoid formation of corona. The finished tubes shall be perfectly straight.
- c) The ingot to be used for producing the Aluminium tubular busbars of grade 63401 W.P (Range 2), shall comply with the requirements specified in Table1 (Clause 6.1) of IS:5082 when analysed in accordance with IS:504 or any other standard instrumental method of analysis.
- d) Aluminium Tube should be suitable for bending at site as per switchyard layout requirement.



## 2.0 TESTS:

In addition to routine tests on the aluminium tubes as per IS 5082, Test Reports for following tests shall also be submitted:

- i) Measurement of the outside diameter, wall thickness and ovality of the tube.  
0.2% proof tests both on the parent metal and aluminium tube as per standards, as appropriate.
- ii) Tensile Strength Test.
- iii) Percentage Elongation Test.

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**SECTION – IV**

**GUARANTEED AND TECHNICAL PARTICULARS OF STRANDED ALUMINIUM  
TUBE (SEPARATE GTP TO BE FILLED FOR EACH TYPE  
OF TUBE )**

S. No.	PARTICULARS	DATA			
1)	Applicable Grade & Standard				
2)	Manufacturing Process				
3)	Chemical Composition				
4)	Min. 0.2% proof Stress				
5)	Min. UTS				
6)	Min. Elongation on 50 mm				
7)	Max. Electrical Resistivity at 20°C				
8)	Min. Electrical Conductivity				
9)	Temp. Coefficient of resistance				
10)	Temp. Coefficient of Linear Expansion over 20°C to 200°C				
11)	Thermal Conductivity at 100°C				
12)	Modulus of Elasticity				
13)	Nominal Size, IPS (EH type)				
14)	Minimum Outside Diameter in mm (no negative tolerance permitted)				
15)	Minimum Thickness in mm (no negative tolerance permitted)				
16)	Nominal Cross Section Area, in Sqmm				
17)	Nominal Weight, kg/m				
18)	Packing				
19)	<b>Required Length</b>				

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**SECTION – V**

**CHECK LIST**

Put a tick mark (✓) in “YES/NO” Column if the specified requirement is met, or put a (X) mark, if the specified requirement is not met and give comments in the “Remarks” column.

**1. TECHNICAL REQUIREMENTS ( FOR ALUMINIUM TUBE)**

S.NO	PARTICULARS	DATA	Yes/No	Remarks
1.	Applicable Grade & Standard	Grade 63401 WP (Range 2) as per IS 5082: 1981		
2.	Type Test Charges	a) RIV Test b) Corona Inception/Extinction Test		
3.	No Negative Tolerance permitted	a) on Overall Diameter b) on Thickness		
4.	Maximum cut length of Al. Tube	7 Meter		
5.	Negative/Positive Tolerance on Length	10 mm		
6.	Maximum Positive Tolerance on Nominal Weight (Kg/m)	8%		
7.	Routine Test	As per clause 2 of Section-II		


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**SECTION – VI**

**QUALITY PLAN**

Bidder shall follow standard BHEL QAP doc. No. TBQM-STD-ALUMINIUM TUBE.

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		<b>BHARAT HEAVY ELECTRICALS LIMITED</b> <b>TRANSMISSION BUSINESS ENGINEERING MANAGEMENT</b>																																				
		<b>NEW DELHI</b>																																				
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	TYPE OF DOC.	STANDARD TECHNICAL SPECIFICATION			NAME	NK	DS	SN																														
	TITLE	<b>GI PIPE &amp; BENDS</b>				SIGN	Sd/-	Sd/-	Sd/-																													
						DATE																																
						GROUP	TBEM	W.O. No																														
	CUSTOMER																																					
CONSULTANT																																						
PROJECT	RATE CONTRACT (ONE YEAR)																																					
<b>SCOPE AND SPECIFIC TECHNICAL REQUIREMENT</b>																																						
<b>1.0 SCOPE</b>  This technical specification covers design, manufacture, testing at works, packing and dispatch of 'GI pipe, its fittings and bends'. The material supplied shall fully comply with relevant Indian Standard given below and the product shall be BIS certified. The sizes and types of Pipes shall be as specified below. No Technical Deviations shall be acceptable in this regard.																																						
<b>1.1 SPECIFIC TECHNICAL REQUIREMENT</b>																																						
<b>1.1.1 Galvanized Iron (GI) Pipe</b> The GI pipes shall be of nominal diameter 50 mm and/ or 100 mm, as per the indent. The pipe shall be of medium Grade as per IS 1239 and shall be of standard length of 6 meters. The pipe shall fully comply with specified standard and carry the BIS certification marking. The pipe shall have a socket at one end and threaded at both ends.																																						
<b>1.1.2 Sockets</b> The sockets shall fully comply with the requirements of IS 1239 (Part-2).																																						
<b>1.1.3 For Bends</b> The bends shall be of 90°, 112.5° and/ or Tee, as specified, for above mentioned pipes. The bends shall, in general, comply with the requirement of IS 1239 (part-2). The specific requirements and BIS certification marking of these bends shall be as per IS 1239 (Part-2). 90°, 112.5° and Tee bends shall have a socket at one end and threaded at all ends.																																						
<table border="1" style="width: 100%;"> <tr> <td>02</td> <td>25.04.13</td> <td>(A)</td> <td><i>[Signature]</i></td> <td><i>[Signature]</i></td> <td>90° bends has been included.</td> </tr> <tr> <td>01</td> <td>30.11.10</td> <td>Sd/-</td> <td>Sd/-</td> <td>Sd/-</td> <td>Document revised.</td> </tr> <tr> <td>Rev No.</td> <td>Date</td> <td>Altered</td> <td>Checked</td> <td>Approved</td> <td>REVISION DETAILS</td> </tr> <tr> <td colspan="4">Distribution</td> <td>To</td> <td>TBMM</td> </tr> <tr> <td colspan="4"></td> <td>Copies</td> <td>OFFICE COPY</td> </tr> </table>									02	25.04.13	(A)	<i>[Signature]</i>	<i>[Signature]</i>	90° bends has been included.	01	30.11.10	Sd/-	Sd/-	Sd/-	Document revised.	Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS	Distribution				To	TBMM					Copies	OFFICE COPY
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Distribution				To	TBMM																																	
				Copies	OFFICE COPY																																	

## SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES FOR ERECTION HARDWARE

### 1.0 SCOPE

The scope of this specification is to specify all details required by a supplier for supply of galvanized hardware for projects being executed by BHEL on turnkey basis.

### 2.0 SPECIFIC TECHNICAL REQUIREMENTS

#### 2.1 BOLTS:

Bolts as per BOQ shall be used in equipment mounting and earthing connection.

All bolts for member connections in towers, beams & equipment support structures shall conform to IS: 12427 - 2001 and for step bolts shall conform to IS: 10238 – 1982.

The mechanical properties shall conform to property class 5.6 of IS:1367 (part 3) - 1991.

All bolt heads shall have hexagonal shape, the heads being forged out of the solid material truly concentric and square with the shank, which must be perfectly straight.

All bolts shall be threaded with metric standard thread to take the full depth of the nut and permit firm grip of the member.

All bolts shall be hot dip galvanized as per IS: 1367 (Part 13) – 1983.

#### 2.2 NUTS:

All nuts shall conform to IS: 1363 (Part 3) –1992.

The mechanical properties shall conform to property class 5 of IS:1367 (part 6) – 1980.

The nuts shall be capable of being worked with fingers along the entire threaded portion of the bolt with a neat fit capable of developing the full strength of the bolt.

All nuts shall be hot dip galvanized as per IS: 1367 (Part 13) – 1983.

#### 2.3 PLAIN WASHERS:

All plain washers shall be punched washers, A type conforming to IS: 2016-1967.

These shall be hot dip galvanized as per IS: 4759 – 1984.

#### 2.4 SPRING WASHER:

All spring washers shall be of spring steel, positive lock type and conforming to type B of IS: 3063-1972. The thickness of spring washer shall be as per IS: 3063 – 1994 (Table 1A & 1B)

These shall be electro-galvanized as per IS: 1573 – 1986 and shall have service grade number – 4 as per IS:1573 – 1986 (Appendix A).

### 3.0 QUANTITIES:

Each nut bolt set will generally have two plain washers and one spring washer

Sl. No.	Bolt Size	Length (mm)	Threading	Spring Washer	Plain Washer
01	M12 – M33	40 - 140	Fully Threaded	Service grade number – 4 as per IS: 1573 – 1986 (Appendix A).	As per table 2 of IS: 2016-1967



# BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP  
ENGINEERING MANAGEMENT, NEW DELHI

BHEL Document No.	Rev.	Prepared by	Checked by	Approved by
TB-235-509-125	05	Name		
Type of Document	STANDARD SPECIFICATION	Sign	--sd--	--sd--
Title	GS FLAT & EARTH ELECTRODE FOR EARTHING SYSTEM	Date	17.08.07	17.08.07
		Group	TBEM	
		W.O. No		
Customer / Consultant				
Tender				

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VI.	Standard QP	1.0 - 4.0

05. 18.05.15 MS Flat of size 75x12 mm & 50x8 mm added.  
Note 4 added in sketch 2.

04	26.11.12	Sd/-	Sd/-	Sd/-	Sd QP included.
03	09.11.12	Sd/-	Sd/-	Sd/-	POWERGRID requirement & Cut Lengths included.
02	10.06.09	Sd/-	Sd/-	Sd/-	Documents updated
01	14.08.07	Sd/-	Sd/-	Sd/-	Revised as per TBMM requirement.
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# SECTION 1

## SCOPE AND SPECIAL TECHNICAL REQUIREMENT

### 1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Earthing Strips & Earthing Electrodes, complete with accessories.

This section covers the general technical requirements of Earthing Strips & Earthing Electrodes. In case of any discrepancies between the requirements mentioned in this section and those specified in the following sections of this specification, the specifications given herein shall prevail and shall be treated as binding requirements.

### 1.1 TECHNICAL REQUIREMENTS:

#### 1.1.1 GALVANIZED MILD STEEL FLAT (Power grid Requirement)

- i) Chemical composition & mechanical properties: Grade –A (Item Designation – Fe410W) of IS: 2062.
- ii) Mass of protective zinc coating: 618 gm/sq.m and minimum thickness of coating shall be 85 microns for items thicker than 6 mm. For less than 6 mm, the thickness shall be as per clause 4.0 of IS 4759, 1984.
- iii) Sizes:

Sl. No.	Description	Approx. Weight (kg)
1	Galvanised Steel Flat 75 x 12 mm	7.0663 kg/meter
2	Galvanised Steel Flat 75 x 10 mm	5.8893 kg/meter
3	Galvanised Steel Flat 50 x 6 mm	2.4008 kg/meter
4	Galvanised Steel Flat 25 x 3 mm	0.5894 kg/meter
5	Mild Steel Flat 50 x 6 mm	2.3316 kg/meter

- iv) Length: 4 m to 6 m
- v) Raw Material: Vendor to procure the raw material from Power Grid approved Sources with PG stamp.

#### 1.1.2 GALVANIZED MILD STEEL FLAT (Other then Power grid Requirement)

- i) Chemical composition & mechanical properties: Grade –A (Item Designation – Fe410W) of IS: 2062.
- i) Mass of protective zinc coating: 1) 610 gm/sq.m and minimum thickness of coating shall be 85 microns for items thicker than 6 mm. For



less than 6 mm, the thickness shall be as per clause 4.0 of IS 4759, 1984.

ii) Sizes:

Sl. No.	Description	Weight (kg)
1	Galvanised Iron Flat 75 x 12 mm	7.065 kg/meter
2	Galvanised Iron Flat 75 x 10 mm	5.888 kg/meter
3	Galvanised Iron Flat 75 x 8 mm	4.710 kg/meter
4	Galvanised Iron Flat 65 x 10 mm	5.10 kg/meter
5	Galvanised Iron Flat 65 x 8 mm	4.082 kg/meter
6	Galvanised Iron Flat 50 x 8 mm	3.140 kg/meter
7	Galvanised Iron Flat 50 x 6 mm	2.4 kg/meter
8	Galvanised Iron Flat 25 x 3 mm	0.589 kg/meter
9	Mild Steel Flat 75 x 10 mm	5.7843 kg/meter
10	Mild Steel Flat 50 x 6 mm	2.3316 kg/meter
11	Mild Steel Flat 75 x 12 mm	7.065 kg/meter
12	Mild Steel Flat 50 x 8 mm	3.140 kg/meter

iii) Length: 4 m to 6 m.

**1.1.3 EARTH ELECTRODE (Mild Steel iron)**

i)	Applicable Standard	IS:1239
ii)	Sizes of Pipe	40 NB
iii)	Grade	Medium
iv)	Thickness of zinc -coating	460 gm/sq.m
v)	Reference Drg.	SKETCH SK-1 (Typical)

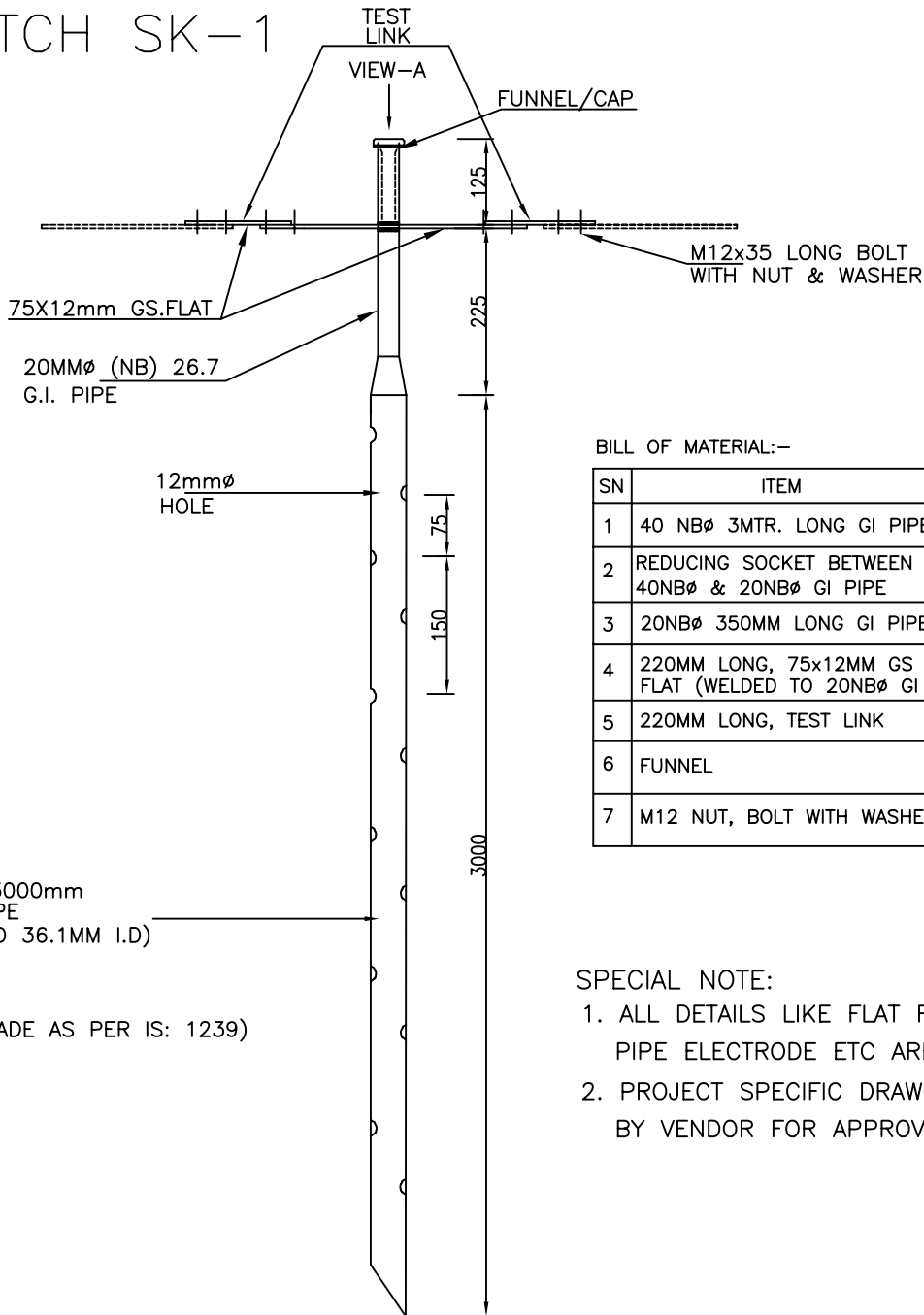
**1.1.4 EARTH ELECTRODE (Cast Iron)**

i)	Cast Iron pipe ID (mm)	100/150 mm
ii)	Thickness (mm)	12/10/13 mm
iii)	Reference Drg.	SKETCH SK-2 (Typical)

**1.2 Manufacturing quality plan:**

- i) Quality plan of GS flat is not required for power grid projects. Therefore, the inspection of GS flat & electrodes for power grid projects will be carried out as per relevant Indian Standards (latest version).
- ii) The QP enclosed with standard specification is to be followed for Non Power Grid projects.

# SKETCH SK-1



## BILL OF MATERIAL:-

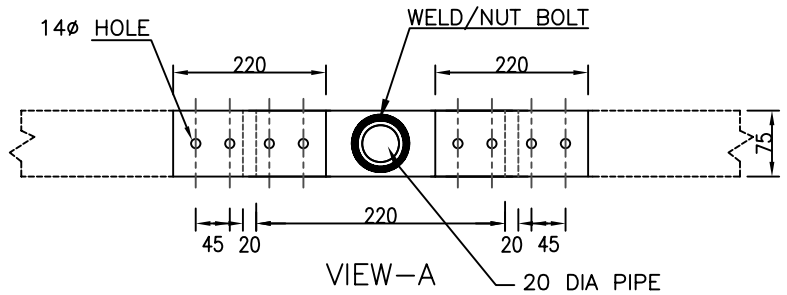
SN	ITEM	UNIT	QTY.
1	40 NB $\phi$ 3MTR. LONG GI PIPE	NOS.	01
2	REDUCING SOCKET BETWEEN 40NB $\phi$ & 20NB $\phi$ GI PIPE	NOS.	01
3	20NB $\phi$ 350MM LONG GI PIPE	NOS.	01
4	220MM LONG, 75x12MM GS FLAT (WELDED TO 20NB $\phi$ GI PIPE)	NOS.	01
5	220MM LONG, TEST LINK	NOS.	02
6	FUNNEL	NOS.	01
7	M12 NUT, BOLT WITH WASHERS	SETS	08

## SPECIAL NOTE:

1. ALL DETAILS LIKE FLAT FIXING TO GI PIPE ELECTRODE ETC ARE TYPICAL.
2. PROJECT SPECIFIC DRAWING TO BE SUBMITTED BY VENDOR FOR APPROVAL.

## NOTE:

1. ALL DIMENSIONS ARE IN MM.
2. STEEL TO CONFORM TO IS:2062, GRADE-A
3. ALL ITEMS TO BE HOT DIP GALVANISED.
4. SUPPLY OF FIXING BOLTS, NUTS, WASHERS FOR GI FLT EARTHING CONDUCTOR IS ALSO PART OF THE SCOPE
5. WASHER TO BE ELECTRO GALVANISED.



EQUIPMENT EARTHING DETAILS  
DETAILS OF PIPE ELECTRODE  
IN TREATED EARTH PIT

COMPUTERREF.NO.

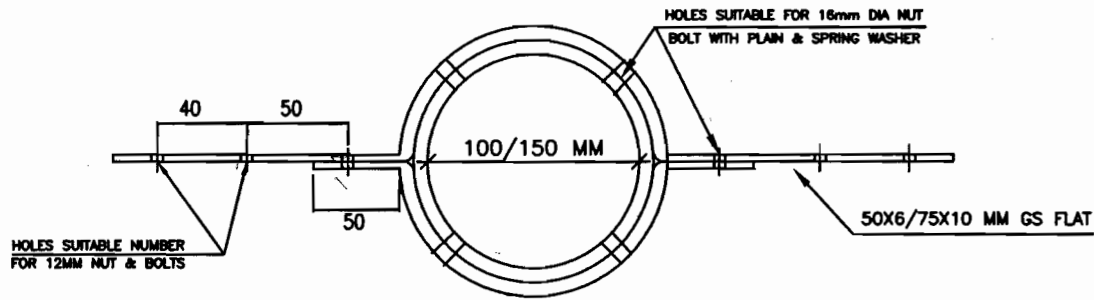
DRG. No.

SKETCH SK-1

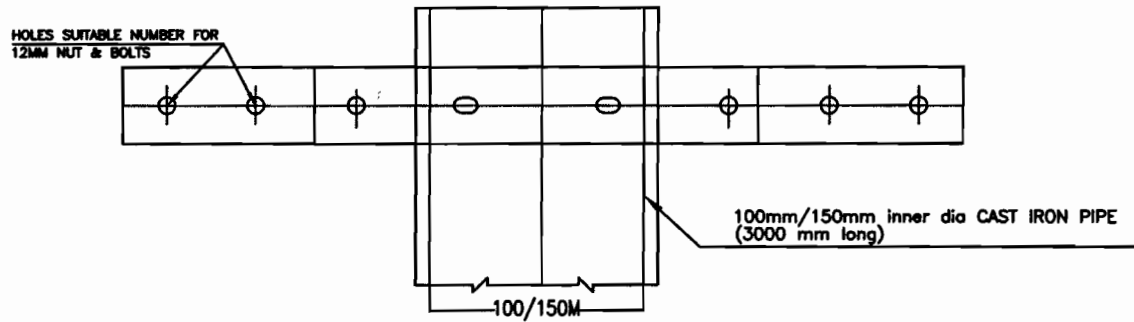
REV. 01

SHEET No.

# SKETCH SK-2



PLAN



ELEVATION

## BILL OF MATERIAL:-

SN	ITEM	UNIT	QTY.
1	100/150MM INNER DIA CI PIPE CONFORMING TO IS :1536-1960	NO.	01
2	16MM NUT, BOLT INCLUDING 1 NO. PLAN WASHERS AND 1 NO. SPRING WASHER	SETS.	06
3	12MM NUT, BOLT INCLUDING 1 NO. PLAN WASHERS AND 1 NO. SPRING WASHER	SETS.	04
4	50X6 OR 75X10 MM GS FLAT (HALF RING)	PAIR	01

## SPECIAL NOTE:

1. ALL DETAILS ARE TYPICAL.
2. PROJECT SPECIFIC DRAWING TO BE SUBMITTED  
BY VENDOR FOR APPROVAL.

## NOTE:-

1. ALL DIMENSIONS ARE IN MM
2. ALL NUT AND BOLTS ARE HOT DIP GALVANIZED.
3. WASHERS SHALL BE ELECTRO-GALVANIZED.
4. Cast iron pipe shall be supplied with GS flat suitably wrapped and connected through welding/bolting to minimize contact resistance.



COMPUTERREF.NO.

DRG. No.

SKETCH SK-2

REV. 03

SHEET No.

## **SECTION - 2**

### **STANDARD SPECIFICATION**

#### **2.1 APPLICABLE STANDARDS**

The materials shall strictly conform to the following Indian Standards, as appropriate:

The materials shall confirm to the latest editions of the following Indian Standards:

- IS 2062: 2011 Steel for general structural purposes
- IS 1730: 1998 Dimensions for steel plate, sheets, strips and flats for general engineering Purposes.
- IS 1731: 1971 Dimensions for steel flats for structural and general engineering purposes.
- IS 2629: 1985 Recommended practices for Hot-dip galvanizing on iron & Steel
- IS 2633: 1986 Methods for testing uniformity of coating of zinc- coated articles.
- IS 1852: 1985 Rolling & Cutting Tolerance for hot rolled steel products.
- IS 1239 (Part 1): 1990 Specification for mild steel tubes, tubular and other wrought steel fittings (Mild Steel tubes)
- IS 1239 (Part 2): 1992 Specification for Mild steel tubes, tubular and other wrought steel fittings (Mild Steel Sockets )
- IS 4826 – 1979 Hot-dipped zinc coatings on mild steel tubes
- IS 4759: 1984 Hot Dip Coatings on Structural Steel and other allied Products
- IS 6745: 1972 Determination of mass of Zinc Coating on Zinc Coated Iron and Steel Articles
- IS 1536: 1993 Cast Iron Pressure Pipe -Specification

#### **2.2 CONSTRUCTIONAL FEATURES**

##### **2.2.1 MILD STEEL FLATS**

All steel required for earthing material shall confirm to Grade –A (Item Designation – Fe410W) of IS:2062: 2011.

### **2.2.2 EARTH ELECTRODES**

- (1) The earth electrodes (Galvanised Iron) shall be perforated and fabricated out mild steel pipes and shall conform strictly to IS 1239 – 2004.
- (2) The earth electrodes (Cast Iron) shall be perforated and fabricated out cast iron pipes and shall conform strictly relevant IS: 3043-2006.

Note: Latest revisions shall be followed for all mentioned standard.

## SECTION - 3

### **GENERAL SPECIFICATIONS**

#### **3.1 INSPECTION AND TESTING**

All tests and inspection of the equipment specified shall be performed to the extent and in the manner as stipulated in the relevant standards and in this specification. All type test/routine tests/acceptance tests as specified shall be conducted as per the details mentioned in the Purchase order for this equipment.

#### **3.2 DOCUMENTATION SCHEDULE AT CONTRACT STAGE: (DOCUMENTATION REQUIREMENT SHALL BE SPECIFIED BY PROJECT PPE AT CONTRACT STAGE AND SHALL VARY FROM PROJECT TO PROJECT).**

<b>A (No. of Copies)</b>	<b>For Approval</b>
	Copies of GA drawings with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
	Copies of GTP
	Copies of type test reports
	Copies of manufacturing quality plan.
<b>B (No. of Copies)</b>	<b>After Approval and For Information/Distribution.</b>
	Copies of GA drawings
	Copies of GTP
	Copies of type, Routine & Acceptances tests.
	Copies of manufacturing quality plan.
	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.

#### **3.3 Material shall not be dispatched without the approval of test certificates by purchasers.**

#### **3.4 MATERIALS AND WORKMANSHIP**

Equipment materials and components shall be new, of high grade and good quality and be to the latest engineering practice. The material and workmanship throughout shall be in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

In general, screw threads shall be standard metric threads. The use of other thread from will be used only after prior approval. The supplier shall furnish locking devices for threaded fasteners, which will lock them in such a manner so as to prevent them from coming loose in transport and in service.

All joints and fastening shall be so designed, constructed and registered that the component part may be accurately positioned and restrained to fulfill their required function. The heads of all bolts shall register flush on the surface, which they fasten.

All the information concerning materials or components to be used in manufacturing, machinery, equipment, materials and components supplied, installed or used shall be submitted for approval. Without such approval the supplier shall run risk of subsequent rejection. The cost as well as time delay associated with such rejection shall be borne by the supplier.

Whenever possible, all similar parts of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The supplier shall apply all lubricants used for installation and operation of the equipment. All consumable required for one-year operation shall be in the scope of supplier.

All components exposed to rain shall be designed with sloped upper surface to avoid water pools.

### **3.5 SURFACE TREATMENT**

- 3.5.1** All metal surfaces shall be treated to provide anti-corrosion protection. All ferrous surfaces for external use shall be hot-dip galvanized after fabrication. High Tensile steel nuts and bolts and spring washers shall be electro-galvanized to service condition .

## **36 WELDING**

All welding shall be done by a qualified welder.

### **3.7 PACKING AND MARKING**

#### **3.7.1 PACKING**

GI Flat may be supplied in open condition. However, while stacking the materials for transportation it should be ensured that, similar items are grouped and tied with steel wires /

strips for convenient handling and shall be done in such away to avoid damage during transits.

