

	STANDARD DRAWING & DOCUMENT LIST
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Sl.	1.1 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-1 of 2)
1	Brief scope of ETC (Erection, Testing & Commissioning) work includes taking over (with verification) of already unloaded material, receipt of complete project material, unloading from truck/ trailer/ carriers, Material handling at Project Site / Project area, material reconciliation, verification, record keeping, handling, material relocating as per site / storage requirements, safe keeping, Pre-erection assembly, erection / installation, testing, pre-commissioning and commissioning including trial run (as per BHEL / Customer FQP) of 765kV AIS and associated systems/equipment and reconciliation after completion of ETC & handing over surplus material & Spares to BHEL/Customer. The Scope also include all T&P including all testing and commissioning equipment suitable for 765kV equipment, hydra/crane, man lifter etc as required to complete installation, testing & commissioning of the system shall be bidder's scope.
2	Bidder Supplied Material - For approved make of supply items, please visit "POWERGRID COMPENDIUM OF VENDORS OF THE EQUIPMENT" at following website address. https://apps.powergrid.in/ims-doc/default Bidder to offer items from powergrid approved make only (as applicable). Bidder to supply material of proven design and make, which have already been extensively used and tested. Bidder to obtain approval from BHEL Engineer incharge / Customer prior to supply. Quantity of supply items are provisional and shall be finalised during contract stage. Qty of supply item may vary upto any extend and and even may get deleted.
3	All consumables required for sucessful erection testing & commissioning of present scope of work is in bidders scope, such as (not limited to) Welding Electrodes, Low hydrogen content welding electrode, Ferruls, Cable Lug, cable ties, , Paint, bitumen compound, Zinc riched enamel paint, red oxide and zinc chromate etc. complete in all respect.
4	All pre/commissioning activities for substation equipment shall be carried out in accordance " Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-03) ".
5	Tower & Equipment foundation shall have foundation bolts pre installed by BHEL's Civil contractor. However installation of some Inserts & Embedded material, bolts, anchor fastner shall be deemed inclusive of bidder's scope of service under respective main item etc works where as required
6	The storage instructions of the equipment manufacturer/ Employer shall be strictly adhered to. POWERGRID Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.
7	ETC of Power / Control / Instrument Cable: Scope includes Cable Laying tagging , dressing, ferruling, lugging, ,soldering, tapping, jointing, crimping, termination, and drilling/ cutting holes in cable gland plates- laying can be either on trays, hanger, supports, underground, buried in ground or through GI/PVC pipe over/under ground, through wall etc. All erection materials viz. Cable Lug, ferrules, cable ties / straps, Al. tags, route markers, GI / PVC wall sleeves with rubber / nylon bushes etc shall be supplied by bidder. excluding supply & Installation of Cable Gland which are covered separately (as a separate BOQ item). Machine ferruling shall be adopted.

Sl.	1.1 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-1 of 2)
8	ETC of Directly Buried Cable (including sand bed & brick cover) - Scope includes laying of cables, directly in buried cable trench. All civil & erection activities such as excavation, supply and placement of sand, bricks, backfilling, compaction, tagging, dressing, ferruling, lugging, installation of cable gland, soldering, tapping, jointing, crimping, termination, and drilling/cutting holes in cable gland plates etc shall be in contractor's scope. All erection materials viz. Sand, Bricks, Cable Lug, ferrules, cable ties / straps, Al. tags, route markers, GI / PVC wall sleeves with rubber / nylon bushes etc shall be supplied by bidder. excluding supply of Cable Gland which are covered separately (as a separate BOQ item / free supply by BHEL). Machine ferruling shall be adopted.
9	For Directly Buried Cable (as mentioned above) bidder to supply & install cable route marker. Location of cables laid directly underground shall be clearly indicated with cable route marker made of galvanised iron plate. The cable route marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings as per relevant standard.
10	All arc welding with shall be done with low hydrogen content electrodes for all earthing works i.e. MS Rod, GI Flat & MS Flat
11	The welds on 40MM MS Rod should be treated with red oxide primer and afterwards coated with two layers of bitumen compound to prevent corrosion.
12	50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Zinc riched enamel paint.
13	Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
14	All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.
15	Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.
16	Installation of Cable Trench Material include all miscellaneous activity including minor fabrication, welding, cutting, drilling holes, bolting, anchor bolting, etc. complete in all respect. Where as fabrication is required shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.
17	Quoted rates are deemed to be inclusive of all miscellaneous works viz erection of mounting hardwares, clamp- connectors, etc complete in all respect. For example - Equipment erection (say Surge Arrestor) means complete erection, metalics, 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.
18	All the phases are to be identified by painting the structures Red, Yellow and Blue by reflecting colour as per as built condition. Phase identification colour is to be provided around the top of the structure with colour band of 100 mm width at a height of approximately 2000mm from the finished ground level.

Sl.	1.1 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-1 of 2)
19	Supply of 110 MM & 50mm dia. PVC PIPES CLASS-IV PIPES (if called in bid price schedule) including Bend and Tee etc shall be as per technical specification TB-XXX-316-041. (Supply of PVC Pipe (class 4) as per IS 4985, alongwith accessories like sockets, bends, tees etc, Customer accepted make.)
20	Supervision of testing and commissioning of Relay / Protection / SAS / Automation / Bus Bar Panels (as applicable) is in the scope of BHEL/ Panel supplier. Necessary manpower support, tools, tackles and testing equipment to be in scope of ETC contractor.
21	Removal of gravel, if gravelling is already done, for connection of Equipment earthing strip to the existing mat (wherever earthing mat is already laid), and after completion of earthing , contractor should place the gravel to bring it in original shape.
22	Complete ETC package is under the scope of bidder. All T&P required to complete the job shall be provided by bidder only. Bidder to arrange MAN LIFTER for 765kV & 400kV equipment erection & testing. Height of manlifter shall be 14m approach for 765kV Yard

