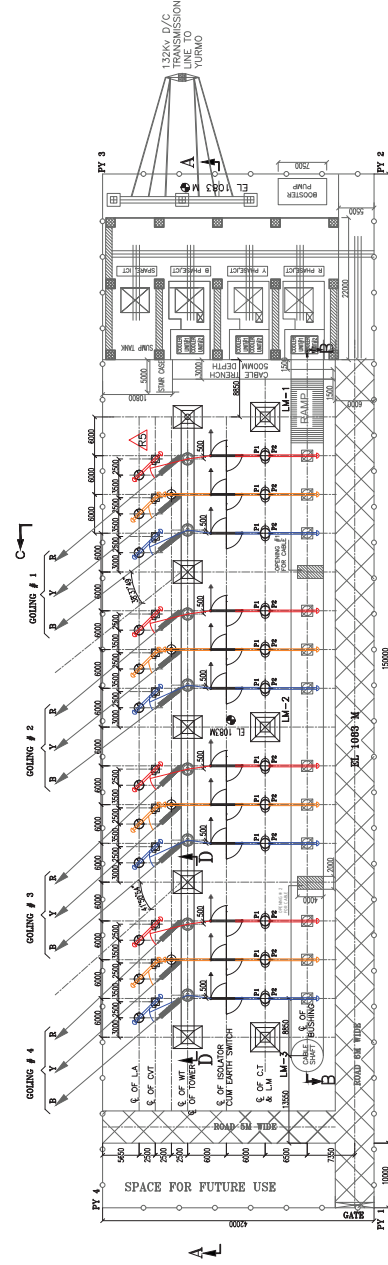


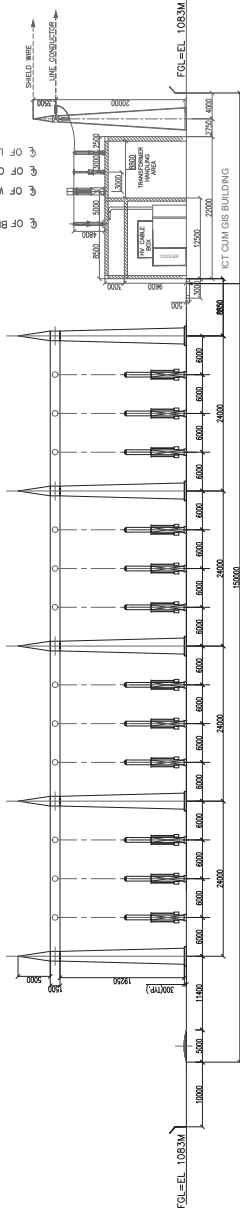
ANNEXURE – 1 (LIST OF DRAWINGS & DOCUMENTS)

Project :	MANGDECHHU HYDROELECTRIC POWER PROJECT (4X180MW) in Bhutan 400kV Pothead Yard
Customer :	Mangdechhu Hydroelectric Project Authority
Consultant :	NHPC
Drawing/Doc No.	Drawing Title
MHP-PYD01DD002	LAYOUT PLAN AND SECTION FOR 400KV POTHEAD YARD
MGD-PYD 02 DD 004	TRENCH LAYOUT OF 400KV POTHEAD YARD
MGD-PYD01GA003	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 ALUMINIUM TUBE
ANNEXURE-E3	SPECIFICAION FOR GI PIPE
ANNEXURE-E4	SPECIFICAION FOR ERECTION HARDWARE

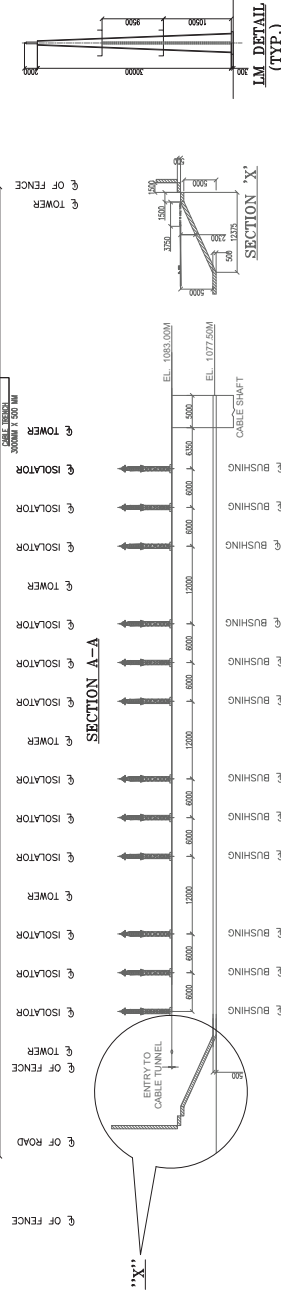
BILL OF QUANTITY		
S.N.	ITEM DESCRIPTION	MAIN QUANTITY
1.	400V, 2000A, 63M FOR 15kV, THREE PHASE HORIZONTAL DOUBLE BREAK ISOLATOR OPERATED ELECTRICALLY GANGED WITH ONE E/S MOTOR OPERATED ELECTRICALLY GANGED.	Nos. 04
2.	400V, 1000A, 63M FOR 15kV, WITH 120% EXTENDED CURRENT RATING, 2 CORE, SINGLE PHASE CURRENT TRANSFORMER.	Nos. 12
3.	400V, 800V/400V, SINGLE PHASE CAPACITIVE VOLTAGE TRANSFORMER (3 SECONDARY).	Nos. 12
4.	330V, DISCHARGE CLASS IV, 20 MA, SINGLE PHASE, STATION TYPE, HEAVY DUTY, METAL OXIDE, GAPLESS TYPE SAME ARRESTOR, TERMINATION OF TRANSMISSION LINE & D.TE.	Nos. 12
5.	400V, 10M POST INSULATORS	Nos. 04
6.	GALVANIZED GANTRY STRUCTURE & SUPPORT STRUCTURES FOR TERMINATION OF TRANSMISSION LINE & D.TE.	LOT 01
7.	ACSR MOOSE CONDUCTOR FOR 400V POTHEAD YARD	LOT 01
8.	4 INCH IPS ALUMINUM TUBE	LOT 01
9.	NAME PLATE & DANGER PLATES, SIZE 300mm X 300mm (MIN) FOR POTHEAD YARD (1No. NAME PLATE & 2Nos. DANGER PLATES PER BAY)	SET 04



PLAN AT EL 1083.00M



SECTION A-A



SECTION B-B

SECTION C-C

SECTION D-D

SECTION E-E

SECTION F-F

SECTION G-G

SECTION H-H

SECTION I-I

SECTION J-J

SECTION K-K

SECTION L-L

SECTION M-M

SECTION N-N

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DRAWING No.	INVENTORY No.	SIGN. & DATE	COMPUTER AIDED PAPER NAME :	COPY RIGHT AND CONFIDENTIAL The information on this drawing is the property of BHARAT HEAVY ELECTRICALS LIMITED. It must not be used directly or indirectly to copy or reproduce in the interest of the company.
900-010-100-9-BL				

LEGEND

- CONNECTION TO GROUND MAT THROUGH RISER
- RE CONNECTION TO ROD ELECTRODE
- PE CONNECTION TO PIPE ELECTRODE WITH TREATED EARTH PIT
- 75x12mm GS FLAT
- 50x6mm GS FLAT
- 40mm DIA MS ROD

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 .

SHEET NO.	DESCRIPTION
01.	TITLE
02.	NOTES
03.	400kV LINE CVT (WITH LMU)
04.	400kV POST INSULATOR (SOLID CORE TYPE)
05.	336kV LIGHTNING ARRESTER
06.	MARSHALLING KIOSK
07.	400kV HORIZONTAL DOUBLE BREAK ISOLATOR (TYPICAL) WITH ONE EARTH SWITCH
08.	TOWER WITH PEAK
09.	LIGHTENING MAST (LM)
10.	400kV CURRENT TRANSFORMER
11.	CABLE TRENCH
12.	ROD ELECTRODE WITHOUT PIT
13.	ROD EARTH ELECTRODE WITH TEST PIT FOR TOWERS AND LM
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	
STATUS OF DRAWING				CUSTOMER	
DISTRIBUTION OF PRINTS				CONSULTANT	
CONTRACTOR				SUB-SUPPLIER/VENDOR	

REV.	DATE	ALTERED CHECKED APPROVED	REV.	DATE	ALTERED CHECKED APPROVED	REV.	DATE	ALTERED CHECKED APPROVED	REV.	DATE	ALTERED CHECKED APPROVED

SUB-SUPPLIER/VENDOR		DESIGNED BY		SCALE		WEIGHT (KG)		REF. TO ASSY. DWG.		ITEM NO./NO. OF ITEM	
		UNTEL.DIMS. GR.		ANGLE		1 : 900					
		TITLE		400KV POTHEAD YARD - EQUIPMENT EARTHING		PHOTOGRAPHY & DETAILS					

BHARAT HEAVY ELECTRICALS LTD.		TRANSMISSION BUSINESS GROUP	
DRG. NO.	WB-H-EH-010-000	REV.	00
DWG. NO.	HBB-POTHEAD0000	REV.	00

