

Package: Supply, Erection, Testing & Commissioning for 400kV Pothead Yard for Punatsangchhu-II Hydro-Electric Project (6x170 MW), Bhutan.

SCOPE:

- 1) Loading/ Unloading, handling, verification & storage of material at site are NOT in bidder's scope. All material shall be stored at BHEL stores. However once material is issued from BHEL stores to contractor, all responsibility of material shall lie with the contractor.
- 2) Bidder shall complete Erection, Testing & Commissioning of 400kV Pothead Yard as per the following BOQ. Any local transportation to & from stores, store to site or vice versa shall also be in bidder's scope.

NOTES

Following also forms the scope of ETC work in addition to above, but not limited to this.

1	Pothead yard ETC work shall be completed in 2 phases. Phase-1 shall involve ETC of all towers & gantry structure. Remaining all ETC work including equipment ETC shall be completed in Phase-2. Bidder shall arrange necessary manpower for both the phases within 15 days of intimation provided by BHEL Site Incharge.
2	Loading/ Unloading, handling, verification & storage of material at site are NOT in bidder's scope. All material shall be stored at BHEL stores. However once material is issued from BHEL stores to contractor, all responsibility of material shall lie with the contractor including temporary storage etc.
3	Any local transportation to & from stores, store to site or vice versa, assembly of material for erection, installation, pre-commissioning test and commissioning tests (as per BHEL FQP) are included in bidder's scope.
4	All the drawings and documents as per Annexure-1 shall be followed for ETC work.
5	Minor Civil works such as modification of civil foundations, making holes in the trenches, grouting, repairing, fixing of trench material to the satisfaction of BHEL/ Customer will be in the scope of ETC contractor.
6	Removal of gravel, if gravelling is done, for connection of Equipment earthing strip to the existing mat (wherever earthing mat is already laid), and after completion of earthing is in contractor scope. Contractor should place the gravel to bring it in original shape to the satisfaction of BHEL/ Customer.
7	The quantities given in items mentioned above may undergo a change to any extent. However, overall value of contract shall be within $\pm 30\%$.
8	Quoted rates are deemed to be inclusive of miscellaneous works viz erection of clamps and connectors.
9	All paint, welding electrodes & other consumable by contract supplies shall be part of ETC works. Paint /welding electrode make etc. is subject to BHEL/CUSTOMER site incharge approval before procurement.
10	Equipment erection (say Isolator) means complete erection, metallics, post insulator, connectors (expansion/rigid tubular for Al.Tube / single/double/quadruple conductor), connection to the next in line (if connected to overhead busbar or droppers) including PG clamps/Tee connectors etc. This will be clear from the enclosed electrical layout drawings.
11	Equipment and tower erection would include supply and erection of miscellaneous items, viz Phase colour discs, labels painting of equipments, phase colour painting, phase marking, bay identification board, danger plates, rubber mats, device number marking on the equipment, keyboard etc as per site requirements. Supply & Mounting of phase color discs & Danger plates shall be as per IS-2551; 1982 & IS 5; 1978.

NOTES

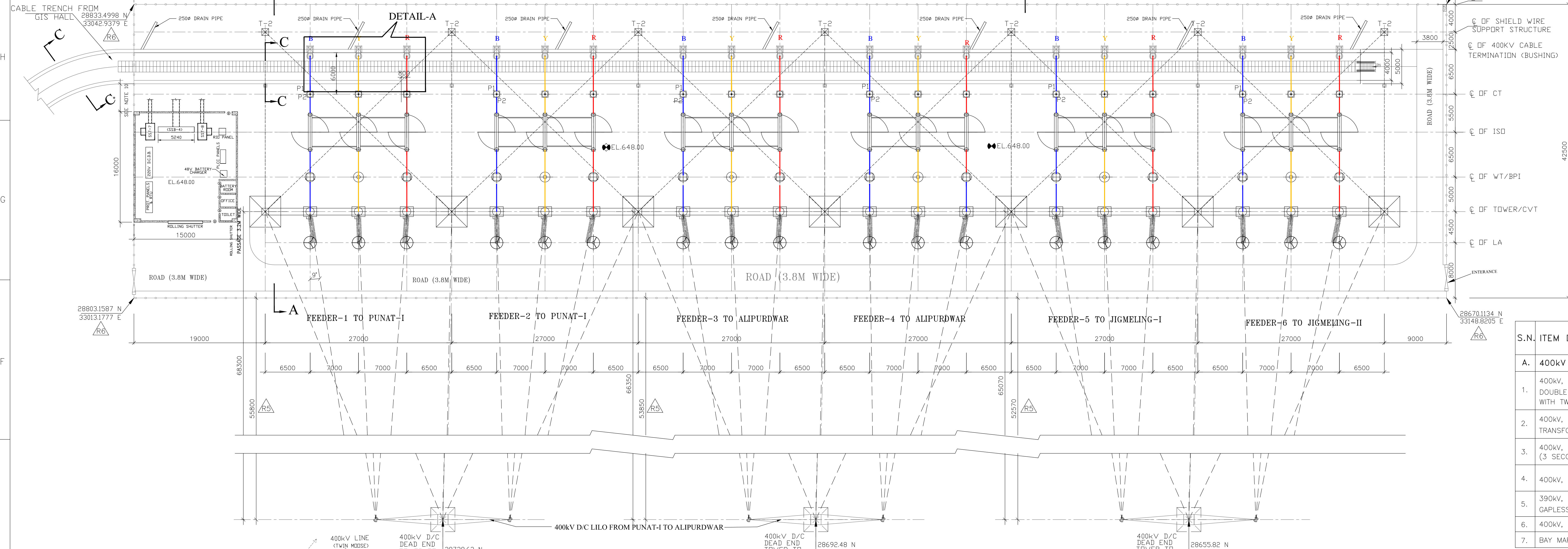
12	Welding of Aluminium tubes (supply of welding sleeve excluded) as per Annexure-B is in ETC contractor's scope and joints shall be tested by radiography. Welding and Bending machines and any other equipment will be in ETC Contractor scope.		
13	Any bending machine required for bending of Aluminium tubes and any other equipment will be in ETC Contractor scope.		
14	Supervision of erection, Testing & commissioning of one 3-ph 400kV Isolator shall be done by supplier/ OEM. However, necessary manpower support, tools, tackles etc shall be in the scope of ETC contractor.		
15	For specification of Cable Glands, GI Pipe & accessories, erection hardware refer Annexure-E1, E2, E3 & E4 respectively.		
16	Scope for spare items shall include shifting to and from stores and handing over to customer.		
17	Testing instruments (duly calibrated) have to be arranged by ETC Contractor at it's own cost (List is only provided for information , if any other instrument not mentioned below but required for sucessful completion of ETC work shall be in ETC contractor's scope) ,		
17.1	Capacitance and Tan delta measurement Kit		
17.2	5kV/1kV Megger		
17.3	Primary current Injection Kit		
17.4	Secondary current/ Voltage Injection kit		
17.5	1Ph Variac		
17.6	Multimeters		
17.7	Clamp on meter		

ANNEXURE – 1 (LIST OF DRAWINGS & DOCUMENTS)

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

Drawing/Doc No.	Drawing Title
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	DELETED
ANNEXURE-E3	SPECIFICATION FOR GI PIPE & Accessories
ANNEXURE-E4	SPECIFICATION FOR ERECTION HARDWARE
ANNEXURE-C	PROJECT DETAILS