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
1	All safety rules and codes applied by the Client/BHEL at site shall be observed by the contractor without exception. The contractor shall be responsible for the safety of the equipment/material and works to be performed by him and shall maintain all light, fencing guards, slings etc. or other protection necessary for the purpose. Contractor shall also take such additional precautions as may be indicated from time to time by the Engineer with a view to prevent pilferage, accidents, fire hazards. Due precautions shall be taken against fire hazards and atmospheric conditions. Suitable number of Clerical staff, watch and ward, store keepers to take care of equipment/materials and construction tools and tackles shall be posted at site by the contractor till the completion of work under this contract.
2	The ETC instructions of the equipment manufacturer/ Employer shall be strictly adhered to. Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.
3	Automatic Relay Test Kit along with Laptop and Testing engineer shall be provided by BHEL/ Panel supplier. (NOT in Bidder's scope). Necessary manpower support, tools, tackles, wiring, BUS wiring and other testing equipment to be in scope of Bidder (ETC contractor).
4	All consumables required for successful erection testing & commissioning of present scope of work is in bidders scope, such as (not limited to) Welding Electrodes, Low hydrogen content welding electrode, Ferrules, Cable Lug, cable ties, Paint, bitumen compound, Zinc riched enamel paint, red oxide and zinc chromate paint ..etc complete in all respect.
5	ETC of Power / Control / Instrument Cable: Scope includes Cable Laying tagging , dressing, ferruling, lugging, installation of cable gland ,soldering, tapping, jointing, crimping, termination, and drilling/ cutting holes in cable gland plates- laying can be either on trays, hanger, supports, underground, buried in ground or through GI/PVC pipe over/under ground, through wall etc. All erection materials viz. Cable Lug, ferrules, cable ties / straps, Al. tags, route markers, GI / PVC wall sleeves with rubber / nylon bushes etc shall be supplied by bidder. excluding supply of Cable Gland which are covered separately (as a separate BOQ item / free supply by BHEL). Machine ferruling shall be adopted.
6	Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-interlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.
7	Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure. Tray shall be supplied by BHEL.
8	All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
9	<p>Bidder to offer items from Powergrid approved make only (as applicable). Bidder to supply material of proven design and make, which have already been extensively used and tested. Bidder to obtain approval from BHEL Engineer incharge / Customer prior to supply. Quantity of supply items are provisional and shall be finalised during contract stage. Qty of supply item may vary upto any extend and and even may get deleted.</p>
10	<p>CABLE LUG: Supply of cable lug is in bidders scope. cable lugs shall be tinned copper solderless crimping type conforming to IS-8309 & 8394 for all control Cables and cables with copper wire.</p> <p>For Aluminium Bimetallic lugs for power cables as required shall be used depending upon type of cables and terminations. Solderless crimping of terminals shall be done by using corrosion inhibitory compound.</p> <p>The cable lugs shall suit the type of terminals provided. The bidder shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve.</p> <p>Bidder to supply cable lug from manufacturer's authorised representative / dealer. Make of cable lug is to be approved by Powergrid i.e. DOWELLS /COMET/ JAIN ELECTRONICS/ JAICO ELECTRIC/ SI METAL WORKS / Powergrid approved make etc.</p>
11	<p>Cable TAGS & Markers - Bidder to supply and install cable tag & markers. The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.</p> <p>Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.</p>

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
12	<p>Cable Gland: Tin/ Nickel, Nickel/chromium - Plated (coating thickness not less than 10 microns) Powergrid approved / Sunil & Co. / Arup/ Comet / QPIE make brass cable glands, double compression heavy-duty type complete with necessary armour clamp & tapered washer etc. Bidder to offer the gland from authorised representative of manufacturer. Cable gland shall be subject to customer approval prior to dispatch. Cable glands shall match with the sizes of different HT/LT/Control cables. After installation of cabling work balance gland holes are to be sealed by bidder with suitable aluminium sheath, cost of additive and aluminium sheet are deemed inclusive in the bidders scope.</p>
13	<p>Modular Multi-diameter Cable sealing system consisting of Openable frames, blocks and accessories shall be installed where the underground and over-ground cables enter or leave concrete bay kiosks /Switchyard panel room & control rooms in the substations. Cable sealing system shall consist of Multi-diameter type peel-able or adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system.</p> <p>Solid blocks shall not be used on frame. Openable frames & stay-plate material shall be of galvanized steel and for compression single piece wedge with galvanized steel bolts shall be used. Cable sealing system should have been tested for fire/ water/ smoke tightness. All the accessories of cable sealing system shall be suitable for mounting after the laying of cable.</p> <p>Modular Multi-diameter Cable sealing system should be Powergrid approved make & conformed relevant IS/IEC</p>

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
14	<p>Cable Transit System / Modular Multi-diameter Cable sealing system: Cable sealing system shall consist of multi-diameter type peel-able or adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system.</p> <p>1) Scope shall include all the items which are necessary for successful supply & installation (including nuts and bolts, if required) and satisfactorily working/maintenance of the offered cable.</p> <p>2) Compression tools and accessories necessary in the installation shall be considered in the supply scope that shall be required at a later stage for new cable.</p> <p>3) The Contract shall be on lump-sum basis for the package. Within the scope of the contract, no variation shall be admissible to the Contractor so far the input remains unchanged. In case of change in scope after award of the contract, the additions/ deletions to the scope shall be as per the breakup unit rates for all the equipment and services furnished by the bidder in his offer.</p> <p>4) Minor Civil work with brick masonry required for installation is in the scope of bidder.</p> <p>5) Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression, single piece wedge with galvanized steel bolts shall be used. 30% spare blocks on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.</p> <p>6) Minor civil work required for installation of cable sealing system is included in the scope of bidder.</p>
15	<p>Insulating Rubber Mats - The scope covers supply and laying of insulating mats of class-A conforming to IS: 15652-2006. These insulating mats shall be laid in front of all floor mounted ACDB, CRP, SAS (As applicable under present scope) in control room building/ Switchyard panel room. The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature. Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat. The Insulating mat shall be of pastable type, to be fixed permanently on the front of the panels except for the chequered plate area which shall not be pasted as per requirement. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS:15652. Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirement.</p>
16	<p>Complete ETC package is under the scope of bidder. All T&P required to complete the job including cranes, forklift e.t.c. shall be provided by bidder. Bidder to arrange MAN LIFTER for equipment erection & testing as per requirement. Height of manlifter boom shall be 14m approach for 765kV Substation.</p>

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
17	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.
18	The welds on MS Rod should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
19	MS / GI flat shall run on the top tier and all along the cable trenches and the same shall be bolted / welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs.
20	The welds involving GI Flat should be treated with zinc chromate primer and coated with zinc rich paint. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.
21	MS Welding - The M.S. flat/angle/channel shall be finally painted with two coats of Red oxide primer and two coats of Zinc rich enamel paint.
22	All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.
23	Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
24	Grouting: Cost of Supply and placement of grouting is deemed inclusive in bidder's scope of work. i) Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. ii) Minimum grade of grout shall be M30. iii) Nominal thickness of grouting shall be approx 80 mm for Tower Structure & approx 60 mm for equipment support struture.
25	All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grounding of anchor bolts, sills, inserts and fastening devices shall be carried out by the contractor including minor modification of civil works as may be required for erection. Cost of the same is deemed inclusive in the scope.