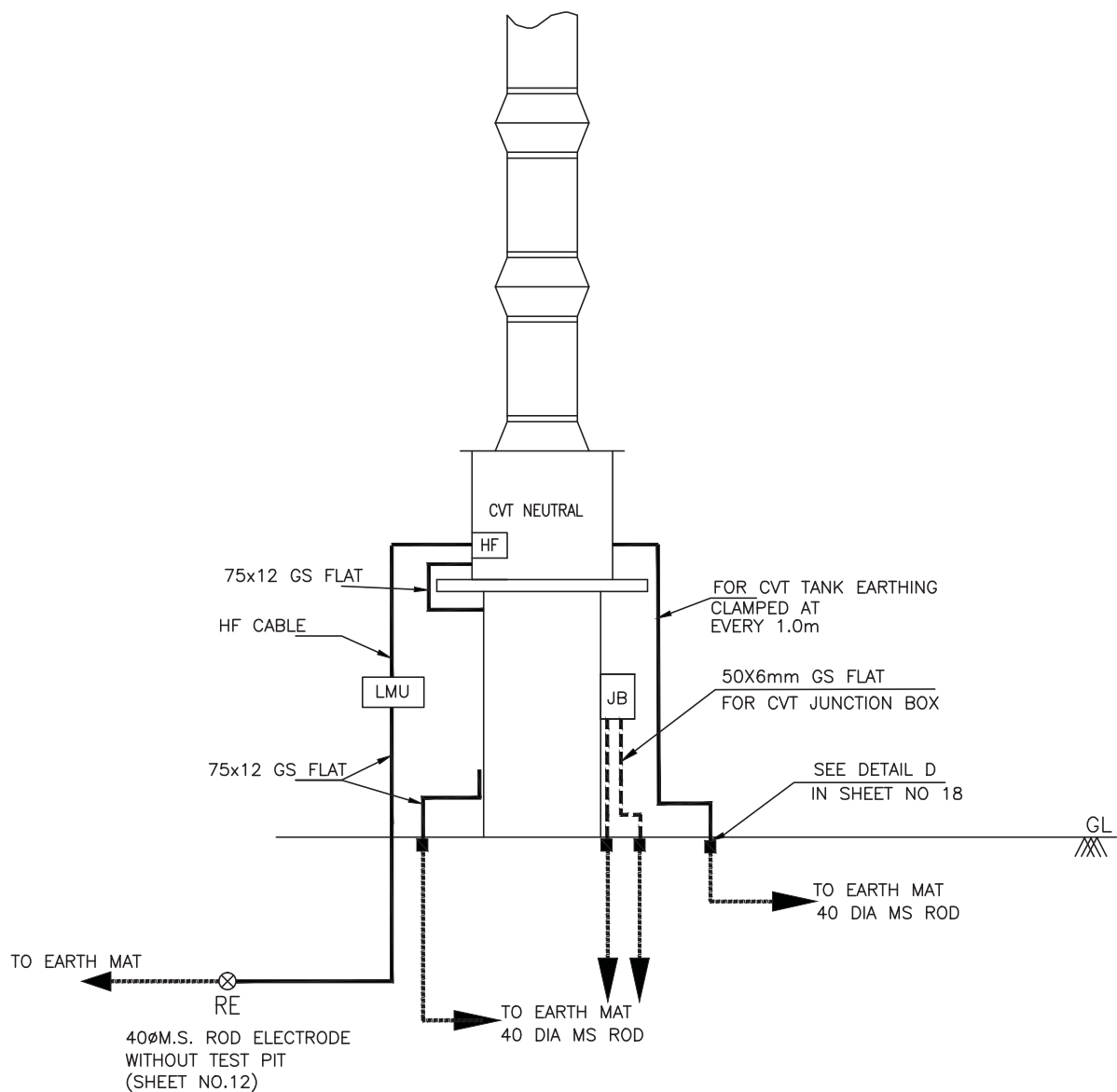
1. RISER FROM THE EARTH GRID SHALL BE 40MM DIAMETER MILD STEEL ROD. RISER SHALL RISE FROM THE GROUND ALONG THE NEAREST EQUIPMENT FOUNDATION/BUILDING COLUMN/WALL TO AVOID ANY OBSTRUCTION TO MOVEMENT OF PERSONNEL.
2. CONNECTION TO ALL EQUIPMENT AND TOWERS SHALL BE BY BOLTED JOINTS. CONTACT SURFACES SHALL 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.
19. ALL GROUND CONNECTIONS SHALL BE MADE BY ELECTRIC ARC WELDING. ALL ARC WELDING OF LARGE DIAMETER CONDUCTORS SHALL BE DONE WITH LOW HYDROGEN CONTENT ELECTRODES.
20. BENDING OF LARGE DIAMETER CONDUCTORS SHALL BE DONE PREFERABLY BY GAS HEATING.



EQUIPMENT EARTHING DETAILS NOTES

DRG. No. TB-4-361-318-006

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)

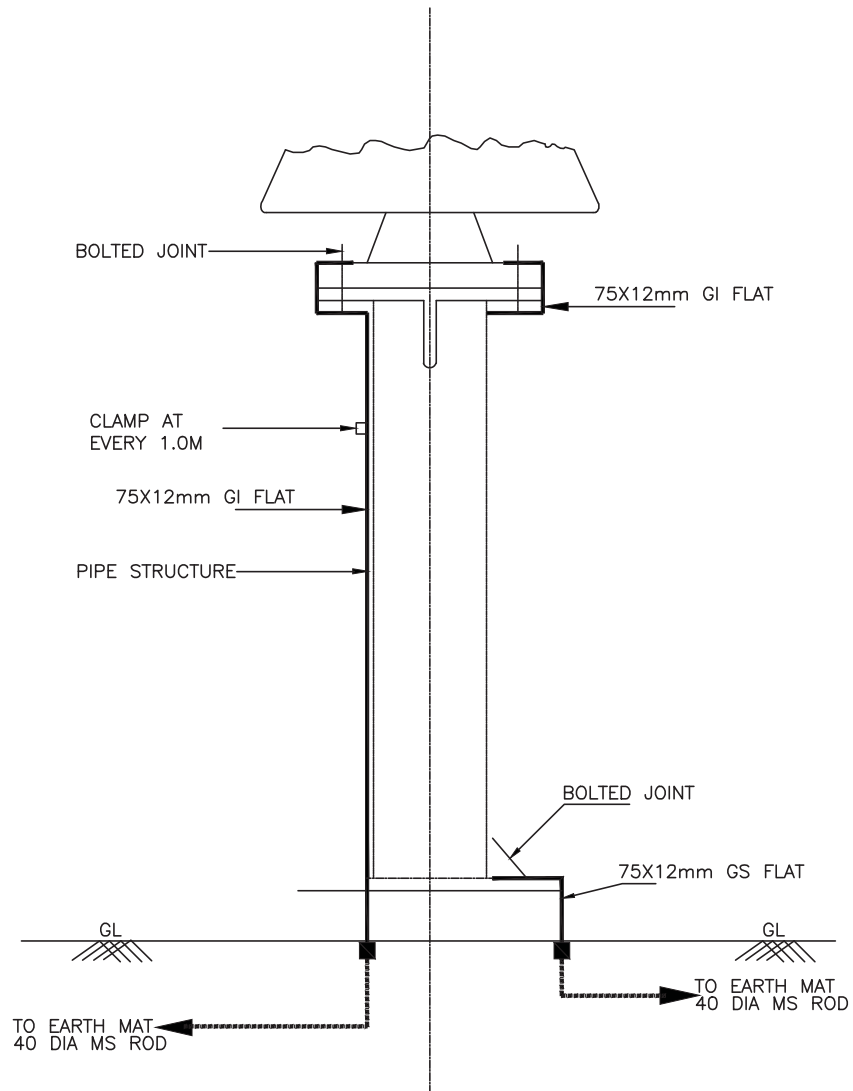
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DRG. No.

TB-4-361-318-006

SHEET No.

03



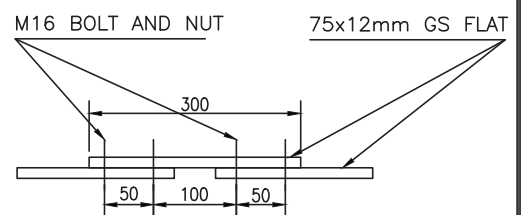
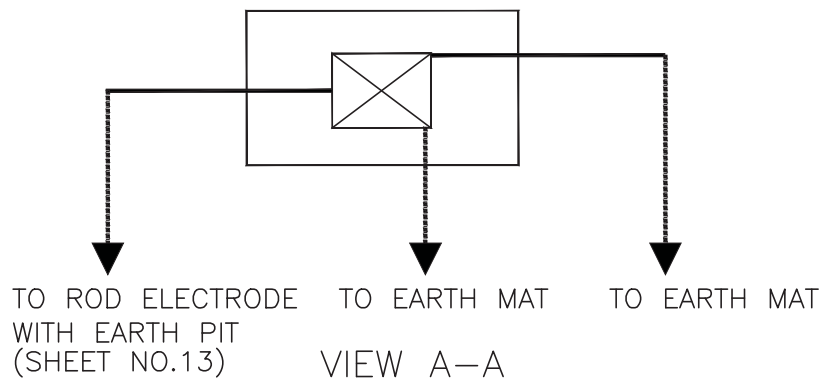
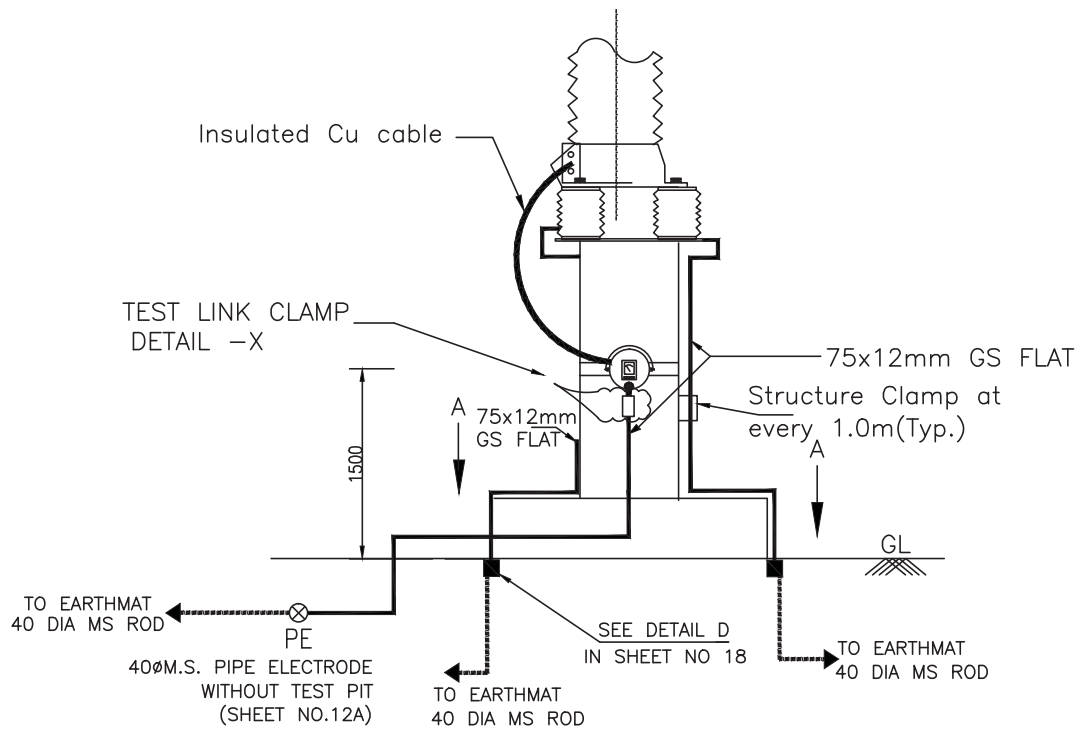
NOS.OF RISERS = 2 NOS.



EQUIPMENT EARTHING DETAILS 400kV POST INSULATOR (SOLID CORE TYPE)

DRG. No. TB-4-361-318-006

SHEET No.
04



(DETAIL -X)