### **3.7.2 MARKINGS**

The following details shall be marked on the packing:

- i) Name and address of the consignee
- ii) Purchase Order No:
- iii) Name of supplier
- iv) Description of material
- v) Tare weight
- vi) Gross weight



# SECTION - 4

## GUARANTEED TECHNICAL PARTICULARS for ELECTRODES

### **1.0 EARTH ELECTRODE (Galvanized iron)**

- 2.1 Mild Steel pipe OD (mm)
- 2.2 Mild Steel ID (mm)
- 2.3 Thickness of zinc –coating
- 2.4 Weight of zinc coating
- 2.5 Applicable standards

### **2.0 EARTH ELECTRODE (Cast Iron)**

- 3.1 Cast Iron Pipe OD (mm)
- 3.2 Cast Iron Pipe ID (mm)
- 3.3 Applicable standards

**CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER**  
**RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED**

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

**BHEL ENQUIRY. NO:**  
**BIDDER OFFER REFERENCE:**

(1)	(2)	(3)	(4)	(5)
S.No.	Parameter	Requirement	Yes / No	Remarks in case reply in Col (4) is <i>NO</i>
1.0	Weight of Zinc coating	Weight of zinc coating shall be as per clause 2.4 of Section-2		
2.0	Tolerance in the flat size	Tolerance in the flat size shall be as per IS:1852-1985		
3.0	Chemical composition of flat/CI Pipe/GI Pipe	Certified copy of the chemical composition of the material as per the relevant standards shall be supplied before the dispatch of the material.		
4.0	Earth electrode	Electrode arrangement shall be provided as per sketch no. SKTECH <b>SK-1</b> / SKETCH <b>SK-2</b>		
5.0	PG stamp	Raw material shall be inspected at source by Powergrid/BHEL.		
6.0	Length	4 to 6 mtrs		
7.0	Conformance	With enclosed QP		

**Date:**

**Signature of the authorized representative of Bidder**

**Company Seal**



# QUALITY PLAN

ITEM: CI PIPE ELECTRODE

OP NO: TBQM-STD-CIE  
REV: 00  
DATE: 15-01-11  
Page 1 of 2

PROJECT:

PACKAGE/CONTRACT:

CONTRACTOR: BHEL

FORMAT OF RECORD

AGENCY

P W V

REMARKS

S.NO.	COMPONENT / OPERATION	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	9	10	11	12	13
1	2	3	4	5	6	7	8					

1.0	INCOMING MATERIALS:											
1.1	MS FLATS	Freedom from defects	Major	Visual	100%	IS 2062	IS 2062	Internal Logbook	M		C	a) MS Flat to be taken from BHEL approved Sources.
		Dimensions		Measure ments	10 %	IS 1852	IS 1852		M		C	b) Correlation of Material Test Certificates to be maintained.
		Mech. Properties		Mech	As per IS 2062	IS 2062	IS 2062	Lab Report / Mfr. TC	Y	M	C	
		A. Yield Strength										
		B) Tensile Strength										
		C) % Elongation										
		D) Bend Test										
		4) Chem. Composition		Chem.	As per IS 2062	IS 2062	IS 2062	Lab Report / Mfr. TC	Y	M	C	
1.2	CI PIPES	Freedom from defects	Major	Visual	100%	IS 1536	IS 1536	Internal Logbook	M		C	a) CI Pipe to be taken from BIS licensees Manufacturer and a copy of valid licenses to be submit along with Test Report.
		Dimensions		Measure ments	10 %				M		C	
		Mech. Properties		Mech	As per IS 1536			Lab Report / Mfr. TC	Y	M	C	b) Co-relation of Material Test Certificates to be maintained.
		c) Hydrostatic Test	-do-	Mechani cal	As per IS 1536	IS 1536	IS 1536	"	M		C	
		4) Chem. Composition		Chem.	IS 1536	IS 1536	IS 1536	"	Y	M	C	
1.3	Hardware (Nuts, Bolts, Plane Washer &	Mechanical, Chemical and Galvanizing test	-do-	Review	IS 1367 - F-17	IS 1367 - P-17, IS 1367, IS 3063 & IS 2016	IS 1367 - P-17, IS 1367, IS 1363, IS 3063 & IS 2016	Lab Report / Mfr. TC	Y	M	C	Hardware to be taken from BHEL approved Sources.
BHEL SIGN & SEAL		LEGEND:		M - MANUFACTURER / SUB CONTRACTOR		P - PERFORMED BY		NAME & SIGN OF				
				C - BHEL / NOMINATED INSPECTOR AGENCY		W - WITNESSED BY						
				N - CUSTOMER / CUSTOMER NOMINATED AGENCY		V - VERIFICATION BY						



# QUALITY PLAN

ITEM : CI PIPE ELECTRODE

Q.P. NO. : TBQM-STD-CIE

PROJECT :

REV. 00

PACKAGE / CONTRACT :

DATE : 15-01-11

CONTRACTOR : BHEL

FORMAT OF RECORD

AGENCY

REMARKS

Page 2 of 2

S.NO.	COMPONENT / OPERATION	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	D 10 11 12	13

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BHEL SIGN & SEAL

LEGEND:

M - MANUFACTURER / SUB CONTRACTOR

P - PERFORMED BY

NAME & SIGN OF APPROVING AUTHORITY & SEAL

C - BHEL / NOMINATED INSPECTOR N AGENCY

W - WITNESSED BY

SEAL

Handwritten signature and stamp of the approving authority.





# QUALITY PLAN

ITEM : GI FLAT / GI PIPE ELECTRODE

Q.P. NO : TBQM-STD-QIF  
REV. 01  
DATE : 12-01-11  
Page 3 of 4

PROJECT :

PACKAGE / CONTRACT :

CONTRACTOR : BHEL

S.NO.	COMPONENT / OPERATION	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD				REMARKS
								P	W	V		
1	2	3	4	5	6	7	8	9	10	11	12	13

d)	Rinsing	visual	-do-	Visual	100 %	IS 2629-1985	IS 2629-1985	"	M		C	
e)	Preluxing	Chem.	-do-	Sp. Gr.	One sample for per shift	IS 2629-1985	IS 2629-1985	"	M		C	
f)	Drying	Visual	-do-	Visual	100 %	Value 1.1-1.3	Value 1.1-1.3	"	M		C	
g)	Hot Dip Galvanizing Zinc Temp.	Visual	-do-	Measure ment	Hourly Reading	IS 2629-1985 450-460 deg C	IS 2629-1985 450-460 deg C	"	M		C	
3.2	Dipping in zinc	"	-do-	Visual	100%	IS 2629-1985	IS 2629-1985	"	M		C	
a)	Quenching	"	-do-	"	"	IS 2629-1985 450 to 460 deg C	IS 2629-1985 450 to 460 deg C	"	M		C	
b)	Passivation	Chem.	-do-	"	"	450 to 460 deg C	450 to 460 deg C	"	M		C	
3.3	GALVANISING TESTS:											
a)		Surface finish no black/dare spots, ash flux, inclusions lumps, pimples and runs etc. ( except small & suitable for patching )	-do-	Visual	100%	IS 2629-1985	IS 2629-1985	Internal Logbook	M		C	
b)		Adhesion Test	-do-	Hammer Test	3 samples per shift	IS 2629-1985	IS 2629-1985	"	M		C	
c)		Thk of coating	-do-	Physical	"	IS 2629-1985	IS 2629-1985	"	M		C	
d)		Wt. Of zinc	-do-	Measure ment	"	IS 6745-1972	IS 6745-1972	"	M		C	
e)		Preece Test	-do-	Chem.	"	IS 2633-1985	IS 2633-1985	IS-4759	M		C	

BHEL  
SIGN & SEAL

LEGEND:

M - MANUFACTURER / SUB CONTRACTOR  
C - BHEL / NOMINATED INSPECTOR AGENCY  
N - CUSTOMER / CUSTOMER NOMINATED AGENCY

P - PERFORMED BY  
W - WITNESSED BY  
V - VERIFICATION BY

BY PROJECT ENGINEER  
DEPT. OF QUALITY CONTROL  
BHEL, BHOPAL  
Date: 12/01/11

BY PROJECT ENGINEER  
DEPT. OF QUALITY CONTROL  
BHEL, BHOPAL  
Date: 12/01/11



# QUALITY PLAN

ITEM : GI FLAT / GI PIPE ELECTRODE

OP NO : TBQM-STD-01F  
REV: 01  
DATE : 12-01-11  
Page 4 of 4

PROJECT :

PACKAGE / CONTRACT :

CONTRACTOR : BHEL

S.NO.	COMPONENT / OPERATION	CHARACTERISTIC CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	D 10 11 12	13

4.0	FINAL INSPECTION							1984						
4.1	Calibration of measuring and testing eqpt..	Calibration	Major	Visual	100%	Periodicity of calibration not to exceed 12 months	Periodicity of calibration not to exceed 12 months	Calibration records	M		C		Calibration should have been done in reputed laboratory	
4.2		a) Visual & Dimensions	-do-	Visual	100%	IS 2629/802-10985-1978	IS 2629/802-10985-1978	Inspection report	M		C			
				Measurement	as per IS 2500-1992 level S4	Appd. Drgs.	Appd. Drgs.		M		C		Final inspection by BHEL	
		b) Mech. And Chem. Test as indicate in Cl. 1.1 & 1.2	-do-	Mechanical & Chemical	As indicated in cl. 1.1 & 1.2	As listed in 1.1 & 1.2	As listed in 1.1 & 1.2		M		C		Final inspection is a CHP	
		c) Galvanizing. Tests as indicated in 3.3	-do-	Mechanical & Chemical	SS/lot offered	IS 6745-1972	IS 6745-1972		M		C			
5.0	Hardware (Nuts, Bolts, Plane Washer & Spring Washer)	Mechanical, Chemical and Galvanizing test	-do-	Review	IS 1367 - P-17	IS 1367 - P-17 IS 1367, IS 1363, IS 3063 & IS 2016	IS 1367 - P-17 IS 1367, IS 1363, IS 3063 & IS 2016	Lab Report / Mfr. TC	M		C		Hardware to be taken from BHEL approved Sources.	
6.0	PACKING	Material, Sturdiness, marking, checking with Packing list	-do-	Visual	100%	BHEL Spec.	BHEL Spec.	Subcontract certificate	M					

BHEL

SIGN & SEAL

LEGEND:

M - MANUFACTURER / SUB CONTRACTOR

C - BHEL / NOMINATED INSPECTION AGENCY

N - CUSTOMER / CUSTOMER NOMINATED AGENCY

P - PERFORMED BY

W - WITNESSED BY

V - VERIFICATION BY

Signature of Mr. P. S. SINGH

Signature of Mr. P. S. SINGH

Signature of Mr. P. S. SINGH

Signature of Mr. P. S. SINGH

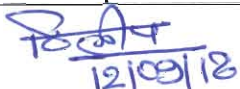
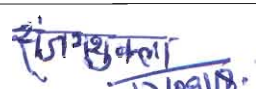
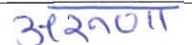
Signature of Mr. P. S. SINGH

**TECHNICAL SPECIFICATION**  
*for*  
**ACSR (MOOSE/ BERSIMIS/ ZEBRA) & AAC (BULL) CONDUCTOR**

**SPECIFICATION NO: TB-XXX-316-019;**  
**REVISION: 03**  
**DATE: 12.09.2018**



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS GROUP**  
**NOIDA, UP (INDIA) – 201305**

	Prepared by	Checked by	Approved by
Name	Dileep Shukla	SK Shukla	Aruna Gulati
Signature			
Date	12.09.2018	12.09.2018	12.09.2018



TECHNICAL SPECIFICATION FOR  
ACSR (MOOSE, BERSIMIS, ZEBRA) &  
AAC BULL CONDUCTOR

SPECIFICATION NO. TB-XXX-316-019

REVISION 03

DATE: 12.09.2018

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	ANNEXURE - B: SCHEDULE OF DEVIATION/CONCESSION/ CHANGE REQUEST	01
	SPECIFIC TECHNICAL REQUIREMENTS	04
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	ANNEXURE - C	02
	ANNEXURE – D1	02
	ANNEXURE – D2	01
	DATA SHEET - A	05
4.	TOTAL NO. OF SHEETS (INCLUDING COVER/ SEPARATOR SHEETS)	23





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AAC (BULL) CONDUCTOR**

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**SECTION - I**

**SPECIFIC TECHNICAL REQUIREMENTS**



**TECHNICAL SPECIFICATION FOR  
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**ANNEXURE-A**  
**COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION**

The bidder shall confirm compliance to the following by signing and/or sealing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of deviations'.
3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (NIT) to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as a part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature



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**ANNEXURE-B**  
**SCHEDULE OF DEVIATION/ CONCESSION/ CHANGE REQUEST**

Bidder shall list out all technical potential deviation (s)/ concession(s)/change request(s) along with clause with respect to technical specifications.

Sl. no.	Page no.	Contract requirement with clause no.	Potential deviation (s)/concession(s)/ change request(s)	Reason(s) / Justification(s)

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Bidder's Stamp & Signature



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## 1.0 PURPOSE

This specification is intended for finalization of rate contract between BHEL TBG and Bidder. Standard technical detail as indicated in the specification shall be agreed upon between BHEL TBG and bidder. Project specific technical details shall be made available to the bidder along with project specific material requirement.

## 2.0 SCOPE

- 2.1 Design, manufacture, inspection and testing at Manufacturer's works, proper packing and delivery to site of **ACSR (MOOSE, BERSIMIS, ZEBRA) & AAC (BULL) CONDUCTOR** conforming to this specification.
- 2.2 It is not the intent to specify herein all the details of design & manufacture of material. However, the material shall conform in all respect to high standard of design, engineering & workmanship and shall be capable of performing in continuous commercial operation at site condition.
- 2.3 Technical requirements of **ACSR (MOOSE, BERSIMIS, ZEBRA) & AAC (BULL) CONDUCTOR** are indicated in Technical Data Section-I & Section-II.
- 2.4 The stipulation(s) of Section-I shall prevail in case of any conflict between the stipulations of Section-I & Section-II, however, bidder shall furnish list of conflict (s)/ ambiguity(ies)/ deviation(s), if any, along with their technical offer and also furnish the basis(s)/ reason(s)/ justification(s) that is considered for submitting technical offer. BHEL/Owner will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/Owner of their interpretation. In case bidder fails to convey the same prior to award, decision of BHEL/Owner decision on interpretation shall be considered final and binding if need arises during the execution. No additional commercial implication on account of conflict(s)/ ambiguity(ies)/ deviation(s) shall be admissible.

## 3.0 BILL OF QUANTITIES

- 3.1 The bidder shall quote for items as per **BOQ/ PRICE SCHEDULE** attached with Notice Inviting Tender (NIT). **The quantity as mentioned in the BOQ is only for evaluation purpose.** However actual ordered quantity may vary from project to project throughout the contract.
- 3.2 The **BOQ/ PRICE SCHEDULE** is as per **ANNEXURE-BOQ**.

## 4.0 DRAWINGS & DOCUMENTS TO BE SUBMITTED

- 4.1 After finalization of rate contract; against specific project requirement following information shall be provided by BHEL,
1. BOQ of required conductor type
  2. Project site information
- 4.2 Following documents shall be submitted for specific project requirement after placement of order for the approval of BHEL/Customer,

Sl. no.	Drawing / Document Description	Document no.	Document Type	First Submission	Resubmission
1	Conductor Cross Section with Technical Data Sheet	TB-XXX-316-E111	Primary	Within 2 week of PO	Within 1 week of comments
2	Drum Drawing	TB-XXX-316-E112	Primary	Within 2 week of PO	Within 1 week of comments
3	Type Test Reports	TB-XXX-316-E113	Primary	Within 2 week of PO	Within 1 week of comments





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4	Quality Plan	TB-XXX-316-E114	Primary	Within 2 week of PO	Within 1 week of comments
5	Routine & Acceptance Test Reports	TB-XXX-316-E115	Secondary	Within 1 week of <del>PO</del> Inspection	

**Notes**

1. Approval on Primary documents is essential for providing manufacturing clearance.
2. The bidder/ manufacturer may note that all re-submissions must incorporate all comments given in the prior submission by the Purchaser. Adequate justification for not incorporating the same must be submitted, failing which the submitted documents may be returned.

**4.3 Drawings/ Documents – Distribution of copies**

Sl. no.	Stages	Set of copies	Submission schedule
1	First submission	6	Within 2 weeks of award of contract
2	Re-submission, if required	6	Within 1 week of comments
3	Distribution copies of drawings in bound volume	6	Within ½ weeks of final approval
4	Distribution copies of type test reports drawings in bound volume	6	Within ½ weeks of final approval
5	Distribution copies of routine test reports in bound volume	6	Within ½ weeks of final approval
6	Compact disc/ Pen drive	1	Within ½ weeks of final approval

**5.0 TECHNICAL QUALIFYING REQUIREMENT & EXPERIENCE**

The technical qualifying requirement & experience shall be as per attached **Annexure-TQR**.

**6.0 TYPE TESTING**

- 6.1 The bidder shall submit the type tests reports for the tests conducted on the conductor(s) identical or similar to those to be supplied under this contract and the test(s) should have been conducted at CPRI/ any NABL accredited independent laboratory/ any accredited laboratory (Accredited based on ISO/ IEC Guide 25/ 17025 or EN 45001 by the national accreditation body of the country, where the laboratory is located) not earlier than five (5) years from the date of original scheduled date of bid opening.
- 6.2 In case, any type test report is found to be technically unacceptable due to project/ customer specific testing procedure other than that mentioned in section-II, such type test(s) shall be conducted by the bidder without any commercial implication to BHEL.
- 6.2 Type test reports of the conductor shall be submitted for approval of BHEL/customer, as per following details but not limited to this,
1. UTS test on stranded conductor
  2. Corona extinction voltage test (dry)
  3. Radio interference voltage (RIV) test (dry), and
  4. DC resistance test on stranded conductor

**7.0 QUALITY ASSURANCE, TESTING & INSPECTION**



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- 7.1 At contract stage, the successful bidder shall submit the same Quality Plan (QP) for approval of BHEL/customer at contract stage. In case bidder has reference Quality Plan agreed with customer, same can be submitted for specific project after award of contract for approval/ extension BHEL/customer. There shall not be any commercial implication to BHEL on account of changes in Quality Plan (QP) during contract stage.
- 7.2 All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved Quality Plan (QP). The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification.
- 7.3 The supplier shall perform all routine and acceptance tests during manufacturing as per requirement of the specification. The material shall be offered for inspection by BHEL/customer in accordance with agreed Quality Plan (QP) with 1 Week advance information. Commercial implications, if any for all these tests shall be deemed to be included in the bid price.
- 7.4 The contractor shall offer material for sample selection for type testing, only after approval of Quality Plan.

**8.0 PACKING AND MARKING**

- 8.1 The conductor shall be wound on non-returnable drums conforming to IS:1778 strong enough and provided with lagging of adequate strength, constructed to protect the conductor against all damages and displacements during transit, storage and subsequent handling and straining operations in the field. Only one conductor length shall be packed on each drum.
- 8.2 Each drum shall have following information marked on it along with other essential data:
1. Name of manufacturer
  2. Drum no.
  3. Size and length of conductor
  4. Net weight of conductor
  5. Total weight
  6. Arrow marking for unwinding, and
  7. Position of the conductor end

**9.0 ABBREVIATIONS USED**

NIT: Notice Inviting Tender  
QP: Quality Plan  
BOQ: Bill of Quantities  
ACSR: Aluminium Conductor Steel Reinforced  
AAC: All Aluminium Conductor  
PO: Purchase Order  
UTS: Ultimate Tensile Strength  
RIV: Radio Interference Voltage  
ACSR: Aluminium Conductor Steel Reinforced  
AAC: All Aluminium Conductor  
NABL: National Accreditation Board for Testing and Calibration Laboratories  
IEC: International Electro-Technical Commission  
ISO: International Organization for Standardization  
IS: Indian Standard  
EN: European Standard



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STANDARD TECHNICAL REQUIREMENTS

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## **1.0 CODES AND STANDARDS**

- 1.1 The materials for conductor shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where it is to be installed.
- 1.2 The ACSR Conductor shall conform to IEC:1089/ IS:398 (Part V)/ any other applicable standard, if it ensures equivalent or superior performance.
- 1.3 The AAC Conductor shall conform to IEC:1089/ IS:398 (Part V)/ any other applicable standard, if it ensures equivalent or superior performance.
- 1.4 The design, material, construction, manufacture, inspection and testing of ACSR (moose, Bersimis, Zebra) & AAC (Bull) conductor shall conform to the latest revision of relevant standards.
- 1.5 In case of conflict between the applicable reference standard and this specification, this specification shall govern.
- 1.6 The conductor shall strictly conform to the following but not limited to Indian and International standards, as appropriate but not limited to,
  1. IS 398 (Part-I) Aluminium conductors for overhead transmission purposes
  2. IEC 1089/IS 398 (Part-V) Aluminium conductors galvanized steel reinforced
  3. IS 2629: 1990 Recommended practice for hot dip galvanizing on iron and steel.
  4. IS 4826: 1992 Hot dip galvanized coatings on round steel wires
  5. IS 2633: 1992 Method for testing uniformity of coating of zinc--coated articles.
  6. IS 6745: 1990 Methods for determination of mass of zinc coating on zinc coated iron and steel articles
  7. IS 8263: 1990 Methods for radio interference test
  8. IS 1778: 1980 Reels and drums for bare conductors
  9. IS 1521: 1991 Method for tensile testing of steel wire
  10. IEC 888 Zinc coated steel wire for stranded conductors
  11. IEC 889 Hard drawn aluminium wire for overhead line conductors
  12. IS 209 Zinc ingot specification
  13. IEC 437 Radio inference test on high voltage insulator
  14. IEC 1089 Radio wire concentric lay overhead electrical standard conductors

## **2.0 TECHNICAL REQUIREMENT**

### **2.1 Workmanship**

- 2.1.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/ hand pressure and/ or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.
- 2.1.2 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing.
- 2.1.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the Technical Data Sheet-A. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC 888.
- 2.1.4 The steel strands shall be pre-formed and post-formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid damage to galvanization during pre-forming and post-forming operation.

### **2.2 Joints in wires**

#### **2.2.1 Aluminium wires**

During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.





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No joints shall be permitted in the individual wires in the outermost layer of the finished conductor. However, joints are permitted in the inner layers of the conductor unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

**2.2.2 Steel wires**

There shall be no joint of any kind in the finished wire used for manufacturing of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

**2.3 Tolerances**

The manufacturing tolerances to the extent indicated in Technical Data Sheet-A shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

**2.4 Materials**

**2.4.1 Aluminium**

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC 889.

**2.4.2 Steel**

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the Technical Data Sheet-A. The steel wire drums shall have the same properties and characteristics as prescribed for regular strength wire in IEC: 888.

**2.4.3 Zinc**

The zinc used for galvanizing shall be electrolytic high grade zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS 209: 1979.

**2.5 Standard length**

The conductor shall be supplied as required. No joint shall be allowed within a single span of stringing, jumpers and equipment interconnection.

**2.6 Tests**

The conductor should have been type tested as per IEC/IS. Following Acceptance & Routine tests and tests during Manufacturing shall be carried out on the conductor. The sample shall be manufactured strictly in accordance with the quality assurance plan approved by owner.

**2.6.1 Type Tests**

The type test, acceptance & routine test and test during manufacturing shall be as following details but not limited to,

**2.6.1.1** The conductor should have been type tested as per IEC/IS. In accordance with the stipulation of the specification, the following type test/ type test reports of the conductor shall be conducted/submitted for approval/ extension,

- |   |                     |
|---|---------------------|
| 1. UTS test on stranded conductor           | (as per Annexure-C) |
| 2. Corona extinction voltage test (dry)     | (as per Annexure-C) |
| 3. Radio interference voltage test (dry)    | (as per Annexure-C) |
| 4. DC resistance test on stranded conductor | (as per Annexure-C) |

**2.6.2 Acceptance Tests**

- |  |                     |
|--|---------------------|
| 1. Visual check for joints, scratches etc. and length of conductor | (as per Annexure-C) |
| 2. Dimensional check on steel and aluminium strands                | (as per Annexure-C) |



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- |  |                           |
|--|---------------------------|
| 3. Check for lay-ratios of various layers            | (as per Annexure-C)       |
| 4. Galvanizing test on steel strands                 | (as per Annexure-C)       |
| 5. Torsion and Elongation test on steel strands      | (as per Annexure-C)       |
| 6. Breaking load test on steel and aluminium strands | (as per IEC 888, IEC 889) |
| 7. Wrap test on steel and aluminium strands          | (as per IEC 888, IEC 889) |
| 8. DC resistance test on aluminium strands           | (as per IEC 889)          |
| 9. UTS test on welded joint of aluminium strands     | (as per Annexure-C)       |

**Note:** All the above tests except test mentioned at SI.No.1 shall be carried out on aluminium and steel strands after stranding only.

**2.6.3 Routine Tests**

1. Check to ensure that the joints are as per specification.
2. Check that there are no cuts, fins etc. on the strands
3. All acceptance test as mentioned above to be carried out on each coil/drum, as applicable.

**2.6.4 Tests during Manufacture**

1. Chemical analysis of zinc used for galvanizing (as per Annexure C)
2. Chemical analysis of aluminium used for making aluminium strands (as per Annexure C)
3. Chemical analysis of steel used for making steel strands (as per Annexure C)



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ANNEXURE-C  
TESTING PROCEDURE FOR ACSR/ AAC CONDUCTOR

1.0 TYPE TESTS

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at a steady rate to 100% of minimum specified UTS and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 Corona Extinction Voltage Test

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per **Annexure-D1/ D2**, as applicable; in line with **Technical Data Sheet - A**.

1.3 Radio Interference Voltage Test

Under the conditions as specified under Sl. No. 1.2 above, the conductor sample shall have radio interference voltage as indicated in **Technical Data Sheet - A**. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC 437.

1.4 D.C Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per clause no. 12.8 of IS 398 (Part V): 1982. The resistance corrected at 20°C shall conform to the requirements of this specification.

2.0 ACCEPTANCE TESTS

2.1 Visual Check for Joints, Scratches etc. for complete length of conductor

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conforms to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

2.2 Dimensional Check on Steel and Aluminium Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

2.3 Check for Lay –ratios of various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification and clause no. 9.4 and 9.5 of IS 398 (Part-V)-1982.

2.4 Galvanising Test on Steel wire

The test procedure shall be as specified in IEC 888/ IS 4826: 1968. The material shall conform to the requirements of this specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

2.5 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause no. 10.3 of IEC 888/ IS 398 (Part V): 1982. In torsion test, the number of complete twists before fracture shall not be less than that indicated in Technical Data Sheet-A. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it



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will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

2.6 UTS test on welded Aluminium strands

Two Aluminium wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

**Note:** All the above tests except test mentioned at Sl. No. 2.1 shall be carried out on aluminium and steel strands after stranding only.

3.0 ROUTINE TESTS

3.1 Check to ensure that the joints are as per specification

3.2 Check that there are no cuts, fins etc. on strands.

3.3 All acceptance tests as mentioned above to be carried out on each coil/ drum, as applicable.

4.0 TESTS DURING MANUFACTURE

4.1 Chemical Analysis of zinc used for galvanising

Samples taken from the zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

4.2 Chemical Analysis of Aluminium used for making aluminium strands

Samples taken from the Aluminium ingots/ coils/ strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements in this specification.

4.3 Chemical Analysis of Steel used for making steel strands

Samples taken from the Steel ingots/ coils/ strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements in this specification.





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**ANNEXURE-D1**

**CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

**1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

**2. Test Levels**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

**3. Test Methods for RIV**

3.1 RIV tests shall be made according to measuring circuit as per International Special- Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

**4. Test Methods for Visible Corona [applicable for 400kV and above]**

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed



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such that test object essentially, fills the frame with no cut-off. In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

**5. Test Records**

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report,

1. Background noise before and after test.
2. Detailed procedure of application of test voltage.
3. Measurements of RIV levels expressed in micro volts at each level.
4. Results and observations with regard to location and type of interference sources detected at each step.
5. Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
6. Onset and extinction of visual corona for each of the four tests required shall be recorded.



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**ANNEXURE-D2  
CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

**1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

**2. Test Levels**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

**3. Test Methods for RIV**

3.1 RIV tests shall be made according to measuring circuit as per International Special- Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

**4. Test Methods for Visible Corona**

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130%, the voltage shall be raised further till inception of corona or 420Kv, whichever is minimum. Thereafter the voltage will be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears.

4.1 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.2 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.