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	-

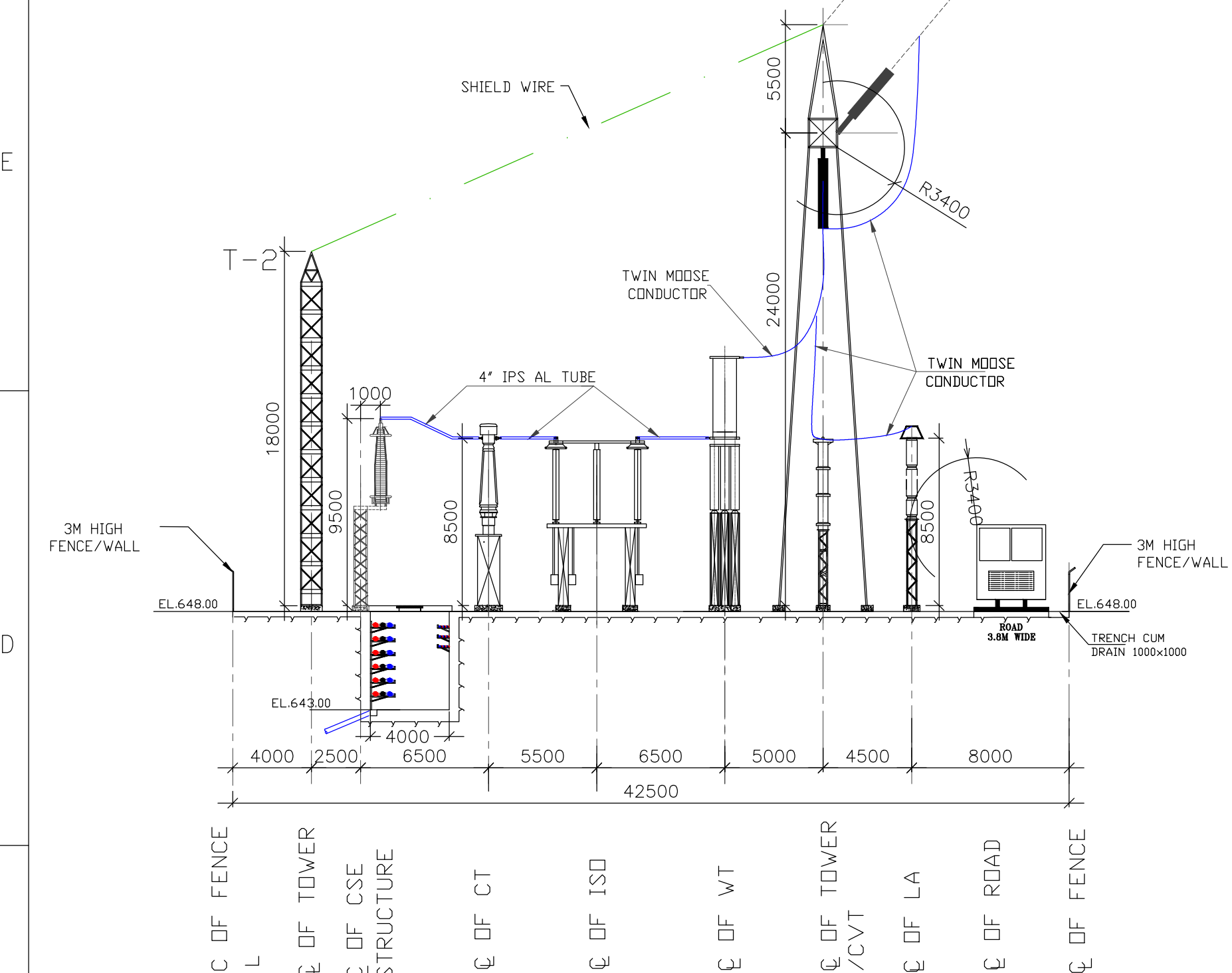
DISC INSULATOR HARDWARE

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

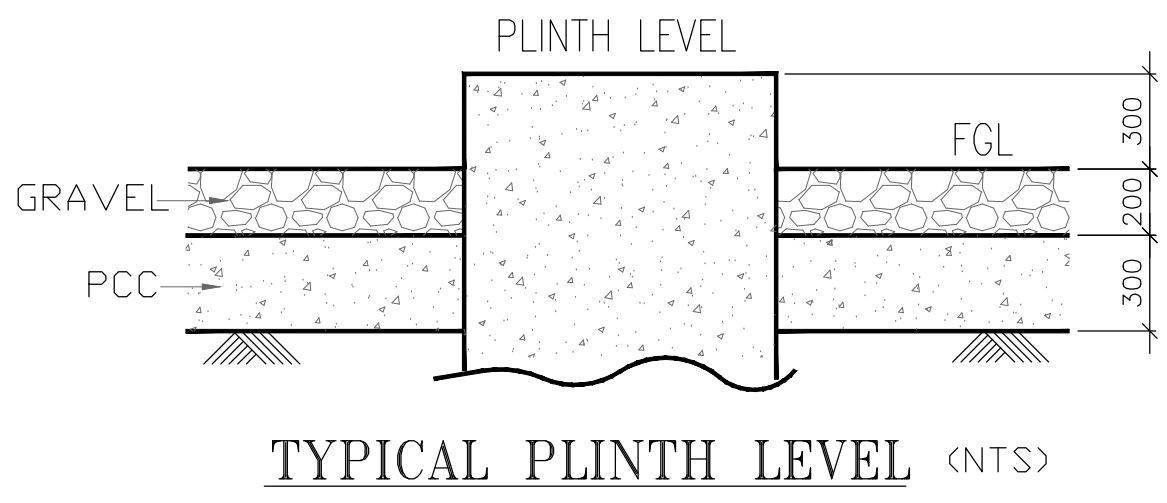
*'-Will be supplied in loose as termination of 400kV lines to dead end gantry is not in BHEL scope.

NOTES:-

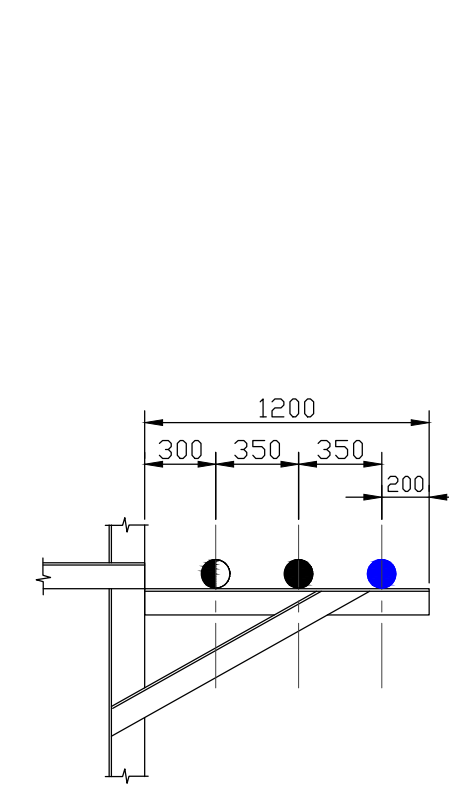
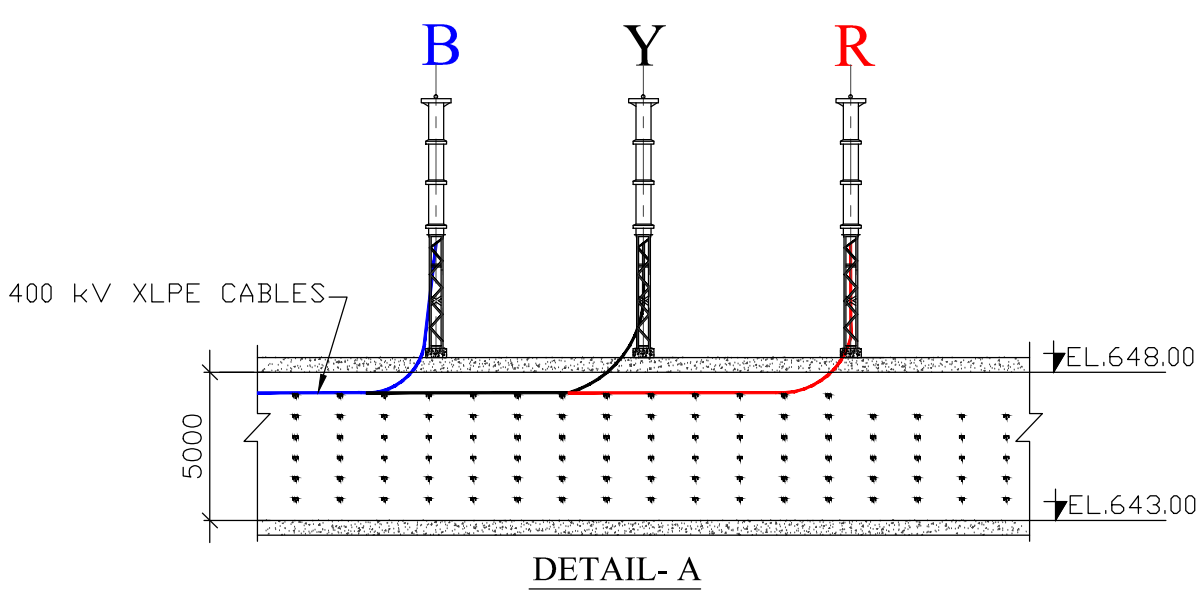
- ALL DIMENSIONS ARE IN mm AND ELEVATIONS ARE IN METRES.
- EXACT LOCATION & DISTANCE OF DEAD END TOWER FOR 400kV D/C SHALL BE GIVEN BY PHPA.
- 40mm AVERAGE SIZE OF GRAVELS (200mmTHICK LAYER) SHALL BE SPREAD OVER 300mm THICK PCC SURFACE FOR GIVING FINISHED GROUND LEVEL IN THE POTHEADYARD. PLINTH LEVEL 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).



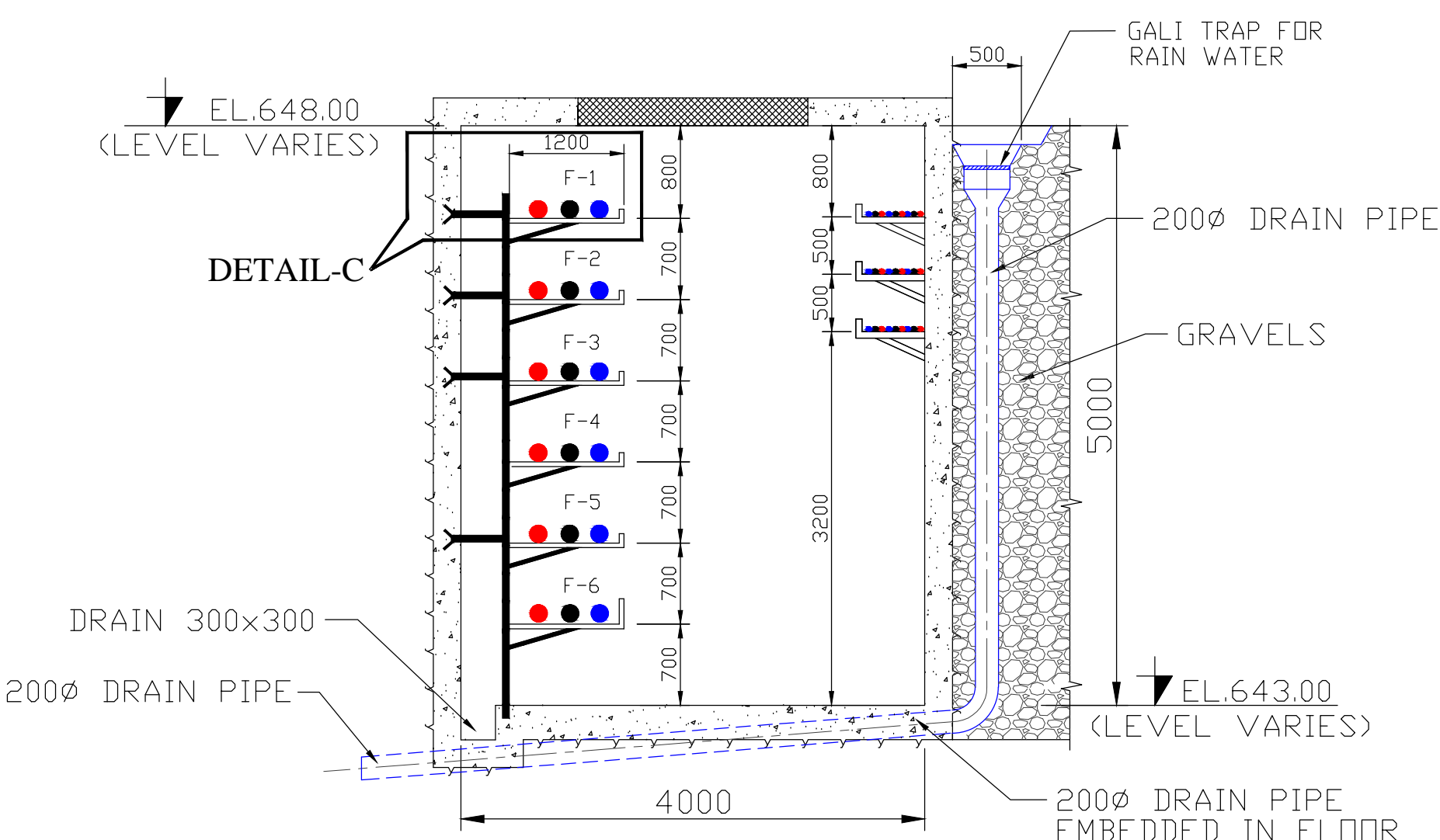
SECTION A-A



TYPICAL PLINTH LEVEL (NTS)

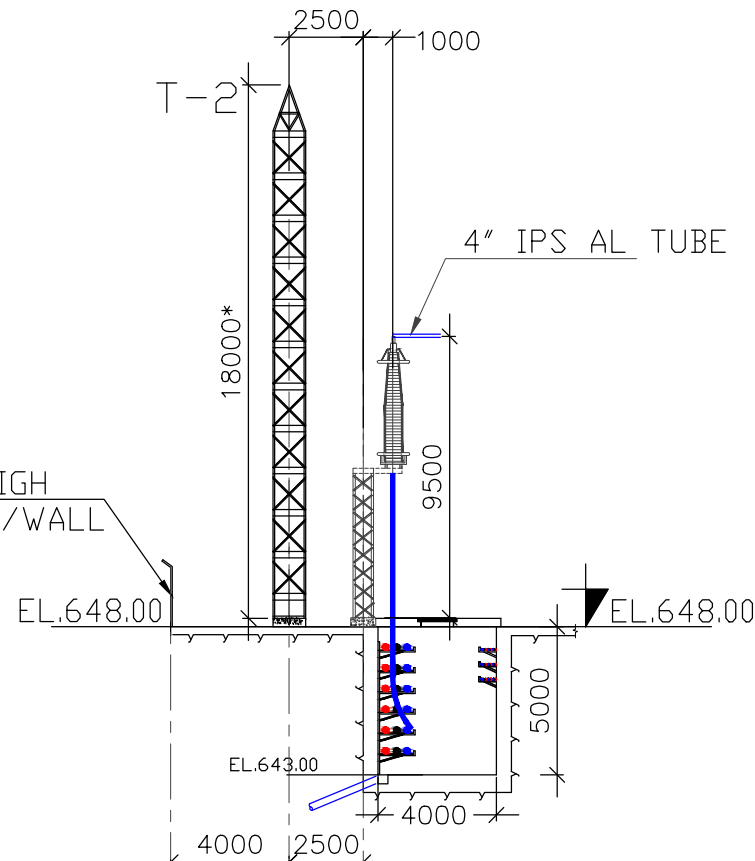


CABLE RACK/TRAY DETAIL (NOT IN BHEL-TBG SCOPE)



SECTION C-C (NTS)

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



SECTION B-B

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.