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

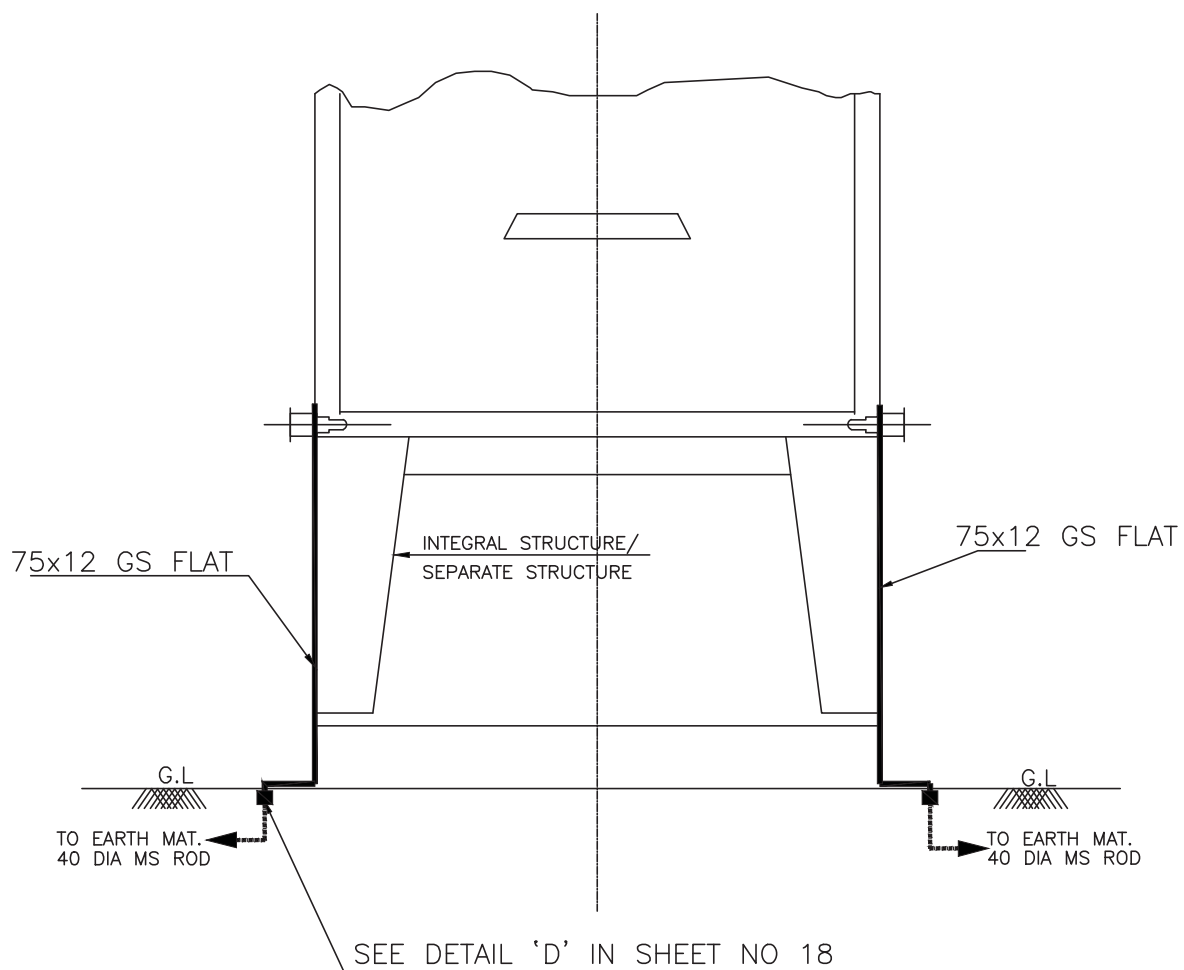
336kV LIGHTNING ARRESTER

COMPU. DRG. REF.

DRG.NO.

TB-4-361-318-006

SHEET No.
05



NOS.OF RISERS = 2 NOS.



EQUIPMENT EARTHING DETAILS

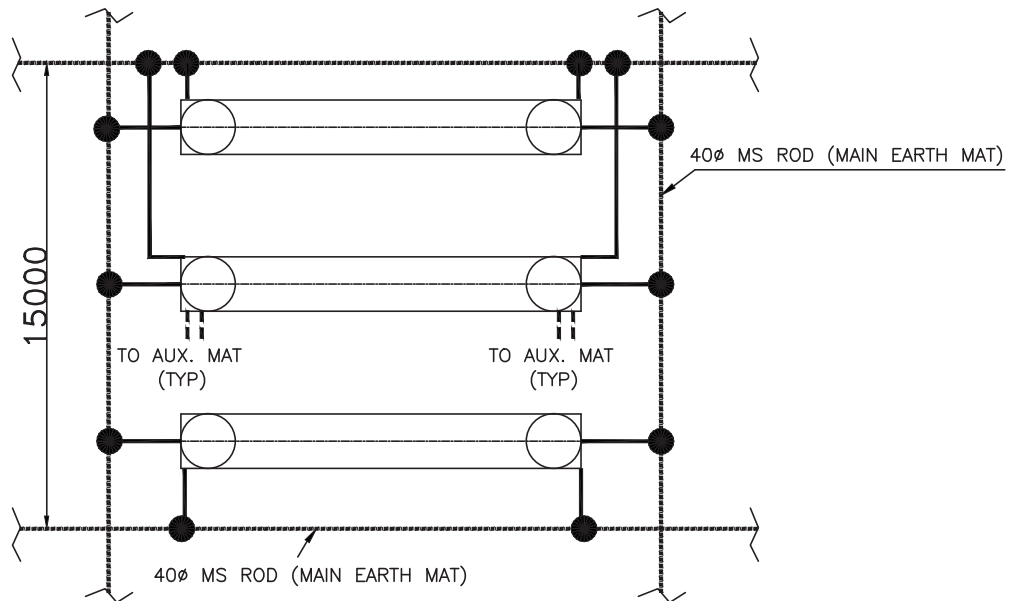
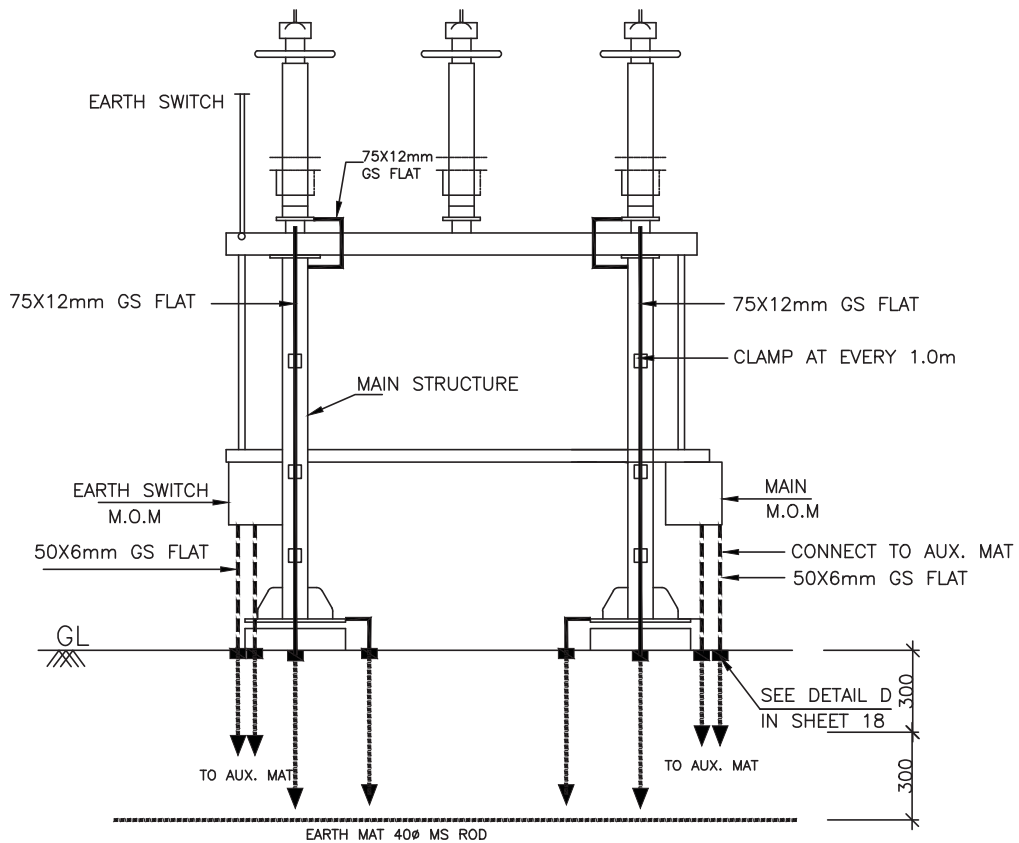
MARSHALLING KIOSK

COMPUTERREF.NO.

DRG. No.

TB-4-361-318-006

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



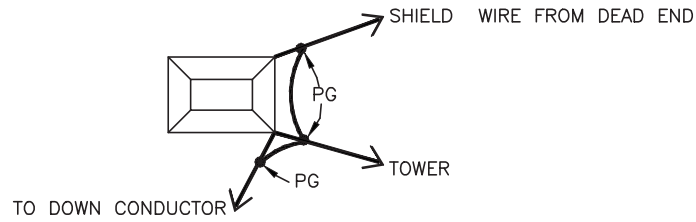
EQUIPMENT EARTHING DETAILS
400kV HORIZONTAL DOUBLE BREAK
ISOLATOR (TYPICAL) WITH ONE EARTH SWITCH

COMPUTERREF.NO.

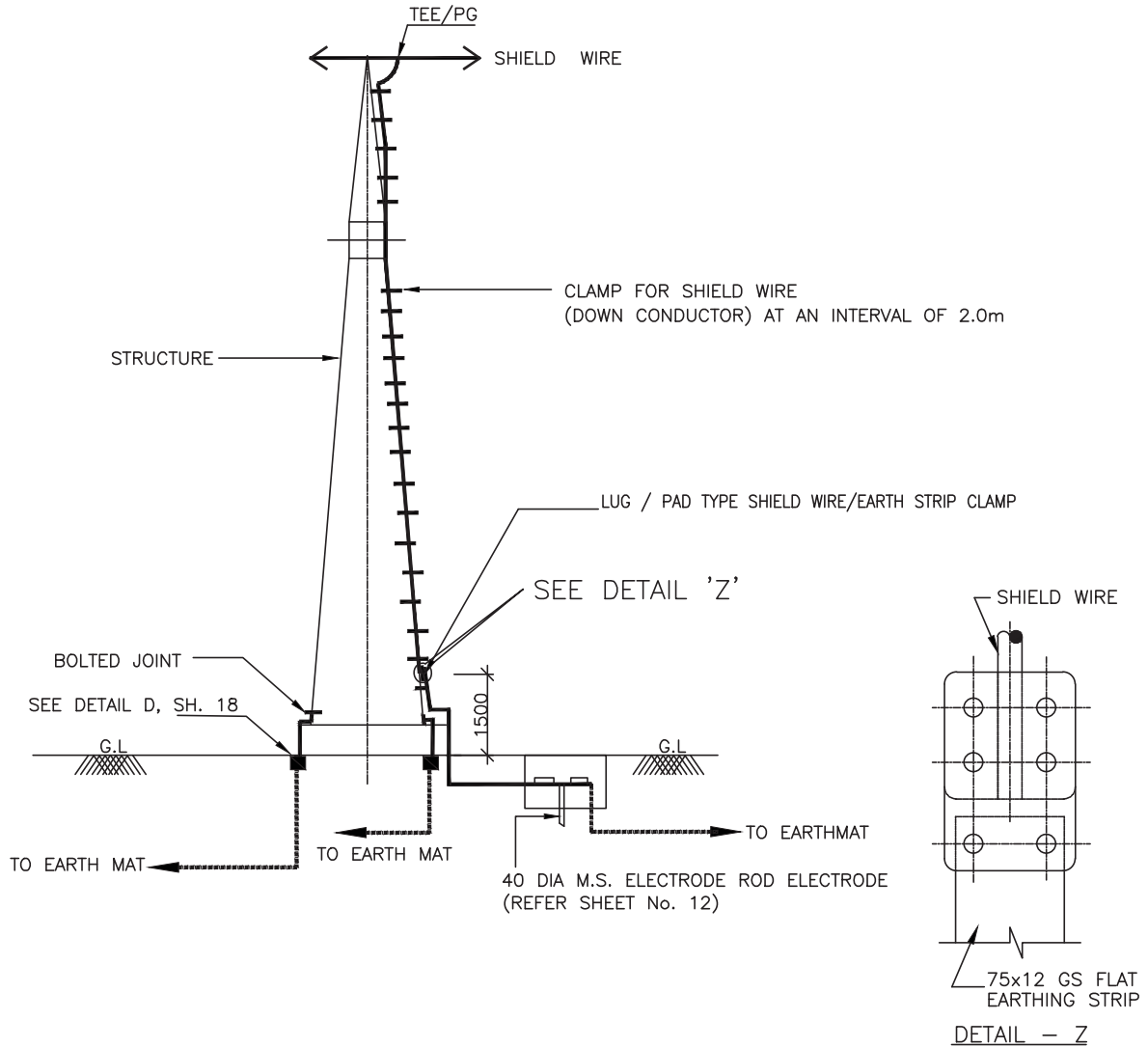
DRG. No.