Sl.	1.2 STANDARD TECHNICAL NOTES & BIDDER'S SCOPE (Part-2 of 2)
26	Any cutting of masonry / concrete work, Wall openings at suitable locations for ventilation fans, Civil works such as grouting, filling up of crevices/ cut outs etc. during installation of equipments, modification of civil foundations, making holes in the trenches/ control room building, fixing of trench material shall be done by the bidder and shall be made good including supply and installation of chicken wire mesh to match the original work. Any other damage caused to civil works during ETC work of the equipment/ system shall be made good to the original finish. Cost of the same is deemed inclusive in the scope.
27	Individual item may vary up-to any extent and even may get deleted, however overall contract value may vary +/- 30%. Variation will be valid up-to contract stage.
28	Testing instruments (duly calibrated) have to be arranged by ETC Contractor in full completion of testing requirement at its own cost on returnable basis (List is only provided for information , if any other instrument not mentioned below but required for successful completion of ETC work shall be in ETC contractor's scope. Bidder to review complete BOQ for possible requirements of instruments)
28.01	CRM (Contact Resistance Measurement kit)
28.02	Capacitance and Tan delta measurement Kit
28.03	Dew Point Measurement kit
28.04	5kV & 1kV Insulation tester
28.05	Primary current / Voltage Injection Kit
28.06	Secondary current/Voltage Injection kit
28.07	1Ph Variac
28.08	Multimeters
28.09	Clamp on meter
28.10	Power supply sockets with extension board -2 nos.
28.11	Necessary numbers of fire extinguisher
28.12	Timing & DCRM (Dynamic Contact Resistance Measurement kit) OPERATIONAL ANALYZER
29	NOT IN BIDDER's scope: Following Testing instruments are NOT IN BIDDER's scope. However complete skilled & unskilled manpower supports are to be provided for successful ETC works
29.01	OMICRON or equivalent kit for Numerical relay testing, Automatic Relay Test Kit along with Laptop

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-425-316-202

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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

BOO OF 765KV EQUIPMENTS				
Sl. NO.	ITEM DESCRIPTION	QTY. AS PER BPS	ACTUAL	SCOPE OF SUPPLY SYMBOL
1	765KV, 3150A, SOKA FOR 1SEC. CIRCUIT BREAKER WITH CLOSING RESISTOR, WITH CONTROLLED SWITCHING DEVICE (WITH SUPPORT STRUCTURE)	03	03	BHEL
2	765KV ISOLATOR-VERTICAL, KNEE TYPE (a) WITH ONE EARTH SWITCH 3150A, SOKA FOR 1 SEC.(3 PH.) (b) WITH TWO EARTH SWITCH 3150A, SOKA FOR 1 SEC.(3 PH.)	05	05	BHEL
3	765KV, 2000-2000-500/1-A, SOKA FOR 1SEC. 1-PHASE & CORE CURRENT TRANSFORMER WITH 120K EXTENDED CURRENT RATING	09	09	BHEL
4	765KV, 8000V, CAPACITIVE VOLTAGE TRANSFORMER, 1-PHASE	06	06	BHEL
5	62MM, 20KA, CLASS-V SURGE ARRESTER (1-PH)	06	06	BHEL
6	765KV, 1MH, WAVE TRAP (1-PH)	04	04	BHEL
7	765KV, BKN POST INSULATOR WITH CORONA RING (1-PH)	26	19	BHEL
8	765KV, GUY WIRE INSULATOR (1-PH)	-	03	BHEL
9	765KV, TENSION INSULATOR AND HARDWARE FITTING WITH TURN BRACKLE SUITABLE FOR QUAD CONDUCTOR	12	12	BHEL
10	765KV, TENSION INSULATOR AND HARDWARE FITTING WITHOUT TURN BRACKLE SUITABLE FOR QUAD CONDUCTOR	12	12	BHEL
11	765KV, TENSION INSULATOR AND HARDWARE FITTING WITH THROUGH CLAMP SUITABLE FOR QUAD CONDUCTOR	06	06	BHEL
12	765KV, SUSPENSION INSULATOR AND HARDWARE FITTING WITH THROUGH CLAMP SUITABLE FOR QUAD CONDUCTOR	06	06	BHEL
13	765KV, SUSPENSION INSULATOR AND HARDWARE FITTING WITH DROP CLAMP SUITABLE FOR QUAD CONDUCTOR	12	15	BHEL

SYSTEM PARTICULARS - 765KV		
Sl. NO.	DESCRIPTION	LEVEL FROM PLWN
1	JACK BUS/MAIN BUS-1 & II	(AT 35M HEIGHT)
2	DROPPERS/JUMPERING	-
3	EQUIPMENT INTERCONNECTION	(AT 14M HEIGHT)
4	765KV SPARE AUXILIARY BUS	(AT 12M HEIGHT)
5	EARTHING	(AT 45M HEIGHT)

CONDUCTOR & STRINGING DETAILS - 765KV	
Sl. NO.	DESCRIPTION
1	QUAD A&C BULL CONDUCTOR WITH 450MM SUB-TENSIONATOR SPACING
2	QUAD A&C BULL CONDUCTOR WITH 450MM SUB-TENSIONATOR SPACING
3	4.5" IPS AL. TUBE/QUAD A&C BULL CONDUCTOR WITH 450" SPACING
4	4.5" IPS AL. TUBE
5	2/3.66mm GI WIRE (10.88mm DIA)

NOTES:-
01. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
02. ALL THE BUS HEIGHT ARE REFERRED FROM TOP OF PLUNH LEVEL.
03. R/S-B PHASE SEQUENCE OF 765KV SHALL BE VERIFIED AT SITE DURING EXECUTION.
04. FOR DETAILS OF BAY MARSHALLING KIOSK CT & CVT JUNCTION BOX LOCATION REF. CABLE TRENCH LAYOUT DRAWING.
05. LOCATION OF PROPOSED SPS SHALL BE MATCH WITH EXISTING SPS.
06. FOR TYPE OF STRUCTURES REFER APPROVED STRUCTURAL LAYOUT DRAWING.
07. GUY WIRE OF EQUIPMENTS AND TOWER SHALL BE 300mm ABOVE GALL & THAT OF GRAVEL FILLING SHALL MATCH WITH THE EXISTING SWITCHYARD.
08. 765KV WAVE TRAP SHALL BE PLACED IN R AND Y PHASE. HOWEVER FOUNDATION SHALL BE CONSTRUCTED IN ALL PHASES.