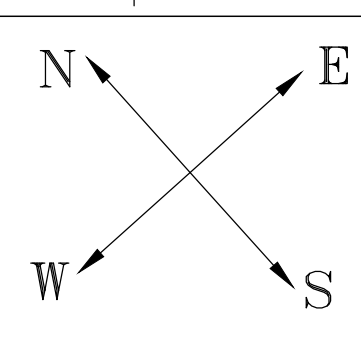
REV.	DATE	ALTERED	CHECKED	AK	DKM
05	24.07.17				
ZONE					

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)

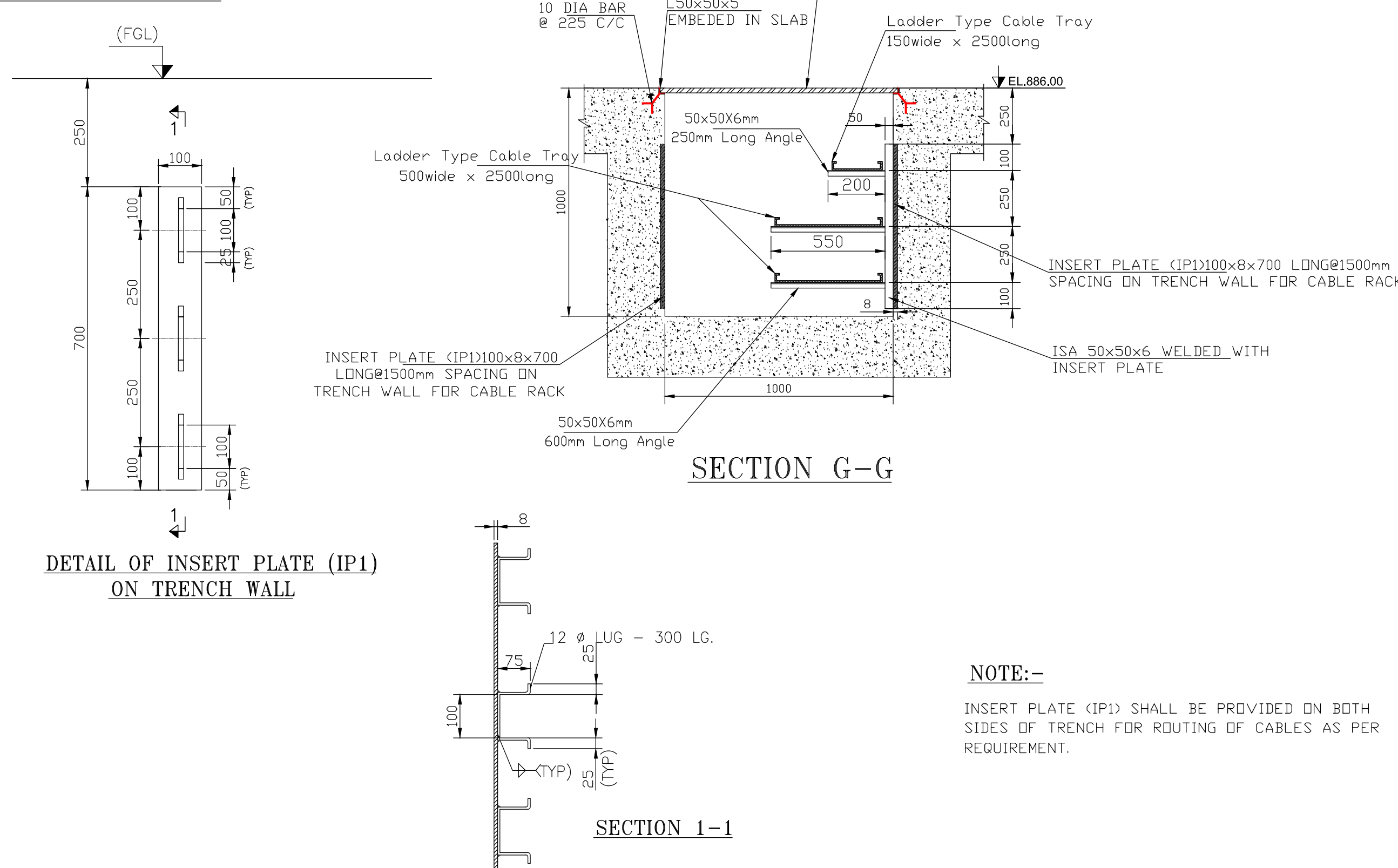
REV.	DATE	ALTERED	CHECKED	AK	DKM
04	12.06.17				
ZONE					

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.

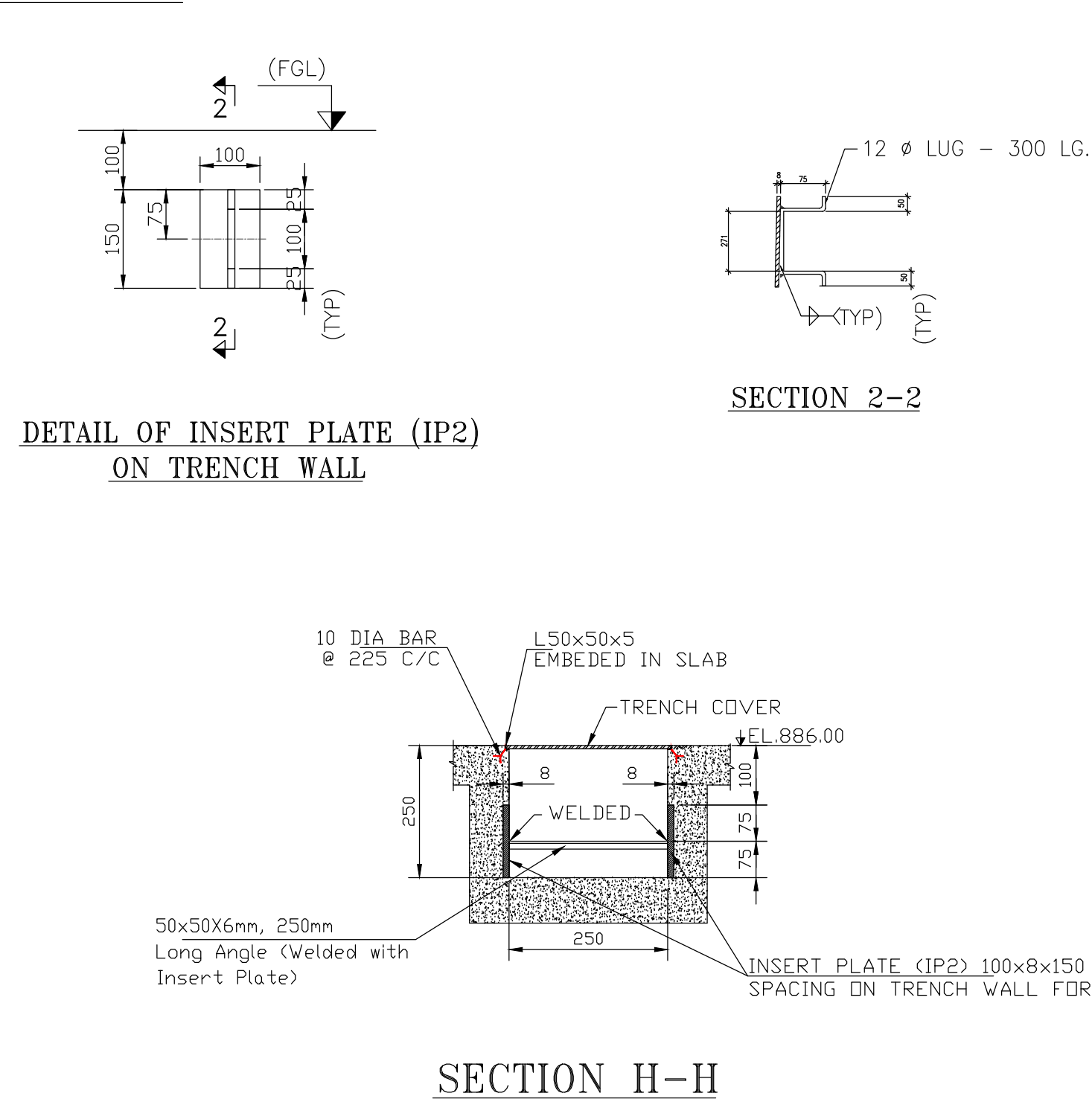
REF DRAWINGS :-	LAYOUT PLAN OF POTHEAD YARD - 1265-PUNAT-II-26 (REV.11)
ADDITIONAL INFORMATION	POTHEAD YARD - LAYOUT PLAN - WAP/PH/EP-II/PH/PTH/LP/S/1537
STATUS OF DRAWING	PROJECT
DISTRIBUTION OF PRINTS	CUSTOMER
	CONSULTANT
	CONTRACTOR
ISSUED BY	UNTOLODIMS. GR.
DEPT. CODE	316
TITLE	LAYOUT PLAN & SECTION ELEVATION DRAWING OF 400KV POTHEADYARD
DRAWING NO.	TB-1-365-316-001
SHT. No.	1
NO. OF SHT.	2