TB-4-361-318-006

SHEET No.
07



DETAIL WHEN 2 E/WIRES TERMINATES A TOWER



NOTE:

1. TWO EARTHING STRIP SHALL BE CONNECTED TO ONE RISER.
2. NO. OF ROD ELECTRODE : 1 NO. PER TOWER WITH DOWN CONDUCTOR.
3. NO. OF RISERS = 2 NOS.



EQUIPMENT EARTHING DETAILS
TOWER WITH PEAK

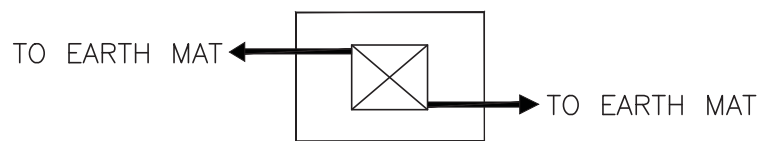
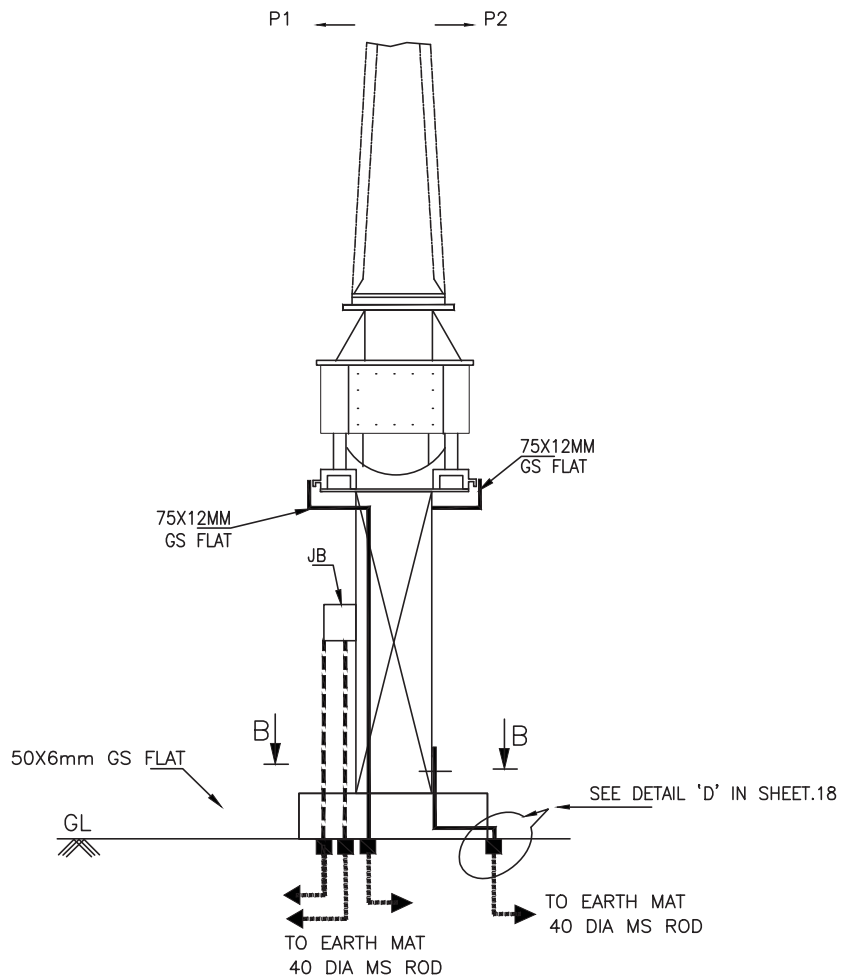
COMPUTERREF.NO.

DRG. No.

TB-4-361-318-006

SHEET No.
08





View B-B

NOS.OF RISERS

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



EQUIPMENT EARTHING DETAILS 400kV CURRENT TRANSFORMER

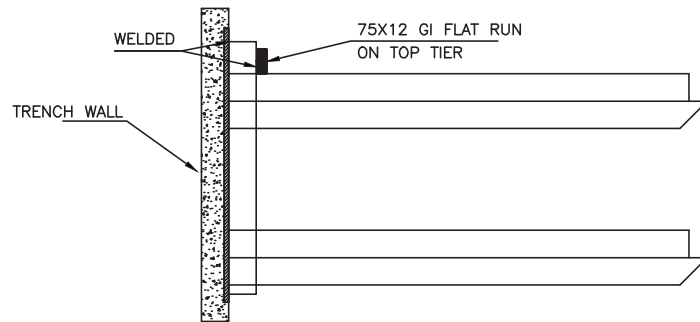
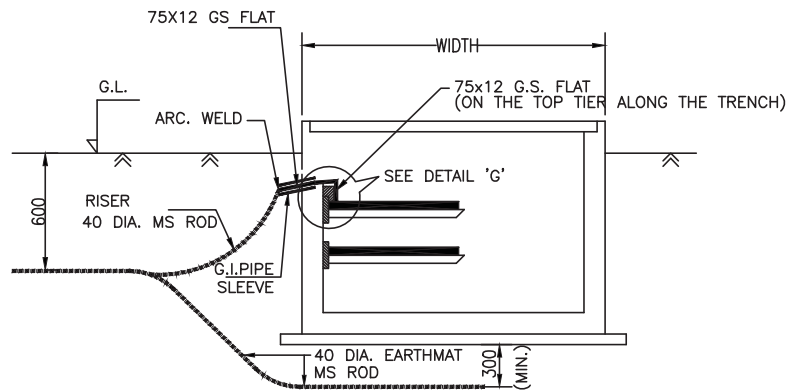
COMPU. DRG. REF.

DRG.NO.

TB-4-361-318-006

SHEET No.

10



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.



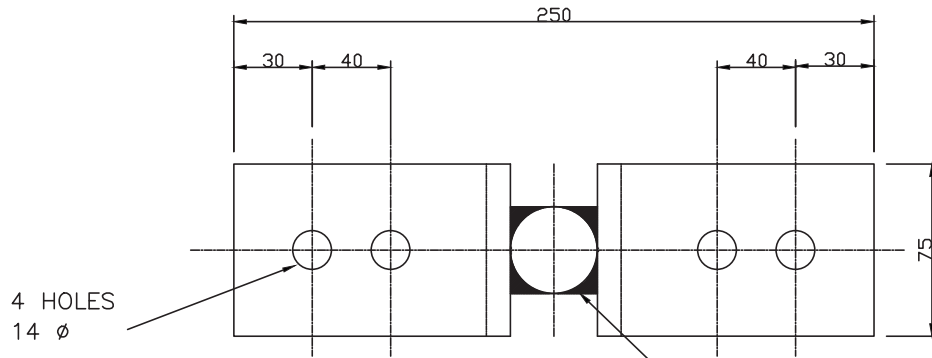
EQUIPMENT EARTHING DETAILS CABLE TRENCH

COMPU. DRG. REF.

DRG. NO.