BHEL REFERENCE DRAWING:

01. SINGLE LINE DIAGRAM
BHEL DRAWING NO. TB-425-316-201, REV-01

PGCIL REFERENCE DRAWING:

01. SINGLE LINE DIAGRAM-TENDER
DRAWING NO. C/PACG/TECH/KOPPAL-II PART-B/RAICHUR/04/01, REV-0

02. GENERAL ARRANGEMENT DRAWING-TENDER
DRAWING NO. C/PACG/TECH/KOPPAL-II PART-B/RAICHUR/04/01, REV-0

LEGENDS

PRESENT SCOPE
EXISTING/FUTURE

SPACE FOR COLONY/TRANSIT CAMP/
OTHER INFRASTRUCTURE
254X103

NOA NO. : CC/TW-AIS/DOM/A04/23/04587/NOA-1/24-102662/01 &
CC/TW-AIS/ DOM/A04/23/04587/NOA-2/24-102662/02 DATED : 23.02.2024

ADDITIONAL INFORMATION
W.O.No.

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

REV.	DATE	ALTERED	AS	DEPT.	BY	DATE
04	29.11.24	CHECKED	JK			
		APPROVED	VK			

LAYOUT IS UPDATED AS PER
PGCIL COMMENTS DT.
16.10.2024.

POWERGRID CORPORATION OF INDIA LIMITED

SUBSTATION PACKAGE-SS 09T FOR (I) EXTENSION OF 765KV KOPPAL-II S/S AND (II)

EXTENSION OF 765KV RAICHUR S/S ASSOCIATED WITH TRANSMISSION SCHEME FOR

INTEGRATION OF RENEWABLE ENERGY ZONE (PHASE-II) IN KOPPAL-II (PHASE-B) IN

KARNATAKA

NAME OF CUSTOMER/PROJECT
NAME OF CONSULTANT

NAME OF CONSULTANT

NAME OF CONSULTANT

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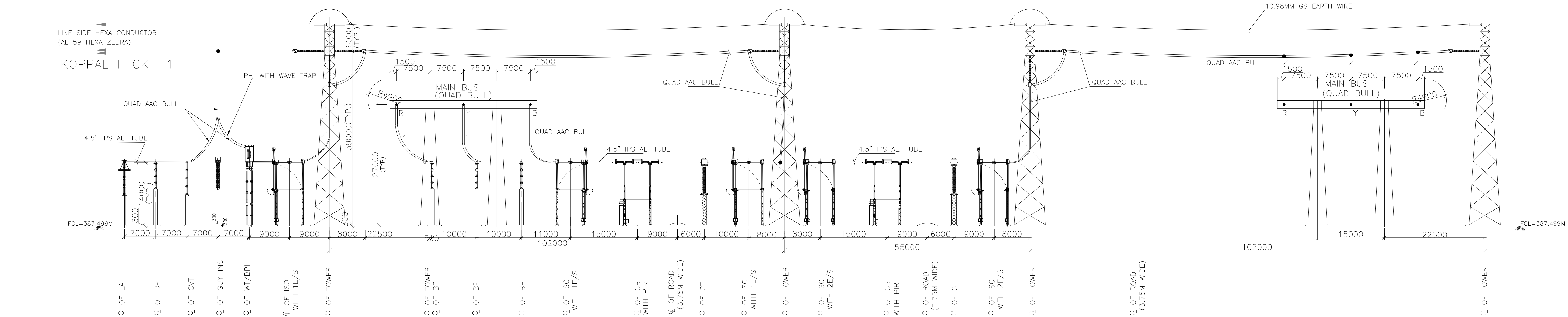
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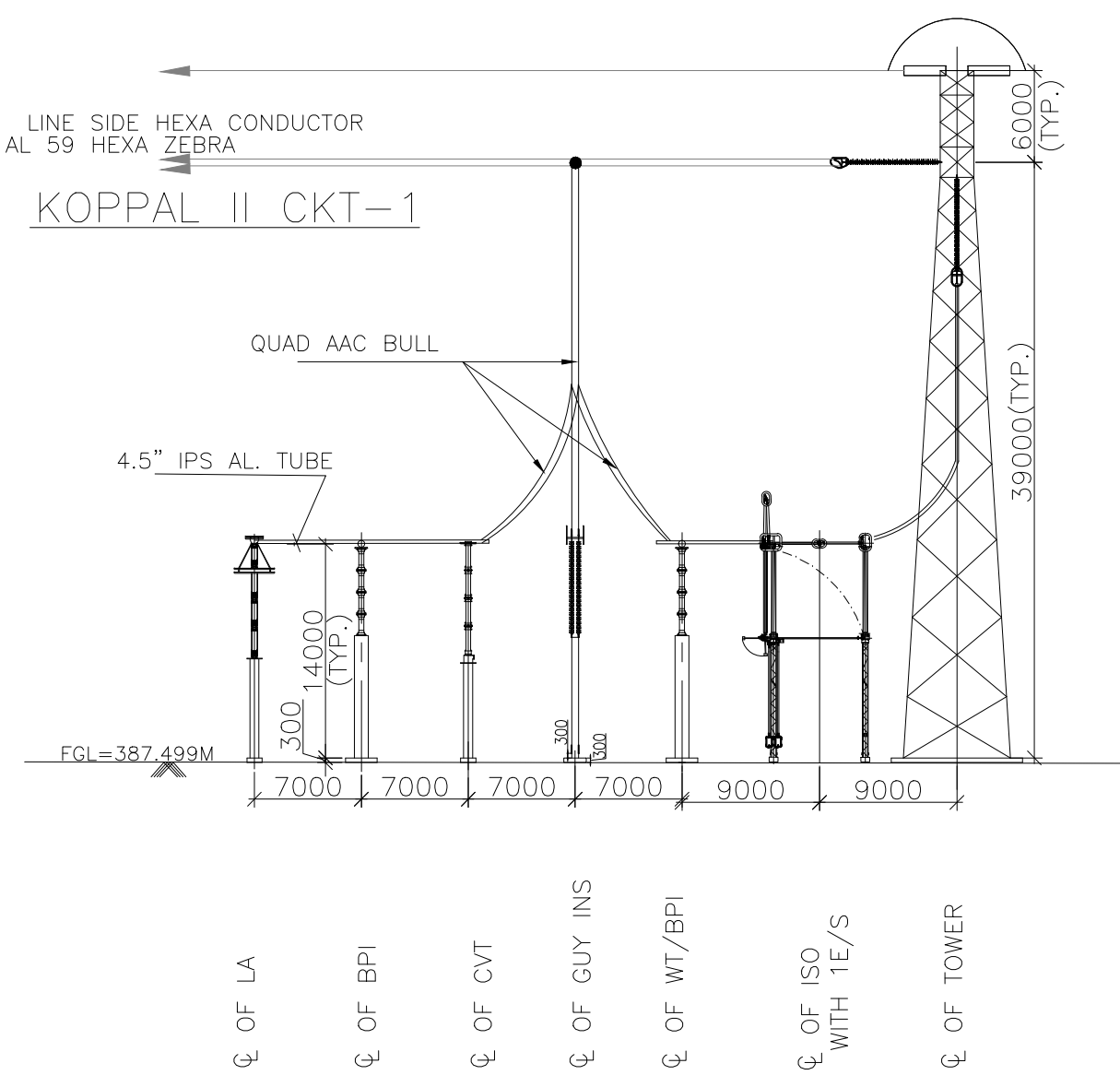
NAME OF CONSULTANT