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## **TECHNICAL DATA SHEET-A**

### **1. Conductor type: ACSR (Moose/ Bersimis/ Zebra) Conductor**

Sl. No.	Description	ACSR Moose	ACSR Bersimis	ACSR Zebra
1.0	Applicable Standard	IS 398/ IEC 1089	IS 398/ IEC 1089	IS 398/ IEC 1089
2.0	<b>Raw Materials</b>			
2.1	Aluminium			
a)	Minimum purity of Aluminium	99.50%	99.50%	99.50%
b)	Maximum copper content	0.04%	0.04%	0.04%
2.2	Steel wires/ rods			
a)	Carbon	0.50% to 0.85%	0.50% to 0.85%	0.50% to 0.85%
b)	Manganese	0.50% to 1.10%	0.50% to 1.10%	0.50% to 1.10%
c)	Phosphorous	Not more than 0.035%	Not more than 0.035%	Not more than 0.035%
d)	Sulphur	Not more than 0.045%	Not more than 0.045%	Not more than 0.045%
e)	Silicon	0.10% to 0.35% (Max.)	0.10% to 0.35% (Max.)	0.10% to 0.35% (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	99.95%	99.95%	99.95%
3.0	<b>Aluminium strands after stranding</b>			
3.1	Diameter			
a)	Nominal	3.53 mm	4.57 mm	3.18 mm
b)	Maximum	3.55 mm	4.61 mm	3.21 mm
c)	Minimum	3.51 mm	4.53 mm	3.15 mm
3.2	Minimum breaking load of strand			
a)	Before stranding	1.57 kN	2.64 kN	1.29 kN
b)	After stranding	1.49 kN	2.51 kN	1.23 kN
c)	Maximum DC resistance of strand at 20 deg. C	2.921 Ohm/km	1.738 Ohm/km	3.626 Ohm/km
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	0.002921 Ohm	0.001738 Ohm	0.003626 Ohm
4.0	<b>Steel strand after stranding</b>			
4.1	Diameter			
a)	Nominal	3.53 mm ✓	2.54 mm ✓	3.18 mm ✓
b)	Maximum	3.60 mm	2.57 mm	3.24 mm
c)	minimum	3.46 mm	2.51 mm	3.12 mm
4.2	Minimum breaking load of strand			
a)	Before stranding	12.86 kN	6.87 kN	10.43 kN
b)	After stranding	12.22 kN	6.53 kN	9.91 kN
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	260 gm	260 gm	260 gm
b)	Minimum number of dips that the	2 dips of one minute & 1dip of half minute	2 dips of one minute & 1dip of half minute	2 dips of one minute & 1dip of half minute





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	galvanised strand can withstand in the standard preece test			
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
<b>5.0</b>	<b>ACSR Conductor</b>			
5.1	Stranding			
a)	Stranding details	Al -54/3.53 mm+ Steel-7/3.53 mm	Al -42/4.57 mm+ Steel-7/2.54 mm	Al -54/3.18 mm+ Steel-7/3.18 mm
b)	Number of strands			
i)	Steel centre	1 Nos.	1 Nos.	1 Nos.
ii)	1st Steel Layer	6 Nos.	6 Nos.	6 Nos.
iii)	1st Aluminium Layer	12 Nos.	8 Nos.	12 Nos.
iv)	2nd Aluminium Layer	18 Nos.	14 Nos.	18 Nos.
v)	3rd Aluminium Layer	24 Nos.	20 Nos.	24 Nos.
5.2	Sectional Area of aluminium	528.50 sq.mm	689.50 sq.mm	428.9 sq.mm
5.3	Total sectional area	597.00 sq.mm	725.00 sq.mm	484.5 sq.mm
5.4	Approximate Weight	2.004 kg/m	2.181 kg/m	1.621 kg/m
5.5	Diameter of the conductor	31.77 mm	35.05 mm	28.62 mm
5.6	UTS of the conductor	161.20 kN (Min)	154 kN (Min)	130.32 kN (Min)
5.7	Lay ratio of the conductor	Max                      Min	Max                      Min	Max                      Min
a)	Outer Steel layer	18                      16	24                      16	28                      13
b)	8/12 wire Aluminium layer	14                      12	17                      10	17                      10
c)	14/ 18 wire Aluminium layer	13                      11	16                      10	16                      10
d)	20/24 wire Aluminium layer	12                      10	13                      10	14                      10
5.8	DC resistance of the conductor at 20°C	0.05552 Ohm/km	0.04242 Ohm/km	0.06868 Ohm/km
5.9	Standard length of the conductor	1800 m	1800 m	1800 m
5.10	Tolerance on Standard length	(±)5%	(±)5%	(±)5%
5.11	Direction of lay of outer layer	Right Hand	Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	2004 kg/km	2181 kg/km	1621 kg/km
b)	Minimum	1965 kg/km	2142 kg/km	1589 kg/km



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c)	Maximum	2045 kg/km	2221 kg/km	1653 kg/km
5.13	Modulus of Elasticity (Final State)	6860 kg/sq.mm	--	--
5.14	Co-efficient of Linear Expansion	19.3x10 <sup>-6</sup> per deg. C	21.5x10 <sup>-6</sup> per deg. C	19.3x10 <sup>-6</sup> per deg. C
5.15	Minimum Corona Extinction Voltage	320 kV rms	320 kV rms	154 kV rms
5.16	RIV at 1 Mhz under dry condition	Max. 1000 microvolts at 320 kV rms	Max. 1000 microvolts at 320 kV rms	Max. 1000 microvolts at 154 kV rms
<b>6.0</b>	<b>Drum Dimensions</b>			
6.1	Applicable Standard	Generally confirms to IS: 1778	Generally confirms to IS: 1778	Generally confirms to IS: 1778
6.2	Drum Dimensions			
a)	Flange Diameter	1800 mm	1800 mm	1850
b)	Traverse width	950 mm	950 mm	925
c)	Barrel Diameter	650 mm	650 mm	650
d)	Flange thickness	50x50 mm	50x50 mm	50x50



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**TECHNICAL DATA SHEET-A  
2. Conductor type: AAC (Bull) Conductor**

Sl. No.	Description	AAC Bull		
1.0	Applicable Standard	IS: 398		
2.0	Raw Materials			
2.1.	Aluminium			
a)	Minimum purity of Aluminium	99.50%		
b)	Maximum copper content	0.04%		
3.0	Aluminium strands after stranding			
3.1	Diameter			
a)	Nominal	4.25 mm		
b)	Maximum	4.29 mm		
c)	Minimum	4.21 mm		
3.2	Minimum breaking load of strand			
a)	Before stranding	2.23 kN		
b)	After stranding	2.12 kN		
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	2.03 Ohm/km		
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	0.00203 Ohm		
4.0	AAC Conductor			
4.1	Stranding			
a)	Stranding details	Al -61/4.25 mm		
b)	Number of strands			
i)	1st Aluminium Layer	1 Nos.		
ii)	2nd Aluminium Layer	6 Nos.		
iii)	3rd Aluminium Layer	12 Nos.		
iv)	4th Aluminium Layer	18 Nos.		
v)	5th Aluminium Layer	24 Nos.		
4.2	Sectional Area of aluminium	865.36 sq.mm		
4.3	Total sectional area	865.36 sq.mm		
4.4	Approximate Weight	2.4 kg/m		
4.5	Diameter of the conductor	38.25 mm		
4.6	UTS of the conductor	139 kN (min.)		
4.7	Lay ratio of the conductor	Max Min		
a)	6 wire Aluminium layer	16 10		
b)	12 wire Aluminium layer	16 10		



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c)	18 wire Aluminium layer	16	10		
d)	24 wire Aluminium layer	14	10		
4.8	DC resistance of the conductor at 20°C	0.03340 Ohm/km			
4.9	Standard length of the conductor	1000 m			
4.10	Tolerance on Standard length	(±)5%			
4.11	Direction of lay of outer layer	Right Hand			
4.12	Linear mass of the conductor				
a)	Standard	2400 kg/km			
b)	Minimum	2355 kg/km			
c)	Maximum	2445 kg/km			
4.13	Modulus of Elasticity	4709 kg/sq.mm (Initial) 5869 kg/sq.mm (Final)			
4.14	Co-efficient of Linear Expansion	23.0x10 <sup>-6</sup> per deg. C			
4.15	Minimum Corona Extinction Voltage	508 kVrms			
4.16	RIV at 1 Mhz	Less than 1000 microvolts at 508 kVrms			
<b>5.0</b>	<b>Drum Dimensions</b>				
6.1	Applicable Standard	Generally confirms to IS 1778			
6.2	Drum Dimensions				
a)	Flange Diameter	1855 mm			
b)	Traverse width	925 mm			
c)	Barrel Diameter	850 mm			
d)	Flange thickness	50x50 mm			



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**TRANSMISSION BUSINESS GROUP**  
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## **SECTION – I**

### **SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES**

#### **1.0 SCOPE**

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of GI SHIELD WIRE.

The equipment is required for the following project.

Name of the customer : Rate contract for various customers

Name of the Project : Rate contract for various projects

#### **1.1 SPECIFIC TECHNICAL REQUIREMENT**

Refer Section II.

#### **1.2 BILL OF QUANTITY**

Sl. No.	Shield Wire Type	Qty
01.	<del>7/8 SWG (7/4.00 mm steel)</del>	<del>20 km</del>
02.	7/9 SWG (7/3.66 mm steel)	1.4 Km

NOTE: Quantity may vary by -25% to +20%.

#### **1.3 TESTS**

Acceptance and routine test shall be performed by the vendor for each order.

#### **1.4 MANDATORY TYPE TESTS**

Bidder shall also indicate the test charges for conducting the following **Type test**:

- a) UTS test ) As per Clause 2.10.1
- b) DC resistance test ) As per Clause 2.10.2

## **SECTION II**

### **STANDARD SPECIFICATION**

#### **2.0 GENERAL**

This section covers the standard technical specification for GI Shield Wire.

#### **TECHNICAL REQUIREMENTS:**

Sl.No	Parameter	7/8 SWG	7/9 SWG
1	Stranding and wire diameter	7/4.0 mm steel	7/3.66 mm steel
2	Strand Arrangement		
	Steel core	1	1
	Outer Steel Layer	6	6
3	Total sectional area	90.62 mm <sup>2</sup>	73.65 mm <sup>2</sup>
4	Overall diameter	12.0 mm	10.98 mm
5	Approximate weight	687 kg/km	583 kg/km
6	Calculated d.c. resistance at 200	2.09 ohms/km	2.5 ohms/km
7	Minimum ultimate tensile strength	77.7 kN	68.4 kN
8	Direction of lay of outer layer	Right hand	Right hand
9	Standard Drum Length	250/500/1000/2000/4000 meter	
10	Protective coating for storage	Boiled linseed oil to avoid wet storage stains.	

#### **2.1 EQUIPMENT SPECIFICATION**

This section covers the general technical requirements of the Galvanised Steel Wire. In case of any discrepancies between the requirements mentioned in this section and those specified in other sections of this specification, this shall prevail after Section 1 and shall be treated as binding requirements.

#### **2.2 APPLICABLE STANDARDS**

The Galvanised Steel Wire shall strictly conform to the following Indian and International standards, as appropriate:

IS: 521(1991)	Method for tensile testing of steel wire
ISO/R89-1959	
IS: 1778-1980	Reels and drums for bare conductors
IS: 2629(1990)	Recommended practice for hot dip galvanizing on iron and steel.
IS: 2633(1992)	Method for testing uniformity of coating of zinc-coated articles
IS: 4826(1992)	Hot dip galvanized coatings on round steel wires
ASTMA-475-72a	
IS: 6745 (1990)	Methods for determination of mass of Zinc coating on zinc- coated iron and steel articles

IS: 209(1992) Zinc ingot  
IS 398 (Parts-I to Aluminium conductors for Overhead transmission purposes  
V): 1992

## **2.3 TECHNICAL REQUIREMENT AND CONSTRUCTIONAL DETAILS**

**2.3.1** The galvanized steel stranded wire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part- II):1976 except where otherwise Specified herein.

## **2.4 WORKMANSHIP**

**2.4.1** All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

**2.4.2** The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

**2.4.3** The steel strands shall be hot dip galvanized (and shall have a minimum zinc coating of 275 g/m<sup>2</sup>) after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics in ASTM designation B498-74.

**2.4.4** The steel strands shall be preformed and post-formed in order to prevent spreading of strands while cutting of composite stranded wire. Care shall be taken to avoid damage to galvanization during pre-forming and post-forming operation.

**2.4.5** To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

## **2.5 JOINTS IN WIRES**

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the stranded wire. There shall be no strand joints or strand splices in any length of the completed stranded wire.

## **2.6 TOLERANCE**

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of the individual steel strands and lay length of the stranded wire:

	Standard	Maximum	Minimum
Diameter	3.66mm	3.75mm	3.57mm
Lay length	181mm	198mm	165mm



## 2.7 MATERIALS

### 2.7.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and shall conform to the following requirements as to the chemical composition:

Element	% Composition
Carbon	Not more than 0.55
Manganese	0.4 to 0.9
Phosphorous	Not more than 0.04
Sulphur	Not more than 0.04
Silicon	0.15 to 0.35

### 2.7.2 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209-1979

## 2.8 STANDARD LENGTH

2.8.1 The stranded wire shall be supplied in standard drum lengths generally in the range of 250/500/1000/2000/4000 m. However, drum lengths where required to be supplied in lengths different from standard lengths specified above shall be provided.

## 2.9 TESTS

2.9.1 The G.S. Wire should have been type tested as per IEC/IS and shall be subjected to routine and acceptance tests in accordance with applicable IS specifications/ ISO/ ASTMA recommendations. Type test reports of the tests conducted earlier (not more than five years earlier) on similar material shall be submitted. If the valid type test reports are not available with the bidder then the tests shall be conducted by the bidder free of cost.

2.9.2 If the purchaser insists to carry out the type test(s) afresh, the same shall be conducted on chargeable basis, for that the bidder shall submit the test charges in the price bid.

### 2.9.3 TYPE TESTS

In accordance with the stipulation of the specification the following type tests shall be conducted on the stranded wire.

- a) UTS test ) As per Clause 2.10.1
- b) DC resistance test ) As per Clause 2.10.2

### 2.9.4 ACCEPTANCE TESTS

- a) Visual check for joints, scratches etc. and length of stranded wire (As per Clause 2.10.3)
- b) Dimensional check(As per Clause 2.10.5)
- c) Galvanizing test (As per Clause 2.10.7)
- d) Lay length check (As per Clause 2.10.6)

- e) Torsion test (As per Clause 2.10.4)
- f) Elongation test (As per Clause 2.10.4)
- g) Wrap test
- h) DC resistance test ( IS 398(Part-III))1976
- i) Breaking load test ( IS 398(Part-III))1976
- j) Chemical Analysis of steel ( IS 398(Part-III))1976)

#### **2.9.5 ROUTINE TESTS**

- a) Check that there are no cuts, fins etc. on the strands.
- b) Check for correctness of stranding.

#### **2.9.6 TESTS DURING MANUFACTURE**

- a) Chemical analysis of zinc used for galvanizing (As per Clause 2.10.8)
- b) Chemical analysis of steel (As per Clause 2.10.9)

#### **2.9.7 SAMPLE BATCH FOR TYPE TESTING**

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance program approved by the Owner. The samples for type testing shall be manufactured strictly in accordance with the quality Assurance Program approved by the Owner.

### **2.10 TESTING PROCEDURE FOR STRANDED GALVANISED STEEL WIRE**

#### **2.10.1 UTS Test**

Circles perpendicular to the axis of the stranded wire shall be marked at two places on a sample of stranded wire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 34 kN and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 kN and held for one minute. The stranded wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

#### **2.10.2 D.C Resistance Test**

On a stranded wire sample of minimum five metres length, two contact clamps shall be fixed with a pre-determined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20<sup>0</sup>C shall conform to the requirements of this specification.

#### **2.10.3 Visual Check for Joints, Scratches etc. and length of Stranded wire**

Stranded wire drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and see that the stranded wire generally conforms to the requirements of this specification. The length of stranded wire wound on the drum shall be measured with the help of counter meter during rewinding.

#### **2.10.4 Torsion and Elongation Tests**

The test procedures shall be as per relevant clause of IS 398 (Part V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 64% for a gauge length of 200 mm.

#### **2.10.5 Dimensional Check**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

#### **2.10.6 Lay Length Check**

The lay length shall be checked to ensure that they conform to the requirements of this specification.

#### **2.10.7 Galvanizing Test**

The test procedure shall be as specified in IS: 4826-1968. The material shall conform to the requirements of this specification.

#### **2.10.8 Chemical Analysis of Zinc used for Galvanizing**

Samples taken from the zinc ingots shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

#### **2.10.9 Chemical Analysis of Steel**

Samples taken from the steel ingots/coils/strands shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

#### **2.11 Following drawings/ documents shall be submitted for approval/ information for each project:**

- i) Guaranteed and other technical particulars
- ii) Drum Drawing
- iii) Type, Acceptance, sample and routine test reports

--XX--

**SECTION – IV**

**GUARANTEED AND TECHNICAL PARTICULARS OF STRANDED G. S.WIRE**

S. No.	Description	Unit	Particulars
<b>1.</b>	<b>Name &amp; Address of manufacturer</b>		
<b>2.</b>	<b>Particulars of raw materials</b>		
2.1	Aluminium		
	a) Minimum Purity of Aluminium	%	
	b) Maximum Copper Content	%	
2.2	Steel wires/Rods		
	a) Carbon	%	
	b) Manganese	%	
	c) Phosphorous	%	
	d) Sulphur	%	
	e) Silicon	%	
2.3	Zinc		
	a) Minimum purity of Zinc	%	
<b>3.</b>	<b>STEEL STRANDS BEFORE STRANDING</b>		
3.1	Diameter		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
3.2	Minimum breaking load of strand	kN	
3.3	Maximum Resistance of 1 M Length of strand of 20°C	Ohm	
<b>4.0</b>	<b>STEEL STRANDS AFTER STRANDING</b>		
4.1	a) Nominal Diameter	mm	
	b) Maximum Diameter	mm	
	c) Minimum Diameter	mm	
4.2	Minimum breaking load of strand	kN	
4.3	Galvanising		
	a) Min. weight of zinc coating of uncoated wire surface	g/ m <sup>2</sup>	
	b) Min. number of one minute dips that the galvanised strand can withstand in the standard Preece test	Nos.	
	c) Min. No. of twists in gauge length equal to 100 times the dia of wire which the strand can withstand in the torsion test	Nos.	
<b>5.</b>	<b>COMPLETED STRANDED WIRE</b>		
5.1	UTS of stranded wire	kN	
5.2	Lay length of outer steel layer	mm	
5.3	DC resistance of stranded wire at 20°C	Ω/km	
5.4	Direction of lay of outer layer	-	
5.5	Linear mass of earth wire		
	a) Nominal	Kg/km	
	b) Maximum	Kg/km	
	c) Minimum	Kg/km	
6.0	Is drum as per I.S	Yes/No	
5.6	Standard length of stranded wire in the drum	m	

**ANNEXURE – A**

**NO DEVIATION CERTIFICATE**

-----  
It is confirmed that there is no deviation and the offer is in full compliance with the specification. It is also confirmed that there are no deviations in any other form such as comments, variations and or exceptions. Further it is confirmed that at all drawings/ data sheets/ QP/ type tests reports shall be submitted to BHEL for organizing approval of ultimate customer. Also, furnishing of all relevant information/ repetition of type tests (if required for meeting the specification requirement) shall be carried out by us at no extra cost to BHEL and without affecting delivery requirements.  
-----

Signature of the authorized representative of Bidder

Name \_\_\_\_\_

Designation \_\_\_\_\_

Place \_\_\_\_\_

Date \_\_\_\_\_

Company Seal

## **ANNEXURE-E8: CABLE RACK MATERIAL**

### **1.0 SCOPE**

This technical specification covers design, manufacture, testing at works, packing and despatch of Cable Trench material complete with accessories as listed below.

This section covers the general technical requirements of Cable Trench Material. In case of any discrepancies between the requirements mentioned in this section and those specified in other sections of this specification, the latter shall prevail and shall be treated as binding requirements.

### **1.1 TECHNICAL PARAMETERS**

#### **A. Rack assembly**

Material of cable racks	:	MS
Size and material of cable rack assemblies	:	50 x 50 x 6 (thick) mm MS angles
Whether Galvanised or painted	:	Galvanized
Mass of Zinc coating	:	610 gm/m <sup>2</sup>

#### **B. Hanger Assembly**

Material of cable racks	:	MS
Material of hanger assemblies	:	50 x 50 x 6 (thick) mm MS angles
Whether Galvanised or Painted	:	Galvanised
Mass of Zinc coating	:	610 gm/m <sup>2</sup>

### **2.1 APPLICABLE STANDARDS**

The Cable Trench Material shall conform to latest revision of the following Indian Standards:

Steel for general structural purpose	:	IS:2062-1999
Method for testing uniformity of coating on Zinc coated articles	:	IS:2633-1986
Recommended practice for hot dip galvanising on iron & steel	:	IS:2629-1985
Hot dip Zinc coating on structural steel and other allied products	:	IS:4759-1984
Method for determination of mass of zinc coating on zinc coated iron and steel articles	:	IS:6745-1972
Rolled steel beams, channel and angles	:	IS:808-1989
Rolling and Cutting tolerances for rolled steel products	:	IS:1852-1985

## **ANNEXURE-E8: CABLE RACK MATERIAL**

Recommended practice for red oxide : IS:2074-1992  
And zinc chromate on iron & steel

### **2.2 TECHNICAL REQUIREMENTS**

- 2.2.1 The material (Mild Steel) used for the supply shall be in sound condition and of recent manufacture, free from defects, loose mill scale, slag, pitting, rust, etc.

The cable rack and hanger assembly shall be hot dip galvanised.

- 2.2.2 Galvanising of the hanger assembly shall be done. The min. thickness of coating shall be 85 microns for all items thicker than 6mm. For items with thickness lower than 6mm requirement of coating thickness shall be as per relevant ASTM. Coating shall be adherent, smooth and reasonably bright, continuous and free from such imperfection as flux, ash, bare and black spot, pimples, lumpiness, rust stains, bulky white deposits and blisters and zinc chromate/red oxide shall conform to IS : 2074-1992.
- 2.2.3 The hanger assemblies shall not have sharp edges cuts, abrasions etc. and the zinc coating shall be adherent, smooth and reasonably bright, continuous and free from such imperfections as flux, ash, bare and black spot, pimples, lumpiness, rust stains.
- 2.2.4 All drilling, cutting, bending etc. of fabricated steel work shall be carried out before galvanising.
- 2.2.5 All angles shall be cut with shearing machine / power hack-saw, cutting with gas welding is not permitted.
- 2.2.6 The bidder shall indicate in his offer, the final weight of the rack after punching and galvanising.

### **2.3 TESTS**

Details of tests for Cable Trench Material shall be as follows:

1. Dimensional and visual examination - As per BHEL approved drawing.
2. Mass of Galvanisation - IS: 6745: 1972
3. Test for galvanising (Acceptance Test)  
The test shall be done as per approved standards
4. Uniformity of zinc coating - IS: 2633: 1986
5. Mass of zinc coating – IS: 6745:1972
6. Chemical composition test -As per IS: 2062-1999.
7. Tensile - As per IS: 2062-1999.
8. Bending test -As per IS: 2062-1999.

900-318-198-9-BL	INVENTORY No.	SIGN. & DATE	COMPUTER AND PAPER NAME :	COPY RIGHT AND CONFIDENTIAL The Information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly in contrary department in the interest of the company.	
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## LEGEND

CONNECTION TO GROUND MAT THROUGH RISER (MS ROD RISER TO BE ARRANGED BY CUSTOMER)

RE CONNECTION TO ROD ELECTRODE (ELECTRODE IS NOT IN BHEL SCOPE)

PE CONNECTION TO PIPE ELECTRODE WITH TREATED EARTH PIT (ELECTRODE IS NOT IN BHEL SCOPE)

75x12mm GS FLAT (BHEL SCOPE)

50x6mm GS FLAT (BHEL SCOPE)

40mm DIA MS ROD (MS ROD IS NOT IN BHEL SCOPE)

## GENERAL NOTES:

- EARTH STRIP CLEATED TO LATTICE /PIPE TYPE STRUCTURE AT AN INTERVAL OF 1.0M SUITABLE PROVISION SHALL BE MADE WITH SUPPORT STRUCTURE.
- ALL EARTH STRIPS SHALL BE TAKEN ALONG EDGE OF STRUCTURE. ALL DRAWING SHOWS TYPICAL ARRANGEMENT ONLY.
- ALL STRUCTURES/EQUIPMENTS SHALL BE EARTHED AS SHOWN IN THE FOLLOWING SHEETS.
- BOLT SIZE FOR CONNECTING EARTHING FLAT TO THE EQPT/STRUCTURE SHALL BE TO SUIT RESPECTIVE HOLE SIZE.
- ALL EARTHING SHALL BE DONE IN ACCORDANCE WITH IS:3043 UNLESS OTHERWISE STATED IN TECHNICAL SPECIFICATION
- EACH RISER OF A PARTICULAR EQUIPMENT SHALL BE CONNECTED TO A DIFFERENT EARTHROD (EITHER HORIZONTAL OR VERTICAL CONDUCTORS OF MAIN EARTHMAT).
- FOR WELDING DETAILS REFER SHEET #17 & 18
- E/WIRE DOWN CONDUCTOR SHALL BE CLEATED AT AN INTERVAL OF 2.0 M ALONG WITH STRUCTURE .
- THE DRAWING IS INDICATIVE AND IS MEANT ONLY FOR ABOVE GROUND EARTHING OF POTHEAD YARD EQUIPMENT, STRUCTURES, TOWERS & MECHANISM BOXES. EQUIPMENT DIMENSIONS & DETAILS ARE TYPICAL.
- ALL BELOW GROUND EARTHING (LAYING OF MAIN EARTHMAT, AUXILIARY EARTHMAT FOR ISOLATOR MOM BOXES AND GROUNDING ELECTRODES (PIPE/ROD) ARE NOT IN BHEL SCOPE. CUSTOMER SHALL ARRANGE RISERS NEAR EQUIPMENT FOUNDATIONS AND EARTHING FROM RISERS TILL EQUIPMENT/ STRUCTURE IS IN BHEL SCOPE.

SHEET NO.	DESCRIPTION
01.	TITLE
02.	NOTES
03.	400KV LINE CVT (WITH LMU)
04.	400KV POST INSULATOR & CABLE TERMINATION
05.	390KV LIGHTNING ARRESTER
06.	MARSHALLING KIOSK
07.	400KV HORIZONTAL DOUBLE BREAK ISOLATOR (TYPICAL) WITH TWO EARTH SWITCH
08.	TOWER WITH PEAK
09.	400KV CURRENT TRANSFORMER
10.	CABLE TRENCH
11.	ROD ELECTRODE WITHOUT PIT (FOR CVT & LA)
12.	ROD EARTH ELECTRODE WITH TEST PIT FOR TOWERS WITH PEAK & SHIELD WIRE SUPPORT STRUCTURE
13.	DELETED
14.	AUXILIARY EARTH MAT FOR ISOLATOR MAIN MECH.,E/S MECH. BOX
15.	GATE/FENCE POST
16.	TYPICAL ARRANGEMENT OF BOLTED JOINTS
17.	WELDING DETAILS
18.	WELDING DETAILS

ADDITIONAL INFORMATION	PROJECT	GX170MW PUNATSANGCHHU-II EM-2 HEP, BHUTAN			
STATUS OF DRAWING	CUSTOMER	PHPA-II, BHUTAN			
DISTRIBUTION OF PRINTS	CONSULTANT	WAPCOS Ltd, Gurgaon			
		Central Electricity Authority, New Delhi			
DATE	NAME	DATE	NAME	DATE	NAME
CHKD	AK				
APPD	DKM				
SUB-SUPPLIER/VENDOR		CONTRACTOR			
		BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP			
		SCALE		REF. TO ASSY. DRL.	
		1 : 900			
		TITLE		REV.	
		ACCVH POTHEAD YARD - EQUIPMENT EARTHING		08	
		PHOTOGRAPHY & DETAILS			