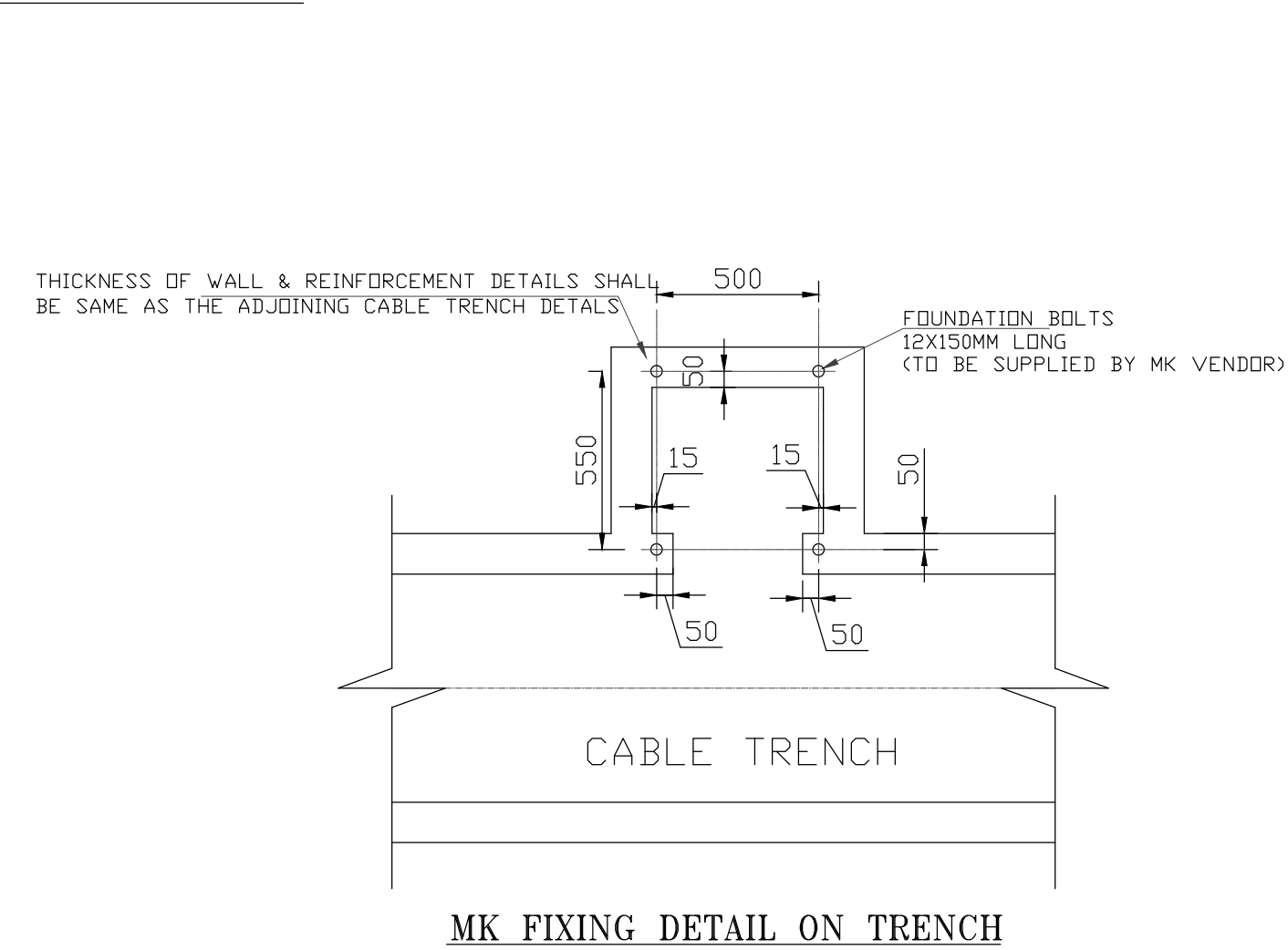
DETAIL-S1



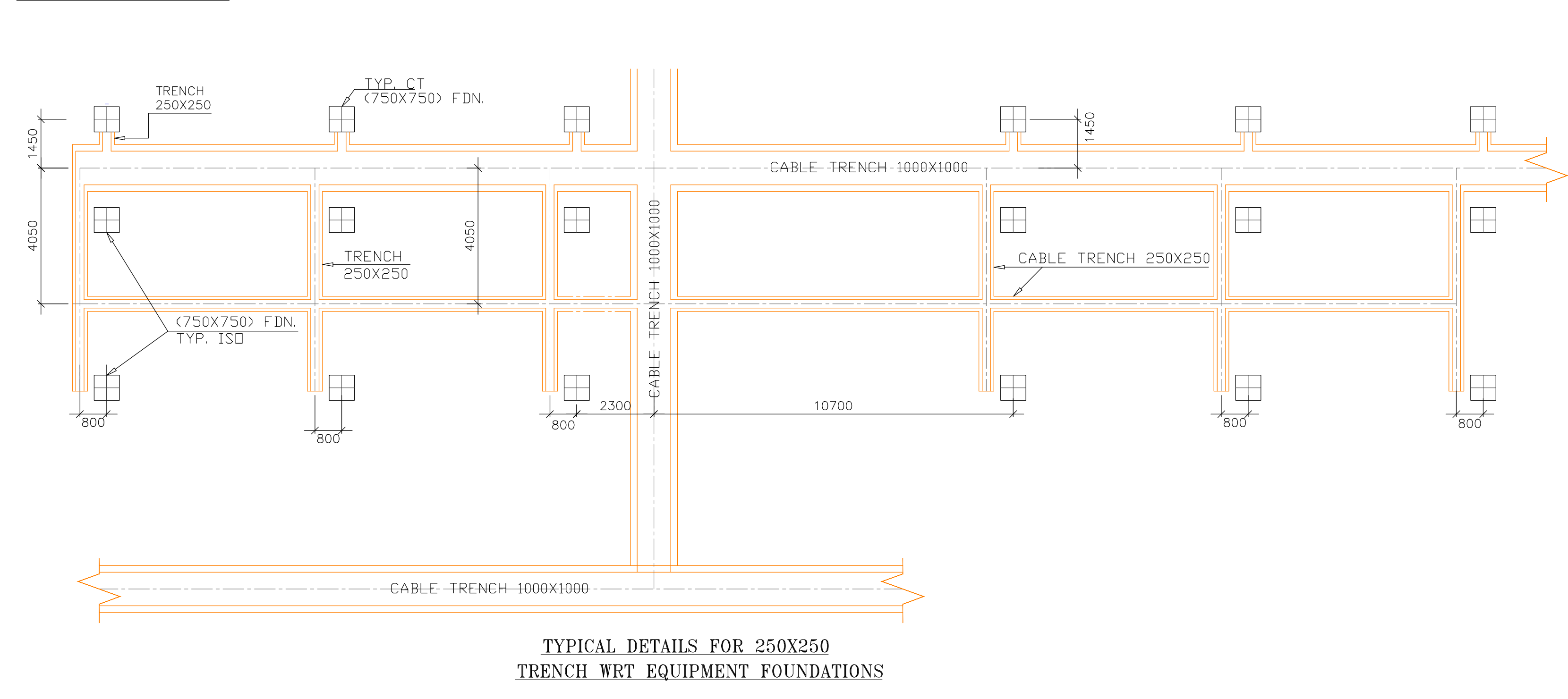
DETAIL-S2



DETAIL-S3





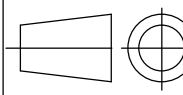


DETAILS-S4



NOTES:—

1. PH/PA/ 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. PH/PA/ 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. TBEM		UNTOL.DIMS. GR.		ANGLE 		SCALE 1:350		WEIGHT (KG)		REF. TO ASSY. DRG.			ITEM NO.		NO. OF ITEM	
					DEPT. CODE: 316																
					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						

REV.	DATE	ALTERED	AK	AK	REV.	DATE	ALTERED	AK	AK	REV.	DATE	ALTERED	AK	AK
06	10.01.19	CHECKED	DKM	<i>Mohab</i>	05	24.07.17	CHECKED	DKM	<i>Mohab</i>	04	12.06.17	CHECKED	AS	-sg-
		APPROVED	DKM				APPROVED	DKM				APPROVED	AS	-sg-
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.				ZONE	DRAWING REVISED BASED ON REVISED CEA DRG. NO. 1265-PUNAT-II-26 (R11) & PHIPA DRAWING "PODHEAT YARD LAYOUT PLAN" - WAP/PHPE-II/PH/PTH LP/S/1537 (REV.4)				ZONE	DRAWING REVISED BASED ON REVISED CEA DRG. NO. 1265-PUNAT-II-26 (R11). AL. TUBE CONDUCTOR HEIGHT IN POTHAEYARD IS KEPT AT 8.5m IN LINE WITH CONTRACT CLAUSE NO. 6.6.11. SECTION-6.			

P00 605 596 P BL		INVENTORY No.	SIGN. & DATE	COMPUTER DRG. PATH 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 any way detrimental to the interest of the company.	
<div>LEGEND</div> <div><div><div></div><div>→</div></div>CONNECTION TO GROUND MAT THROUGH RISER (RISERS TO BE ARRANGED BY CUSTOMER)</div> <div><div><div></div><div>⊗</div></div>RECONNECTION TO EARTH ELECTRODE (ELECTRODE IS NOT IN BHEL SCOPE)</div> <div><div><div></div><div></div></div>75x12mm GS FLAT (BHEL SCOPE)</div> <div><div><div></div><div></div></div>50x6mm GS FLAT (BHEL SCOPE)</div> <div><div><div></div><div></div></div>MAIN MAT/ RISER EARTH CONDUCTOR (NOT IN BHEL SCOPE)</div>							

GENERAL NOTES:

1. AS PER CLAUSE NO. 6.1.2, SECTION-6, DOCUMENT-III OF EM-2 CONTRACT SPECIFICATION ALL BELOW GROUND EARTHING (MAIN EARTHMAT, AUXILIARY EARTHMAT FOR ISOLATOR MOM BOXES, GROUNDING ELECTRODES & ALL RISERS ARE NOT IN BHEL SCOPE. CUSTOMER SHALL ARRANGE REQUIRED NO. OF RISERS NEAR EQUIPMENT FOUNDATIONS AS MENTIONED IN THIS DRAWING. EARTHING FROM THOSE RISERS TILL EQUIPMENT/ STRUCTURE SHALL BE IN BHEL SCOPE.

2. EARTH STRIP CLEATED TO LATTICE /PIPE TYPE STRUCTURE AT AN INTERVAL OF 1.0M SUITABLE PROVISION SHALL BE MADE WITH SUPPORT STRUCTURE.

3. ALL EARTH STRIPS SHALL BE TAKEN ALONG EDGE OF STRUCTURE. ALL DRAWING SHOWS TYPICAL ARRANGEMENT ONLY.

4. ALL STRUCTURES/EQUIPMENTS SHALL BE EARTHED AS SHOWN IN THE FOLLOWING SHEETS.

5. BOLT SIZE FOR CONNECTING EARTHING FLAT TO THE EQPT/STRUCTURE SHALL BE TO SUIT RESPECTIVE HOLE SIZE.

6. ALL EARTHING SHALL BE DONE IN ACCORDANCE WITH IS:3043 UNLESS OTHERWISE STATED IN TECHNICAL SPECIFICATION

7. EACH RISER OF A PARTICULAR EQUIPMENT SHALL BE CONNECTED TO A DIFFERENT EARTHROD (EITHER HORIZONTAL OR VERTICAL CONDUCTORS OF MAIN EARTHMAT).

8. FOR WELDING DETAILS REFER SHEET #13 & 14.

9. E/WIRE DOWN CONDUCTOR SHALL BE CLEATED AT AN INTERVAL OF 2.0 M ALONG WITH STRUCTURE .

10. 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.

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.

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

12.