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

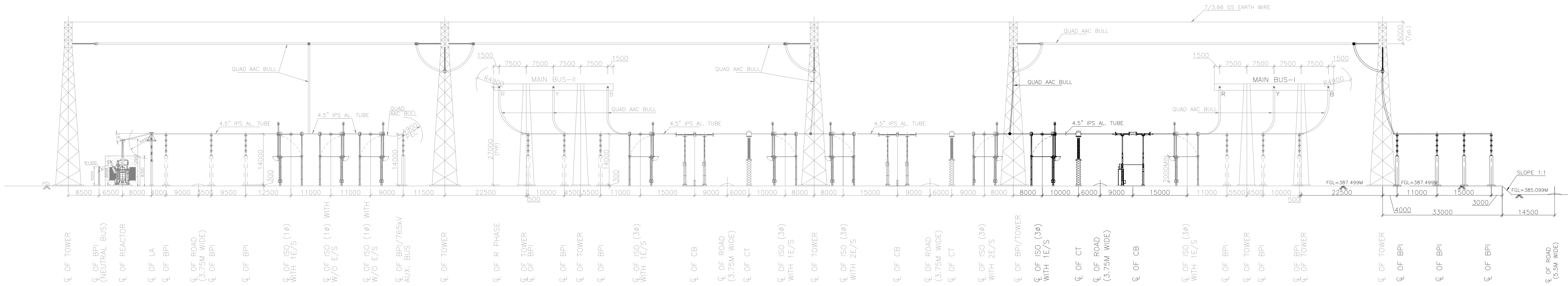
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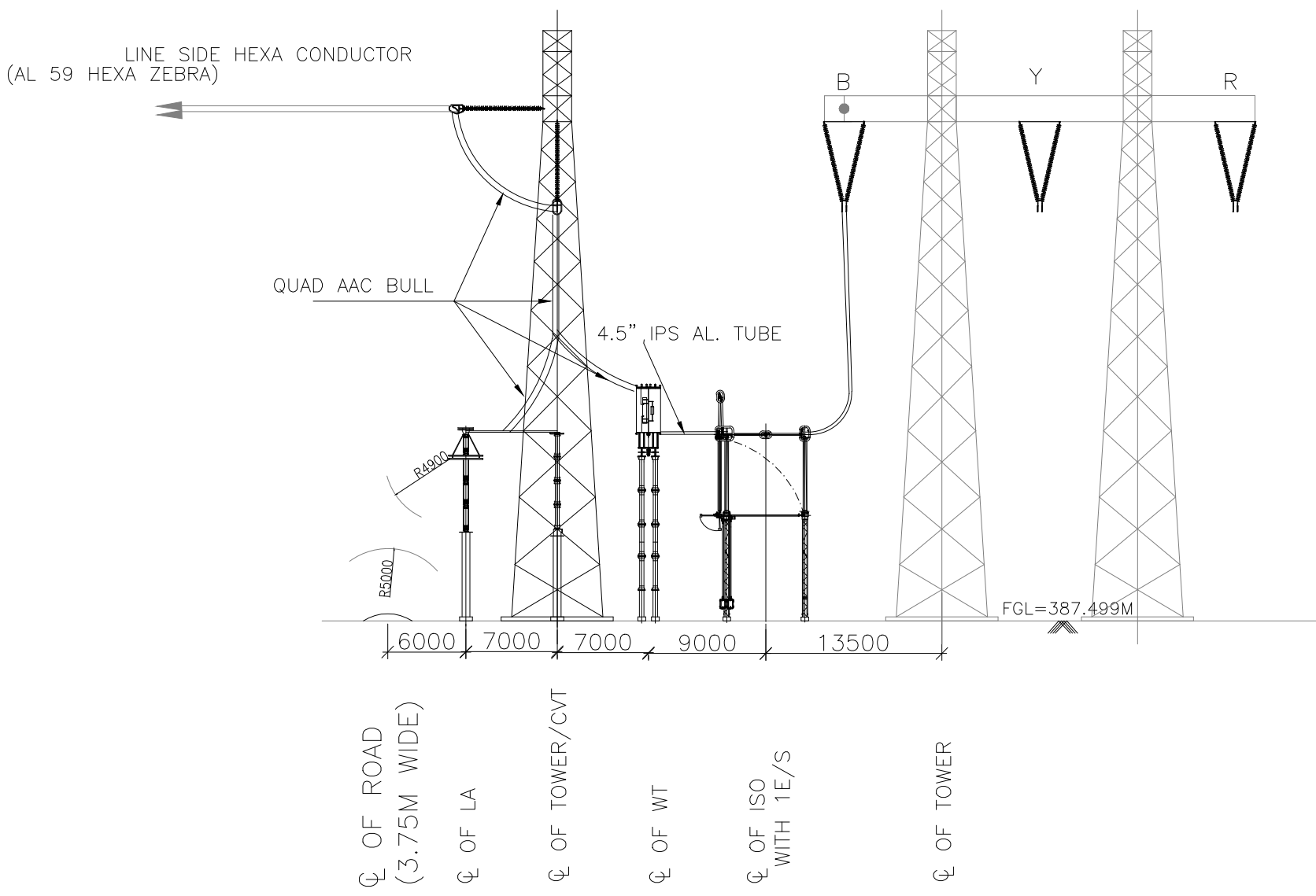
SECTION A-A (765 kV)
KOPPAL II LINE CKT1-TIE-FUTURE