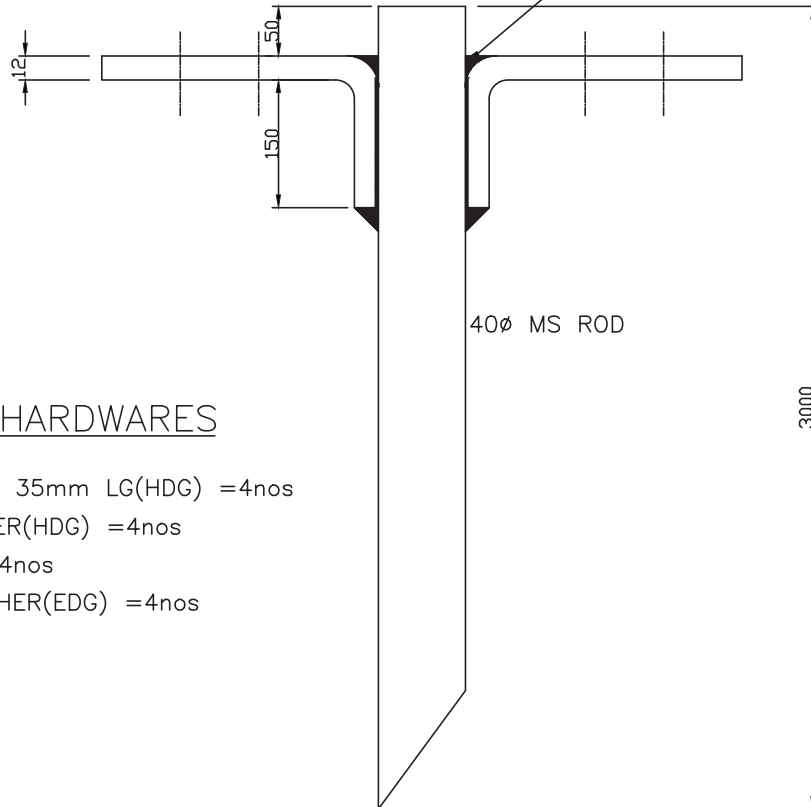
TB-4-361-318-006

SHEET
11



PLAN

WELDING



40 MS ROD

NOTES

BOQ OF HARDWARES

1. M 12 BOLT 35mm LG(HDG) =4nos
2. PLAIN WASHER(HDG) =4nos
3. NUT(HDG) =4nos
4. SPRING WASHER(EDG) =4nos

ELEVATION

ROD ELECTRODE



400KV ROD EARTH ELECTRODE

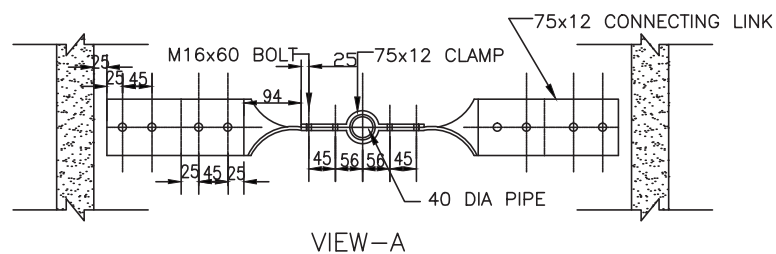
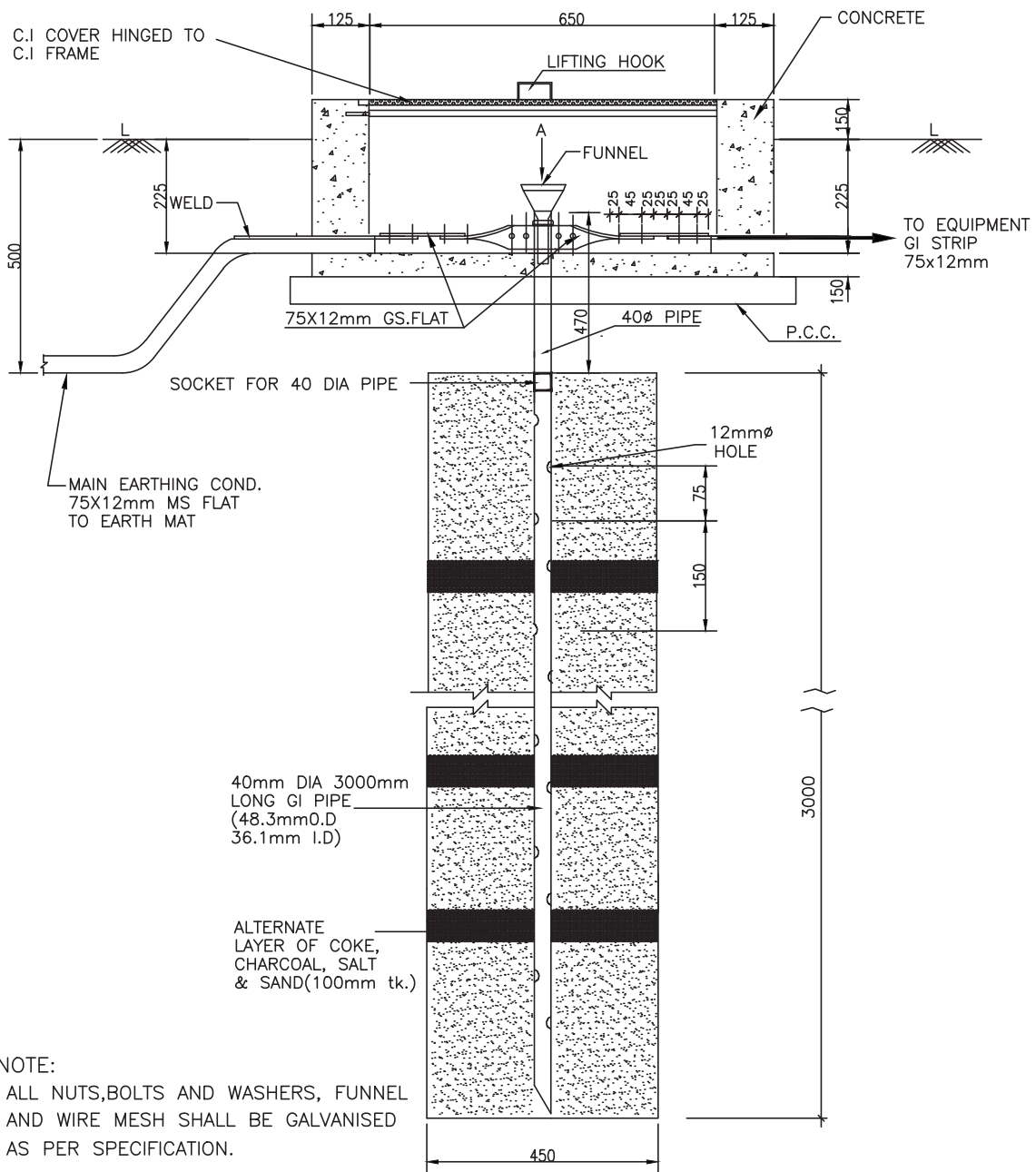
DRAWING NO.

TB-4-361-318-006

REV. 00

SHEET No.

12



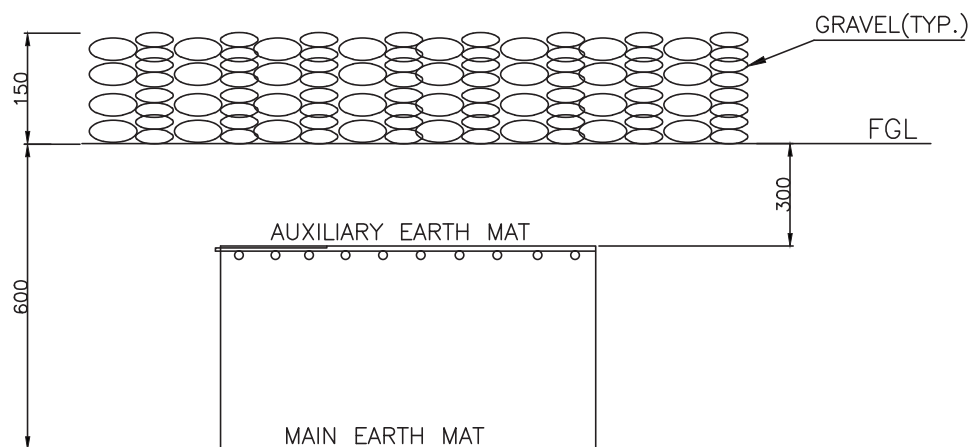
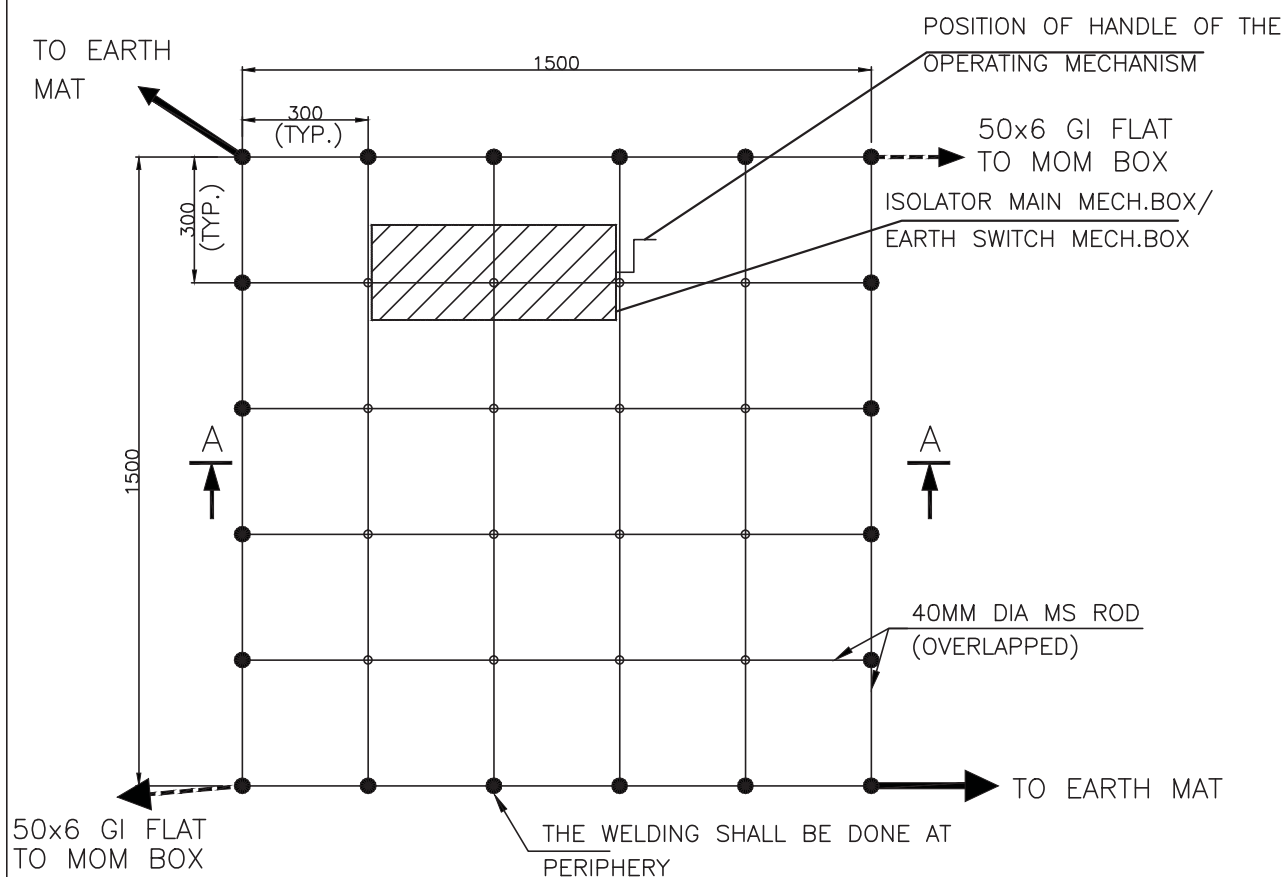
EQUIPMENT EARTHING DETAILS
DETAILS OF PIPE EARTH ELECTRODE
IN TREATED EARTH PIT (ET)

DRG. No.

TB-4-361-318-006

REV. 00

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

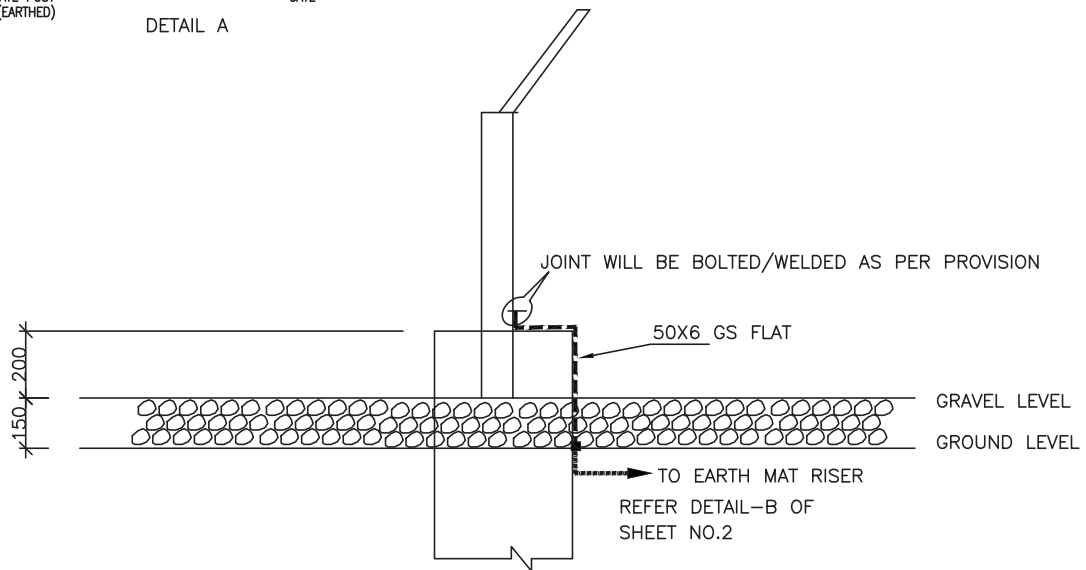
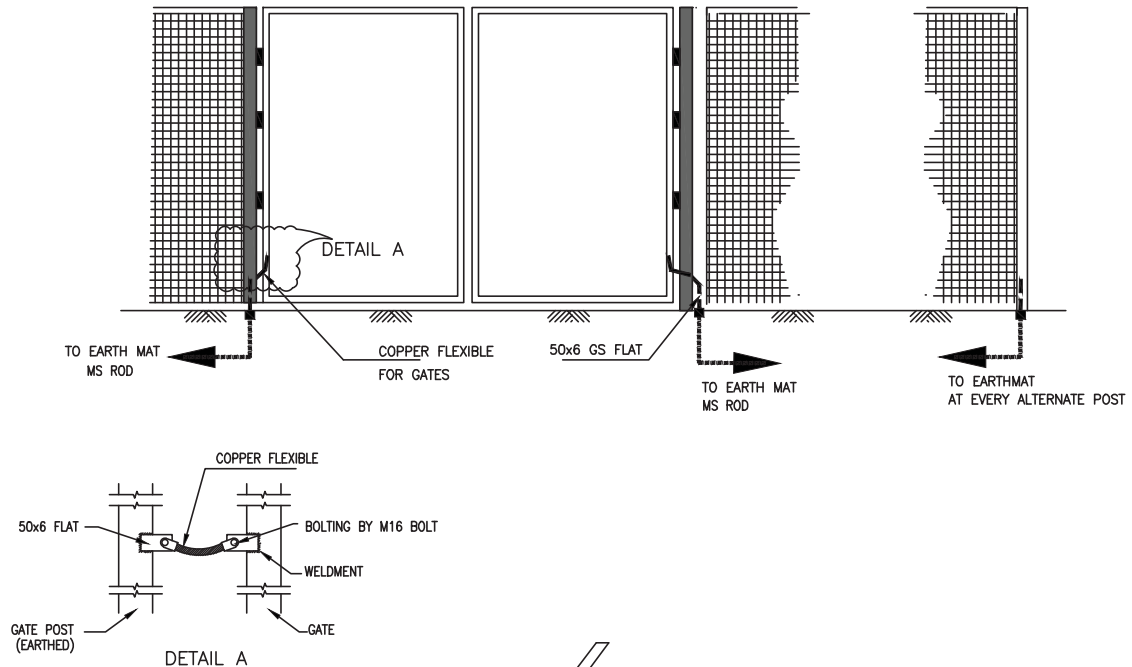
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14

FENCE GATE

FENCE GROUNDING



EVERY ALTERNATE POST OF FENCE & GATES SHALL BE CONNECTED TO EARTHING LOOP BY 50X6 MM GS FLAT. EARTHING CONDUCTOR SHALL BE BURIED 2000mm OUTSIDE THE SWITCHYARD FENCE.