TYPICAL ARRANGEMENT OF BOLTED JOINTS

13.

WELDING DETAILS

14.

WELDING DETAILS

15.

400KV WAVE TRAP

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1. RISER FROM THE EARTH GRID SHALL BE PROVIDED BY CUSTOMER FROM THE MAIN GROUND MAT TO THE NEAREST EQUIPMENT FOUNDATION 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. DETAILS OF CONDUCTOR BELOW THE GROUND LEVEL (I.E. MAIN EARTHMAT, AUXILIARY EARTHMAT FOR ISOLATOR MOM BOXES, EARTH ELECTRODES & RISERS SHALL BE AS PER CUSTOMER/ CEA DRAWING NO. 1265-PUNAT-II-P-56.
5. IN THE DRAWINGS FGL REPRESENTS FINISHED GROUND LEVEL OF LAYOUT DRAWING OF POTHEAD YARD.
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 RISERS 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) MAIN EARTH CONDUCTORS AT A DEPTH OF 150MM BELOW PCC SHALL BE PROVIDED BY CUSTOMER 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.

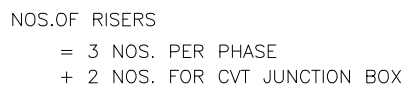


EQUIPMENT EARTHING DETAILS NOTES

DRG. No.

TB 4 365 509 004

SHEET No.
02



EQUIPMENT EARTHING DETAILS

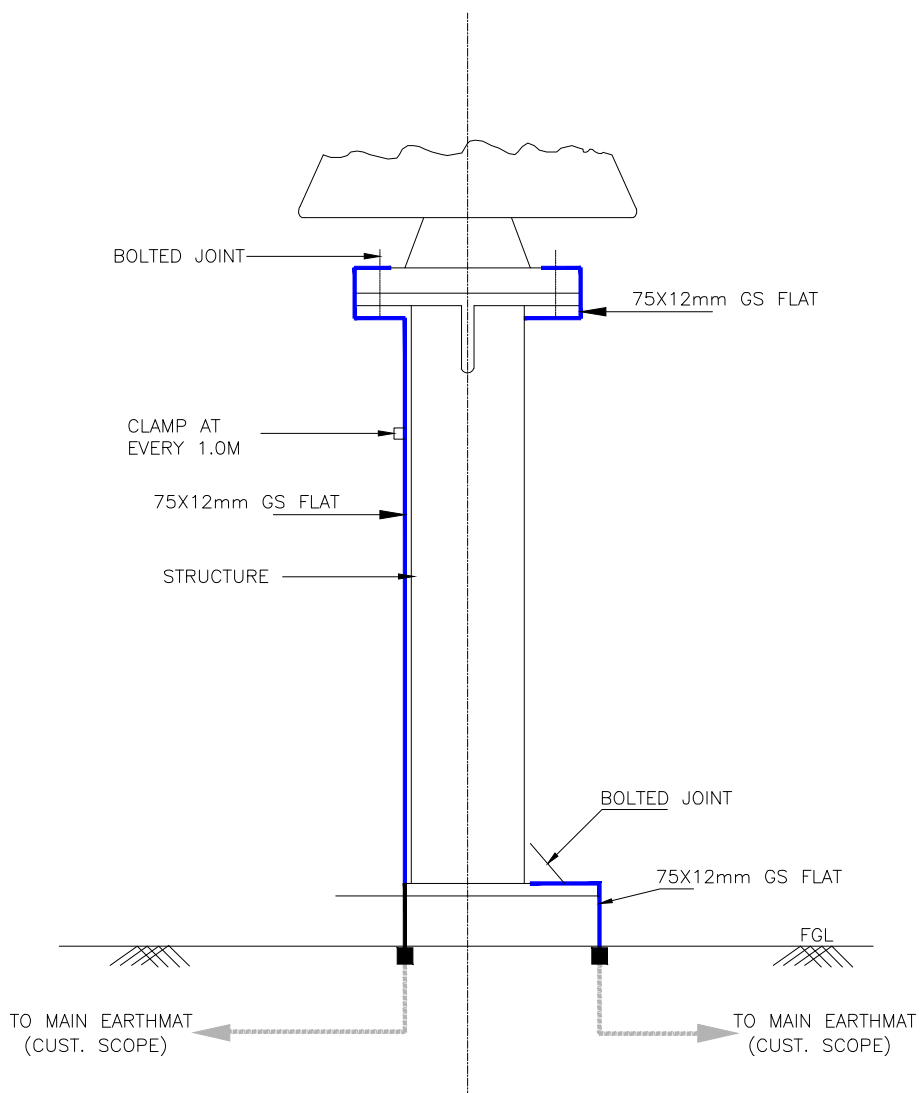
400kV LINE CVT (WITH LMU)

COMPUTERREF.NO.

DRG. No.

TB 4 365 509 004

SHEET No.
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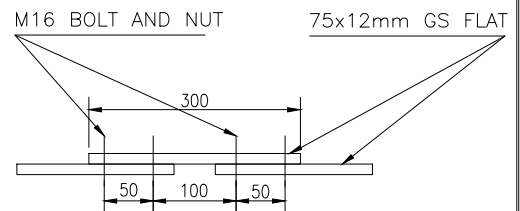
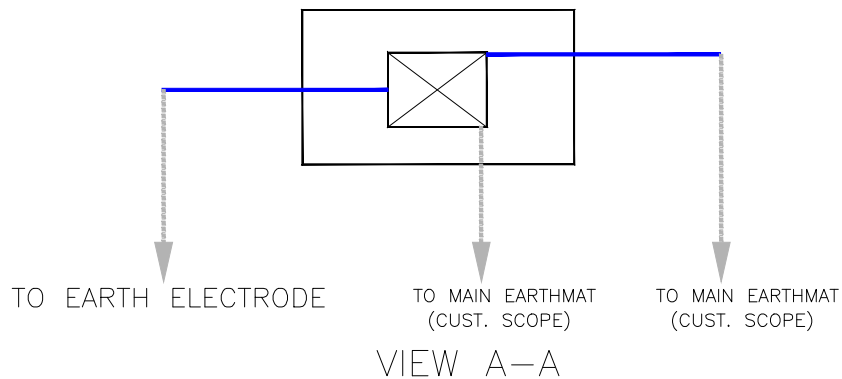
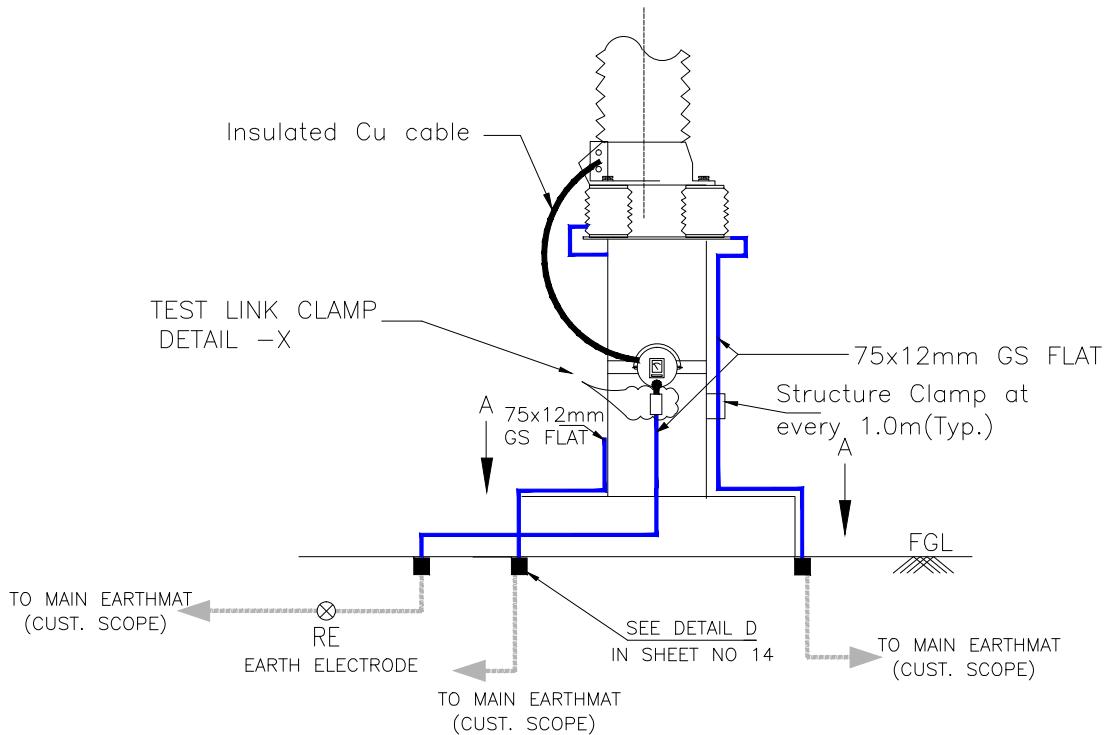
NOS.OF RISERS = 2 NOS.



EQUIPMENT EARTHING DETAILS 400kV POST INSULATOR & CABLE TERMINATION

DRG. No. TB 4 365 509 004

SHEET No.
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(DETAIL -X)

NOTES;

1. LA SHALL BE EARTHED THROUGH EARTH TERMINAL OF SURGE COUNTER
2. NO. OF EARTH ELECTRODES : 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