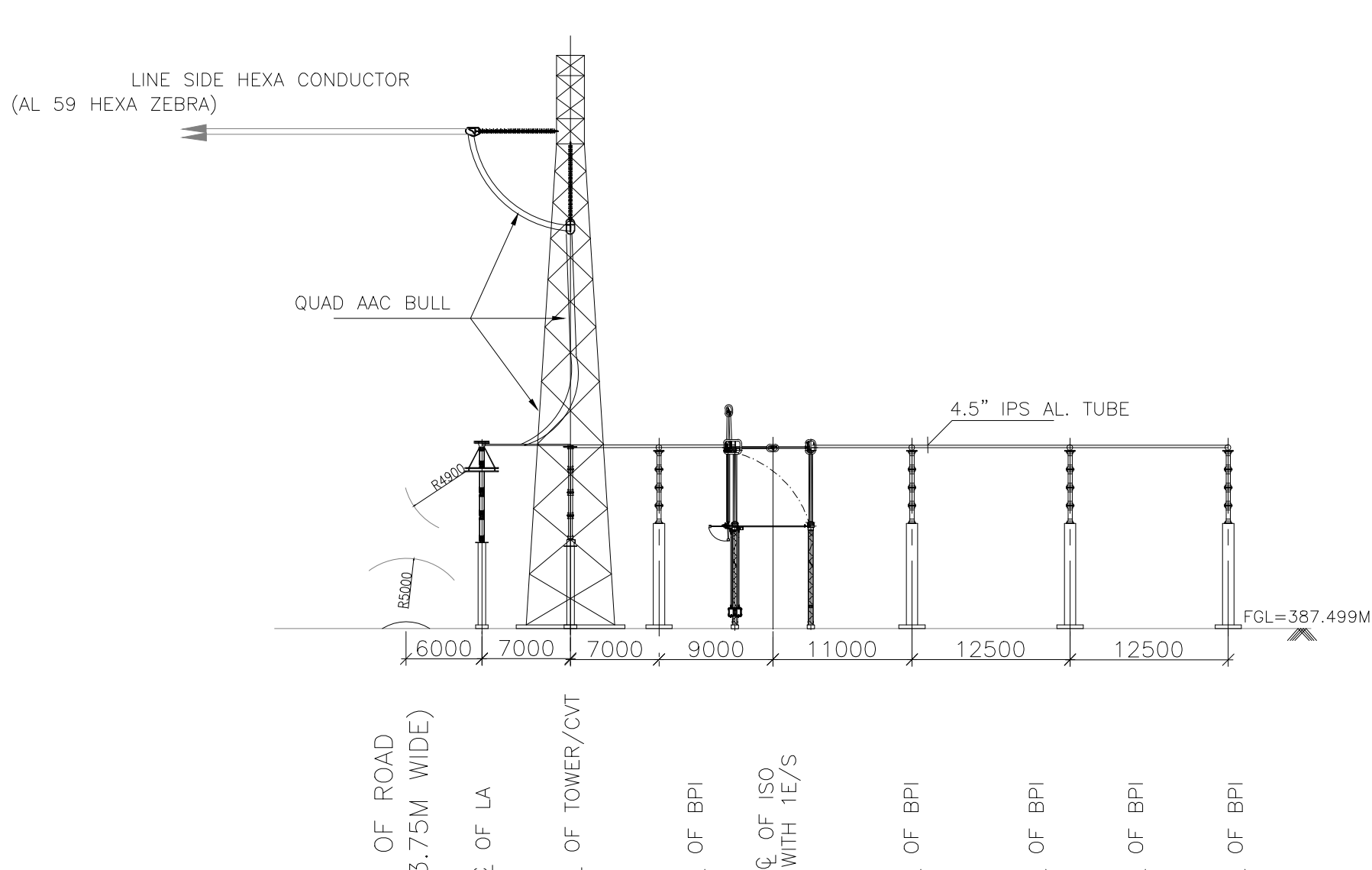
KOPPAL II LINE CKT1(PHASE W/O WT)



SECTION B-B (765 kV)
REACTOR-TIE-KOPPAL II CKT-2



SECTION C-C (765 kV)
KOPPAL II CKT-2 (R PHASE)



SECTION D-D (765 kV)
KOPPAL II CKT-2 (B PHASE)

NOA NO. :		CG/T/W-AIS/DOM/A04/23/04587/NOA-1/24-102662/01 & CG/T/W-AIS/ DOM/A04/23/04587/NOA-2/24-102662/02 DATED : 23.02.2024	
ADDITIONAL INFORMATION W.O.No.		POWERGRID CORPORATION OF INDIA LIMITED SUBSTATION PACKAGE -SS 09T FOR (I) EXTENSION OF 765KV KOPPAL-II S/S AND (II) EXTENSION OF 765KV RAICHUR S/S ASSOCIATED WITH TRANSMISSION SCHEME FOR INTEGRATION OF RENEWABLE ENERGY ZONE (PHASE-II) IN KOPPAL-II (PHASE-B) IN KARNATAKA	
STATUS OF DRAWING		NAME OF CUSTOMER/PROJECT NAME OF CONSULTANT	
DISTRIBUTION OF PRINTS		Bharat Heavy Electricals Limited Bharat Heavy Electricals Ltd. Transmission Business Group	
REV.	DATE	ALTERED CHECKED APPROVED	REVISIONS NO. DATE
ZONE			
DRAWING TITLE		POWERGRID DRAWING NO. TB202362-1002353-SC1113-765KV-ELECT-LAY-PLAN	
RAICHUR S/S-765KV ELECTRICAL LAYOUT PLAN		DRAFTING, K./BHEL DRAWING NO. TB-425-316-202	
		PAGES / SHEET NO. 02 / 02	