FENCE EARTHING

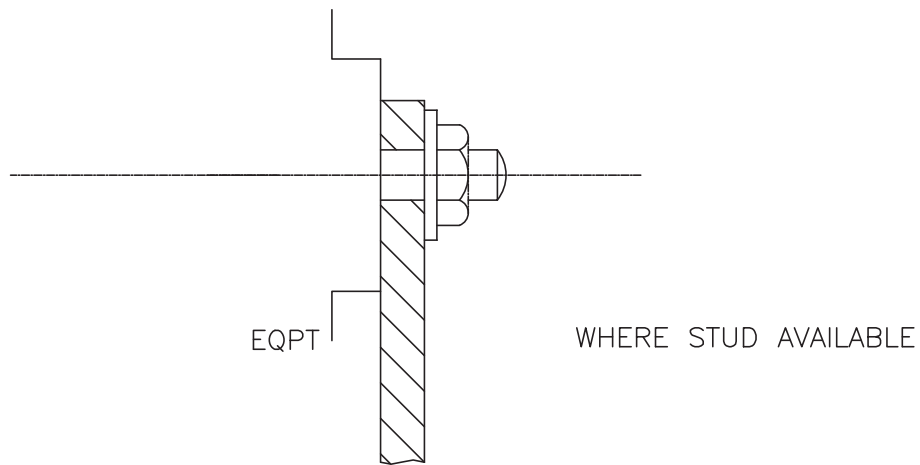


EQUIPMENT EARTHING DETAILS GATE/FENCE POST

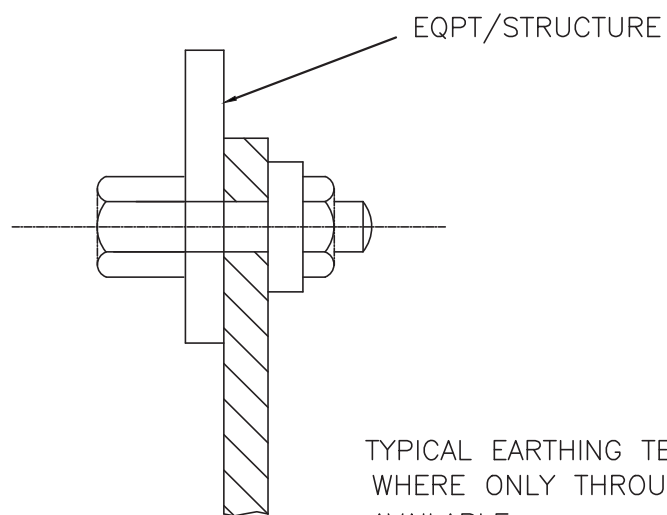
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TB-4-361-318-006

SHEET No.
15



TYPICAL EARTHING TERMINAL JOINT



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

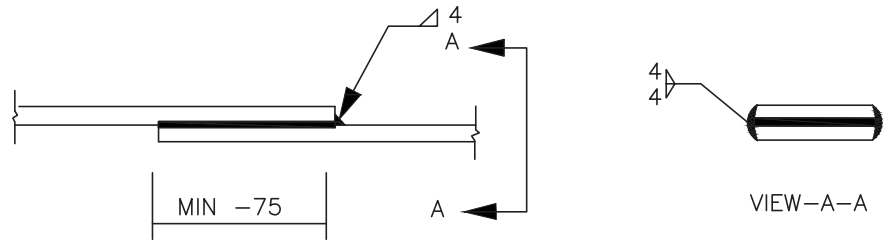
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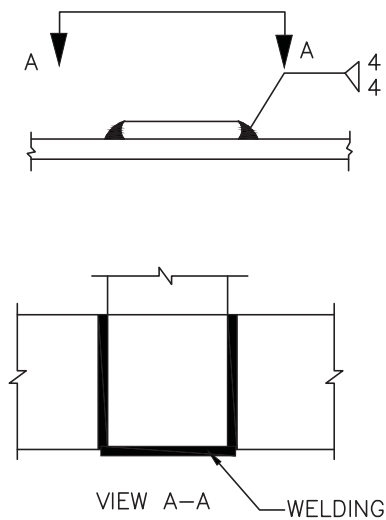
SHEET No.
16

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

1. STRAIGHT LAP JOINT/RISER



2. CROSS LAP JOINT



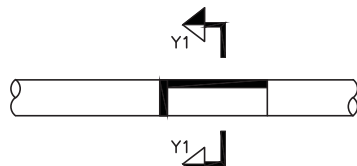
EQUIPMENT EARTHING DETAILS WELDING DETAILS

COMPUTERREF.NO.

DRG. No.

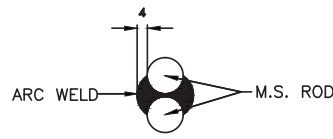
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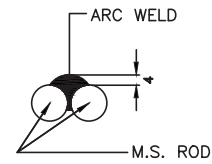


ELEVATION

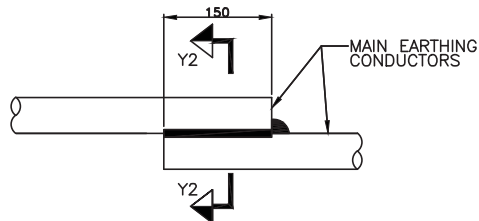
(CONDUCTOR IN HORIZONTAL PLANE)



SECTION Y2-Y2

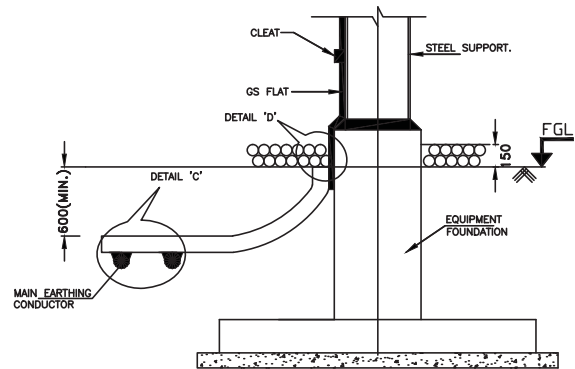
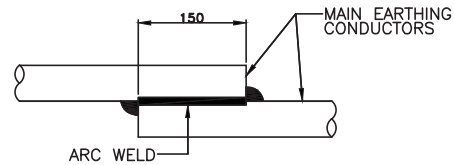


SECTION Y1-Y1

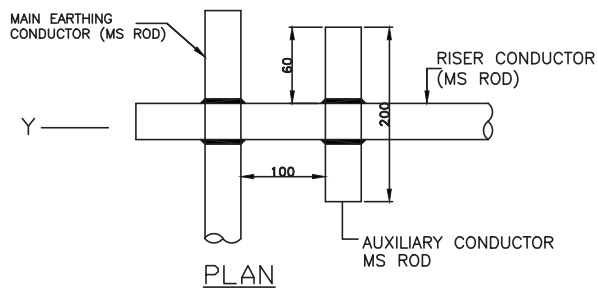


ELEVATION

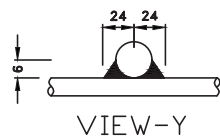
(CONDUCTOR IN VERTICAL PLANE)



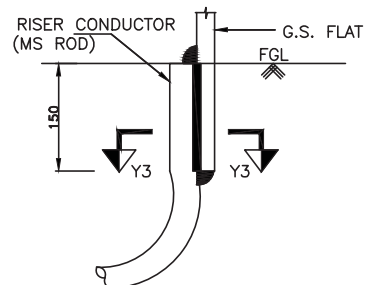
TYPICAL DETAILS OF RISER



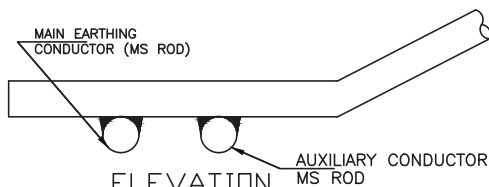
PLAN



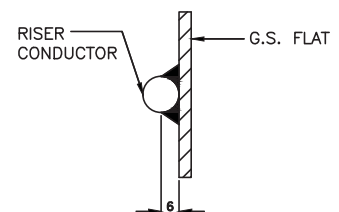
VIEW-Y



ELEVATION
DETAIL-D



ELEVATION
DETAIL-C



SECTION Y3-Y3

TYPICAL OVERLAPPING JOINT OF TWO CONDUCTORS



EQUIPMENT EARTHING DETAILS

WELDING DETAILS

COMPUTERREF.NO.

DRG. No.

TB-4-361-318-006

SHEET No.

18

LIST OF MANDATORY SPARES FOR MANGDECHHU

ANNEXURE - A

Sl.No.	Item Description	Unit	Quantity
1	400kV CURRENT TRANSFORMER	Nos.	2
2	400kV CAPACITOR VOLTAGE TRANSFORMER	Nos.	2
3	400kV, 2500A, 3 Ph, HDB Isolator, motor/ manual operated complete with 9 nos. of support insulators	Nos.	1
4	336kV, 1 Phase, Gapless type Metal Oxide Surge Arrester complete with surge counter & leakage current meter	Nos.	2
5	400kV Disc Insulators	Nos.	24
6	Twin Moose conductor	m	100
7	Hardware fittings & fastners	Nos. (of each type)	3

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.

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.