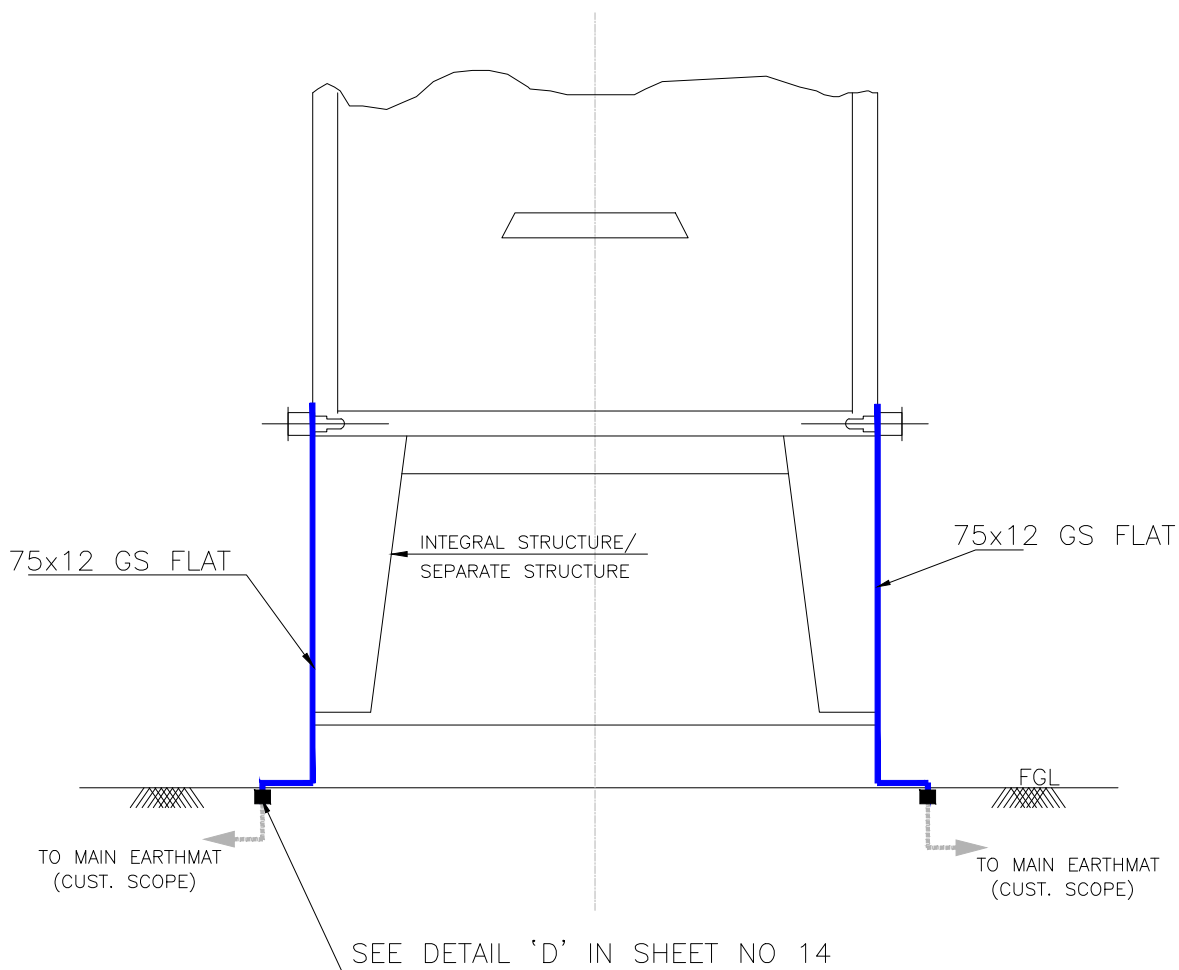
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TB 4 365 509 004

SHEET No.

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NOS.OF RISERS = 2 NOS.



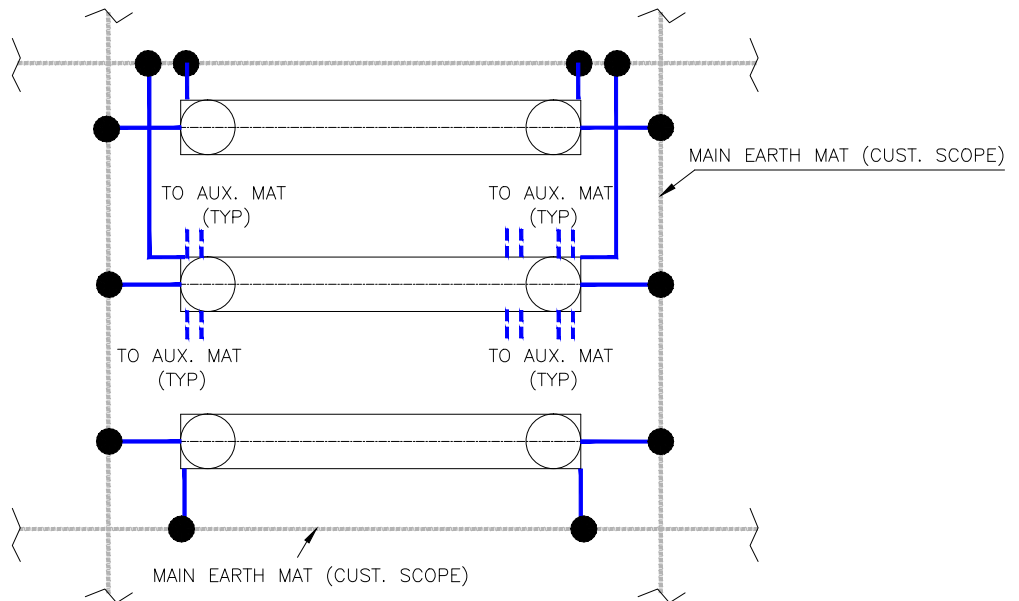
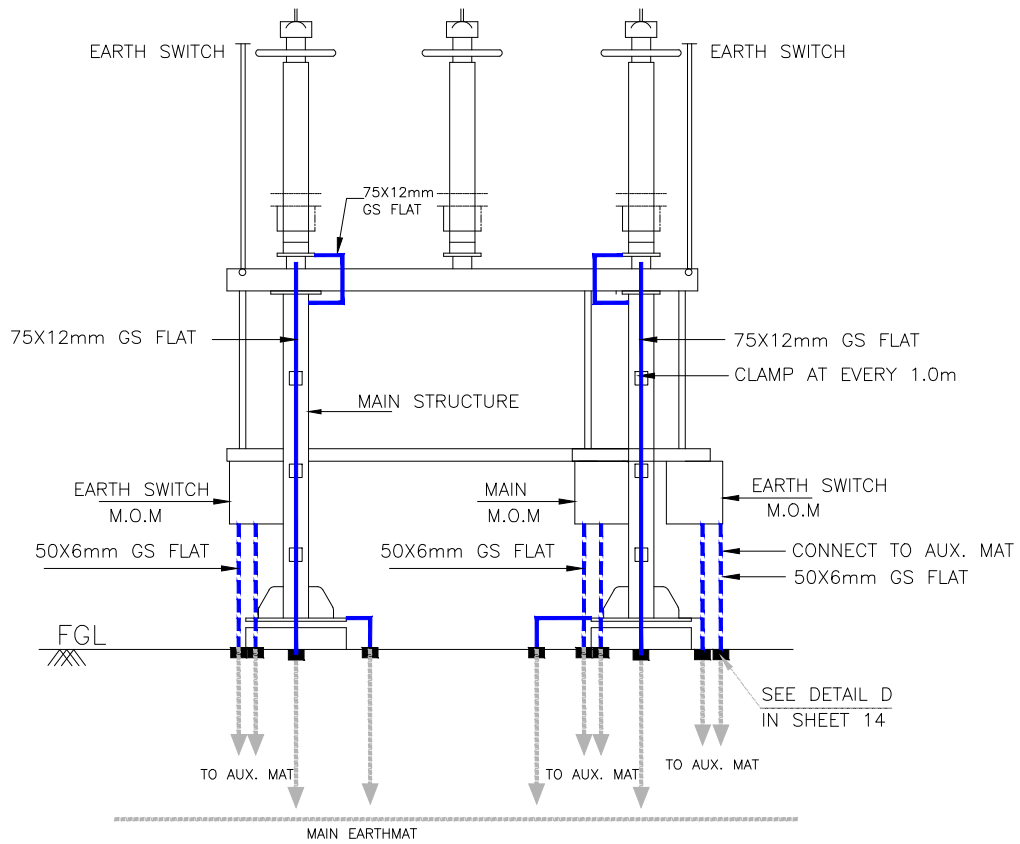
EQUIPMENT EARTHING DETAILS MARSHALLING KIOSK

COMPUTERREF.NO.

DRG. No.

TB 4 365 509 004

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 (REFER DETAIL OF AUXILIARY MAT IN SHEET 11)



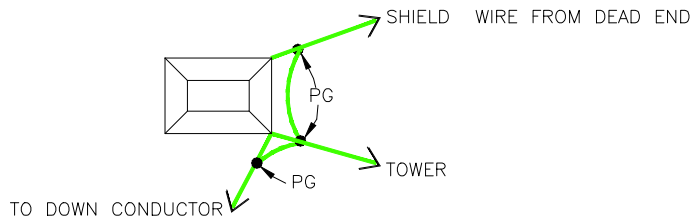
EQUIPMENT EARTHING DETAILS
400kV HORIZONTAL DOUBLE BREAK
ISOLATOR (TYPICAL) WITH TWO EARTHSWITCH

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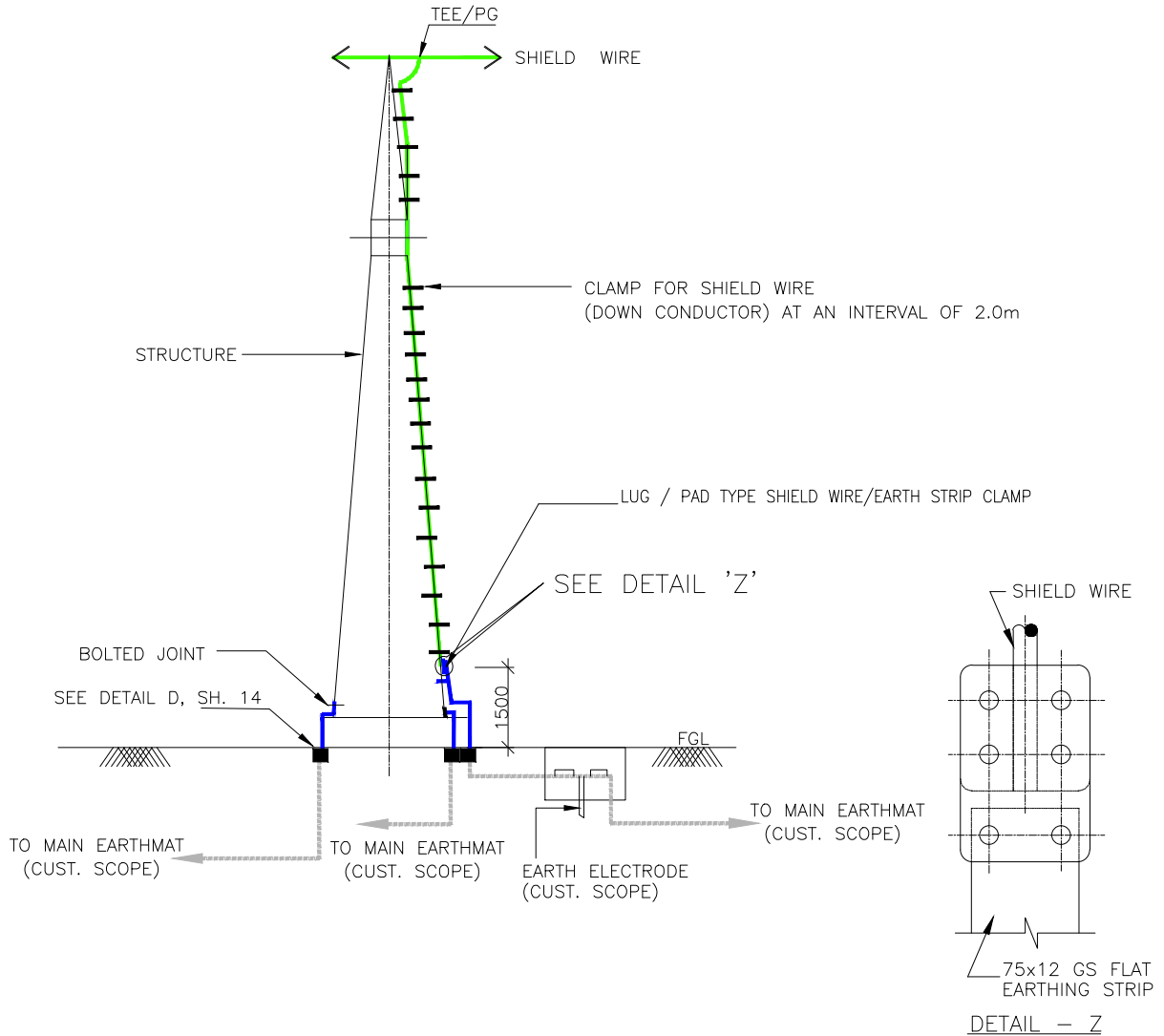
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SHEET No.
07



DETAIL WHEN 2 E/WIRES TERMINATES A TOWER



NOTE:

1. TWO EARTHING STRIP CAN BE CONNECTED TO ONE RISER.
2. NO. OF EARTH ELECTRODE : 1 NO. PER TOWER WITH DOWN CONDUCTOR.
3. NO. OF RISERS = 2 NOS. (MIN.)