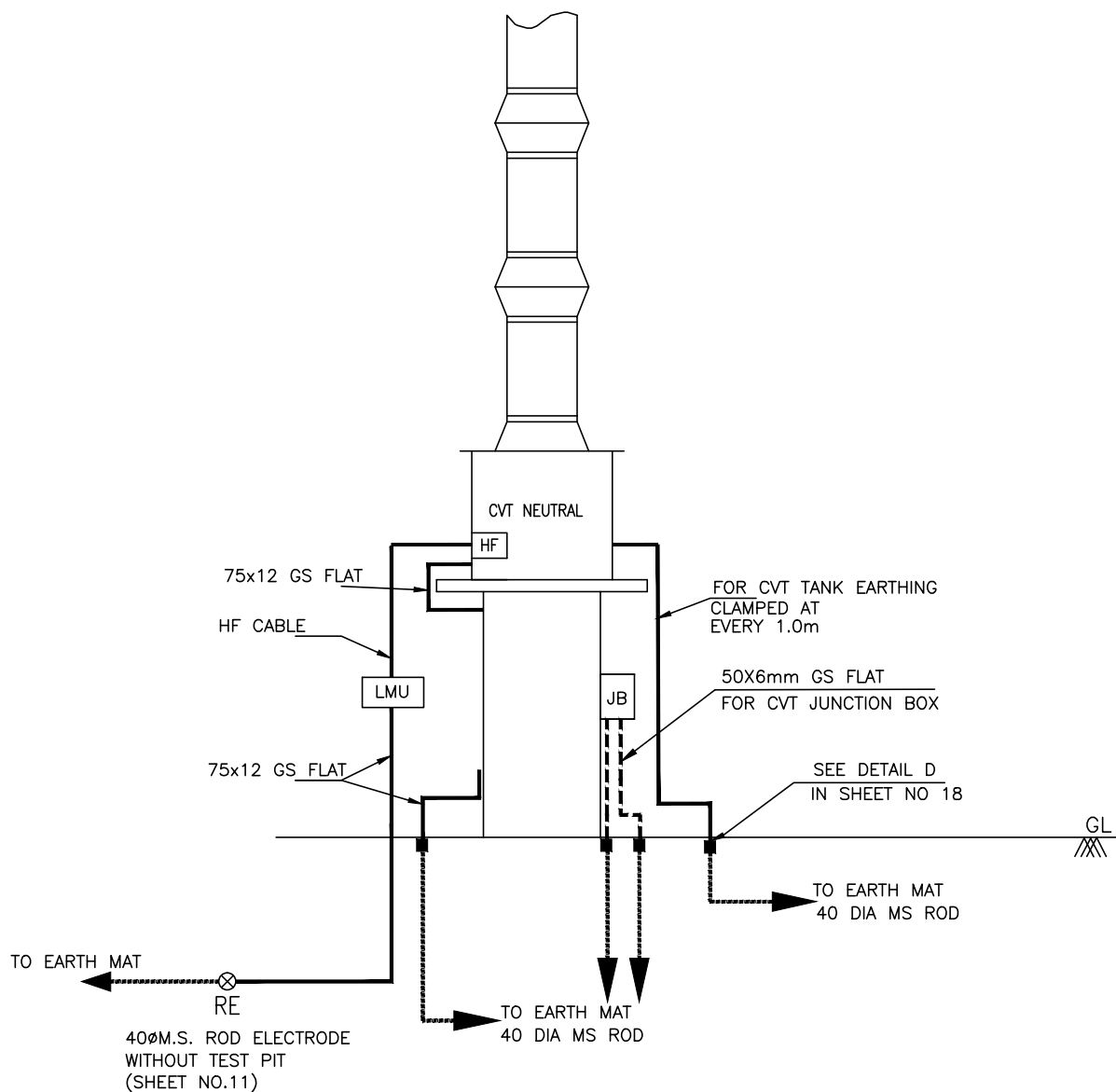
1. RISER FROM THE EARTH GRID SHALL BE 40MM DIAMETER MILD STEEL ROD. RISER SHALL RISE FROM THE GROUND ALONG THE NEAREST EQUIPMENT FOUNDATION/BUILDING COLUMN/WALL TO AVOID ANY OBSTRUCTION TO MOVEMENT OF PERSONNEL.
2. CONNECTION TO ALL EQUIPMENT AND TOWERS SHALL BE BY BOLTED JOINTS. CONTACT SURFACES SHALL BE THOROUGHLY CLEANED BEFORE CONNECTIONS. EQUIPMENT BOLTED CONNECTIONS AFTER BEING TESTED AND CHECKED SHALL BE PAINTED WITH ANTI CORROSIVE PAINT/COMPOUND.
3. CONNECTIONS BETWEEN EQUIPMENT EARTHING LEADS AND BETWEEN MAIN EARTHING CONDUCTORS SHALL BE OF WELDED TYPE. FOR RUST PROTECTION THE WELDS SHOULD BE TREATED WITH RED LEAD COMPOUND AND AFTERWARDS THICKLY COATED WITH BITUMEN COMPOUND.  
THE SURFACES TO BE WELDED SHALL BE CLEANED OF DIRT, OIL, GREASE AND OXIDES BEFORE WELDING. ANY OXIDE FILMS THAT MAY HAVE FORMED DURING WELDING MUST BE REMOVED FROM THE WELDED JOINT.
4. EARTHING CONDUCTOR FOR EQUIPMENT SHALL BE OF GALVANISED M.S. OF SIZE 75x12/50x6 mm.  
THE CONDUCTOR BELOW THE GROUND LEVEL SHALL BE 40 mm DIA BLACK MS ROD.
5. IN THE ATTACHED DRAWINGS GL REPRESENTS GROUND LEVEL.
6. ALL THE EQUIPMENTS SHALL BE EARTHED AT TWO POINTS WITH 75x12 mm. G.S. FLAT EVEN THOUGH THEY ARE SHOWN OR NOT IN THE DRAWING DUE TO CLARITY.
7. ALL JUNCTION BOXES, OPERATING MECHANISAM BOXES, GROUND MOUNTED CONTROL CABINETS SHALL BE EARTHED AT TWO POINTS WITH 50x6mm G.S. FLAT BY TWO SEPARATE AND DISTINCT EARTH CONNECTERS.
8. EARTHING CONDUCTORS FROM EQUIPMENT STRUCTURES SHALL BE CONNECTED TO THE NEAREST POSSIBLE EARTH MAT RISER. EQUIPMENT EARTHING SHALL BE AS PER IS 3043.
9. ALL JOINTS BETWEEN 40 DIA M.S. ROD AND 75x12 mm. G.S. FLAT SHALL BE BELOW GROUND LEVEL.
10. FOR WELDED JOINTS LOW HYDROGEN CONTENT ELECTRODES SHALL BE USED.
11. METTALIC SHEATHS/SCREENS, AND ARMOUR OF MULTI CORE CABLES SHALL BE EARTHED AT BOTH ENDS.  
METTALIC SHEATHS AND ARMOUR OF SINGLE CORE CABLES SHALL BE EARTHED AT SWITCHGEAR END ONLY UNLESS OTHERWISE INSTRUCTED BY THE EMPLOYER.
12. EQUIPMENT BOLTED CONNECTIONS AFTER BEING TESTED AND CHECKED SHALL BE PAINTED WITH ANTI CORROSIVE PAINT/COMPOUND.
13. LOCATION OF EARTHING CONDUCTORS/RISERS SHOWN IN THE EARTHING DRAWING MAY CHANGE TO SUIT THE SITE CONDITION.
14. FOR SURGE ARRESTER, EARTHING LEAD FROM SURGE COUNTER TO MAIN EARTHMAT SHALL BE SHORTEST IN LENGTH AS PRACTICALLY AS POSSIBLE.
15. AN ADDITIONAL AUXILIARY GRID OF 1500MMX1500MM COMPRISING OF CLOSELY SPACED(300MMX300MM) 40 DIA CONDUCTORS AT A DEPTH OF 300MM FROM FINISHED GROUND LEVEL SHALL BE PROVIDED BELOW THE OPERATING HANDLE OF ISOLATORS AND EARTH SWITCHES. THIS GRID SHALL BE CONNECTED TO THE MAIN GROUND GRID.  
THE EARTH CONNECTION TO OPERATING HANDLE SHALL BE MADE OF FLEXIBLE CONNECTION. THE MOM BOX OF THE ISOLATOR TO BE CONNECTED TO THIS AUX. GRID.
16. ALL NON CURRENT CARRYING METALIC PARTS SHALL BE EARTHED AT TWO DIFFERENT PLACES.
17. ALL EQUIPMENT DRAWINGS SHOWN ARE INDICATIVE ONLY.
18. WELDING OF EARTHING CONDUCTOR SHALL BE CONNECTED IN VERTICAL PLANE WHEREVER POSSIBLE.



## EQUIPMENT EARTHING DETAILS NOTES

DRG. No. TB-4-365-318-006

SHEET No.  
02



NOS.OF RISERS

= 2 NOS. PER PHASE

+ 2 NOS. FOR CVT JUNCTION BOX

ROD ELECTRODE = 1 NO. PER CVT (NEUTRAL IS CONNECTED TO GROUND VIA LMU)



## EQUIPMENT EARTHING DETAILS 400kV LINE CVT (WITH LMU)

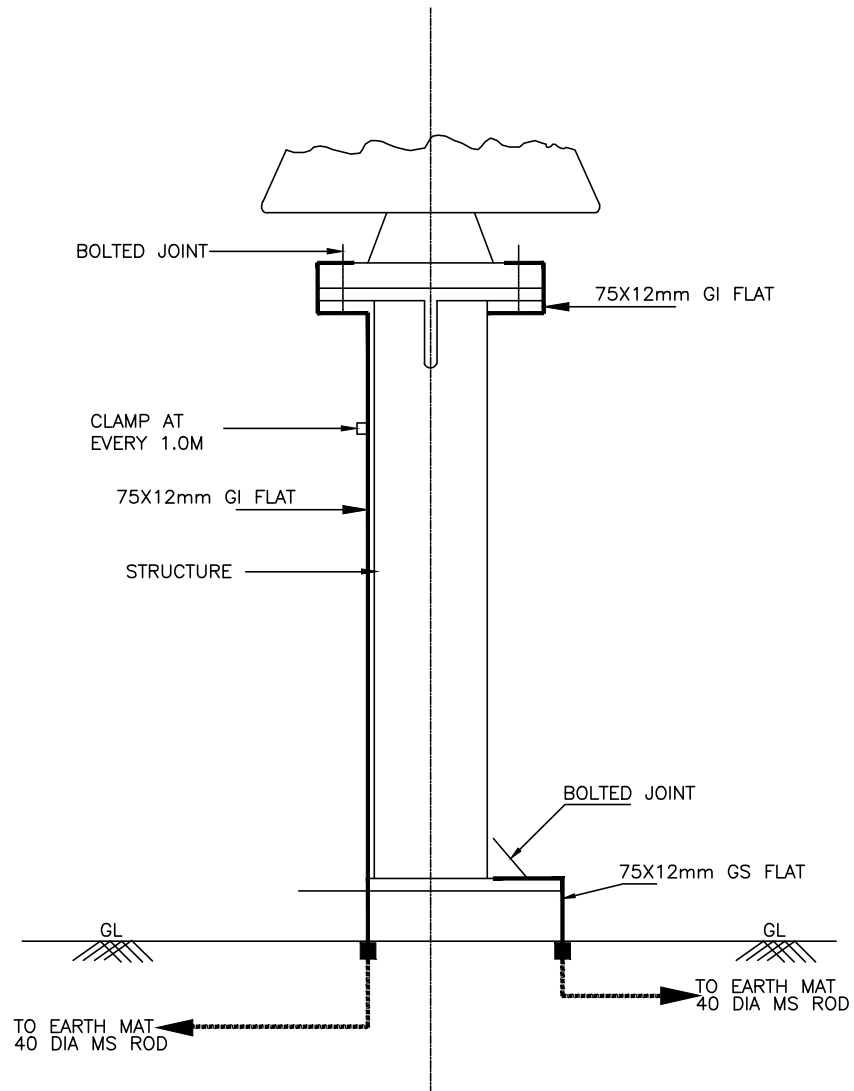
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DRG. No.

TB-4-365-318-006

SHEET No.

03



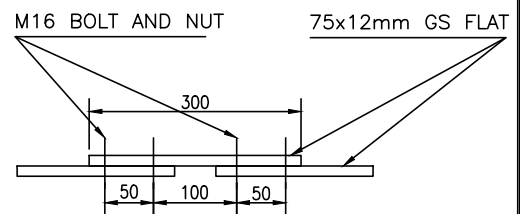
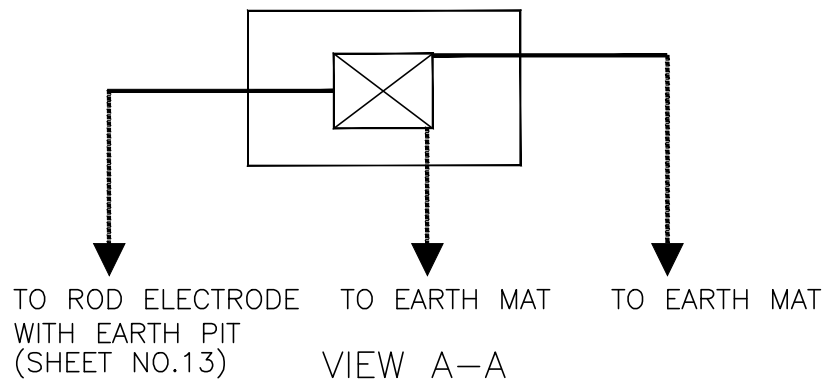
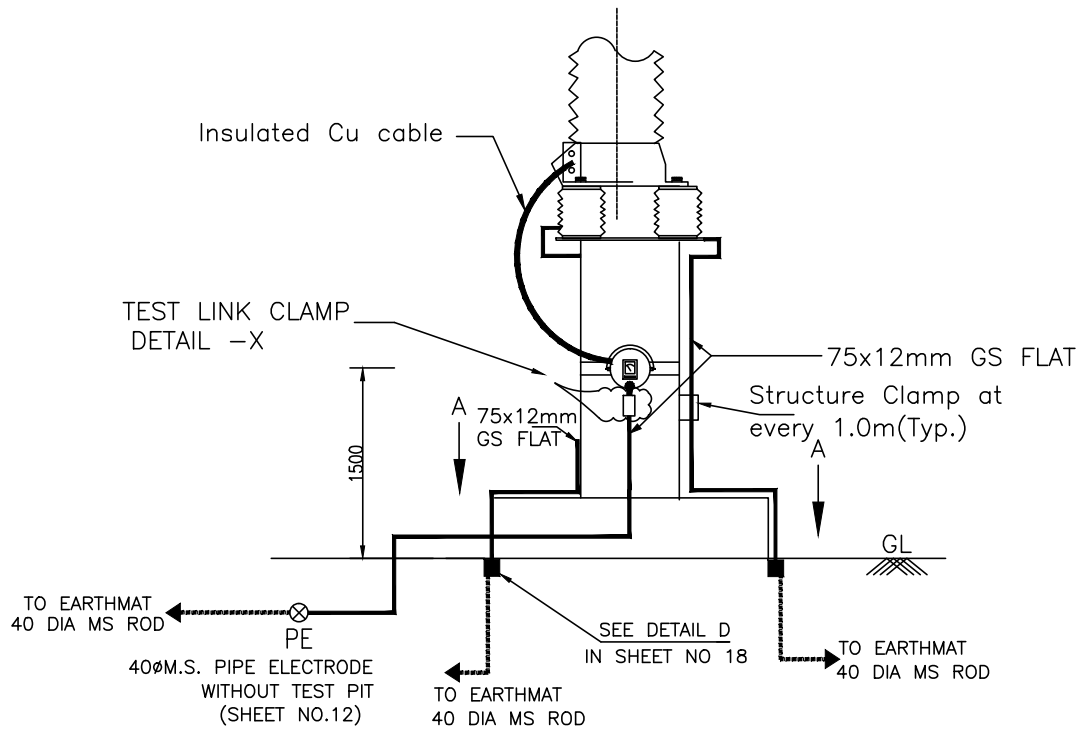
NOS.OF RISERS = 2 NOS.



# EQUIPMENT EARTHING DETAILS 400kV POST INSULATOR & CABLE TERMINATION

DRG. No. TB-4-365-318-006

SHEET No.  
04



NOTES;

1. LA SHALL BE EARTHED THROUGH EARTH TERMINAL OF SURGE COUNTER
2. NO. OF ROD ELECTRODE : 1 NO.  
NO OF RISERS = 3 NOS.
3. TEST LINK SHALL HAVE PROVISION TO BOLT TEST LEAD BEFORE ISOLATING THE MAIN EARTHING CONNECTIONS (AS PER SKETCH ABOVE) = 1NO.



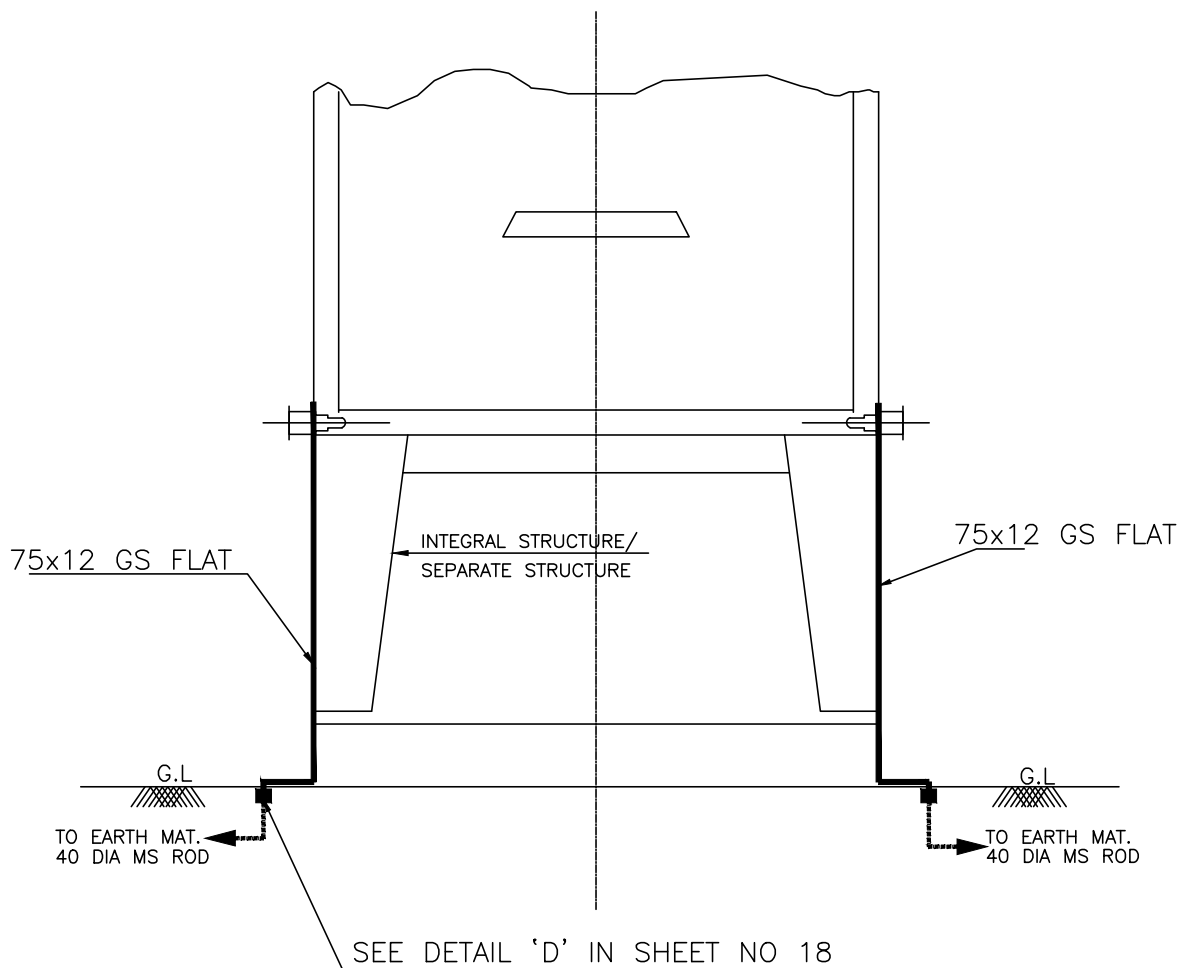
EQUIPMENT EARTHING DETAILS  
390kV LIGHTNING ARRESTER

COMPU. DRG. REF.

DRG.NO.

TB-4-365-318-006

SHEET No.  
05



NOS.OF RISERS = 2 NOS.



## EQUIPMENT EARTHING DETAILS

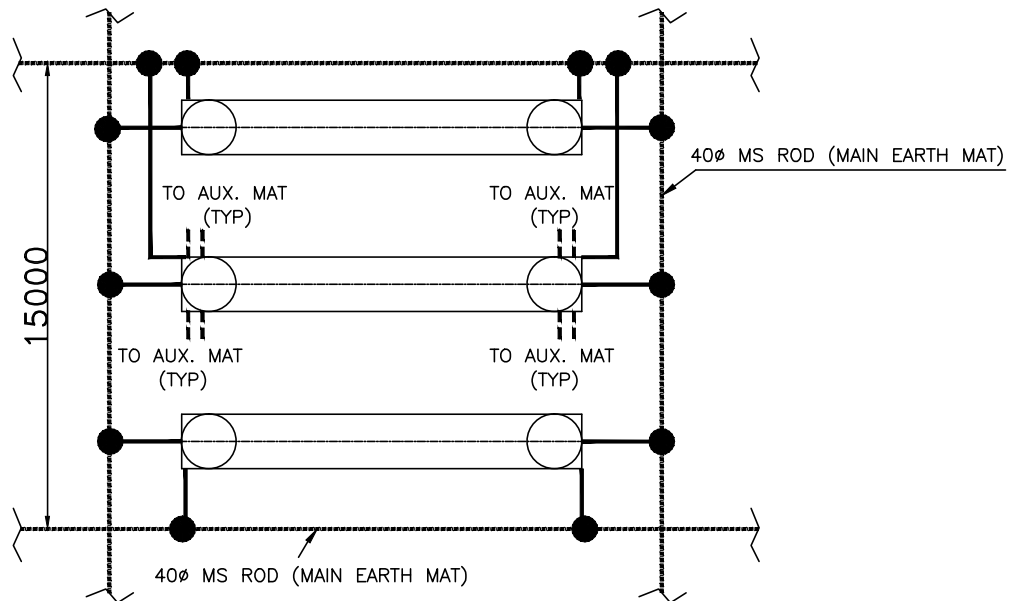
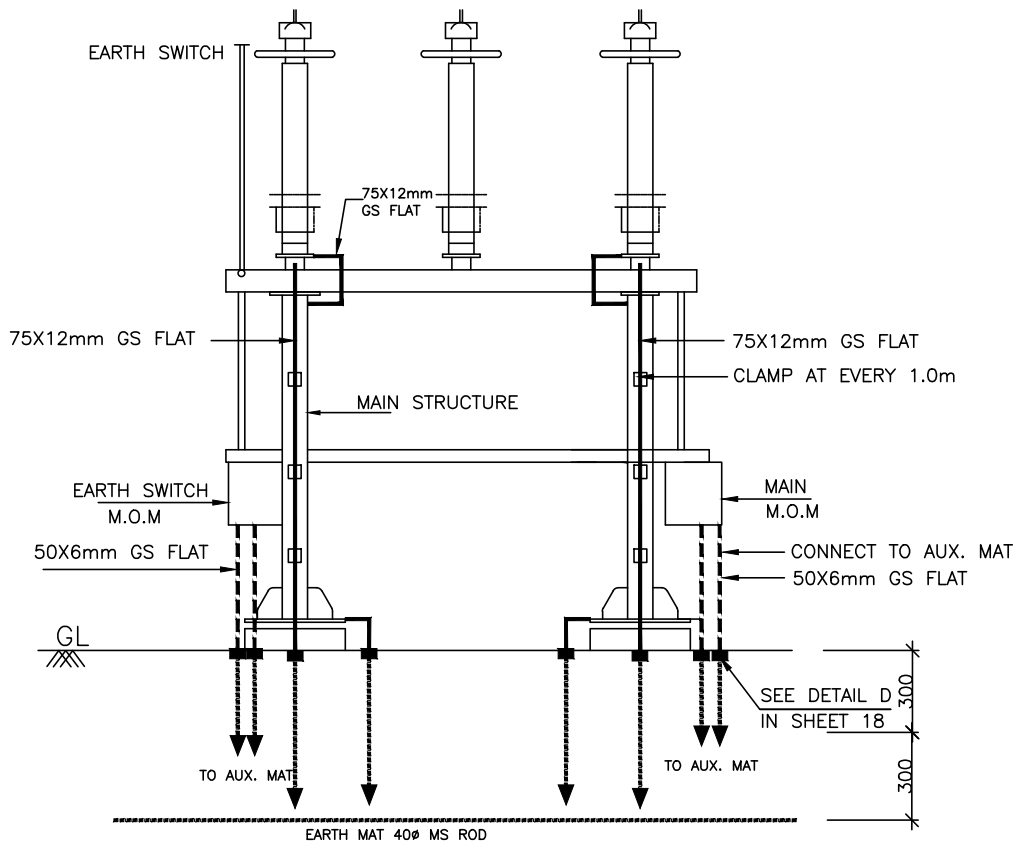
### MARSHALLING KIOSK

COMPUTERREF.NO.

DRG. No.

TB-4-365-318-006

SHEET No.  
06



**NOTES:**

1. NO. OF RISER FOR EQUIPMENT = 4 Nos./PHASE
2. NO. OF RISER FOR MECHANISM BOX = 2 Nos./BOX
3. NO. OF AUXILIARY MAT = 1 No./BOX



**EQUIPMENT EARTHING DETAILS**  
400kV HORIZONTAL DOUBLE BREAK  
ISOLATOR (TYPICAL) WITH ONE EARTH SWITCH

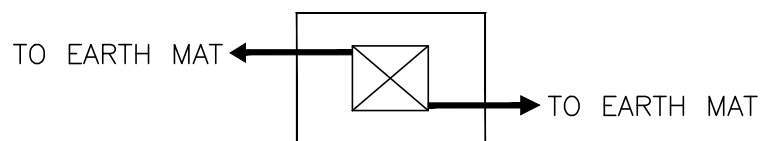
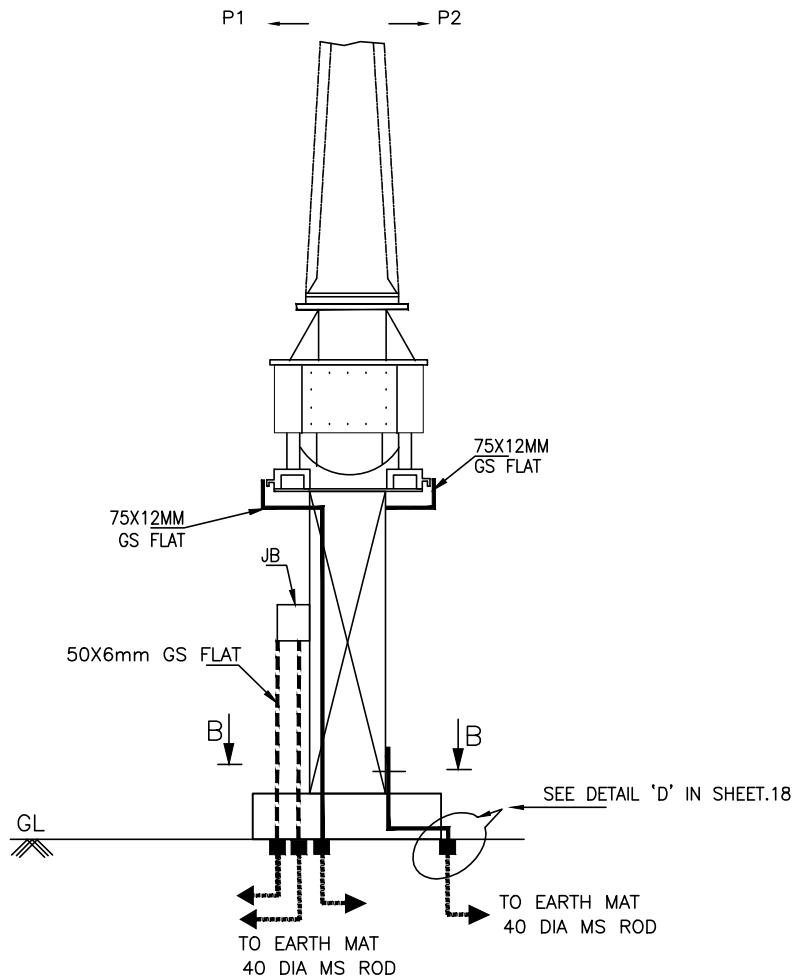
COMPUTERREF.NO.

DRG. No.

TB-4-365-318-006

SHEET No.  
07





View B-B

NOS.OF RISERS  
 = 2 NOS. PER PHASE FOR CT  
 + 2 NOS. FOR CT JB



# EQUIPMENT EARTHING DETAILS 400kV CURRENT TRANSFORMER

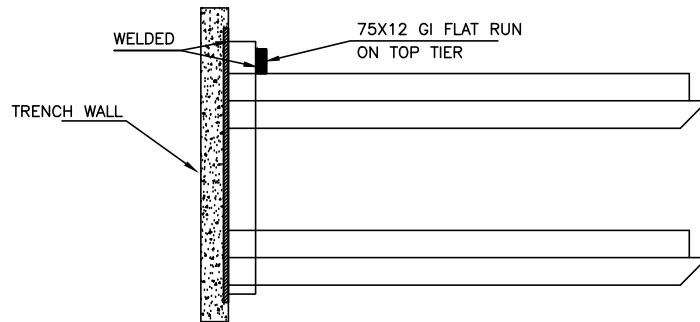
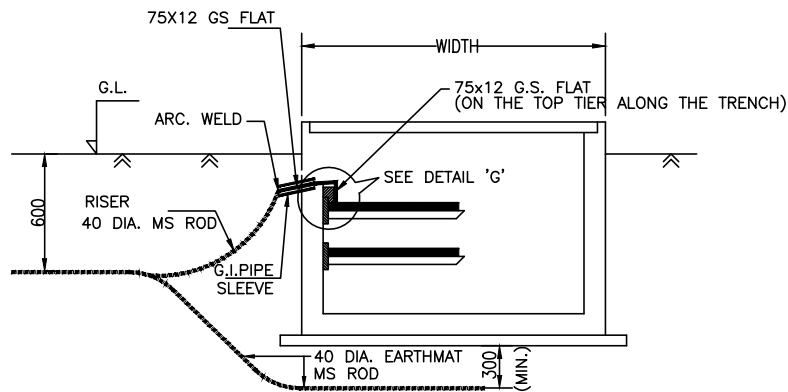
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DRG.NO.

TB-4-365-318-006

SHEET No.  
 09





DETAIL 'G'

DETAIL FOR CONNECTING GI FLAT RUNNING  
ON TOP TIER TRENCH TO EMBEDDED PLATE.

**NOTE:**

1. RISERS SHALL BE PROVIDED AT AN INTERVAL OF 20M ALONG THE LENGTH OF TRENCH.
2. THE EARTH STRIP (75x12 G.S. FLAT) SHALL BE WELDED/CLEATED TO TOP RACK ALONG THE TRENCH RUN AT EVERY 0.75M.
3. WHERE THE CABLE RACKS ARE PROVIDED ON BOTH SIDES OF THE TRENCH, BOTH SIDES SHALL BE EARTHED AS PER ABOVE.
4. CABLE & CABLE TRAY EARTHING SHALL BE DONE AS PER SPECIFICATION.
5. TRENCH SECTION SHOWN IS INDICATIVE. TOP TIER OF ALL TRENCH SECTIONS AS PER LAYOUT DRAWING SHALL BE EARTHED.