ANNEXURE-E2

	<h2 style="text-align: center;">BHARAT HEAVY ELECTRICALS LIMITED</h2> <h3 style="text-align: center;">TRANSMISSION PROJECTS ENGINEERING MANAGEMENT</h3>									
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CUSTOMER/ CONSULTANT										
PROJECT										
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<u>CONTENTS</u>										
Sec. No.	Description						No. of Sheets			
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2.	Equipment Specification						3			
3.	Project Details & General Specifications						8			
4.	Guaranteed and Technical Particulars (To be filled during contract stage)						1			
5.	Check list (To be filled during tender stage)						1			
6.	Quality Plan						1			
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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)	280 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 Ω -mm/ mm ²
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 ² /cm/°C

12	Nominal Size, IPS (EH type)	3 Inch	4 Inch	4.5 Inch
13	Minimum Outside Diameter in mm (no negative tolerance permitted)	88.90 +2.2	114.2 +2.2	120 +1.5
14	Modulus of elasticity (kg/mm ²)	6700	6700	6700
15	Minimum Thickness in mm (no negative tolerance permitted)	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	Required Length	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 - 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

GENERAL TECHNICAL REQUIREMENTS

1.0 PROJECT LOCATION

The Project is located on Trongsa Dzongkhag (District) of Central Bhutan. It is a run of river scheme, with a Dam proposed across River Mangdechhu about 800 m downstream of its confluence with Telegangchhu, near Chunjapang village on Gelephu-Trongsa Highway. Dam site is located about 14 km from Trongsa. A diversion tunnel will be on the right bank of Mangdechhu to facilitate construction of the Dam whereas all other components (Intake, Desilting Chambers, Head Race Tunnel, Surge Shaft, Pressure Shaft, Power House, Tail Race Tunnel and Pot Head Yard) are on the left bank. Power House site will be near Yurmu 45 km from Trongsa and about 40 km from Dam site by road. A gross head of 733 m between the HRT intake site and the power house site is to be utilized for power generation.

The approximate distance of Project dam site from different important towns is as below:

From Trongsa to Dam Site 14 Kms
From Trongsa to Thimphu 203 Kms
From Dam site to Gelephu 238 Kms
From Gelephu to Bongaigaon 68 Kms
From Gelephu to Kolkata 890 Kms
From Gelephu to Siliguri (In India) 320 Kms
From Gelephu to Phuentsholing 195 Kms
From Phuentsholing to Trongsa 375 Kms

LOCATION:

• Country:	Bhutan
• District:	Trongsa Dzongkhag
• River:	Mangdechhu
• Nearest Village:	Chunjapang
• Dam site:	Near Chunjapang village
Latitude:	27 ° 28' 48 " N
Longitude:	90 ° 29' 41" E
• Nearest Rail Head:	New Bongaigaon, Assam, India
• Nearest Airport:	Paro (Bhutan), Guwahati (Assam - India)



Project: Mangdechhu Hydroelectric Project Authority (4x180MW), Trongsa, Bhutan
Customer: Mangdechhu Hydroelectric Project Authority, Thimphu, Bhutan

Technical Specification

Doc No: TB-361-316-0XX

Section-3: Project Details & General Specifications

Rev. No. 01

The pothead yard has been provided at **EL. 1083 m**, on left bank of river where a relatively flatter terrain is available.

2.0 PROJECT DETAILS

Project Title	:	Mangdechhu Hydroelectric Project Authority (4x180MW), Trongsa, Bhutan
Customer	:	Mangdechhu Hydroelectric Project Authority (MHPA), Bhutan
Consultant	:	M/s NHPC, Faridabad

2.1 SITE CONDITIONS (FOR DESIGN PURPOSES)

2.1.1 SITE CONDITIONS

a).	Average rainfall per year	:	1162 mm
b).	No. Of months of tropical monsoon	:	4 (June to Sept)
c).	Altitude (Pothead Yard over ground)	:	EL 1083m

2.1.2 DESIGN AMBIENT

a).	Minimum Temperature	:	-7.0°C
b).	Maximum Temperature	:	36°C
c).	Design Ambient Temperature	:	40 °C

2.1.3 RELATIVE HUMIDITY

a).	Maximum	:	100%
b).	Minimum	:	20%

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

Mangdechhu project in Central Bhutan and its neighbourhood area lies in close proximity to the north-eastern region of India, which falls in **zone V** of seismic zoning map and has been affected by moderate to high intensity earthquake in the past. Value of peak ground acceleration has been recommended as **0.36g** for Maximum Credible Earthquake (MCE) and **0.18g** for Design basis Earthquake (DBE).



The forces being caused by earthquake including hydraulic loads, which may occur additionally, shall be taken into account for the computations. Stresses resulting after including these loads shall not exceed permissible stresses.

The bidder shall design all equipment supplied under this contract to satisfy the seismic criteria. The bidder shall submit to the Employer the method of calculation and relevant codes he intends to use for this purpose. In addition to the above, the IS 1893 shall be adopted for seismic design. Hydrodynamic forces due to seismic conditions shall be considered on HM or EM equipments in addition to hydro static loads.

2.1.6 COMMUNICATION & TRANSPORT LIMITATIONS

For shipments, the Manufacturer shall pack the items to meet size and weight restrictions of the Indian railways and Indian / Bhutanese road systems. Shipments from Manufacturer's work (in case offshore consignments) shall travel to Port of entry – India, from where these will be transported, after necessary port clearances etc., by the Bidder to nearest rail head for the Project, and further transported to site. However, in certain cases the Bidder may be required to transport the materials from Port of entry to Project site directly by road transport. For onshore consignments, the Bidder shall be responsible in all respects for transportation of all material and equipment up to the project site.

The Bidder shall consult with the concerned authorities in railways and highways to ensure that his packaging will be such as to permit him to transport the plant and equipment within such imposed limits. The Bidder shall arrange to deliver the maximum sized sub-assemblies consistent-with safe and convenient transport.

All materials and equipment etc. arrived at nearest railhead for the Project will be unloaded from rail wagons and reloaded on to road transport for shipment to project site by the Bidder.

All components shall be so designed and constructed as would enable easy assembly of components at works and at the same time permit easy transportation. The weights and sizes of the components/packages shall be within the permissible transport limits for the project site.

Goods Transport

The nearest broad guage railhead is Bongaigaon about 68 Km from the border town of Gelephu (which is about 238 Km from the Project Site).

Transport Limitation

The road from the border town of Gelephu to the Project site winds through the hills with narrow curve and the road is single lane. There is a possibility of transporting the equipment using Siliguri – Phuntsholing – Thimphu – Trongsa road which is lengthy. Employer shall not be responsible for the selection of route. . The bidder shall have to transport his consignment suitably always keeping in view the transportation limitation.



Project: Mangdechhu Hydroelectric Project Authority (4x180MW), Trongsa, Bhutan
Customer: Mangdechhu Hydroelectric Project Authority, Thimphu, Bhutan

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2.1.7 AUXILIARY POWER SUPPLY

		415V AC System	240V AC System	220 V DC System
1.	Nominal Voltage	415 V	240 V	220 V
2.	No. of phases	3ph, 4 wire	1ph, 2 wire	2 wire
3.	Frequency (Hz)	50 \pm 5 %	50 \pm 3 %	NA
4.	Voltage variation	\pm 10 %	\pm 10 %	\pm 10 & -20 %
5.	Grounding	Neutral grounded	Neutral grounded	Un grounded

2.1.8 SYSTEM PARAMETERS

The equipment being supplied shall be suitable for increased external insulation levels with suitable altitude correction factor for an altitude of 1083 M from MSL

Correction factor: 1.01

S. No.	Description	400 kV System
a)	Lightning Impulse Withstand Voltage (kVp)	1425*1.01 \approx 1440
b)	Switching Impulse Withstand Voltage (kVp)	1050*1.01 \approx 1061
c)	P.F. Withstand Voltage (kVrms)	630*1.01 \approx 637
d)	Highest System Voltage (kV)	420
e)	Rated Frequency (Hz)	50
f)	Creepage Distance (mm/kV)	25*
g)	Short Circuit Capability (kA for 1sec)	63
h)	Rated peak withstand current (kA)	157.5
i)	Partial discharge of switchgear assembly at highest voltage for equipment (pC)	< 10

* – bidder to take care corrections on account of altitude.

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



4 STANDARDS

Although European or IEC standards for design, testing, workmanship, material and Works have been mostly selected in these specifications as a basis of reference, other standards and recommendations of standard international organizations will be acceptable provided they ensure equal or higher quality than those specified, and provided, furthermore, that the Bidder submits for approval, detailed standards which he proposes to use. When IEC or ISO Recommendations or other Standards are referred to, the Edition shall be that current at the time of issue of Tender Documents, together with any Amendments issued to that date. Standard publications issued by the following organizations of standardization are considered being approved standards for the works:

Standards for General Application

- i) ISO International Standards Organisation
- ii) IEC International Electro technical Commission
- iii) IEEE Institute of Electrical and Electronic Engineers
- iv) IS Indian Standards
- v) AISI American Iron and Steel Institute
- vi) ANSI American National Standards Institute
- vii) ASME American Society of Mechanical Engineers
- viii) ASTM American Society for Testing and Materials
- ix) AWS American Welding Society
- x) BS British Standards
- xi) IIW International Institute of Welding
- xii) AWS American National Standard

Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable.

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.

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/ IEEE 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

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and the classifications and grades in conformance with the latest issue of the respective relevant standard. Material to other standards may be used if approval by the Engineer in- Charge has been obtained. Material specifications, including grade or class data, shall be shown on the appropriate detail drawings submitted for review. If using stock material not specifically prepared for the works under this Contract, the Bidder shall submit evidence that the material complies with approved standards and that the material is adequate for the intended use. The Bidder shall indicate in the Technical Data Schedules, the materials and applicable standards for all major parts of the supply. The materials shall be carefully selected for the intended purpose and due consideration of the site conditions and the tropical environment. Higher-grade material shall be used where ordinary material is insufficient.

6 DESIGN

6.1 Allowable Stress

The layout of the parts of items of works shall fundamentally consider the most severe conditions to which they will be subjected during testing and operation. If different stress values are given in the different sections of this specification or in the relevant standards and regulations, then the more stringent values shall be applicable. The dimensions of the parts which are exposed to repetitive and alternating stresses as well as to impacts and vibrations shall take into account the safety measures approved in practice.

6.2 Design Criteria

The equipment shall be designed for the worst possible combination of the following loading conditions as applicable:

- i) All static and dynamic hydraulic loads,
- ii) All loads due to dead weight and frictional forces,
- iii) Seismic or wind loads, and
- iv) Other loads.

6.3 Noise

The noise level caused by the installed Works shall not exceed the following values if not otherwise stated in the Particular Technical Specifications:

- i) Machine hall, workshops, etc. max. 85 dB (A) at any place 1 m distant from operating equipment.
- ii) Offices, control rooms, max. 55 dB (A) rooms, canteens, etc.

The noise level definition and measurement shall be in accordance with ISO. The values stated



shall be adhered to taking a normal civil construction into account.

7 WORKMANSHIP

7.1 Finished Surfaces

Where the finish is not indicated or specified, the type of finish shall be most suitable for the surface to which it applies and shall be consistent with the class of fit required. Surfaces to be machine-finished shall be indicated on the shop drawings by symbols.

7.2 Unfinished Surfaces

Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground free of all projections and rough spots.

7.3 Protection of Machined Surfaces

Machine-finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other surfaces shall be protected with wooden pads or other suitable means. Unassembled pins or bolts shall be oiled or greased and wrapped with moisture-resistant paper or protected by other approved means.

8 STRUCTURAL MATERIALS

8.1 Materials

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade meeting specification requirement and shall be subjected to acceptance by the Employer. Material specifications, including grade or class shall be shown on the appropriate Bidder's detail drawings submitted for review.

All materials or parts used in the equipment shall be tested in conformity with the standards accepted by the Employer. Certified Material Test Report for the materials of major/important components and/or materials for special application shall be furnished to the Employer as soon as possible after the tests are performed. Each test certificate shall identify the components for which the materials are used and shall contain all information necessary to verify compliance with the contract.