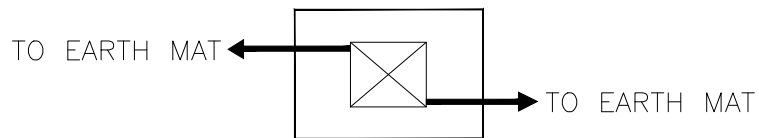
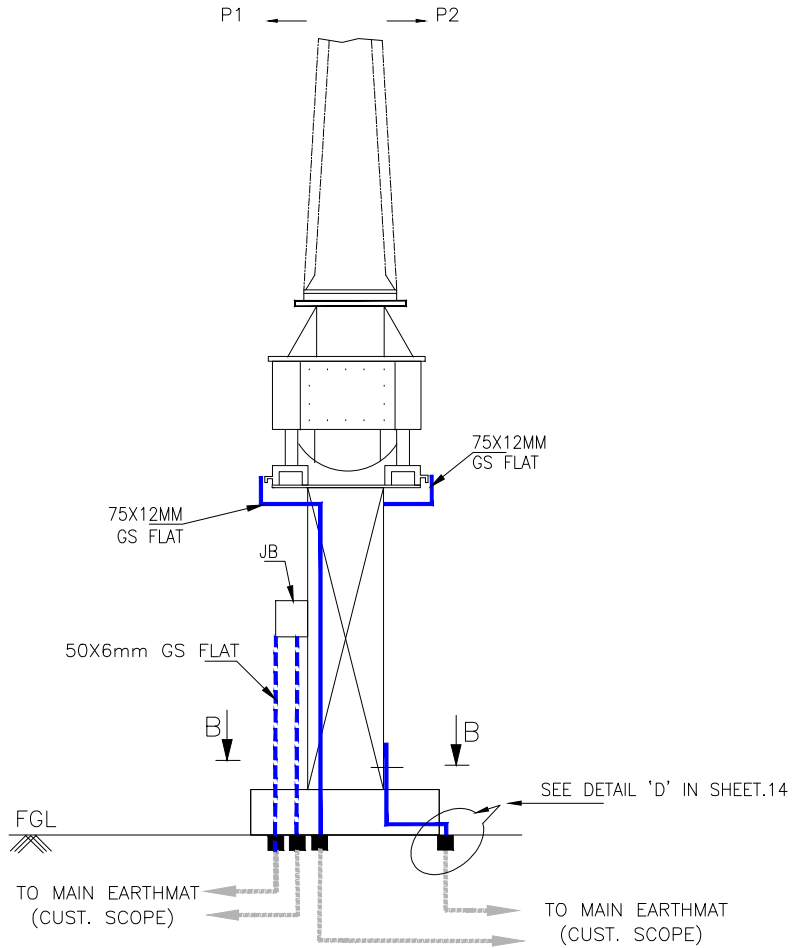
EQUIPMENT EARTHING DETAILS
TOWER WITH PEAK & STRUCTURE FOR SUPPORTING SHIELD WIRE

COMPUTERREF.NO.

DRG. No.

TB 4 365 509 004

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

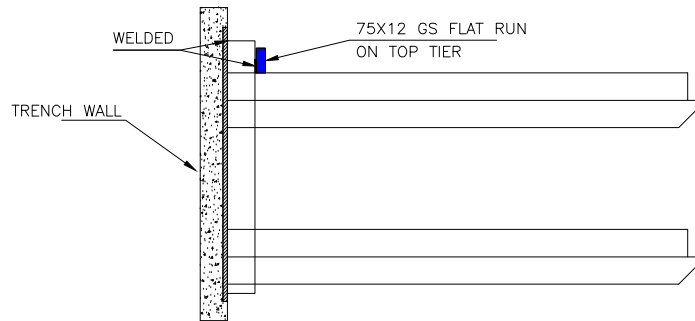
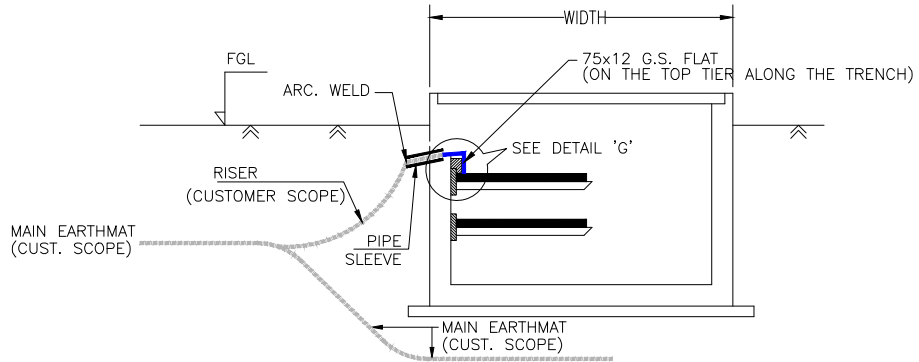
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TB 4 365 509 004

SHEET No.

09



DETAIL 'G'

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

NOTE:

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



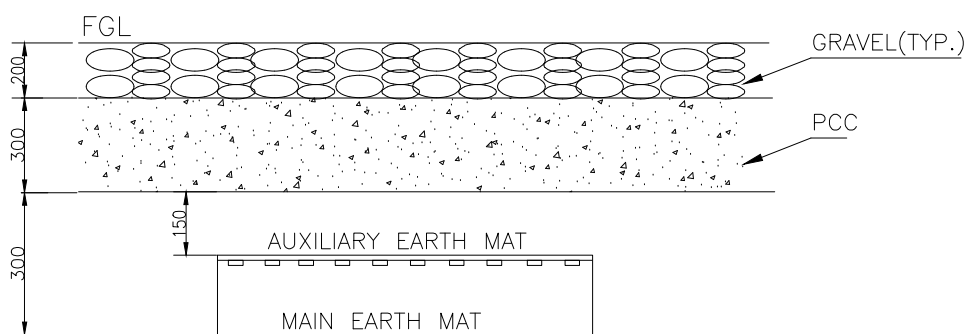
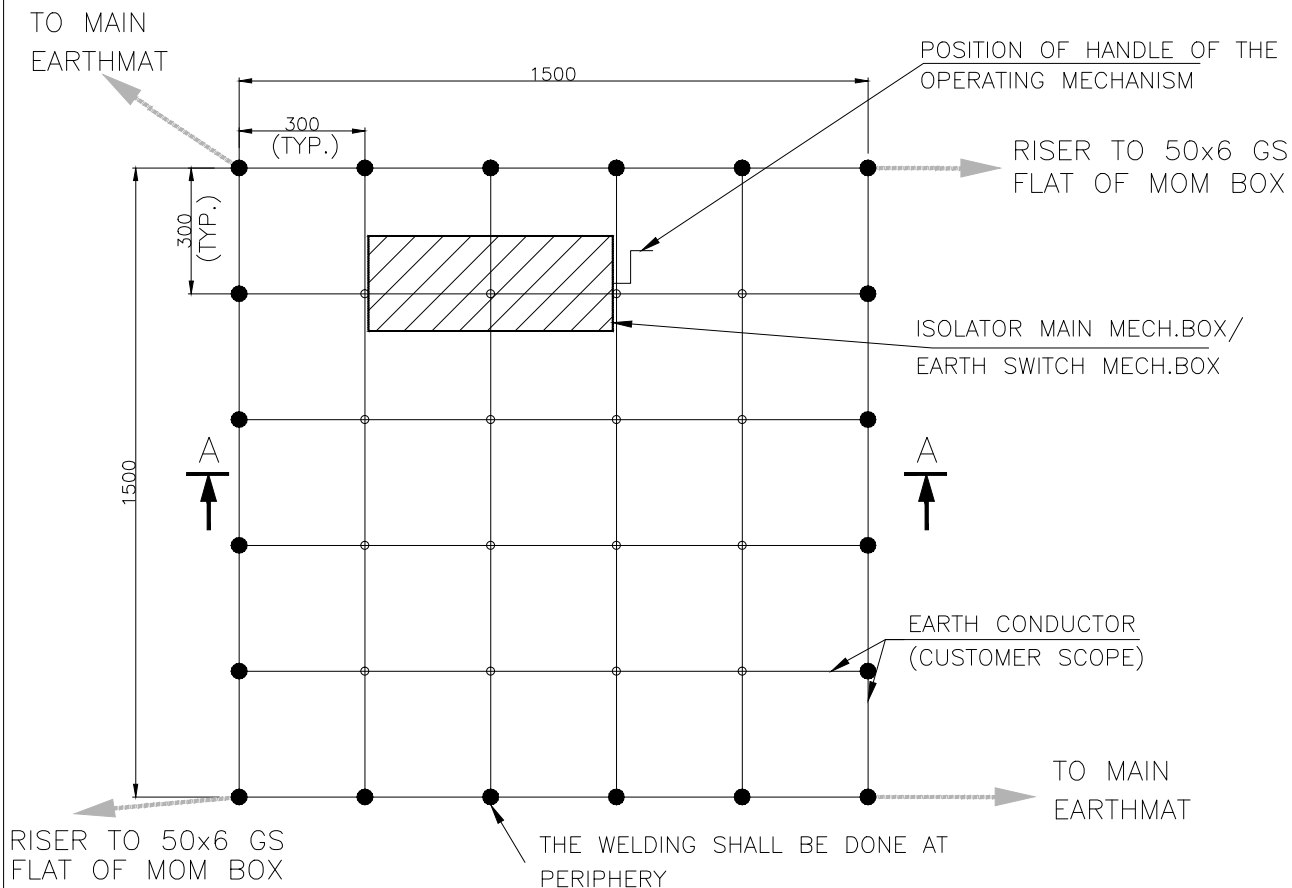
EQUIPMENT EARTHING DETAILS CABLE TRENCH

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DRG. NO.