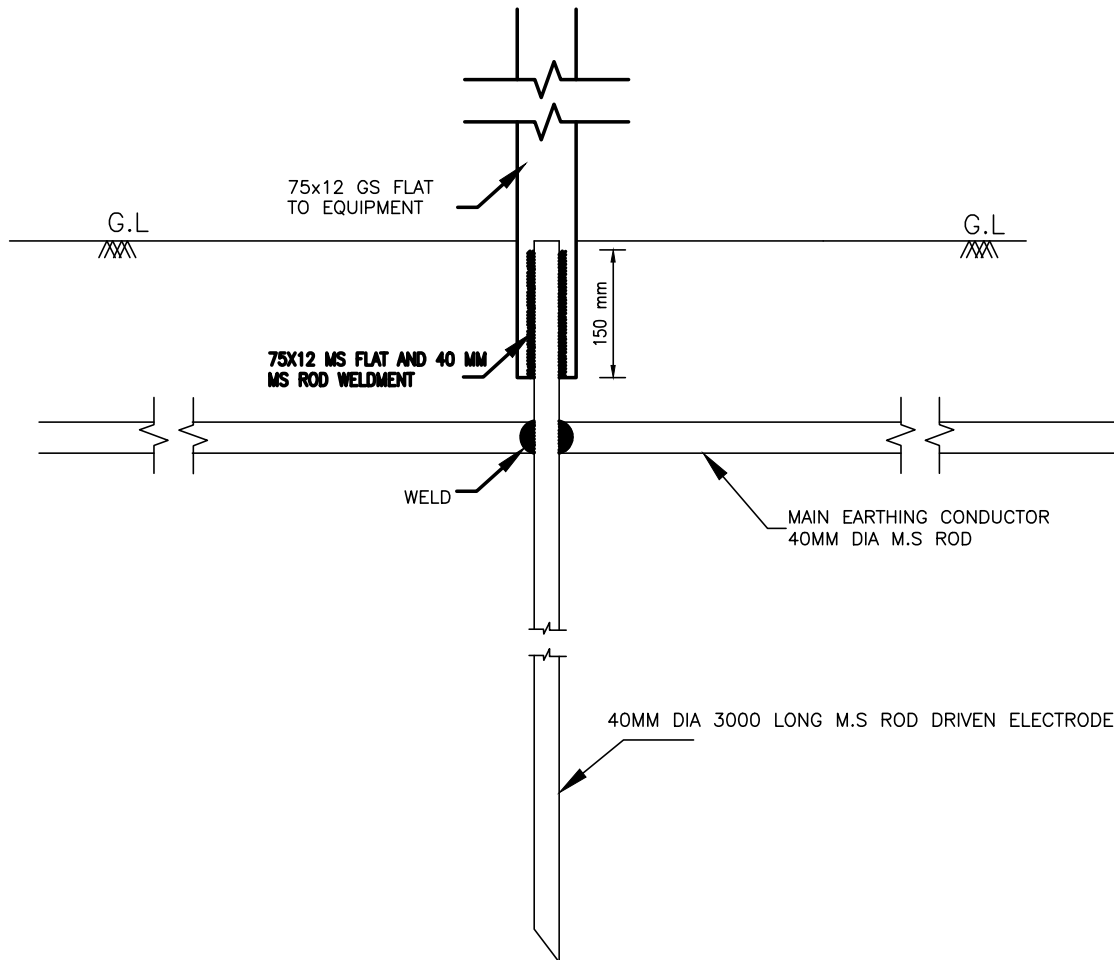
## EQUIPMENT EARTHING DETAILS CABLE TRENCH

COMPU. DRG. REF.

DRG. NO.

TB-4-365-318-006

SHEET  
10



APPLICABLE FOR CVT & LA

NOTES:-

1. SUPPLY OF FIXING BOLTS NUTS & WASHERS FOR GI FLAT EARTHING CONDUCTOR IS ALSO FORMS PART OF THE SCOPE.
2. ALL NUTS, BOLTS & WASHERS SHALL BE GALVANISED.



EQUIPMENT EARTHING DETAILS  
ROD ELECTRODE WITHOUT PIT (FOR CVT & LA)

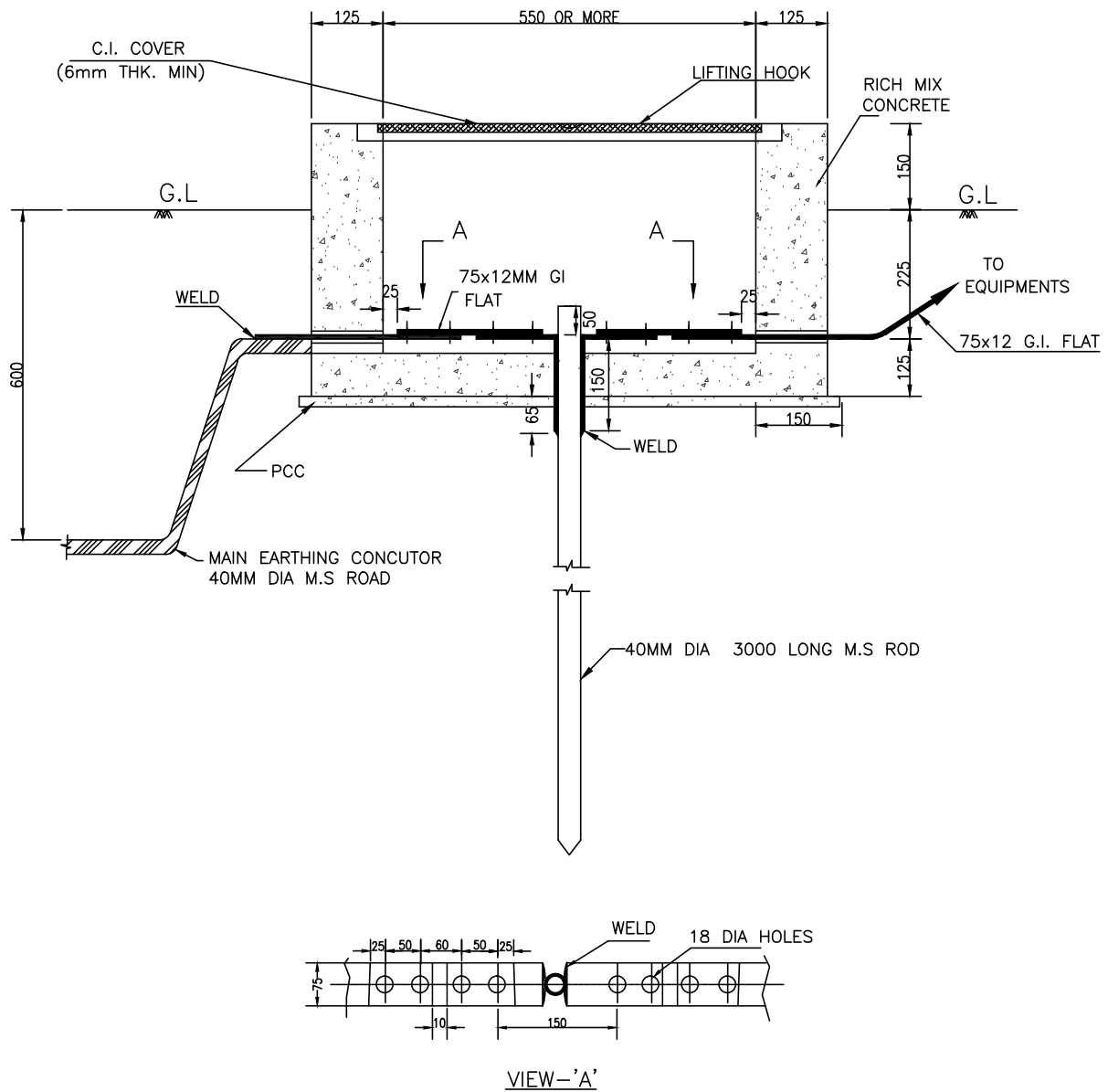
COMPU. DRG. REF.

DRG.NO.

TB-4-365-318-006

SHEET No.

11



NOTES:-

1. SUPPLY OF FIXING BOLTS NUTS & WASHERS FOR GI FLAT EARTHING CONDUCTOR IS ALSO FORMS PART OF THE SCOPE.
2. TO BE USED FOR CONNECTING DOWN CONDUCTOR OF SHIELD WIRE SUPPORT STRUCTURES & TOWERS WITH PEAK.



## EQUIPMENT EARTHING DETAILS

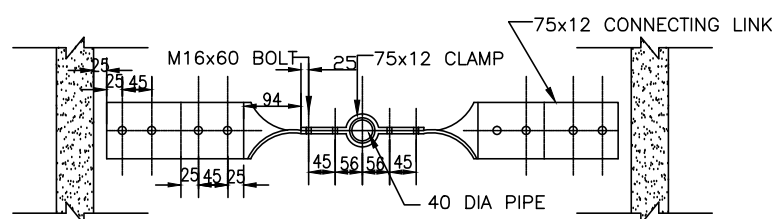
ROD EARTH ELECTRODE WITH TEST PIT FOR TOWERS WITH PEAK & SHIELD WIRE SUPPORT STRUCTURE

COMPU. DRG. REF.

DRG. No.

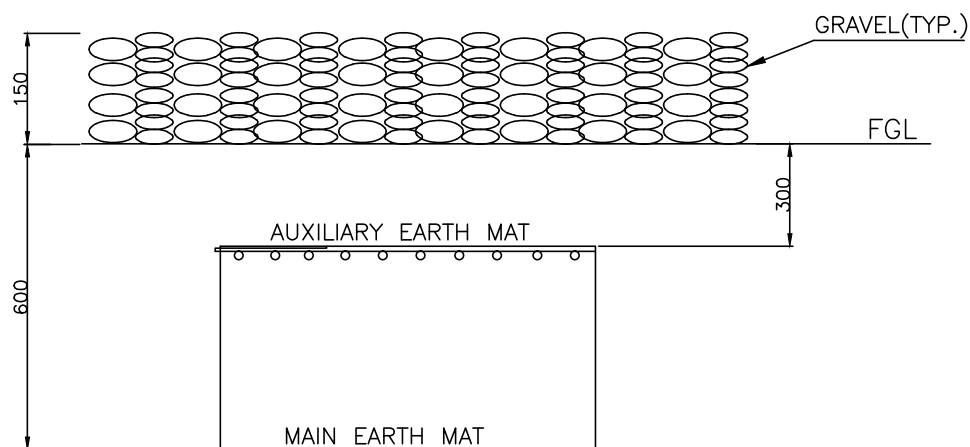
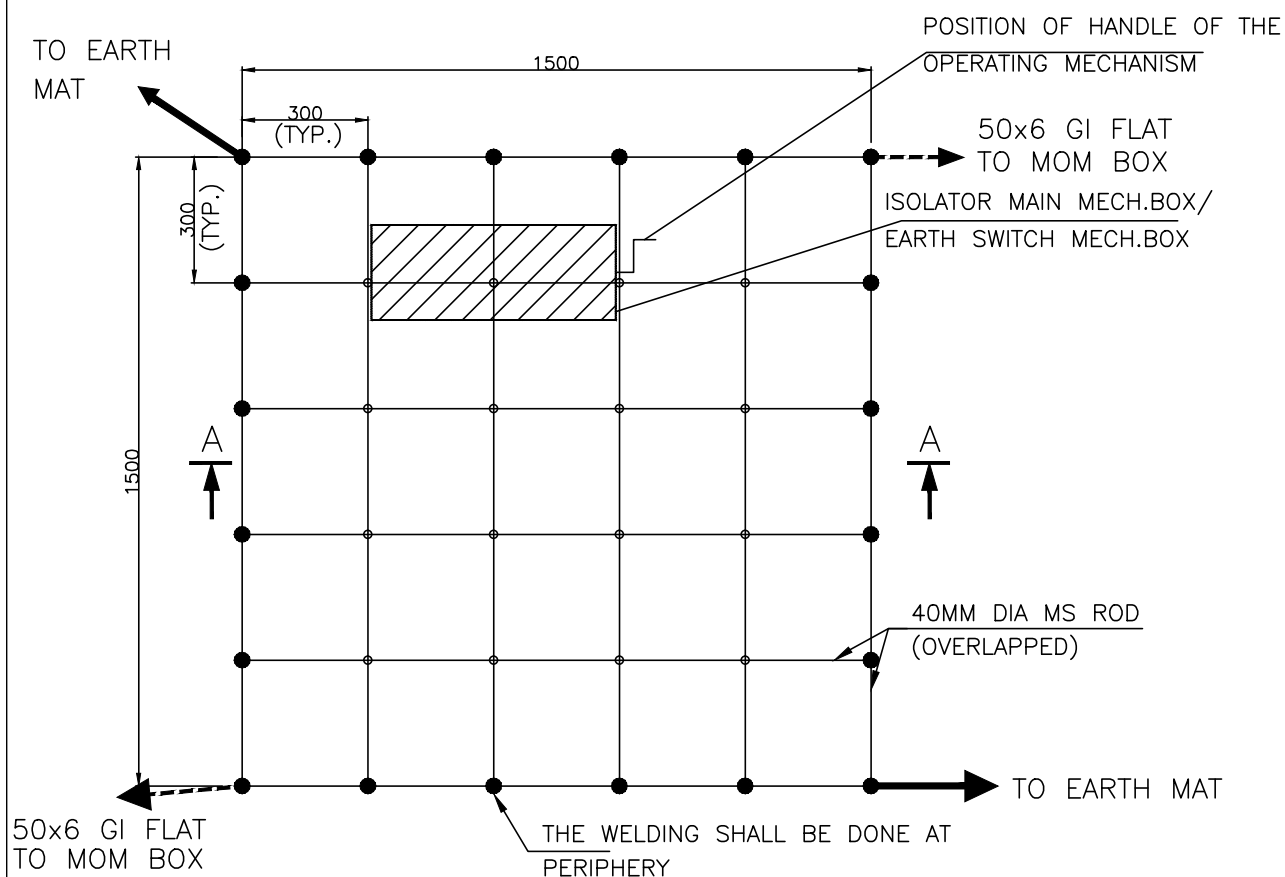
TB-4-365-318-006

SHEET No.  
12



**BHEL**

SHEET No.  
13



### SECTION AA

#### NOTE:

AUX. EARTH MAT SHALL BE SO POSITIONED THAT THE FOOT OF THE OPERATOR ALWAYS LIE OVER THE AUX. EARTH MAT AREA WHILE ATTENDING / OPERATING THE MECH. BOX THE CABLE TRENCH ROUTING SHALL BE PLANNED ACCORDINGLY.



## EQUIPMENT EARTHING DETAILS

### AUXILIARY EARTH MAT FOR ISOLATOR MAIN MECH., E/S MECH. BOX

COMPU. DRG. REF.

Report No.

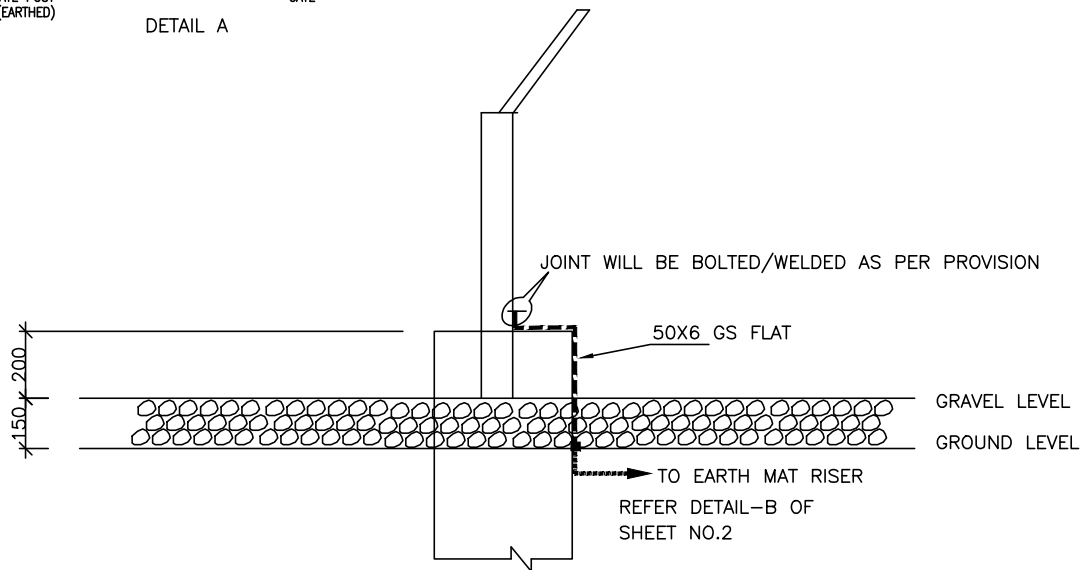
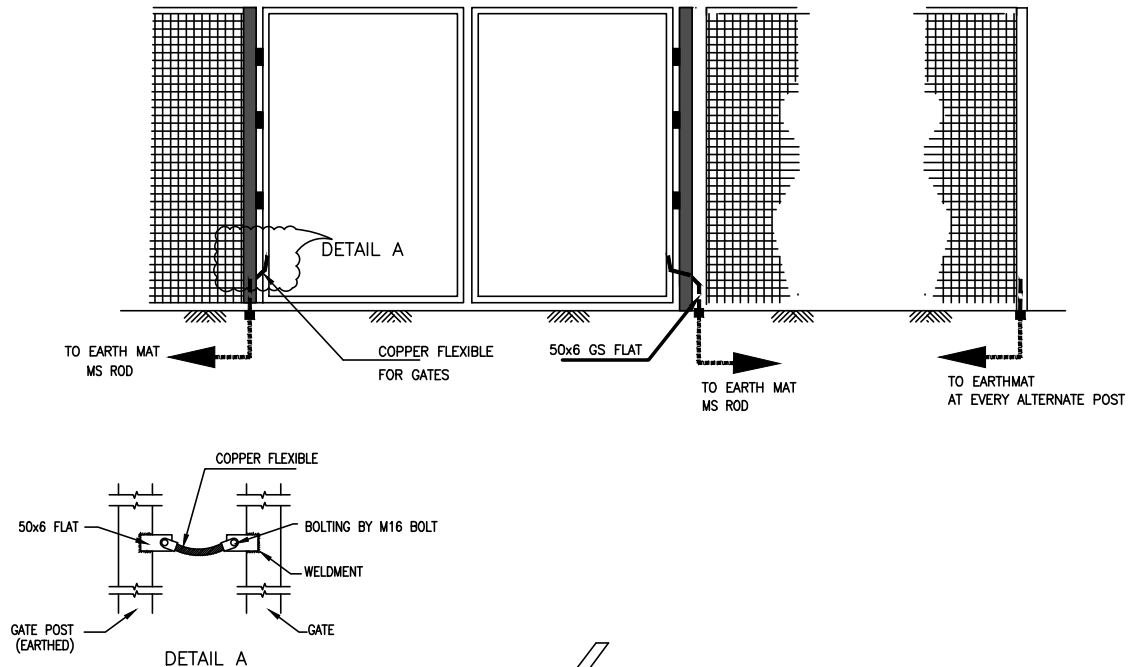
TB-4-365-318-006

SHEET No.

14

## FENCE GATE

## FENCE GROUNDING



EVERY ALTERNATE POST OF FENCE & GATES SHALL BE CONNECTED TO EARTHING LOOP BY 50X6 MM GS FLAT.

## FENCE EARTHING



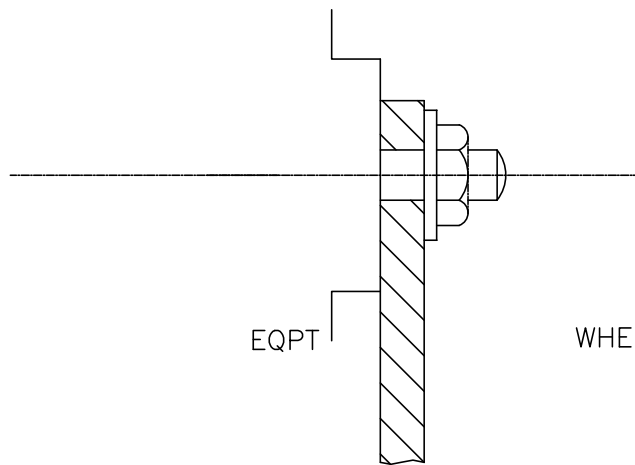
## EQUIPMENT EARTHING DETAILS GATE/FENCE POST

DRG. No.

TB-4-365-318-006

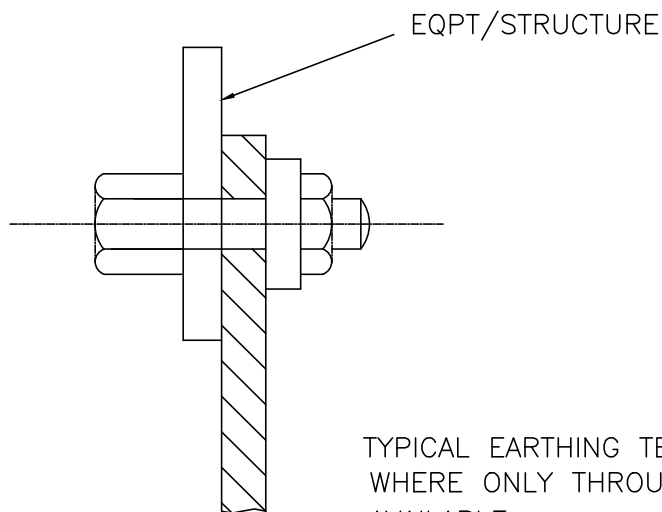
SHEET No.

15



WHERE STUD AVAILABLE

TYPICAL EARTHING TERMINAL JOINT



TYPICAL EARTHING TERMINAL JOINT  
WHERE ONLY THROUGH HOLE IS  
AVAILABLE

### NOTE

1. THIS IS GENERAL TYPICAL BOLTING ARRANGEMENT APPLICABLE TO ALL PANELS, EQUIPMENT ETC. WHERE BOLTING ARRANGEMENT IS PROVIDED.
2. IN CASE EARTHING TERMINAL COMPRISES ONLY A TAPPED HOLE SUITABLE BOLT/ SCREW WITH WASHER MAY BE USED FOR EARTHING CONDUCTOR TERMINATION



## EQUIPMENT EARTHING DETAILS

### TYPICAL ARRANGEMENT OF BOLTED JOINTS

DRG. No.

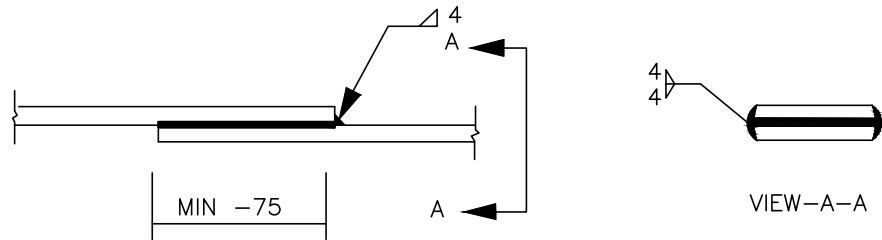
TB-4-365-318-006

SHEET No.  
16

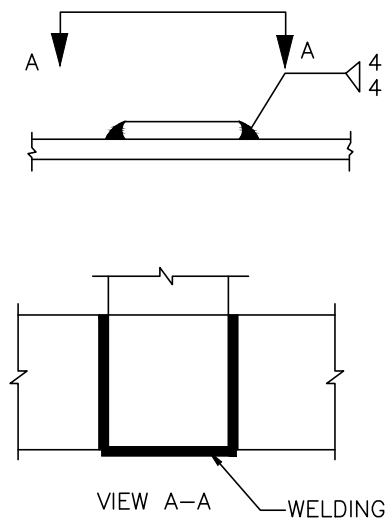


## STRIP TO STRIP (75x12/50X6 MS FLAT)

### 1. STRAIGHT LAP JOINT/RISER



### 2. CROSS LAP JOINT



## EQUIPMENT EARTHING DETAILS

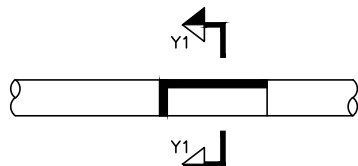
### WELDING DETAILS

COMPUTERREF.NO.

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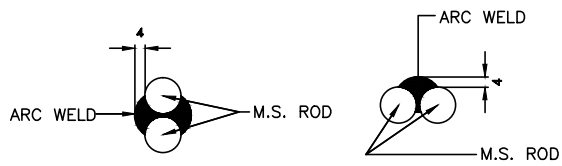
TB-4-365-318-006

SHEET No.  
17



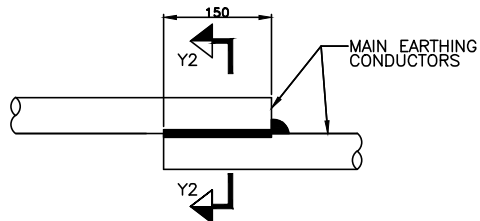
ELEVATION

(CONDUCTOR IN HORIZONTAL PLANE)



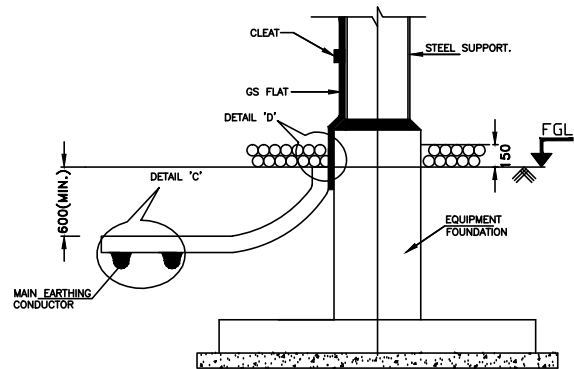
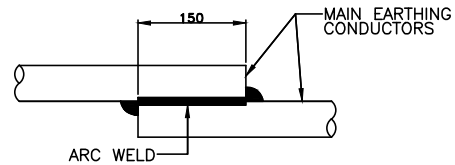
SECTION Y2-Y2

SECTION Y1-Y1

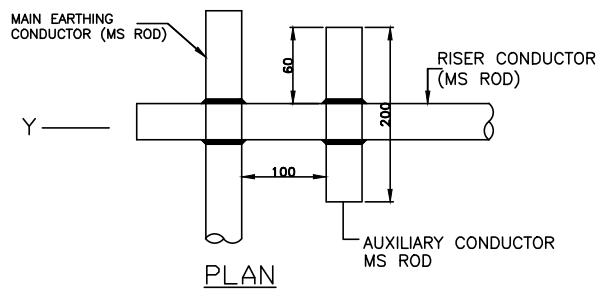


ELEVATION

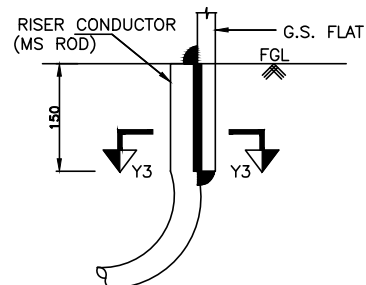
(CONDUCTOR IN VERTICAL PLANE)



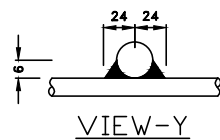
TYPICAL DETAILS OF RISER



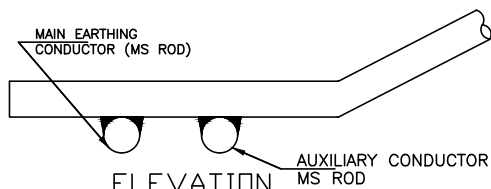
PLAN



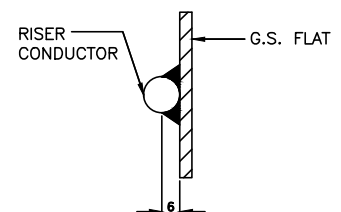
ELEVATION  
DETAIL-D



VIEW-Y



ELEVATION  
DETAIL-C



SECTION Y3-Y3

TYPICAL OVERLAPPING JOINT OF TWO CONDUCTORS



## EQUIPMENT EARTHING DETAILS

WELDING DETAILS

COMPUTERREF.NO.

DRG. No.

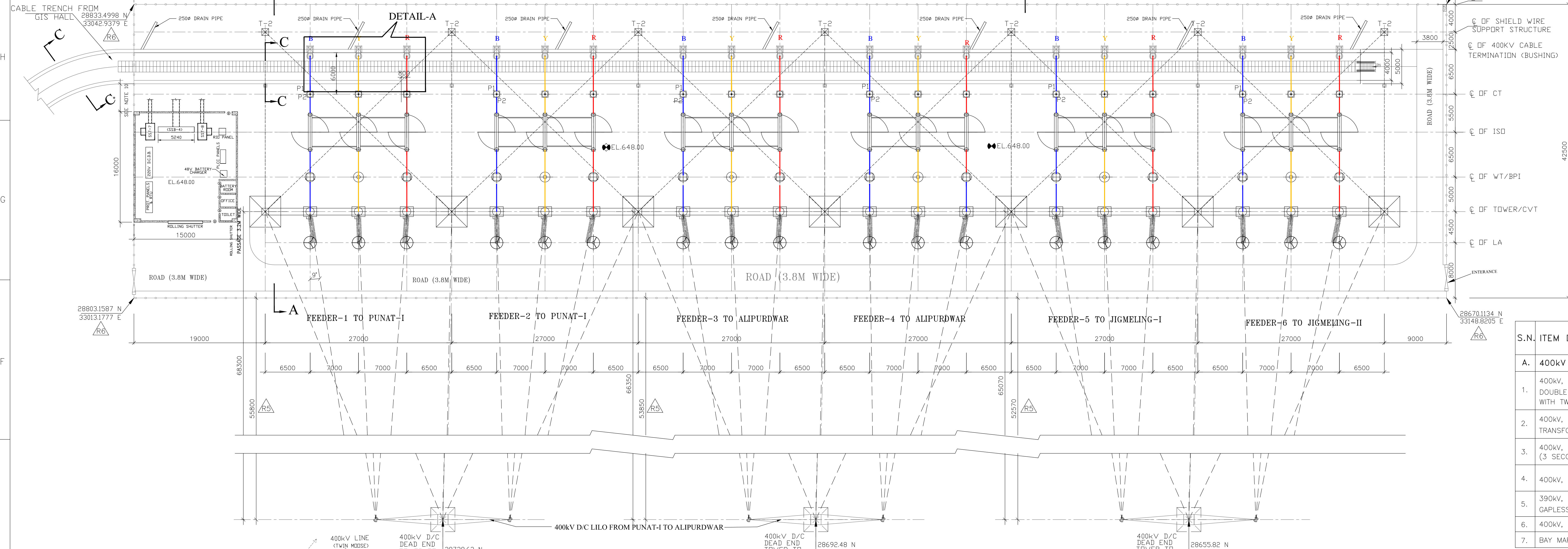
TB-4-365-318-006

SHEET No.