8.2 Bolts, Nuts, Studs and Screws etc.

Bolts at the joints shall be so staggered that nuts may be tightened with spanner without fouling. Step bolts, at least 75mm long and of diameter not less than 16mm, spaced equally about 450mm apart shall be used on one of the legs of each column structure, from 2500mm above ground level to the top of the column, Lightning Mast. The step bolts shall be capable of withstanding a vertical load of not less than 150kg.

All bolts, studs, screws, nuts, and washers shall be to the ISO standard (metric system) except other standards will be considered for specific applications. The extent to which other standards are proposed shall be indicated by the bidder.

Where mild steel bolts and nuts are used, they shall be of the precision cold forged washer faced type if commercially available in the size required. Alternatively, approved hot forged bolts and



nuts, machined so that the undersides of bolt head and nut are faced and parallel to one another when assembled, may be used. In the latter case, a suitable fillet shall be machined between the bolt head and shank. All parts, other than structural steel work, bolted together, shall be spot faced on the back to ensure that nuts and bolt heads bed down satisfactorily. Bolts machined from bar stock shall not be used without approval of the Engineer in- Charge. All bolting material shall be adequately treated against corrosion before dispatch from the workshop. Mild steel nuts and bolts shall be zinc or cadmium plated. Stainless steel bolts, nuts washers and screws shall be used in water or when exposed to high humidity, for holding renewable parts and parts made of stainless steel.

All bolts or studs which will be subject to high stress and/or temperature shall be of approved high tensile material with nuts of approved material. All bolts and studs larger than 60 mm in diameter, which are not accessible for tightening, and untightening by commercially available pneumatic impact wrenches shall be drilled for heaters or shall have an extension for pre-tensioning by hydraulic tools.

Washers shall be provided under bolt heads and nuts unless otherwise approved by the Engineer in-Charge. All ferrous nuts and bolts on Works items where dismantling may be required during the life of the Works shall have their threads coated with an approved anti-seize compound. When in position, all bolts or studs shall project through the corresponding nuts by at least one thread, but this projection shall not exceed three threads, unless more length is required for adjustment. All nuts and set screws shall be securely fastened, to prevent loosening due to vibrations, using spring washers, lock nuts, split pins, self-locking inserts or 'Loctite' as appropriate for the purpose and material used.

The bidder shall supply the net quantities plus 5 percent of all permanent bolts, screws and other similar items and materials required for installation at the Site. Any such rivets, bolts, screws, etc., which are surplus after the installation of the Works has been completed shall become spare parts and shall be wrapped, marked and handed over to the Employer.

8.3 Corrosion resistant bolts and nuts

Corrosion resistant steel or bronze shall be used for bolts and nuts when either or both are subjected to frequent adjustment or frequent removal, such as adjusting bolts for packing glands on removable screens or strainers, on adjustable bearings, rubber seal holders, etc. Bolts on manholes shall be of high-strength stainless steel. Protective measures against electrolyte corrosion shall be foreseen where necessary.

8.4 Galvanizing

All the members of structures of the **outdoor switchyard** shall be galvanized by hot dip process conforming to latest edition of IS: 2629. The min. deposit shall be **0.610Kg/sq.m** & shall withstand four dips in copper sulphate solution. Purity of zinc to be used shall be 99.95% as per IS: 209.

A) Material

For galvanising, only original blast furnace raw zinc shall be applied, which shall have a purity of 98.5%. The thickness of the zinc coat shall be:



- For bolts and nuts, approx. 60 micrometer
- For all other parts, except for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 70 micrometer

B) Galvanizing of Hardware

Bolts, nuts, washers, locknuts and similar hardware shall be galvanised in accordance with the relevant standards. Excess spelter shall be removed by centrifugal spinning.

C) Straightening after galvanizing

All plates and shapes, which have been warped by the galvanizing process, shall be straightened by being re-rolled or pressed. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. Materials that have been harmfully bent or warped in the process of fabrication or galvanising shall be rejected.

D) Repair of galvanising:

Material on which galvanising has been damaged shall be re-dipped unless the damage is local and can be repaired by soldering or by applying a galvanising repair compound; in this case, the compound shall be applied in accordance with the manufacturer's instructions. Soldering shall be done with a soldering iron using 50/50% solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanised coating becomes damaged after having been dipped twice shall be rejected.

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.

9 QUALITY ASSURANCE PLAN (QAP)

9.1 Quality Control and Assurance

To ensure quality during each stage of work, the Bidder shall establish a system defining quality assurance plan/procedures during various stages of work.

The bidder shall maintain quality control during manufacturing of equipment as per the approved quality assurance plan. The model quality assurance plan for equipment / components for each section are given hereafter. Final quality assurance plan (QAP) for manufacturing shall be approved during detailed engineering.



The Bidder shall submit the detailed Quality Assurance Plan for the complete equipment/materials along with the bid for approval and acceptance by the Employer. This shall form integral part of the contract. The QAP shall include inspection and tests proposed to be conducted on raw material/bought out items at the time of induction in the process of manufacturing and at final stage of assembly.

Based on the test certificate, inspection report dispatch clearance shall be issued by the employer. The materials/equipments/items shall only be dispatched after issue of material dispatch clearance certificate (MDCC).

Detail Model Quality Assurance Plan is attached here with of each and every equipments/ auxiliaries. These are to be strictly observed /followed by the Manufacturer / Bidder/ Sub – Vendor.

Inspections and tests shall be carried out by the Bidder as per approved QAP with due regard to stipulations in relevant sections at various stages of manufacturing for assuring the full compliance of supply with the requirements of specification.

The Bidder shall follow approved site quality assurance plan and installation procedures. The Bidder shall maintain the quality records during site installation and commissioning which shall be produced to engineer in charge for approval at defined stages.

Inspection and tests shall be carried out at site by bidder during installation and commissioning as described in relevant clauses.

9.2 Type Tests

Type tests shall verify that all components of the equipment perform satisfactorily, both electrically and mechanically, at the rating assigned. All equipment proposed according to the specification shall be type tested at typical units in accordance with the relevant standards specified in respective sections.

The type tests for equipment, except wherever mentioned specifically as mandatory in respective section, may not be mandatory if similar typical units of equipment have been type tested and test certificate(s) for relevant tests are accepted by the Employer.

The bidder shall prepare written documents, in a form agreed upon by the bidder and the Employer, of all test certificates/ results and hand over these documents to the Employer in due time for review and acceptance as required.

All cost associated with the mandatory type tests shall be included in contract price. Also, the bidder shall conduct the type test(s) at his own cost for which certificate(s) are not acceptable.

9.3 Routine Tests

Routine tests shall be conducted on various equipment/components as elaborated in respective section and/or approved quality assurance plan (QAP).

10 DEVIATIONS FROM SPECIFICATIONS

Deviation, if any, from any of these specifications shall be listed out separately. Bidder shall attach a separate sheet titled as “DEVIATIONS FROM SPECIFICATIONS” and list all deviations



details of each deviation Section wise and Clause wise. In absence of any deviation listed out separately, adherence to the specifications shall be assumed.

11 PACKING AND FORWARDING

The bidder shall prepare all plant, devices & materials for shipment to protect them from damage in transit & shall be responsible for make good all damages due to improper preparations, loading or shipment.

After the workshop assembly & prior to dismantling for shipment to the site, all items shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so they are clearly visible.

Dismantling shall be done into convenient sections, so that the weights & sizes are suitable for transport to site & for handling on the site under the special conditions of the project.

All individual pieces shall be marked with the correct designation shown on the bidder's detailed drawings and other documents (packing lists, spare part lists, in Operating and Maintenance Instructions, etc.).

Marking shall be done preferably by punching the marks into the metal before painting, galvanising, etc., and shall be clearly legible after painting, galvanising etc. In labelling, the bidder shall endeavour to use as few designations as possible and each part of identical size and detail shall have the same designation, regardless of its final position in the plant.

All parts shall be suitably protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc.

All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in biodegradable packing material. Where parts may be affected by vibration, they shall be carefully protected and packed to ensure that no damage will occur while they are being transported and handled.

The bidder shall pack all the consignment in **sea worthy packaging**, (only for items transported via sea), strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

The packaging and storage of electronic equipment shall be strictly in accordance with internationally accepted standards. Electronic equipment shall be packaged, shipped and stored in anti-static packing. All packages shall be stored indoor. Packages containing electronic equipment shall be stored in humidity controlled environment.

The material used for shipment of material frame at manufacturer's works withstanding the above shall be preferably environment friendly. Biodegradable packing shall be used to the extent possible.

The Engineer in-Charge reserves the right to inspect & approve the packing before the items are dispatched but the bidder shall be entirely responsible for ensuring that the packing is suitable for transit & such inspection will not exonerate the bidder from any loss or damage due to faulty packing.



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.

The bidder shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked with following information on at least two sides:

1. Name of the consignee
2. Name of Contract Agreement Number
3. Country of origin
4. Port of entry
5. Name of Supplier
6. Item number (if applicable)
7. Package number, in sequence & quantity as per package
8. Description of works
9. Net & gross weight, volume
10. Sign showing top/bottom side of the Box
11. Storage Code/ Symbols
12. Handling and unpacking instructions
13. Packing List of the material.

A copy of detailed packing list shall also be kept inside the Box.

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

12 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

13 DOCUMENTATION

13.1 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.

13.2 APPROVAL PROCEDURE

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Employer would be discussed and finalised at the time of award. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer. The following schedule shall be followed generally for approval.

i.	Approval/comments/by employer on Initial submission	Within 2 weeks of receipt
ii.	Resubmission	Within 2 (two) weeks (whenever from date of comments required) Including both ways postal time.
iii.	Approval or comments	Within 2 weeks of receipt of resubmission
iv.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The bidder may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.



The title block for the drawings and documents and the numbering system shall be furnished to the successful bidder, which has to be strictly followed.

13.3 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

13.4 DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A	For Approval (7 Sets – each revision), Hard copies as well as soft copies
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.
07	Copies of manufacturing and field quality plan.
07	Copies of installation, operation & Maintenance manual.
B	After Approval and For Information/Distribution (5 Sets).
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.



Project: Mangdechhu Hydroelectric Project Authority (4x180MW), Trongsa, Bhutan
Customer: Mangdechhu Hydroelectric Project Authority, Thimphu, Bhutan

Technical Specification

Doc No: TB-361-316-0XX

Section-3: Project Details & General Specifications

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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.

19 LIST OF ENCLOSURES

1. Model QAP for Pothead yard equipment

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)	Required Length				

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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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		BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS ENGINEERING MANAGEMENT NEW DELHI							
DOCUMENT No.		TB-XXX-316-040		Rev. No.	02	Prepared	Checked	App.	
TYPE OF DOC.		STANDARD TECHNICAL SPECIFICATION				NAME	NK	DS	SN
TITLE		GI PIPE & BENDS				SIGN	Sd/-	Sd/-	Sd/-
						DATE			
						GROUP	TBEM	W.O. No	
CUSTOMER									
CONSULTANT									
PROJECT									
COPYRIGHT AND CONFIDENTIALITY The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in anyway detrimental to the interest of the company		SCOPE AND SPECIFIC TECHNICAL REQUIREMENT							
		1.0 SCOPE 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.							
		1.1 SPECIFIC TECHNICAL REQUIREMENT							
		1.1.1 Galvanized Iron (GI) Pipe 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.							
		1.1.2 Sockets The sockets shall fully comply with the requirements of IS 1239 (Part-2).							
		1.1.3 For Bends 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.							
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.			
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**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