TB 4 365 509 004

SHEET
10



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

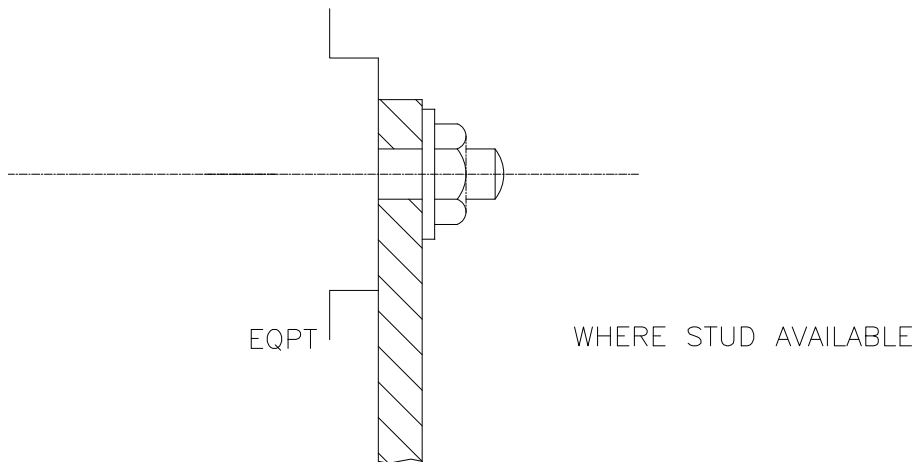
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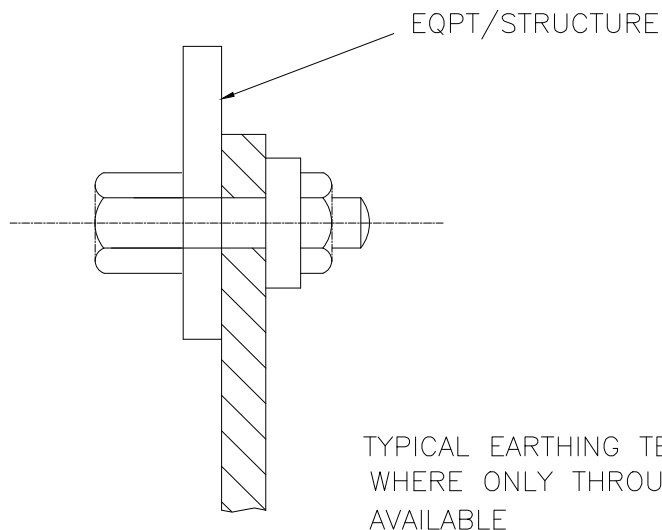
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SHEET No.

11



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

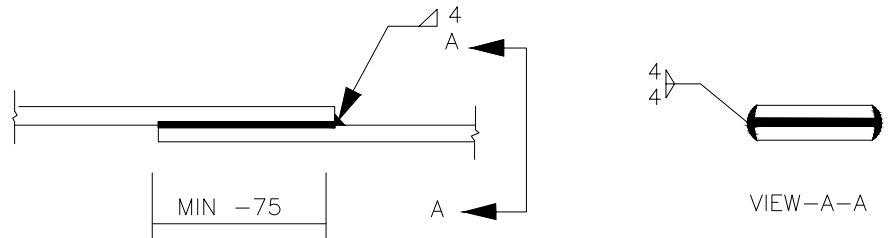
DRG. No.

TB 4 365 509 004

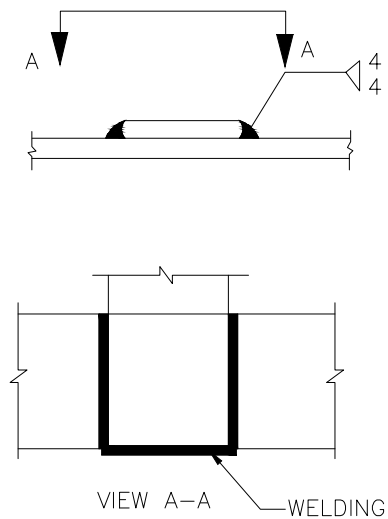
SHEET No.
12

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

1. STRAIGHT LAP JOINT/RISER



2. CROSS LAP JOINT



EQUIPMENT EARTHING DETAILS

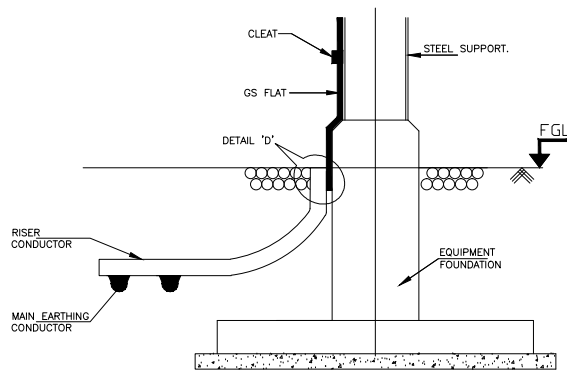
WELDING DETAILS

COMPUTERREF.NO.

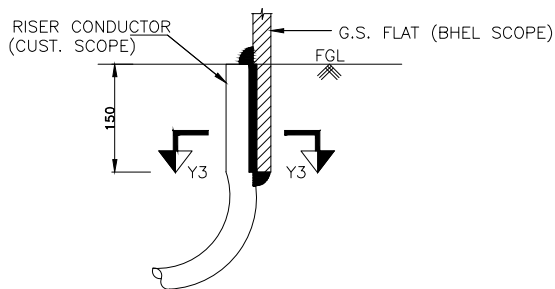
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TB 4 365 509 004

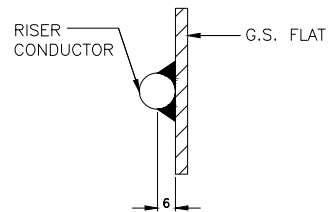
SHEET No.
13



TYPICAL DETAILS OF RISER



ELEVATION
DETAIL-D



SECTION Y3-Y3

TYPICAL CONNECTION DETAILS OF RISER TO EQUIPMENT EARTHING FLATS

NOTES:-

1. CUSTOMER SHALL PROVIDE THE RISER NEAR EQUIPMENT FOUNDATIONS. FOR NO. OF RISERS REFER INDIVIDUAL EQUIPMENT EARTHING DETAILS SHEET SHALL BE REFERRED.
2. RISER & MAIN EARTH MAT CONDUCTORS SHALL BE AS PER CUSTOMER/CEA DRAWING NO. 1265-PUNAT-II-P-56. LOCATION OF RISERS SHALL BE AS NEAR AS POSSIBLE TO EQUIPMENT FOUNDATION.



EQUIPMENT EARTHING DETAILS

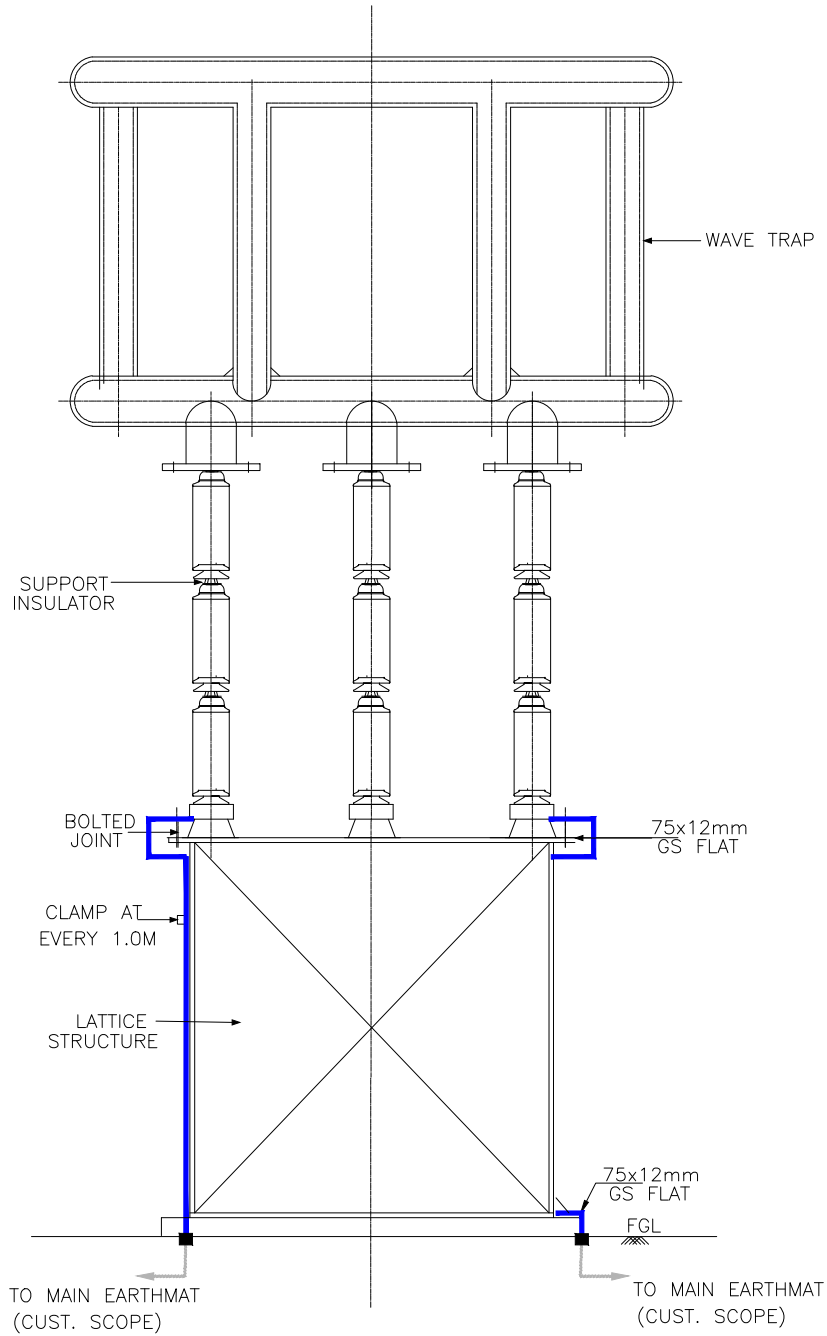
WELDING DETAILS

COMPUTER REF. NO.

DRG. No.

TB 4 365 509 004

SHEET No.
14



NOS.OF RISERS= 2 NOS./STRUCTURE



EQUIPMENT EARTHING DETAILS

400kV WAVE TRAP

COMPUTER REF. NO.

DRG. No.

TB 4 365 509 004

SHEET No.
15

LIST OF MANDATORY SPARES FOR PUNATSANGCHHU-II

ANNEXURE - A

Sl.No.	Item Description	Unit	Quantity
LIST OF MANDATORY SPARES			
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

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 deflection.

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.

		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		RATE CONTRACT (ONE YEAR)							
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.			
Rev No.		Date	Altered	Checked	Approved	REVISION DETAILS			
Distribution					To	TBMM	OFFICE COPY		
					Copies				

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



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	:	6x200MW Punatsangchhu – I Hydroelectric Project, Bhutan	6x170MW Punatsangchhu – II Hydroelectric Project, Bhutan
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



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

	(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%

2.1.4 WIND PRESSURE (AS PER IS:875-1987)

a). Design wind speed : 47 m/sec.

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/m² 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.
Copper flexible. |
| b) | All CT circuits | Min. of 4 nos. of 4.0mm ²
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 mm².
- 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

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.



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	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.

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.