18



100-918-298-1-1-BL



SYSTEM PARAMETERS

DESCRIPTION	400kV
LIGHTNING IMPULSE WITHSTAND VOLTAGE (kvp)	1425
SWITCHING IMPULSE WITHSTAND VOLTAGE (kvp)	1050
P.F. WITHSTAND VOLTAGE (kVrms)	630
HIGHEST SYSTEM VOLTAGE (kV)	420
CREEPAGE DISTANCE (mm)	10500
SHORT CIRCUIT CAPABILITY (KA FOR 1SEC)	50

CLEARANCE TABLE

	400kV
PHASE TO PHASE (PP)	4100
LIVE PART TO EARTH (PE)	3400
SECTION CLEARANCE (SC)	6500
MINIMUM VERTICAL CLEARANCE FROM ANY ENERGIZED METAL PART TO TOP OF PLINTH	8000
VERTICAL CLEARANCE FROM BOTTOM OF THE LOWEST PART OF BUSHING OR SUPPORTING INSULATOR TO TOP OF PLINTH	2550

S.N.	ITEM DESCRIPTION	MAIN QUANTITY (Nos.)	SPARES QUANTITY (Nos.)
A.	400kV :		
1.	400kV, 2000A, 50kA FOR 1Sec. THREE PHASE HORIZONTAL DOUBLE BREAK ISOLATOR MOTOR OPERATED MECHANICALLY GANGED WITH TWO E/S MOTOR OPERATED MECHANICALLY GANGED.	06	-
2.	400kV, 2000A, 5 CORE, 50kA FOR 1Sec. SINGLE PHASE CURRENT TRANSFORMER.	18	05
3.	400kV, 4400pt, SINGLE PHASE CAPACITIVE VOLTAGE TRANSFORMER (3 SECONDARY).	18	05
4.	400kV, 2000A, 1mH, 1 PH 50kA FOR 1Sec. PEDESTAL WAVE TRAP.	12	03
5.	390kV, DISCHARGE CLASS III, 10 kA, HEAVY DUTY, METAL OXIDE, GAPLESS TYPE SURGE ARRESTOR.	18	05
6.	400kV, 6kN BUS POST INSULATOR	06	03
7.	BAY MARSHALLING KIOSK	06	-

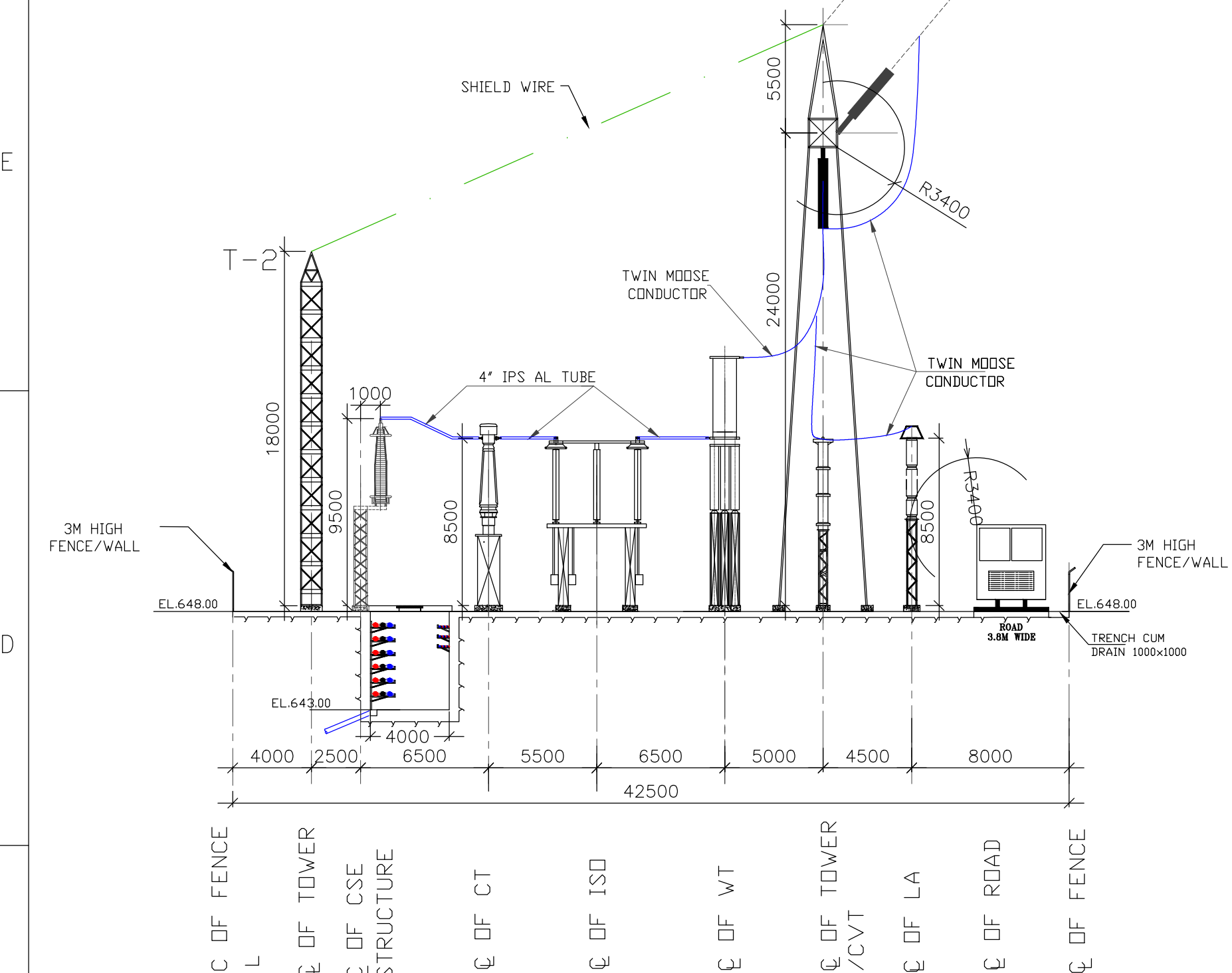
DISC INSULATOR HARDWARE

DESCRIPTION	UNIT	MAIN QTY.	SPARES
400 KV SINGLE SUSPENSION (1X25) HARDWARE WITH DROP CLAMP SUITABLE FOR TWIN ACSR MOOSE CONDUCTOR	SETS	18	2
400 KV SINGLE TENSION (1X25) HARDWARE SUITABLE FOR TWIN ACSR MOOSE CONDUCTOR WITH TURN BUCKLE	SETS	18*	1

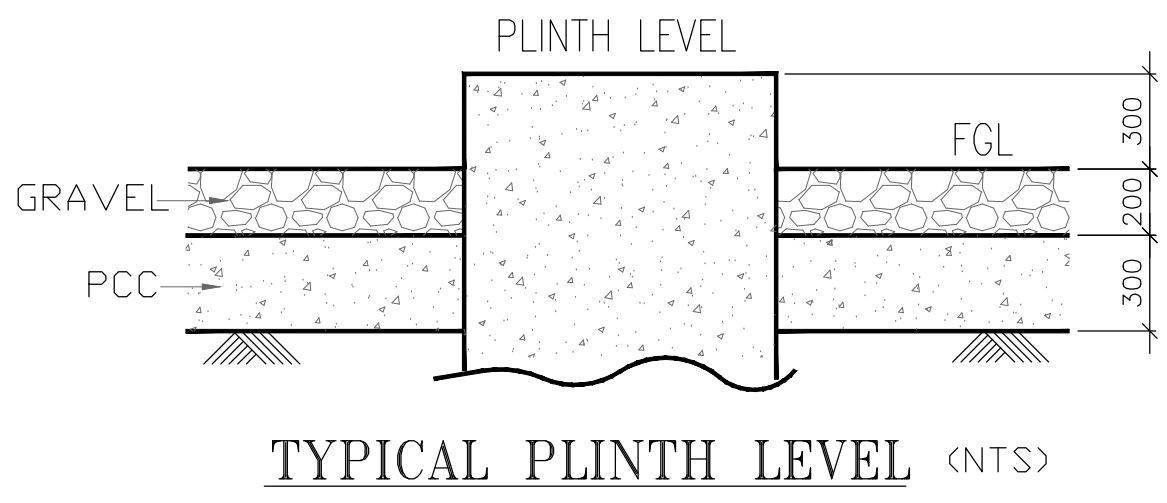
\*'-Will be supplied in loose as termination of 400kV lines to dead end gantry is not in BHEL scope.

NOTES:-

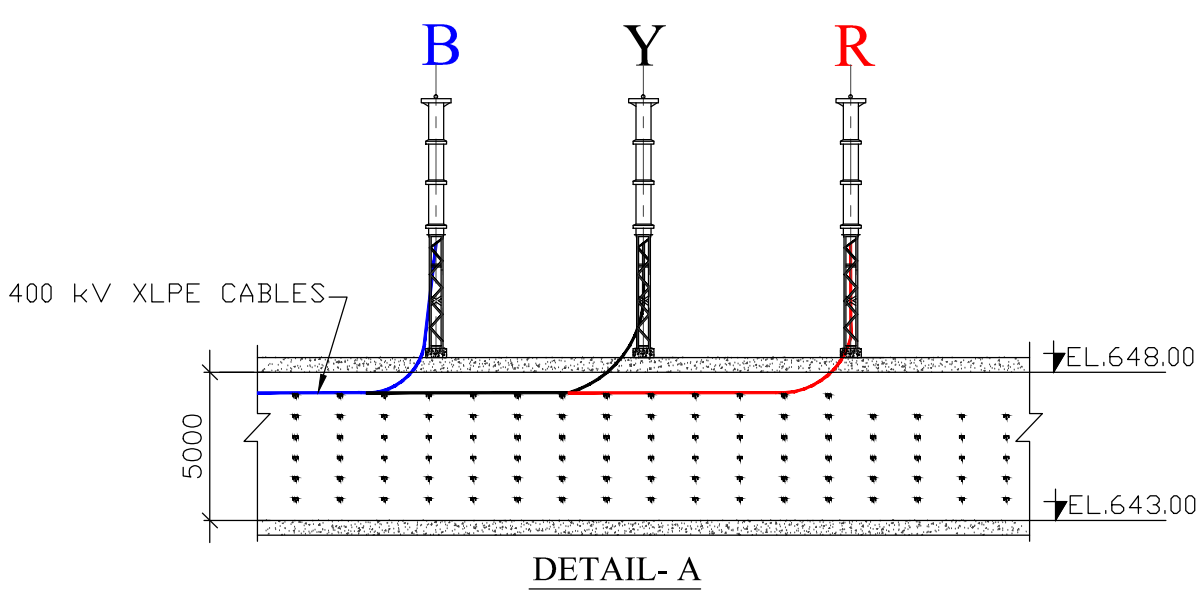
- ALL DIMENSIONS ARE IN mm AND ELEVATIONS ARE IN METRES.
- EXACT LOCATION & DISTANCE OF DEAD END TOWER FOR 400kV D/C SHALL BE GIVEN BY PHPA.
- 40mm AVERAGE SIZE OF GRAVELS (200mmTHICK LAYER) SHALL BE SPREAD OVER 300mm THICK PCC SURFACE FOR GIVING FINISHED GROUND LEVEL IN THE POTHEADYARD. PLINTH LEVEL OF VARIOUS EQUIPMENT/TOWERS IN POTHEADYARD SHALL BE KEPT 300mm ABOVE FINISHED GROUND LEVEL.
- CUSTOMER SHALL TERMINATE 400kV LINES WITH TENSION INSULATORS.
- WAVE TRAPS PHASE ARE INDICATIVE ONLY (TO BE DECIDED BASED ON ATTENUATION TEST AT SITE). FOUNDATION OF WAVE TRAP SHALL BE PROVIDED IN ALL THREE PHASES.
- LA PRESSURE RELIEF VALVE SHALL NOT BE TOWARDS ANY EQUIPMENT KEPT NEAR LIGHTNING ARRESTOR.
- ANY CIVIL WORK INCLUDING LAND FILLING/CUTTING, PCC, GRAVEL SPREADING, FOUNDATION, CABLE TRENCHES, ROADS, FENCING & GIS BUILDING ETC. IS NOT IN BHEL TBG SCOPE.
- SIZE & LOCATION OF BAY MK IS INDICATIVE ONLY & MAY VARY AS PER ACTUAL DIMENSIONS & TRENCH LOCATIONS AT SITE.
- COORDINATES OF CORNER OF POTHEADYARD & DEAD END TOWERS ARE AS PER PHPA-II INPUT DRAWING "POTHEAD YARD - LAYOUT PLAN" - WAP/PH/EP-II/PH/PTH/LP/S/1537 (REV.4).



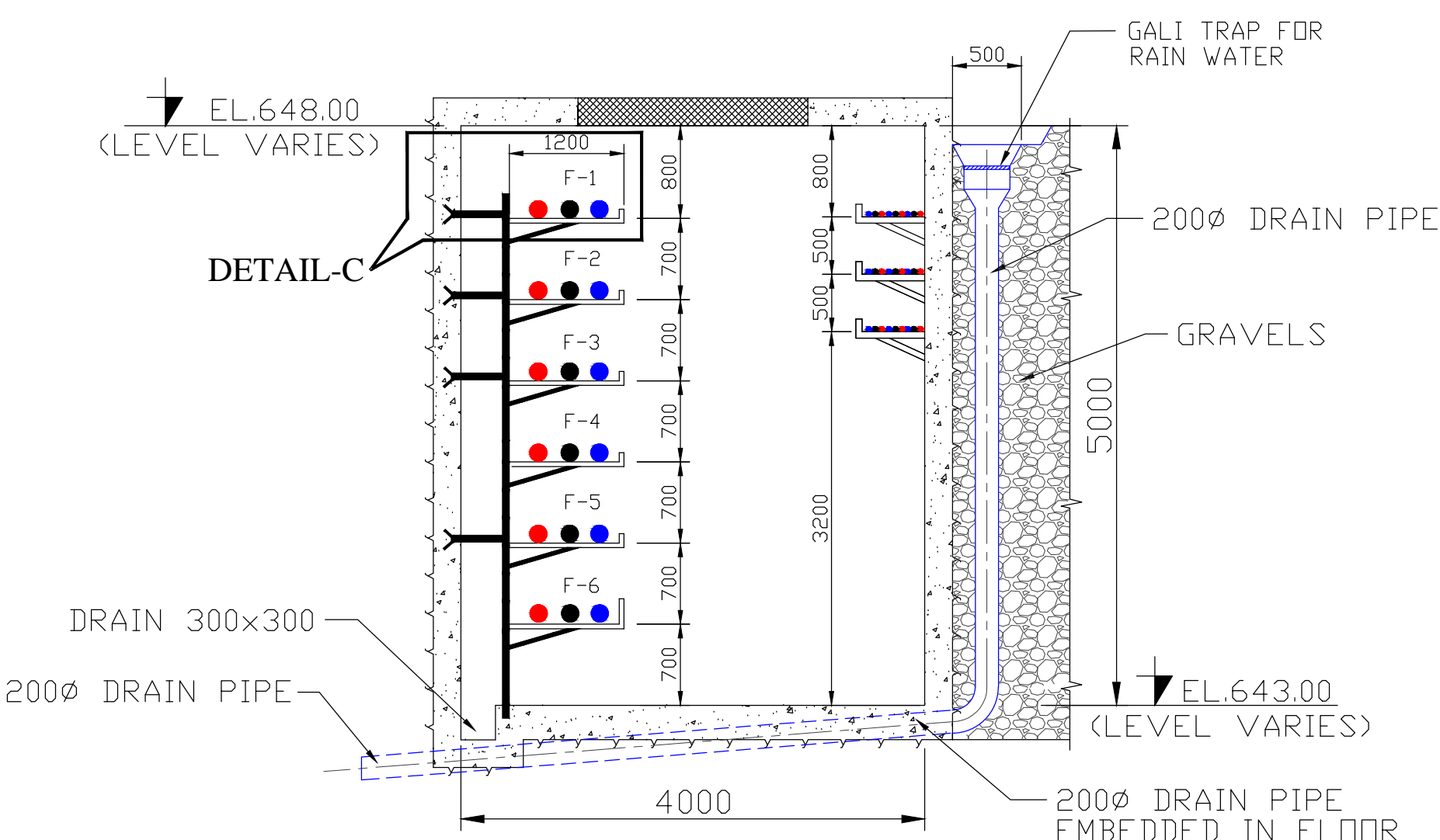
SECTION A-A



TYPICAL PLINTH LEVEL (NTS)

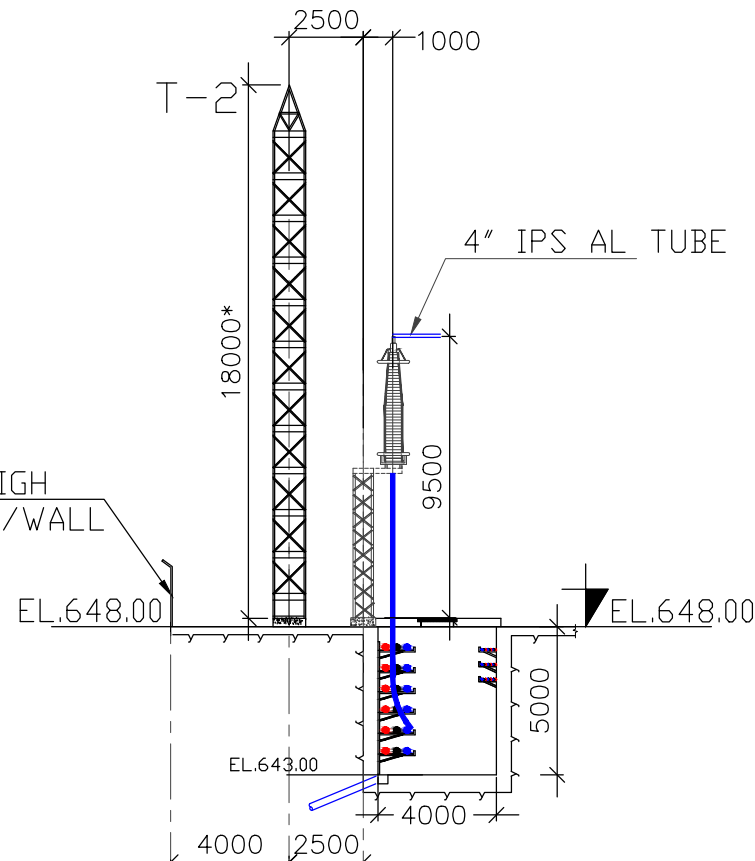


DETAIL-A



SECTION C-C (NTS)

(CABLE TRENCH MATERIALS ARE NOT IN BHEL-TBG SCOPE)



SECTION B-B

CABLE RACK/TRAY DETAIL (NOT IN BHEL-TBG SCOPE)

LEGEND:-

- 400 kV XLPE CABLE TERMINAL WITH ONE CABLE PER PHASE (EQUIPMENT & STRUCTURE ARE NOT IN BHEL SCOPE)
- 400 kV CT
- 400 kV WAVE TRAP.
- 400 kV CVT
- 400 kV LA
- 400 kV BUS POST INSULATORS.
- 400 kV HDB ISOLATOR
- SHEILDING WIRE
- NOT IN BHEL SCOPE

REV.	DATE	ALTERED	CHECKED	AK	DKM
06	10.01.19				
ZONE					

DRAWING REVISED BASED ON REVISED CEA DRG. NO. 1265-PUNAT-II-26 (R13) SHEET 2 INCLUDED SHOWING TRENCH ROUTE & CABLE TRENCH INSERTS DE-TAILS & MK FIXING DETAILS.

REV.	DATE	ALTERED	CHECKED	AK	DKM
05	24.07.17				
ZONE					

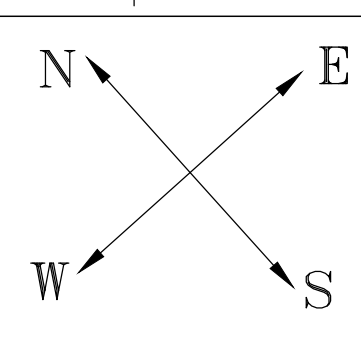
DRAWING REVISED BASED ON REVISED CEA DRG. NO. 1265-PUNAT-II-26 (R11) & PHPA DRAWING "POTHEAD YARD - LAYOUT PLAN" - WAP/PH/EP-II/PH/PTH LP/S/1537 (REV.4)

REV.	DATE	ALTERED	CHECKED	AK	DKM
04	12.06.17				
ZONE					

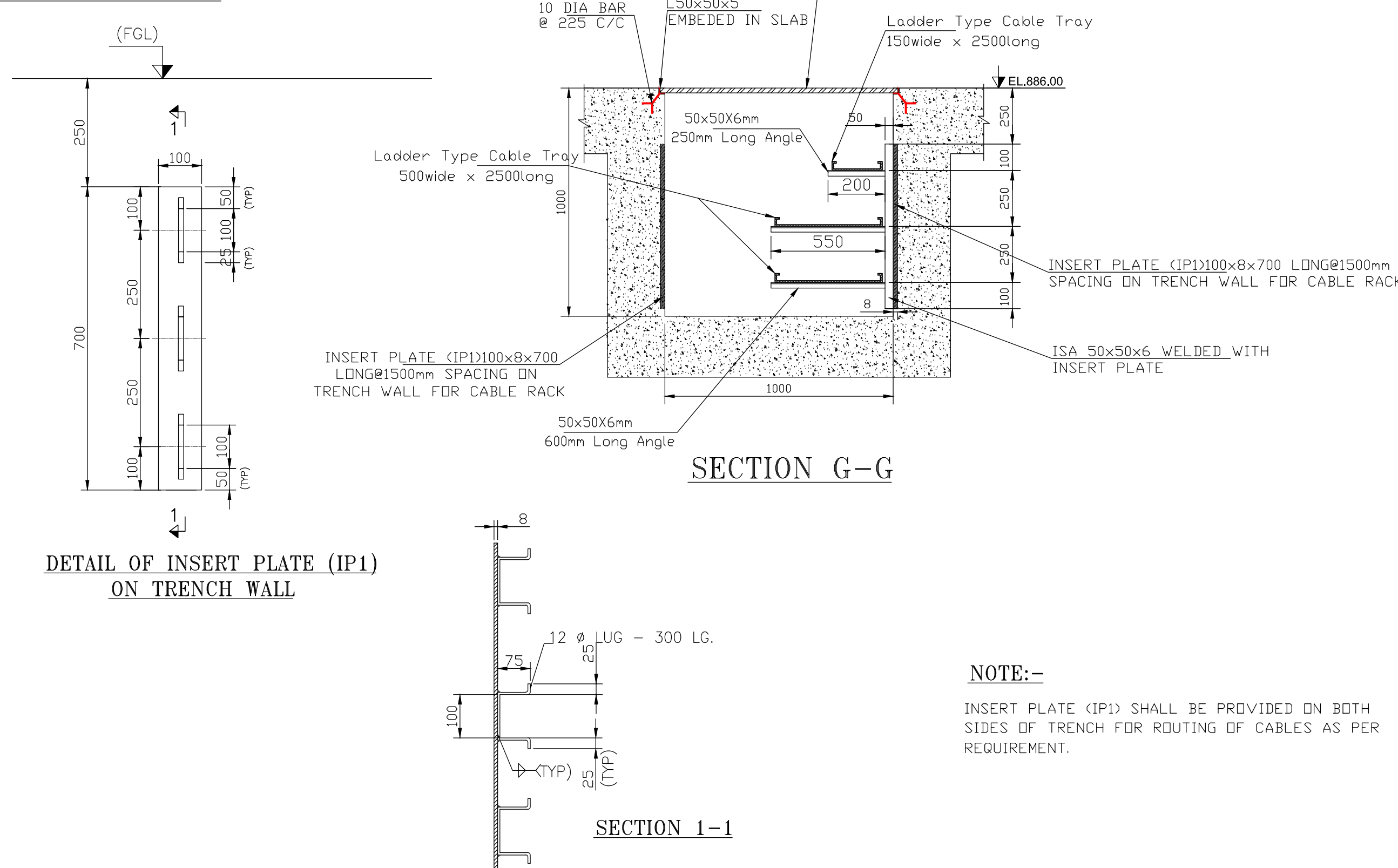
DRAWING REVISED BASED ON REVISED CEA DRG. NO. 1265-PUNAT-II-26 (R11). AL. TUBE CONDUCTOR HEIGHT IN POTHEAD YARD IS KEPT AT 8.5m IN LINE WITH CONTRACT CLAUSE NO. 6.6.11, SECTION-6.

REF DRAWINGS :-	LAYOUT PLAN OF POTHEAD YARD - 1265-PUNAT-II-26 (REV.11)
ADDITIONAL INFORMATION	POTHEAD YARD - LAYOUT PLAN - WAP/PH/EP-II/PH/PTH/LP/S/1537
STATUS OF DRAWING	PROJECT
DISTRIBUTION OF PRINTS	CUSTOMER
	CONSULTANT
	CONTRACTOR
ISSUED BY	UNTOL.DIMS. GR.
DEPT. CODE	ANGLE
	SCALE
	WEIGHT (KG)
	REF. TO ASSY. DRG.
	ITEM NO./NO. OF ITEM
	DRAWING NO.
	REV.
	SHT. No.
	NO. OF SHT.



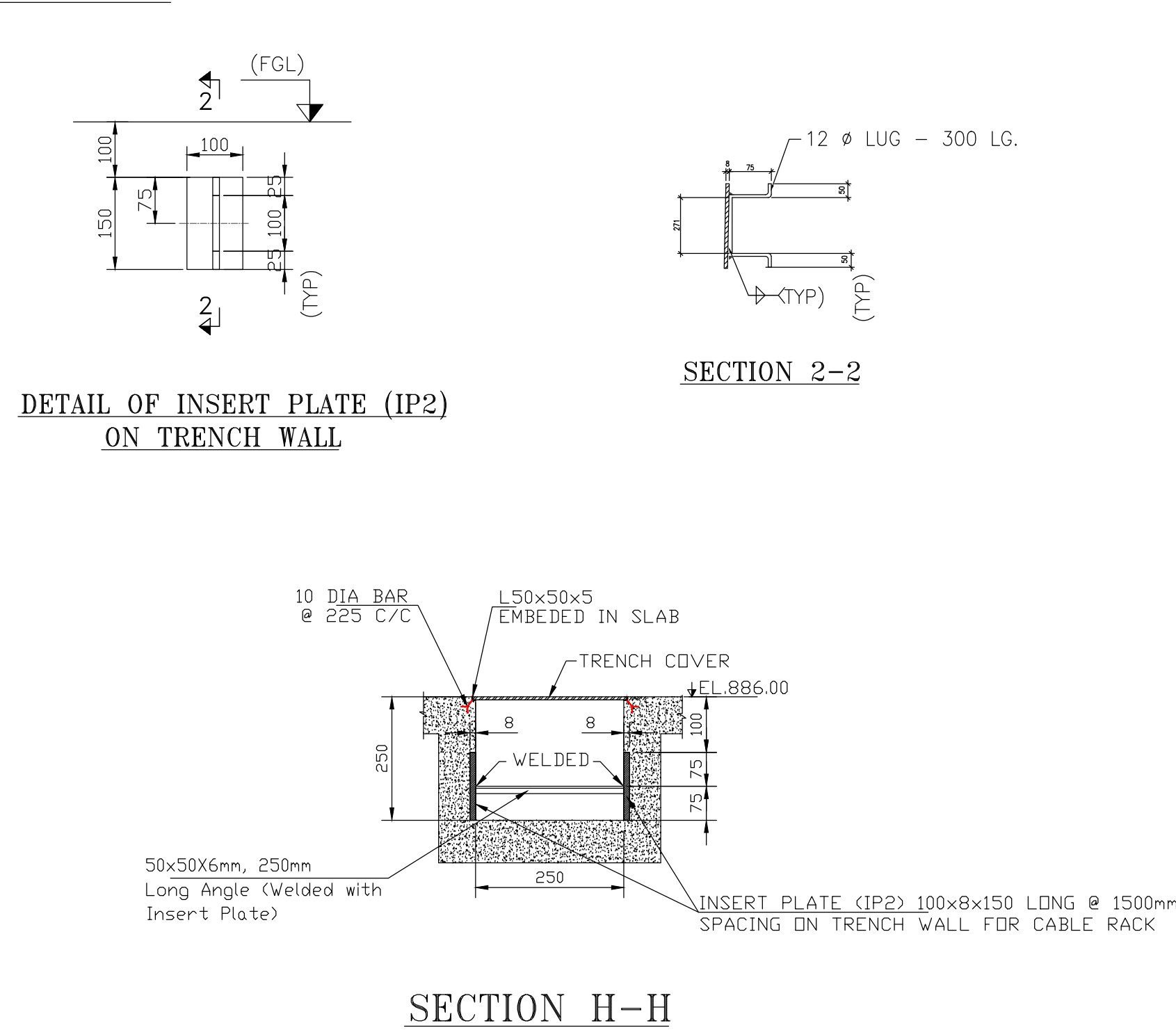


DETAIL-S1

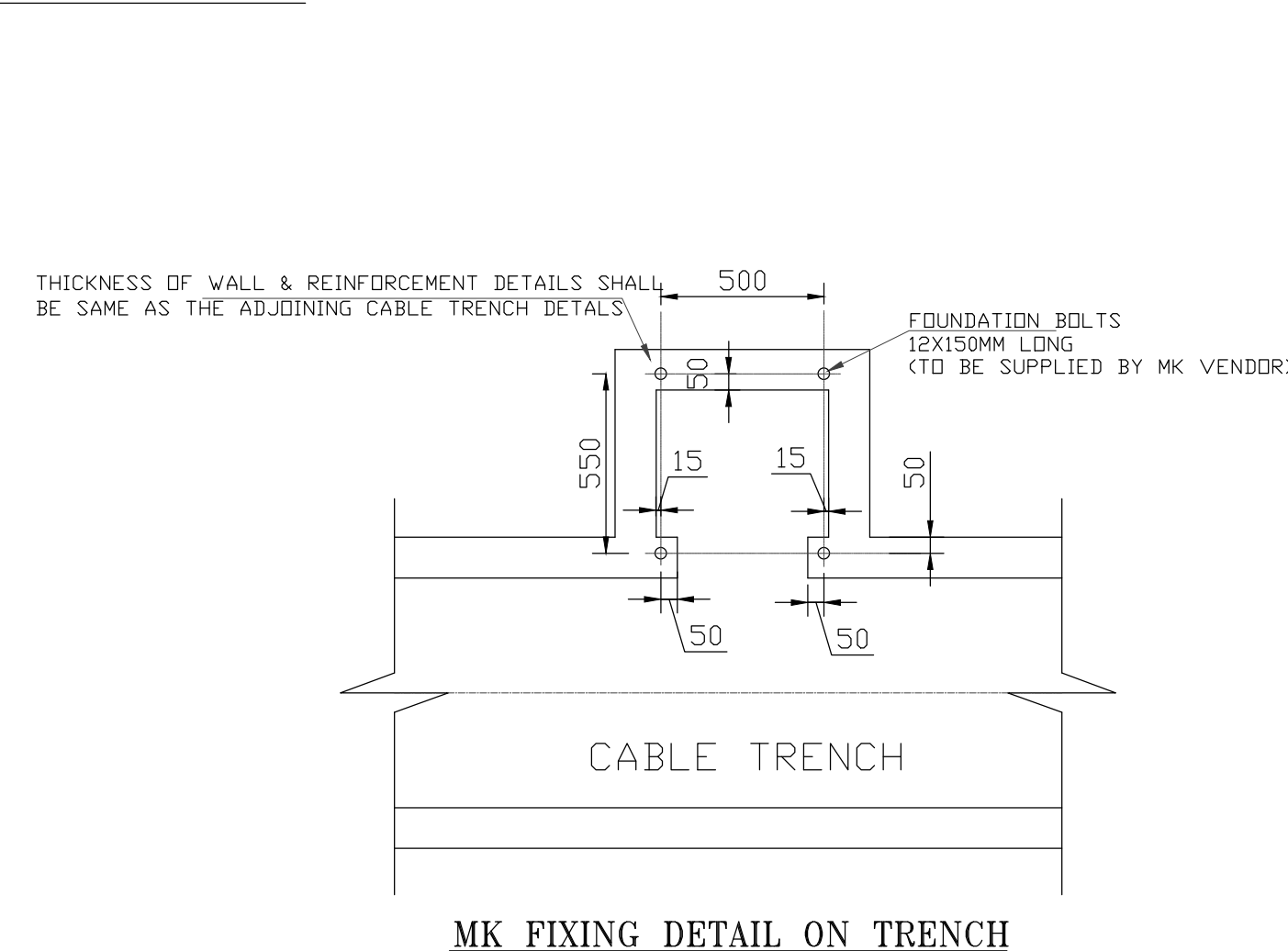


NOTE:-  
INSERT PLATE (IP1) SHALL BE PROVIDED ON BOTH SIDES OF TRENCH FOR ROUTING OF CABLES AS PER REQUIREMENT.

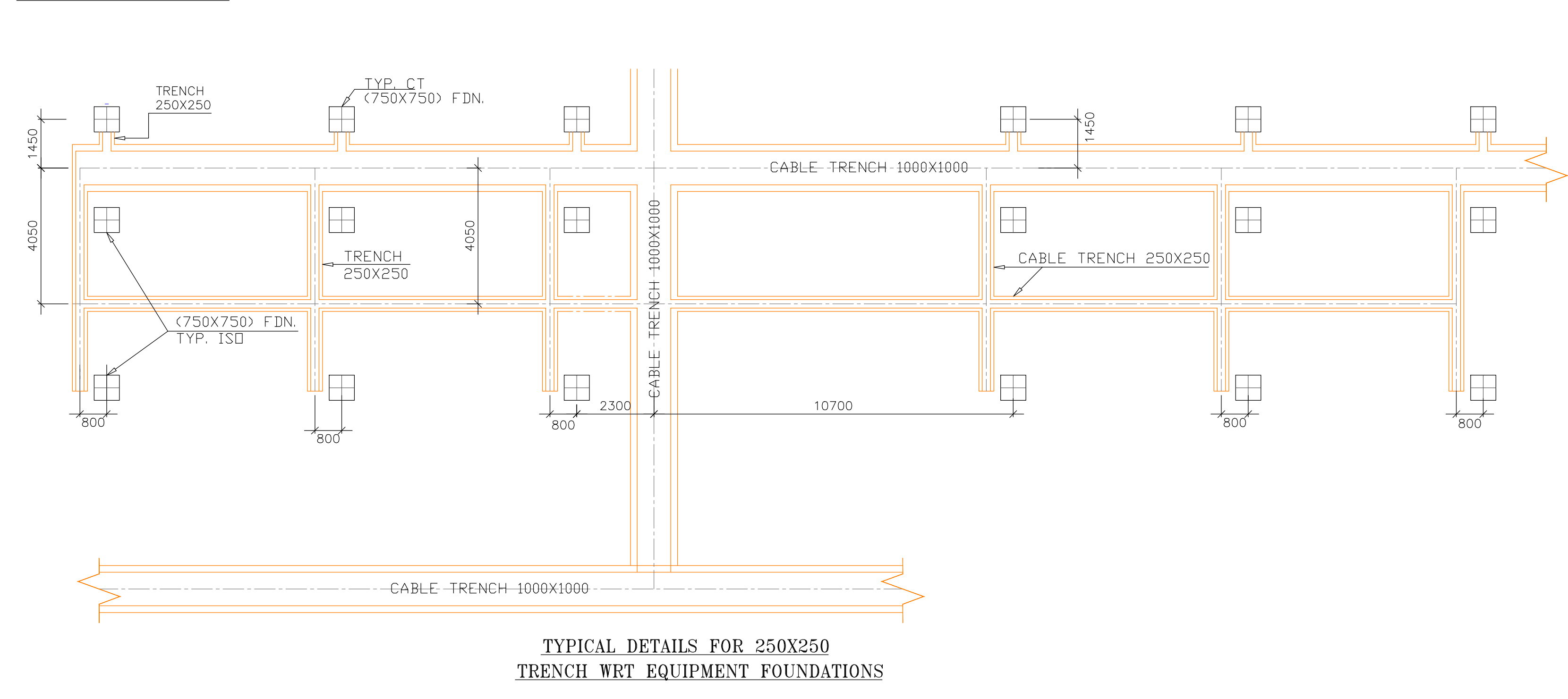
DETAIL-S2



DETAIL-S3





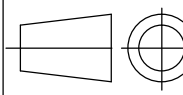


DETAILS-S4



NOTES:—

1. PHPA/ CONSULTANT TO PROVIDE INSERT PLATES IN CABLE TRENCHES SECTION G-G & H-H FOR FIXING BHEL SUPPLIED CABLE SUPPORT ARRANGEMENT. DETAILS ARE GIVEN IN DETAIL S1 & S2.
2. PHPA/ CONSULTANT TO PROVIDE THE ARRANGEMENT AS SHOWN IN DETAIL S3 FOR MOUNTING MK ON CABLE TRENCH.
3. FOR TYPICAL DETAILS FOR 250X250 TRENCH WRT EQUIPMENT FOUNDATION REFER DETAIL S4.

REF DRAWINGS :-					LAYOUT PLAN OF POTHEAD YARD - 1265-PUNAT-II-26 (REV.11)														
					POTHEAD YARD - LAYOUT PLAN - WAP/PHEP-II/PH/PTH/LP/S/1537														
ADDITIONAL INFORMATION					PROJECT		6X170MW PUNATSANGCHHU-II EM-2 HEP, BHUTAN												
STATUS OF DRAWING					CUSTOMER		 PHPA-II, BHUTAN												
DISTRIBUTION OF PRINTS					CONSULTANT		 WAPCOS Ltd, Gurgaon												
					 Central Electricity Authority, New Delhi														
DRN		NAME	SIGN	DATE	NO. OF VAR	CONTRACTOR		 BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP											
CKD		DKM	-sd-																
APPD		RS	-sd-																
SUB-SUPPLIER/VENDOR						ISSUED BY DEPT. <b>TBEM</b>		UNTOL.DIMS. GR.		ANGLE 		SCALE 1:350		WEIGHT (KG)		REF. TO ASSY. DRG.		ITEM NO. OF ITEM	
						DEPT. CODE: <b>316</b>													
						TITLE LAYOUT PLAN & SECTION ELEVATION DRAWING OF 400KV POTHEADYARD										DRAWING NO. TB-1-365-316-001		REV. 06	
						SHt. No. 2										NO. OF SHt. 2			

**PROCEDURE FOR WELDING OF ALUMINIUM BUSES**

**A. Recommended welding procedures to insure a sound weld are as follows:**

Pure aluminum melts at 660 Deg. C while aluminum alloy melts in the range of 519 Deg. C depending on the alloy content of the particular metal involved. When aluminum alloy are heated there is no change in color. This makes it difficult, if not impossible; to tell metal is near the welding temperature.

The ever present surface oxide films on aluminum have a melting point of 1982 Deg. C. The parent aluminum or aluminum alloy can therefore be melted without fusing the surface oxides. Unless this film is removed, cleanliness of the molten filler metal and the parent metal cannot be completed and both strength and conductivity may be sacrificed. Therefore, it is of prime importance that aluminum oxides be removed from the aluminum alloys before welding is started. In the shielded arc welding method the shielding gas has a tendency to clean the material as welding progresses.

**B. CLEANING OF BUSES & FITTINGS:**

It is very important to remove all greases and oxides from the surfaces to be welded. This can be accomplished by using a mild alkaline solution or standard degreasing solution. The preferred method is to use a stainless steel wire brush and vigorously scrub the surfaces to be welded. The stainless steel brushes are specified because the stainless steel has fewer tendencies to pick up particles of aluminum.

**C. WELDING METHODS**

The following types of welding methods for welding aluminum fittings and buses are recommended.

**1. TUNGSTEN-ARC WELDING (TIG)**

The inert-gas shielded tungsten arc process is widely used for welding aluminum bus fittings. In this process the arc is established between a non-consumable tungsten electrode and the section to be welded. Inert gas envelopes the arc to prevent oxidation during welding.

Hence no flux is required. A bare filler rod supplies filler metal to the weld area. To initiate the arc the tungsten electrode is placed in contact with the component and then withdrawn to establish an arc length of approximately 3/16". The arc is given a circular motion until the base metal liquefies and the weld puddle is established. Filler metal is added by hand as required. In this process, if more than one pass is required for a sufficient weld, the weld should be wire brushed between passes, to remove any surface dirt or oxides which have accumulated from the previous pass. Since no flux is used the finished weld does not require cleaning. In this process the heat of the tungsten arc is concentrated in a smaller area and is much faster than the conventional type of welding and distortion of the weld is negligible since the heat is concentrated in a small area. In this process, if thickness is greater than 0.5" arc to be welded, pre-heating of parts will increase the arc speed.

**2. METALLIC ARC INERT GAS SHIELDED WELDING**

MIG welding process combines the advantages of tungsten arc welding with the increased welding speed. Welding can be done from any position and the process can be either manual or automatic. Manual welding techniques are somewhat different from other methods. However, a welder can be trained to use the MIG process with only a few days concentrated training. In the MIG process the bare filler rod is supplied as a coil of bare wire. In the commercially available equipment this wire is added to the weld at predetermined rate by a motor driven feed that can be adjusted to the magnitude of the welding current. In this process as well as the tungsten arc process, gas forms a shield around the arc to prevent oxidation during welding.

Either helium, argon or a mixture of helium and argon are suitable shielding gases. Pure argon is most widely used on the gas arc usually mixed to combine the hotter arc argon. If exceptionally hot arc characteristics are required pure helium can be substituted for the gas mixture. Precaution should be

## **Annexure-B**

exercised if this substitution is made in that it is very easy to burn through the items that are to be welded with a pure helium atmosphere.

As it is readily apparent, the basic difference between the two types of welding apparatus is the automatic feeding mechanism for the filler wire. In both types of apparatuses the electrode holder and the welding gun can or cannot be cooled by water. If welding currents of more than 125 Amps are required, both methods will have to have water cooling apparatuses to the electrode holder and the welding gun.

### **D.WELDERS QUALIFICATIONS**

No welding should be done until the operator has had experience with welding aluminum alloys by the methods described above. Men with previous experience with in metal welding should be selected for training in welding aluminum for a period of training of not less than one week after which time the man can be considered to be proficient in the use of the equipment and in the welding of aluminum joints. After this period there should be no difficulty experienced in welding aluminum alloys. It is suggested, if practical, that welders should practice on actual fittings or buses before proceeding with the welding of the required job.

The following is the recommended specification for the current fittings wire feeds, gas flows etc. These specifications are of a general nature to the extent that many factors have to be considered such as:

1. Type of equipment used, whether water cooled or not.
2. The size and mass of the piece to be welded.
3. The position of the weld.
4. And most important of all, the operator's skill
5. All persons in the welding area would wear the proper shields. The arc is approximately twice as strong as the standard AC welding arc. Extreme caution should be exercised for the protection of eyes.

### **ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING** **LIQUID PENETRANT EXAMINATION OF WELDED JOINTS**

#### **a) Evaluation of indications:**

- Relevant indications are those which result from mechanical discontinuities.
- Linear indications are those indications in which the length is more than three times with width.
- Rounded indications or indication, which are circular or elliptical with the length less than three times, the width.
- Any questionable or doubtful indications shall be re-tested to verify whether or not actual defects are present.
- Localised surface imperfections, such as may occur from machining marks, surface conditions, may produce similar indications, which are not relevant to detection of unacceptable discontinuities.

#### **b) Acceptance standards:**

- Linear indications
- Four or more rounded defects with any dimensions more than 1.6 mm in a line separated by 1/16 inch (1.6 mm) or less (edge to edge)

#### **c) Defect removal and repair:**

Unacceptable imperfections shall be removed and reexamination made to assure the complete removal. Whenever a defect is removed and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners. Where welding is required after removal of a defect, the area shall be cleaned and welding performed in accordance with a qualified welding procedure. Completed repairs shall be re-examined by the method originally used for detection of the defection.

## **Annexure-B**

**d) Treatment of imperfections believed non-relevant.**

Any indication of an imperfection, which is believed to be non-relevant, shall be regarded as defect unless, on re-evaluation, it is shown by re-examination by the same method or by the use of other non-destructive methods and/ or by surface conditioning that no unacceptable defect is present.

**e) Examination of areas from which defects have been removed:**

After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure the defect has been eliminated.

**f) Re-examination of repaired areas:**

After repairs are made, the repaired areas shall be blended.

### **ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING** **RADIOGRAPHIC EXAMINATION OF WELDED JOINTS**

Radiographic examination shall cover minimum 10% of weld seam and acceptance standard for visual examination and Radiography shall be as follows:

Any of the following imperfections shall not be acceptable.

1. Cracks
2. Zone of incomplete fusion or penetration, which exceed 10% of the weld length of the joint in longitudinal or transverse butt weld, where full penetration is intended by the weld procedure, some lack of penetration acceptable. The total length of weld with lack of penetration shall not exceed 10% of the overall weld length. At no place, shall weld penetration be less than 90% of the thickness of the material. Continuous occurrence of lack of penetration is permitted, but shall not exceed 50 mm in any 500 mm length of weld.
3. Inadequate weld dimensions, root cavity (shrinkage) and incompletely filled groove greater than 10% effective throat thickness.
4. Excess penetration shall be permitted provided it does not exceed 25% of the wall thickness or 4 mm whichever is smaller.
5. Weld reinforcement: Build up in excess of 25% of the effective throat thickness shall be dressed. Any reinforcement shall be substantially symmetrical about the center line of the weld and shall be of smooth contour blending smoothly at the toes with the parent material.
6. Undercutting and overlapping, greater than 10% effective throat thickness.
7. Elongated cavities and/or worm holes exceeding 3 mm dia or equivalent area in length provided the limitations on porosity are met with.
8. Copper, tungsten or oxide inclusions greater than  $t/1$  or 3 mm whichever is smaller.
9. Crater pipes exceeding 25% of effective throat thickness or 3 mm whichever is smaller.
10. Porosity: Scattered porosity not exceeding 0.5% by volume is acceptable. In general, the size of the pores shall not exceed 0.8 mm dia, but occasional 1.6 mm dia pores may be acceptable, provided the following limits are not exceeded.
  - a) Where pore size is 0.4 mm or less, up to 150 pores may be permitted in 1000 mm sq. area of radiograph.
  - b) Where pore size is 0.8 mm or less, up to 19 pores may be permitted in 1000 mm. sq. area of radiograph.



## **Annexure-B**

- c) Where pore sizes are generally 0.8 mm dia or less, but occasional 1.6 mm dia/pores are present, up to 9t pores of 0.8 mm dia may be permitted in 1000 sq. mm area of radiograph, provided the number of pores up to 1.6 mm in dia does not exceed it.
- d) However, visible surface porosity > 1mm dia is not acceptable.

Note:

- i. In all cases, t+ thickness of the thinnest section of the weld under examination.
- ii. Unacceptable weld defects shall be repaired in accordance with the original welding procedure. All repairs shall be 100% inspected in accordance with original testing procedure.



## SECTION - 3

### PROJECT DETAILS AND GENERAL SPECIFICATIONS

#### GENERAL TECHNICAL REQUIREMENTS

#### 1.0 PROJECT LOCATIONS

**6X200 MW PUNATSANGCHHU-I HEP** :- The Project is located on Punatsangchhu River in Wangdue Phodrang Dzongkhag in Western Bhutan. Access to the project site is from right bank through Wangdue-Tsirang highway. All the project components are located on the left bank of river Punatsangchhu, between 6.5 km and 16 km downstream of Wangdue Bridge. The dam site is about 80 km from Thimphu and is connected by highway.

Paro (Bhutan) is the nearest airport (about 110 km). The nearest railway station is Hasimara (India) on Siliguri - Alipurduar Broad Gauge line of NF Railway. The project area could be approached from Bagdogra airport near Siliguri via Phuentsholing - Semtokha (near Thimphu) - Dochula (about 425 km). The project area can also be approached from Gelephu.

**6X170 MW PUNATSANGCHHU-II HEP** :- The Project is located on Punatsangchhu River in Wangdue Phodrang Dzongkhag in Western Bhutan. Access to the project site is from right bank through Wangdue-Tsirang highway. All the project components (except diversion tunnel) are located on the right bank of river Punatsangchhu, between 22 km and 38 km downstream of Wangdue Bridge. The dam site is about 94 km from Thimphu and is connected by highway.

Paro (Bhutan) is the nearest airport (about 125 km). The nearest railway station is Hasimara (India) on Siliguri - Alipurduar Broad Gauge line of NF Railway. The project area could be approached from Bagdogra airport near Siliguri via Phuentsholing - Semtokha (near Thimphu) - Dochula (about 440 km). The project area can also be approached from Gelephu.

#### 2.0 PROJECT DETAILS

Project Title	:	<b>6x200MW Punatsangchhu – I Hydroelectric Project, Bhutan</b>	<b>6x170MW Punatsangchhu – II Hydroelectric Project, Bhutan</b>
Customer	:	M/s Punatsangchhu – I Hydroelectric Project Authority (PHPA-I), Bhutan	M/s Punatsangchhu – II Hydroelectric Project Authority (PHPA-I), Bhutan
Consultant	:	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi	M/s Wapcos, Gurgaon Central Electrical Authority, New Delhi
Postal Address	:	Superintending Engineer	Superintending Engineer



	(Generation) Punatsangchhu-I Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)- 02-376135	(Generation) Punatsangchhu-II Hydroelectric Project Authority, Lobesa, Bhutan Tel: (+975)-02-376131 Fax: (+975)-02-376135
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## 2.1 SITE CONDITIONS (FOR DESIGN PURPOSES)

### 2.1.1 SITE CONDITIONS

		<u>PHPA-1</u>	<u>PHPA-2</u>
a). Average rainfall per year	:	665.11 mm	665.11 mm
b). No. Of months of tropical monsoon	:	5 (May to Sept)	5 (May to Sept)
c). Altitude (Pothead Yard over ground)	:	EL 887	EL 648

### 2.1.2 DESIGN AMBIENT

		<u>PHPA-1</u>	<u>PHPA-2</u>
a). Minimum Temperature	:	4.0°C	4.0°C
b). Maximum Temperature	:	35°C	40°C
c). Design Ambient Temperature	:	35 °C	40 °C

### 2.1.3 RELATIVE HUMIDITY

a). Maximum	::	100%
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### 2.1.4 WIND PRESSURE (AS PER IS:875-1987)

a). Design wind speed	:	47 m/sec.
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### 2.1.5 SEISMIC FACTORS

The Power House site is located in seismic zone-IV, as such, various equipment shall be designed for installation and operation in earthquake prone area. The seismic loads occur due to the horizontal and vertical accelerations which may be assumed to act non-concurrently. **The coefficients for horizontal acceleration as 0.4g and vertical acceleration as 0.2g shall be used for design purposes.** The seismic loads shall be equal to the static loads corresponding to the weights of the parts / accessories multiplied by the coefficient of the acceleration.



The base frame / supports and fixing devices of various equipment shall be strong enough to withstand the forces in normal operation and in abnormal conditions with forces superimposed due to occurrence of earthquake and short circuit simultaneously. The civil foundation drawings and the embedment which are to be grouted in concrete shall be supplied by the bidder. The copies of type test reports for similar type of foundation equipments, if tested earlier, should be furnished alongwith the bid. If the equipment covered in this package have not been type tested earlier, design calculations of simulated parameters should be furnished during design stage.

To prevent the movement of various equipment and its parts during earthquake, suitable devices shall be provided for fixing of various equipment with the foundations. The bidder shall include necessary bolts and fittings for embedding in the concrete foundation in their scope of supply.

#### 2.1.6 COMMUNICATION & TRANSPORT LIMITATIONS

The transport limitation by road from Phuentsholing to the project site would be the governing factor in respect of the permissible package size and weight.

The existing roads, wherever required, will be improved and upgraded to allow the transport of the packages of the following size and weight. However, the bidder shall make his assessment regarding road condition while dispatching such packages.

- i) Size in meters (LXBXH) = 14mx5mx4m (without height of the trailer)
- ii) Weight (tonnes) = 100 tonnes (including weight of trailer with multiple wheels preferably hydraulic maneuvering wheels).

The bidders shall design their equipment such that the transport packages are within the above limitations.

Lighter packages with reduced width and height but with lengths up to 18 m can be transported, which shall, however, be subject to prior confirmation from the purchaser.

#### 2.1.7 AUXILIARY POWER SUPPLY

		415V AC System	220V AC System	220 V DC System (Un grounded)
1.	Nominal Voltage	415 V	220 V	220 V
2.	No. of phases	3ph, 4 wire	1ph, 2 wire	2 wire
3.	Frequency (Hz)	50 $\pm$ 3 %	50 $\pm$ 3 %	NA
4.	Voltage variation	$\pm$ 10 %	$\pm$ 10 %	$\pm$ 10 %



### 2.1.8 SYSTEM PARAMETERS

S. No.	Description	400 kV System	220 kV System
a)	Lightning Impulse Withstand Voltage (kVp)	1425	1050
b)	Switching Impulse Withstand Voltage (kVp)	1050	-
c)	P.F. Withstand Voltage (kVrms)	630	460
d)	Highest System Voltage (kV)	420	245
e)	Creepage Distance (mm)	10500	6125
f)	Short Circuit Capability (kA for 1sec)	50	40

### 2.1.9 MINIMUM CLEARANCE

S. No.	Description	400 kV System	220 kV System
a)	The minimum vertical clearance from any energized metal part to the top of the plinth	8.0 m	5.0 m
b)	The minimum vertical distance from the bottom of the lowest part of bushing or supporting insulators to the top of plinth	2.55 m	2.44 m
c)	The minimum clearance between the live parts and earth	3.4 m	2.1 m
d)	The minimum clearance between phases	4.1 m	2.1 m
e)	The minimum sectional clearance	6.5 m	As per IS

## 3 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification. It is recognised that the Manufacturer may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously.

## 4 STANDARDS

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.



The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

In case governing standard for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in the offer along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaser's / owner's approval. The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

## **5 MATERIALS**

### **5.1 General Requirements for materials**

All materials of the equipment / structures shall be of first class commercial quality, considering strength, ductility, durability, best engineering practice and the normal or severe operating service to which the equipment will be subjected, free from any defects and imperfections, of recent manufacture and unused and where indicated of the classifications and grades designated therein. Materials not specifically described herein but used for manufacturing of the equipment, shall be the most suitable for the purpose and shall comply with the latest specifications of Bureau of Indian Standards, or the American Society for Testing of Materials (ASTM), or approved equivalent standards. If the bidder desires for any reason to deviate from or use materials not covered by these specifications, he shall state the exact nature of the deviation or exception and shall submit for the approval of Purchaser complete specifications of the materials he proposes to use alongwith the reason of such deviation. All materials, supplies and articles not manufactured by the bidder shall be the products of recognized, reputed manufacturers and product shall have the marking of standards to which it conforms.

The materials liable to be attacked by termites or other insects shall not be used. All workmanship shall be of the highest quality to ensure smooth functioning of equipment / material offered. The design, dimensions and materials of all parts, shall be so chosen that the electro-mechanical and thermal stresses to which they may be subjected shall not render them liable to distortion or damage under the most severe conditions encountered in actual service.



## **5.2 Corrosion Resistant Materials**

- 5.2.1 Bronze hinge pins shall be provided for all doors.
- 5.2.2 The surface of mild steel fabricated items and other metal surfaces shall be thoroughly cleaned by grit blasting and coated with corrosion resisting paint to prevent rusting. The Bolts or Nuts, which are subject to frequent removal and the bolts to be projected above the concrete with nuts subjected to removal, shall either be of stainless steel or hot dip galvanized / electro galvanized.

## **5.3 Magnetic & Non-magnetic materials**

- 5.3.1 Conductor material of Isolated & segregated phase bus ducts and Tubular conductors shall be of high conductivity aluminum alloy confirming to relevant standard.
- 5.3.2 Fixing and supporting materials of cables, bushings, bus bar enclosures etc. must be of non-magnetic material such as aluminium or nonmagnetic metallic alloy.
- 5.3.3 All sliding surfaces subject to continuous contact with grease over extended periods without movement shall be bronze or bronze faced.
- 5.3.4 Substitutions for specified materials shall be made only with the written consent of purchaser. The Bidder shall be responsible for the suitability of materials to be used in the construction of the equipment covered in various Sections of this documents.
- 5.3.5 To the extent feasible and without adversely affecting the strength and durability, materials for field welds, if required, shall be used such that these do not require preheating or stress-relieving.

# **6 DESIGN STRESSES**

## **6.1 General Criteria**

- 6.1.1 Liberal factors of safety shall be used throughout the design, and especially in the design of all parts subject to alternating stresses or to shock loading or to most severe operational loadings, including those due to electrical short circuit faults. The Supplier shall furnish complete information, including computations regarding the maximum unit stresses used in the design for record and reference of purchaser during design stage.
- 6.1.2 The life of equipment supplied shall be not less than thirty five (35) years.

# **7 WORKMANSHIP**

## **7.1 General Requirements**

- 7.1.1 Workmanship shall be of the highest grade and in accordance with the best modern practices for the manufacture of high-grade machinery, notwithstanding any omissions from these specifications or associated drawings. All work shall be performed by workmen skilled in their respective trades.
- 7.1.2 Machining of renewable parts shall be accurate and to specify dimensions according to the drawing so that replacements made may be readily installed. The Supplier shall keep and maintain in storage for at least 10 years or more, at his own expense,





sufficient templates, gauges, patterns, or other records used in the manufacture to enable him to make repair and furnish replacement parts for future needs. Notwithstanding this, if the Manufacturer/Bidder, in future, intends to wind up his business, he shall give the information to this effect to the Purchaser, sufficiently in advance, so as to enable him to consider buying life time spares before the closure of the business.

## **8 STRUCTURAL MATERIALS**

### **8.1 Bolts, Nuts, Studs and Screwed Connections**

All threads shall be clean and accurately cut before assembling. Screwed parts shall be lightly lubricated or coated with jointing compound as may be applicable before connection. All screwed connections shall be made adequately and no such force shall be used which may permanently deform the material. Metric threads shall be provided.

### **8.2 Fastening Elements for Equipment**

- (i) Fastening elements for the equipment viz. the bolts, studs, nuts, screws, washers shall be of material which is most suitable for the operating conditions and the frequency of removal for dismantling of the respective components, parts. These items shall conform to relevant national or international standards.
- (ii) The fastening elements shall be of following materials depending upon the condition of operation:
  - a) Subjected to regular Corrosion resistant steel as removal for dismantling per applicable grades for maintenance or frequent adjustment.
  - b) Subjected to less frequent High tensile steel/other dismantling suitable materials per laid down practice.
- (iii) The fasteners (nuts and bolts) for the parts subjected to pressure shall be machined on the shank, under the head and nut.
- (iv) Wherever necessary, the fastening elements shall have locking devices and anti-vibration devices. The washers shall be of the taper type.
- (v) Where there is a risk of corrosion, bolts and studs shall be finished flush with surface of the nuts.
- (v) With the exception of high strength friction grip bolts, the bolts shall be designed so that with nuts fully tightened, the stress intensity at the bottom of the thread shall not exceed one half (1/2) of the yield point of the bolt material under all conditions.
- (vii) In case, nuts and bolts are of manufacturer's own standards, which are different from the usual national or international standards, the supplier shall supply taps & dies for the threads and special spanners for the nuts & bolts.
- (vi) The supplier shall state the standards to which the fastening elements offered conform.



### 8.3 Galvanizing

- (i) All drilling, punching, tapping, cutting, and bending of various parts shall be completed and all burrs removed prior to galvanizing.
- (ii) Galvanizing shall be applied by the hot dipped process and shall consist of the smooth, clean zinc coating free from defects and of uniform thickness. The quantity of Zinc applied shall not be less than 610g/m<sup>2</sup> of the surface area. Original blast-furnace raw-zinc (minimum purity 98%) shall be used. Sheardizing or other alternative process shall not be used without the approval of the Purchaser and / or Consultant.
- (iii) Material / parts on which galvanizing has been damaged shall be redipped unless, in the opinion of the purchaser, the damage is local and can be repaired by applying a coat of galvanizing repair paint.

### 8.4 Non-metallic Coatings

- (i) Coatings in this category include sprayed or sheet linings, as applied to tanks, vessels and pipes carrying aggressive fluids and wrappings as applied to buried or immersed pipe work. The materials employed may be rubber PVC sheet, glass reinforced resin or plastic.
- (ii) Surface preparation and application of the coating shall be in strict accordance with the approved instructions of the coating supplier.
- (iii) The surface of the parts to be embedded in the concrete shall be cleaned from mill scale, dirt, oil, grease and other residues and shall be covered with a substantial coating of Portland cement wash or other proprietary coating before dispatch.

### 8.5 Material of Rating Plates, Name Plates and Labels

- (i) Rating and diagram plates shall give the information as required in latest edition of IEC/IS standard.
- (ii) A rating plate of non-corrodible material sheets shall be attached to each major and auxiliary item of goods / apparatus and cable end terminals. This plate shall be permanently engraved with the designed full load ratings, serial number, type, date of manufacture and other identifications deemed necessary. Where necessary, diagram shall also be supplied.
- (iii) All markers/labels shall be made of **halogen & silicon free polyamide material with inflammability class V2 as per UL 94**, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest Bluemark UV technology so as to comply the Wipe Resistance according to DIN EN 61010-1/VDE 0411-1.

### 8.6 Machine Work

- 8.7.1 Unless otherwise shown on the approved shop drawings, all allowances, tolerances, and gauges for metal fits shall conform to applicable ISS or to ANSI Standard B4.1 for the class as shown or otherwise required. Sufficient machining allowance shall be left while placing pads to ensure true surface of solid material. Finished contact or bearing



surfaces shall be true and exact to ensure full contact.

- 8.7.2 All machined parts shall be accurately machined and like parts shall be interchangeable. Drilled holes for bolts shall be accurately located and drilled to templates when necessary or specified. The holes for fit-up bolts or dowels shall be carefully reamed and the bolt or dowel shall enter with a light driving fit. Bolt and screw threads shall conform to applicable ISS or to ISO standard.

## 8.8. Surface Finish

- 8.8.1 Surfaces to be machine-finished shall be indicated on the shop drawings by symbols which conform to applicable ISS or to ANSI B46.1 or to equivalent standard. Values of roughness height are specified in microns as "average deviation from the mean surface". Values of roughness, width and waviness height are not specified but shall be consistent with the general type of finish as specified by the roughness height. Compliance with the specified surface will be compared to roughness comparison specimens.

## 8.9 Type of Finish and Roughness Value

- (i) Surfaces which are to be machined to dimensions where the tolerance is 0.5mm or greater shall have a maximum roughness value of 12 microns.
- (ii) Stationary mating surfaces, where reasonably accurate positioning of the members or a moderately tight joint is desired, shall have a maximum roughness value of 6 microns.
- (iii) Surfaces in sliding or rotating contact, where motion is slow and loads are light, shall have a maximum roughness value of 3 microns.
- (iv) Surfaces in sliding or rotating contact, when loads and speeds are moderate, shall have a maximum roughness value of 1.6 microns.
- (v) Surfaces in sliding or rotating contact, where loads are heavy and/or the motion is rapid, shall have a maximum roughness value of 0.8 microns.

## 8.10 Unfinished Surfaces

So far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground or machined to secure reasonable alignment. Unfinished surfaces shall be true to the lines & dimensions shown on the drawings and shall be chipped or ground free from projections or rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in a manner approved by purchaser.

# 10 PAINTING AND PROTECTIVE COATINGS

## 10.1 General Requirements

- (a) All surfaces shall be thoroughly cleaned of rust, mill scale, oil, grease and dirt



prior to shipment and before painting. Paint shall only be applied to dry and clean surfaces.

- (b) Except for surfaces that will be embedded in concrete and as otherwise specified, all un-machined or unturned internal or external surfaces shall be given not less than one coat of red lead primer. Any exterior surfaces requiring welding during manufacture shall be ground smooth after welding before application of the primer coat. The primer coat shall be applied quickly after the welding and grinding is over.
- (c) Except as otherwise provided the Bidder's standard painting system for miscellaneous auxiliary equipment such as motors, motor starters, gauges, pumps, etc. will be satisfactory. All equipment shall have a neat & attractive appearance.
- (d) Flaws in exterior surfaces shall be ground smooth before applying the prime coat. This shall in no way reduce the unit strength.
- (e) The minimum total dry film thickness shall be **1.5 mils (38 microns)** for prime finishes 2 mils (50 microns) for lacquer finishes and 3 mils (75 microns) for enamel finishes.
- (f) All needs of final touch up paint for application at site shall be included in the scope of supply.

## 10.2 Specific Requirements

Except as otherwise specified, the interior and exterior steel surfaces of cabinets/cubicles shall be thoroughly cleaned after fabrication by sandblasting, pickling and rinsing or other means and then shall receive a rust inhibitive phosphatizing or equivalent treatment prior to painting in accordance with applicable IS standard or article 20-6.6.1 of ANSI standard C37.20. Exterior surfaces shall then be primed, filled wherever necessary and given not less than two coats of quick air drying lacquer or synthetic enamel. Cubicles and terminal boxes for electrical devices shall be finish painted with semi-gloss finish in accordance with applicable IS standard or **ANSI Standard Indoor Light Gray No. 61** or as approved by Purchaser. Interior surfaces shall receive not less than one coat of corrosion resisting paint in accordance with the manufacturer's standard practice. Inside of cubicle shall be painted in approved colour by suitable quality paint.

## 10.3 Conforming Standards for Paints

The bidder shall submit the specifications and the names of manufacturers of all paints which will be incorporated into the work for approval of the purchaser. Paint shall dry with a surface such that touchup paint will adhere. Colour scheme will be approved by the purchaser.

# 11 CASTING

## 11.1 General Requirements



Castings shall be free from injurious defects and foundry irregularities such as projections, ridges, hollows and chip marks so that they will not require surface smoothing operations in the field prior to painting. The location of existing defects shall be determined and they shall be completely removed to sound metal. The structure of the castings shall be homogenous and free from excessive non-metallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting shall not be permissible and such casting shall be rejected. All castings involving welded fabrication shall be stress-relieved.

### **11.2 Dimensions of Castings**

The thickness and other dimensions of the castings shall conform substantially to the dimensions on the drawings and shall not be reduced by shop or foundry practices to the extent that the resulting stresses in the metal will exceed the stresses allowed under this Document. Castings shall not be warped or otherwise distorted nor shall their dimensions be oversized to such an extent as to interfere with proper fit with other parts.

### **11.3 Surface Finish**

All parts shall be free from burrs, sharp edges and imperfections after cutting, machining and welding. All visible parts shall receive special attention in order to ensure pleasing appearance of the complete equipment.

## **12 ELECTRICAL EQUIPMENT – GENERAL REQUIREMENTS**

### **12.1 Electric Motors**

- 12.1.1 All motors shall comply with relevant National or International Standards.
- 12.1.2 Supplier shall be fully responsible for ensuring that the motor duty cycle, rating, performance, tests and mechanical arrangements are all entirely relevant, suitable for compliance with the above standards for the application at the station in the extreme environmental and conditions specified.
- 12.1.3 The preferred type of A.C. motor is squirrel cage, totally enclosed, fan-cooled, except for single-phase motor with rating less than 0.5 kW. The standard types of motors would be subject to approval of purchaser. Motors above 1.0 kW shall be 3-phase type.
- 12.1.4 The stator insulation system shall be class-F or a higher class but in each case, temperature rises shall be limited to Class-F wherever practicable on full continuous rated load.
- 12.1.5 All A.C. motors shall be capable of direct on-line starting and of continuous operation at rated output under abnormal frequency conditions. These shall also be capable of operation for a period of not less than 5 minutes, with a voltage of 25 percent below nominal voltage at nominal frequency, without injurious overheating. The starting



- current at full voltage shall not exceed six times the full load current. Each motor shall be tested at Manufacturer's works to confirm compliance with this requirement.
- 12.1.6 Ball or roller bearings shall be used. Vertical shaft motors shall have approved thrust bearings. Lubrication fittings shall be provided for the bearings.
- 12.1.7 The terminal box shall be weatherproof and firmly fixed to the motor frame. The terminal studs shall be adequately sized for the current duty required and shall be identified. All terminal boxes shall have approved cable adapter plates, sealing chambers or conduit entries.
- 12.1.8 The arrangement of the terminal box shall be such as to facilitate installation of cables and allow interchanging of any two phase leads without disturbing the sealing compound, if this is used at cable terminations.
- 12.1.9 Wherever practicable, the motor end cover shall be removable from the driving end and shall have a removable plug to allow the speed to be checked by means of a portable tachometer.
- 12.1.10 All motors having a mass of 50 kg or more shall be fitted with lifting lugs.
- 12.2 Starters and Contactors**
- 12.2.1 Motors starters and contactors shall be equipped with short circuit protection and local disconnected devices. All starters shall be preferably from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V Isolating transformer with primary circuit breaker and secondary fuses. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.
- 12.2.2 Starters and contactors shall comply with applicable IS standard or IEC 60947-4-1 or NEMA IC 1 and shall be suitable for direct on-line starting, uninterrupted electrical duty and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation, unless otherwise approved by the purchaser. The enclosures shall be complete with the locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards and other necessary items as required by the duty of the starter or contactors.
- 12.2.3 Starters & contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal voltage, at nominal frequency.
- 12.2.4 Thermal type over load and phase failure relays shall be supplied with starters for motors of 7.5 kW or higher rating. For motors of less than 7.5 kW rating, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to monitor current in one phase shall be provided for motors above 7.5 kW.
- 12.2.5 Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts.



## **12.3 Moulded Case Circuit Breakers (MCCBs) and Miniature Circuit Breakers (MCBs)**

### **12.3.1 MCCBs**

All moulded case circuit breakers shall be 2-pole or 3-pole, as required, having thermal time delay and instantaneous trips with provision for "On-Trip-Off" controls as well as suitable indications for these positions in the operating mechanism. The circuit breakers used in the motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with the applicable specification IEC 60947-2 or equivalent standards.

### **12.3.2 MCBs**

All miniature circuit breakers shall be 2-pole or 3-pole, as required, having thermal time delay and instantaneous trips with provision for "On-Trip-Off" controls as well as suitable indications for these positions in the operating mechanism. MCBs shall be used in the supply control circuits, or on the secondary side of CTs & VTs. The breakers shall comply with the applicable specification IEC 60947-2 or equivalent standards.

## **12.4 Control Relays**

Relays used as auxiliary control devices in conjunction with magnetic contactors shall be of the type designed for GIS application with provision for convertible contacts. All contacts shall have a minimum thermal current rating of 10 A over a range of 6 to 600 V AC.

## **12.5 Pilot Devices**

12.5.1 Pilot devices such as selector switches, push-button switches & thermostats shall be of heavy duty type and where mounted outdoors, shall be housed in weatherproof enclosures specially designed for the extreme conditions of environment.

12.5.2 All electrical contacts for control, alarm and shutdown shall have a thermal current rating of not less than 10A at 220 V DC.

## **12.6 Instruments / Meters**

12.6.1 The instruments mounted on panels shall be of the semi flush type, back connected, matching type, shape and of approved finish to present neat and fitting arrangement consistent with the functional requirements.

12.6.2 Mechanical quantity measuring instruments which are directly mounted on equipment shall have circular dials and shall be properly supported and guarded against accidental injury/breakage. These shall be placed in convenient location.

12.6.3 The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. The changes in the ambient temperature within the range prevailing at site shall not affect the accuracy.





- 12.6.4 The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale.
- 12.6.5 The instruments which make contacts shall have contacts suitable for 250 V AC or 220 V DC circuits.
- 12.6.6 All the instruments shall conform to relevant National or International applicable standards. They shall be subjected to type and routine tests prior to despatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V to ground (RMS) for one (1) minute as per the relevant standards.
- 12.6.7 The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at the rated voltage of the instrument. The coil rating of the measuring instruments shall be co-ordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade as far as accuracy class is concerned.

## 12.7 Terminal Blocks

- 12.7.1 All internal wiring to be connected to the external equipment shall terminate on blocks, preferably vertically mounted on the side of cabinet, junction box.
- 12.7.2 The terminal blocks to be provided shall be fully enclosed with removable covers. The Terminal Blocks shall be 650V / 1100V grade and shall have continuous rating to carry the maximum expected current. These shall be of moulded design made up of unbreakable polyamide 6.6, V0 grade, touch proof. All metal parts including screws should be non-ferrous in nature. The terminal blocks shall have screw locking design to prevent loosening of conductor /screw and withstand vibration level of 5g .All terminal blocks shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.
- 12.7.3 The Terminal Blocks for the current transformers and voltage transformers secondary leads shall be provided with sliding disconnect switch. All the testing & measuring operations shall be possible without removing the connections. All the metal parts for current transformer and voltage transformer terminal block shall be non-ferrous with fire fire retardant, unbreakable polyamide 6.6 of V0 class housing .All accessories as well shall be of similar material features. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.
- 12.7.4 At least **20% spare terminal** shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 12.7.5 The boxes shall be provided with **20% spare terminals** unless otherwise specified.
- Unless otherwise specified, terminal blocks shall be suitable for connecting the cables of following sizes on each side:



- |    |                       |   |
|----|-----------------------|---|
| a) | All circuit except CT | Min. two (2) Nos. 2.5sq.mm.<br>Copper flexible.         |
| b) | All CT circuits       | Min. of 4 nos. of 4.0mm <sup>2</sup><br>copper Flexible |
- 12.7.6 There shall be a minimum clearance of **250 mm** between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks shall be minimum of **150 mm**.
- 12.7.7 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Cabinet wiring should be suitable for 50 deg. C as the space heaters will keep the temperature 10 deg. C higher than the ambient.
- 12.7.8 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal is run parallel and in close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite to the wiring duct shall be reserved for the external cable connection. All adjacent terminal blocks shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cables.
- 12.8 Equipment Wiring**
- 12.8.1 Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilizing slip-on ferrules approved by the purchaser.
- 12.8.2 The markers provided may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.
- 12.8.3 The markers must withstand a tropical environment and high humidity. Only fungus-proof materials will be accepted. The ferrules of adhesive type are not acceptable.
- 12.8.4 All trip circuits shall employ markers having a red background.
- 12.8.5 Sensitive control circuits shall be effectively shielded against extraneous signals and interference. Separate terminals shall be provided for termination of individual cable shields which will be grounded at source end only.
- 12.8.6 All wiring connections shall be readily accessible and removable for test or other purposes. The wiring between the terminals of the various devices shall be point to point.
- 12.8.7 The splices or tee connections between terminal points are not acceptable. The wire runs shall be neatly trunked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipment.
- 12.8.8 **Multi-conductor copper cables 2.5 sq.mm for PT circuits and 4.0 sq.mm for CT circuits** shall be connected to the terminal blocks in such a manner as to minimise



crossovers. The claw washers or crimp type connectors used shall be of approved design & shall be used to terminate all small wiring. The grommets or insulating bushings shall be installed, where necessary.

#### 12.9 Cubicles and Control Panels

- 12.9.1 The enclosures of cubicles and control panels shall be of **sheet steel with minimum thickness of 2.5 mm and gland plate shall be of minimum thickness of 3 mm**. These shall have rigid & self-supporting construction and supplied with channel bases.
- 12.9.2 The cubicles shall be fitted with close fitting, gasketed, hinged, lift-off doors capable of being opened through 180°. The doors shall be provided with integral lock and master key.
- 12.9.3 The cubicles and panels shall be vermin-proof. The gland plates of removable type shall be supplied and located in such a way so as to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor / roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by purchaser.
- 12.9.4 The cubicles and panels shall be adequately ventilated, if required, by vents or louvres and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.
- 12.9.5 Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.
- 12.9.6 Unless stated otherwise all the cubicles and panels shall be provided with a ground bus 40 Sq. mm copper bar extending throughout the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120 mm<sup>2</sup>.
- 12.9.7 The standard phase arrangement when facing the front of the motor control centers and switchboards shall be RYB from left to right, from top to bottom and front to back. All the instruments, devices, buses and other equipment involving 3-phase circuits shall be arranged and connected in accordance with the standard phase arrangement, wherever possible. Electrical clearances shall conform to the applicable standards and shall not require cutting away of adjacent framework.
- 12.9.8 All the instruments, control knobs and indicating lamps shall be flush mounted on the panels. The devices sensitive to vibration shall not be installed on doors or hinged panels and no equipment shall be installed on rear of access doors.
- 12.9.9 The instrument and control wiring, including all the electrical interlocks and the interconnected wiring between sections shall be completely installed and connected to terminal blocks by the supplier.
- 12.9.10 The arrangement of control and protection devices on the panels and the exterior



- finish of the panels shall be subject to the approval of the purchaser. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.
- 12.9.11 Switched interior light and socket outlets shall be provided for all the cubicles and control panels.
- 12.9.12 All the cubicles and the control panels shall be provided with lamacoid name plates, non-rustic, identifying the purpose of the panel & all its components.
- 12.10 Alarm Contacts**
- 12.10.1 Wherever applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices:
- (i) Local annunciator
  - (ii) Station annunciator
  - (iii) Computerized Control System.
- 12.10.2 All alarm contacts shall be of changeover type. Wherever required, relays shall be provided as contact multiplier.
- 12.11 Earthing**
- 12.11.1 The earthing terminals for the equipment covered in these specifications shall also be included in the scope of supply. The supplier shall connect the earthing terminals to the grounding conductors available in the vicinity area of the equipment.
- 12.11.2 The earthing risers from the station earthing mat to the vicinity of equipment will be arranged by the purchaser unless specified otherwise.

### **13 QUALITY ASSURANCE PLAN (QAP)**

#### **3.1 Quality Assurance Programme**

The supplier should adopt suitable quality assurance program to control all necessary activities to ensure that the equipment and / or services under the scope are in accordance with this specification. A quality plan detailing out the specific quality measure and procedures adopted for controlling the quality characteristics to be submitted for BHEL and PHPA approval.

The quality program is defined by ISO 9001, 1994 Quality systems- Model for quality assurance in design, development, production, installation and servicing.

#### **13.2 Quality Assurance Test**

- 13.3.1 A quality assurance plan detailing specific control procedures proposed to be adopted for controlling the quality characteristics for major items & equipment shall be furnished. The bidder shall submit and finalise manufacturing Quality Plans for all the major components and equipment with the purchaser. These quality plans will detail out various tests/inspections to be carried out and standards as mentioned in these specifications, various quality practices & procedures followed by bidder's Quality Control Organisation, the relevant reference documents acceptance norms



etc., various stages of material procurement, manufacture, assembly and final testing/performance testing etc. These shall include but not limited to the following:

- (i) Test of raw material.
- (ii) Non Destructive Tests as approved by Purchaser.
- (iii) Component Inspection and Tests.
- (iv) Assembly Inspection and Tests.
- (v) Pressure Test
- (vi) High Voltage Dielectric and other test
- (vii) Operational Tests
- (viii) Performance and efficiency tests as applicable.

- 13.3.3 The bidder shall furnish field quality plans which will detail out the quality practices & procedures etc. for all the equipment to be followed by the bidder's site quality control organization during various stages of site activities from receipt of material/equipment at site. The field quality plans shall also be approved by the PHPA/ BHEL.
- 13.3.4 No material shall be dispatched from the manufacturer's works before the same is accepted prior to pre-dispatch / final inspection including verification of records of all previous tests/inspection by PHPA/ BHEL's / their authorized representative duly authorized for despatch.
- 13.3.5 All the vendors/sub-vendors proposed by the bidder for procurement of major bought out items including castings, forgings, semifinished and finished components/equipments, list of which shall be drawn up by the bidder and finalized/approved in consultation with PHPA/ BHEL. The bidder's proposal shall include vendor/sub-vendor's facilities established at the respective works, the process capability, process stabilization, Q.C. system followed, experience list etc. along with their own technical evaluation of vendor/sub-vendors and shall be submitted to the purchaser for approval prior to any procurement. The approval for such vendor/sub-vendor shall not relieve the bidder from any obligation, duty or responsibility under the contract. This action shall, however, not involve PHPA/ BHEL in any complications arising between the bidder and his sub-contractor(s)/vendor/sub-vendors from whom he proposes to procure the material and submit their quality plans for PHPA/ BHEL's approval.
- 13.3.6 Normally no request for change of vendors/sub-vendors shall be entertained by PHPA/ BHEL. But in the peculiar circumstances if the request for change of vendors/sub-vendors is found reasonable and justified then the same shall be entertained and the decision of PHPA/ BHEL in this respect shall be final and binding. The time consumed for the change of vendors/sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the bidder from the responsibility to complete the work within stipulated time in any manner.



- 13.3.7 The quality requirements as agreed for the main equipment supply shall be applicable for the replacement items and all the spares as required.
- 13.3.8 All materials used or supplied shall be accompanied by valid & approved material certificates and tests & inspection reports. These certificates and reports shall indicate the acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

#### 14 DEVIATIONS FROM SPECIFICATIONS

All the deviations from the specifications shall be separately listed in Performa enclosed with respective sections of this Document, in the absence of which it will be presumed that the provisions of the specifications have been fully complied with by the bidder.

#### 15 PACKING AND FORWARDING

- 15.1 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The bidder shall be responsible for any damages to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by bidder without any extra cost. The replacement of damaged equipment shall be made promptly in order to complete the work within specified schedule and without waiting for the settlement of insurance claim.
- 15.2 The outside of the Box shall have the following details:
- Name of Contract Agreement Number
  - Name of the consignee
  - Name of Supplier
  - Total weight of consignment
  - Sign showing top/bottom side of the Box
  - Storage Code/ Symbols
  - Handling and unpacking instructions
  - Packing List of the material.
- A copy of detailed packing list shall also be kept inside the Box.
- 15.3 All removable external accessories and other components susceptible to damage if transported mounted on the equipment, shall be dismantled, adequately packed and shipped separately. All openings thus resulted shall be sealed by means of temporary steel plates (blanks).
- 15.4 Packing shall be sturdy and adequate to protect all assemblies, components, auxiliary devices and accessories from injury by corrosion, dampness, heavy rains, breakage and vibration encountered at the plant site.



- 15.5 Mandatory Spare parts and Tools & Tackles required for Operation & Maintenance shall be packed separately and clearly marked.

## **16 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE**

- 16.1 All the equipment, apparatus, materials and supplies covered under the specification shall be subjected to test in the shop and at the field In the presence of the representatives of PHPA / consultants/ BHEL for conformity with the requirements of the specifications. The method and procedure for the tests shall be as specified for particular item or shall be in conformity with the applicable standards for making such tests. The details of the test procedures and test equipment to be used should be intimated well in advance i.e. at least 6 weeks before these tests are conducted.
- 16.2 The end customer (PHPA)/ BHEL, his duly authorised representative and/or outside inspection agency acting on behalf of purchaser shall have at all reasonable times access to the supplier's premises or works and shall have the power to inspect and examine the materials and workmanship of the works during its manufacture or erection. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The equipment, if found unsatisfactory at any stage as to workmanship or material is liable to be rejected.
- 16.3 The test reports shall indicate the tests performed, the results obtained, instruments used, names of personnel carrying out the tests and provision for signature of the witnesses. They shall also show the test report number and the date of conducting the test. The format of these reports shall be submitted alongwith testing procedures for the Purchaser's (PHPA)/ BHEL approval well in advance.
- 16.4 All services such as labour, materials, electricity, fuel, water, stores, apparatus and instruments required for conducting any or all tests shall be arranged & provided by the supplier at his cost.

**The price of conducting all tests and additional type tests is deemed to be included in Bid price.**

### **1.15 TRANSPORTATION, HANDLING, STORING AND INSTALLATION**

The Bidder is required under the Contract to undertake transportation of goods from FOB/Ex-works to Project Site including clearing, forwarding and handling at port of entry, storage and preservation at site, intermediate location (if any) and further transportation to work site, including handling wherever required. All necessary transportation equipment including lifting and handling equipment shall be provided and/ or hired by the Bidder at his own cost.

Where the Bidder is required to effect delivery under any other terms, for example, by post or to another address, the Bidder shall be required to meet all the expenses until delivery on the site.

Where assemblies are supplied in more than one section, bidder shall make all necessary mechanical and electrical connections between sections including the connection between buses.



Bidder shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the bidder at his own expenses.

## **1.16 DOCUMENTATION**

### **1.16.1 DRAWINGS**

All drawings shall be prepared in AutoCAD and ultimate documentation would include drawings/documents on CDs. All dimensions and data shall be in SI metric units.

All items of the equipment should be clearly identified by proper part nos. in the contract drawings. Such parts, which are to be dispatched to site from works in dispatchable units and are reassembled at site, should be marked by proper identification marks at works and indicated in the drawings and quantified. The shipping list should be sent along with the general arrangement drawings for engineer's approval. All the items of the shipping list should be identified in the drawing.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at supplier's risk.

Approval of drawing or work by the purchaser/consultant shall not relieve the bidder of any of his responsibilities and liabilities under the contract.

In case of any modifications that may be necessary during erection or commissioning of the equipment, the bidder shall carry out modifications in the original drawing & submit 'As Built drawings' and required no. of prints thereof.

### **1.16.4 DOCUMENTATION SCHEDULE AT CONTRACT STAGE**

<b>A</b>	<b>For Approval (7 Sets – each revision), Hard copies as well as soft copies</b>
07	Copies of GA drawings with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
07	Copies of type test reports
07	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.





Project: 6X200 MW PUNATSANGCHHU-I HEP & 6X170 MW PUNATSANGCHHU-II HEP, BHUTAN  
Customer: PHPA-I & II BHUTAN

Technical Specification  
Section-3: Project Details & General Specifications

Doc No: TB-356-316-0XX  
Rev. No. 00

07	Copies of manufacturing and field quality plan.
07	Copies of installation, operation & Maintenance manual.
<b>B</b>	<b>After Approval and For Information/Distribution (5 Sets).</b>
05	Copies of GA drawings
05	Copies of type, Routine & Acceptances manual.
05	Copies of Insulation, Operation & Maintenance manual.
05	Set's of 'As Built' drawings
01	Sets of RTF of all drawings
02	All drawing/documents AS BUILT on CD-ROM.

**NOTE:**

1. Any revision of drawings / documents shall be submitted in the same no. of copies submitted first time for approval
2. Final drawings / documents shall be submitted in bound volume with customer and project details etc. written on the top.