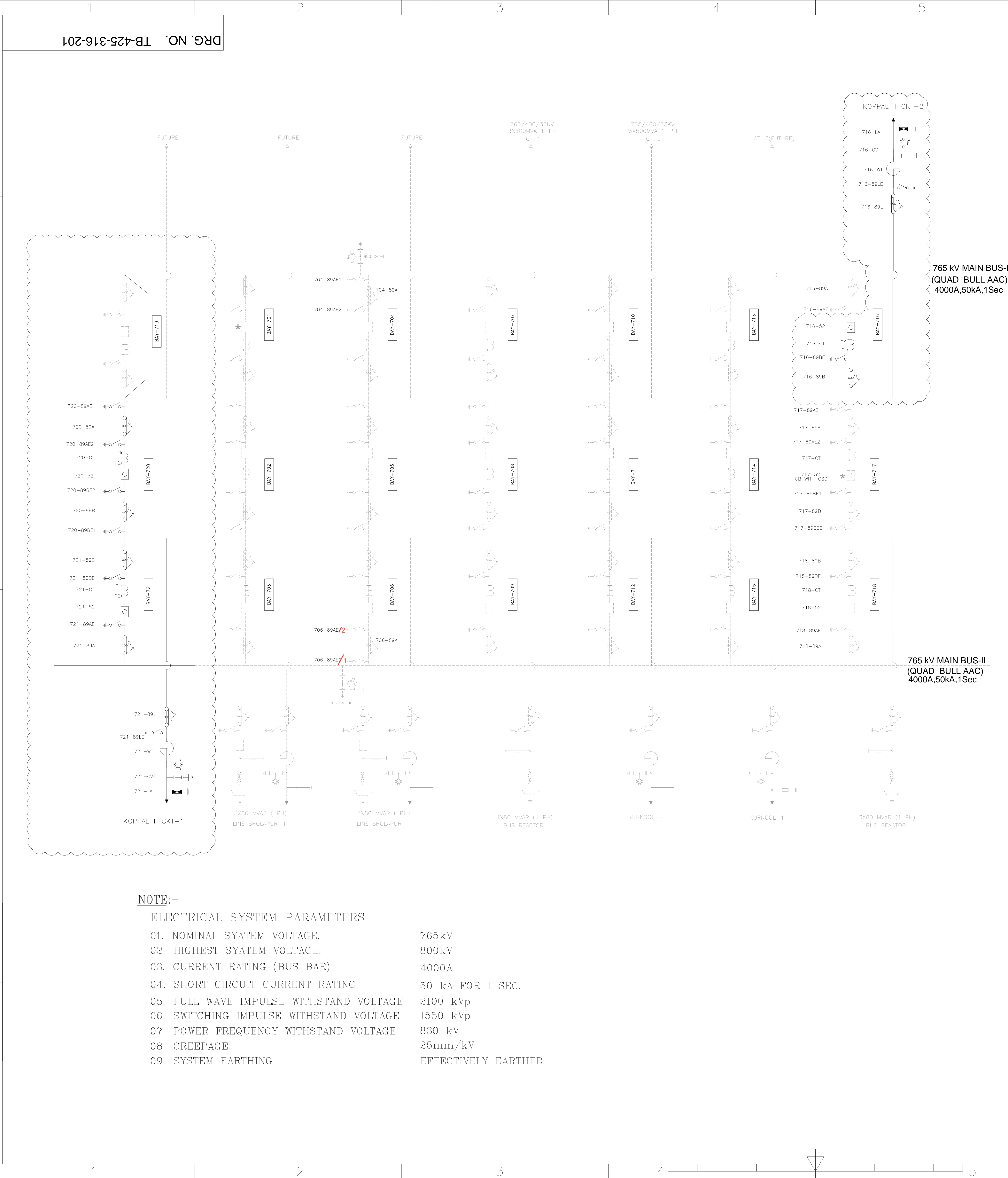
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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO



NOTE:-	
ELECTRICAL SYSTEM PARAMETERS	
01. NOMINAL SYATEM VOLTAGE.	765kV
02. HIGHEST SYATEM VOLTAGE.	800kV
03. CURRENT RATING (BUS BAR)	4000A
04. SHORT CIRCUIT CURRENT RATING	50 ka FOR 1 SEC.
05. FULL WAVE IMPULSE WITHSTAND VOLTAGE	2100 kVp
06. SWITCHING IMPULSE WITHSTAND VOLTAGE	1550 kVp
07. POWER FREQUENCY WITHSTAND VOLTAGE	830 kV
08. CREEPAGE	25mm/kV
09. SYSTEM EARTHING	EFFECTIVELY EARTHED

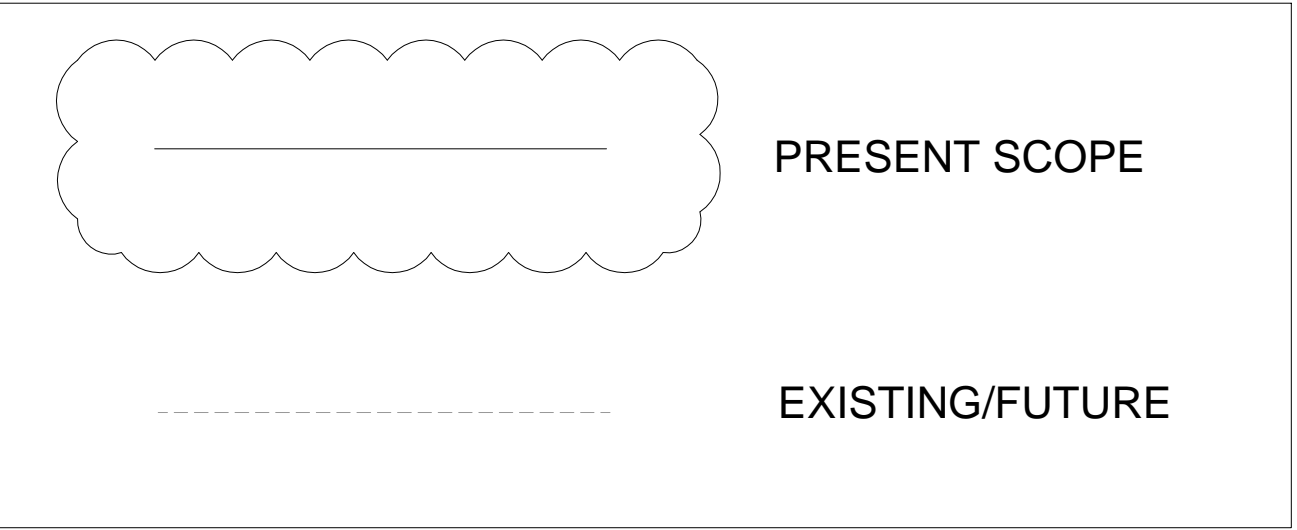
BILL OF QTY. FOR 765kV MAIN EQUIPMENTS:

SL.NO.	DESCRIPTION	RATING	S. C. RATING	QUANTITY	SYMBOL	SCOPE OF SUPPLY	LEGEND
1	SF6 CIRCUIT BREAKER WITH CR,WITHOUT CSD (3-PH)	3150A	50 KA FOR 1 S.	03		BHEL	52
2	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	05		BHEL	89/89E
3	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	02		BHEL	89/89E1 /89E2
4	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING.	3000A	50 KA FOR 1 S.	09		BHEL	CT
5	CVT (1 PH.)	8800pF	NA	06		BHEL	CVT
6	SURGE ARRESTER (1 PH.)	624 kV	NA	06		BHEL	LA
7	WAVE TRAP (1 PH.) PEDESTAL TYPE.	1mH, 3150A	50 KA FOR 1 S.	04		BHEL	WT

765kV LINE CVT DETAILS				
Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(765kV/√3) / 110V/√3	0.5 & 3P	50	Protection
2	(765kV/√3) / 110V/√3	0.5 & 3P	50	Protection
3	(765kV/√3) / 110V/√3	0.2	50	Metering

765kV CT DETAILS (3000A)							
Core No.	Current Ratio	Output Burden at Lowest Tap (VA)	Minimum KPV (V)	Max. Ie(mA) at KPV	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000-2000-500/1A	-	3000-2000-500	20-30-120	15-10-2.5	PX	BUS BAR DIFF PROTECTION
2	3000-2000-500/1A	-	3000-2000-500	20-30-120	15-10-2.5	PX	BUS BAR DIFF PROTECTION
3	3000-2000-500/1A	20VA	-	-	-	0.2s, ISF ₄₀	Metering
4	3000-2000-500/1A	20VA	-	-	-	0.2s, ISF ₄₀	Metering
5	3000-2000-500/1A	-	3000-2000-500	20-30-120	15-10-2.5	PX	LINE PROTECTION
6	3000-2000-500/1A	-	3000-2000-500	20-30-120	15-10-2.5	PX	LINE PROTECTION

LEGENDS:

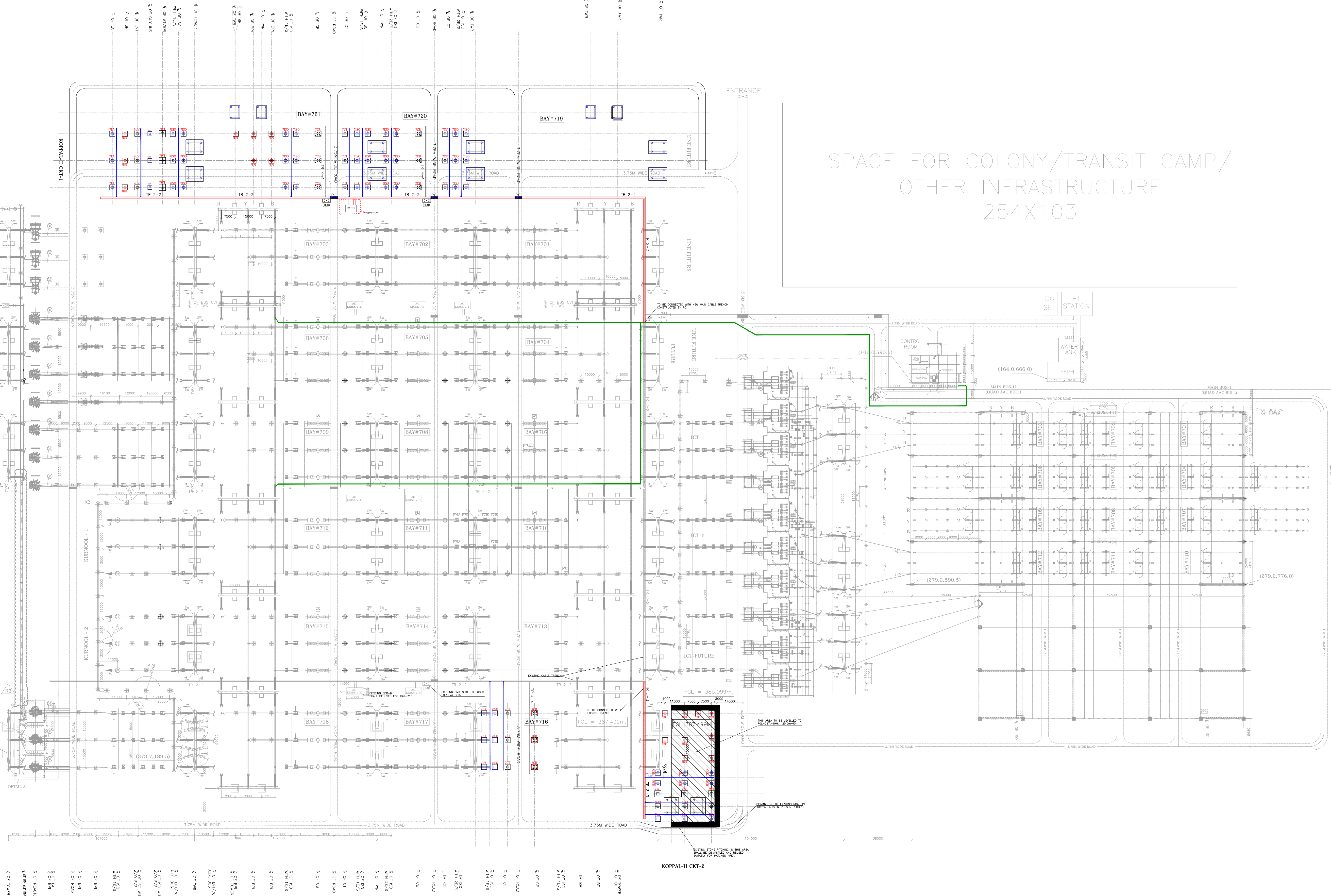


NOA NO. :		CC/TIW-AIS/ DOM/A04/23/04597/NOA-1/24-102662/01 & CC/TIW-AIS/ DOM/A04/23/04597/NOA-2/24-102662/02 DATED : 23.02.2024																	
ADDITIONAL INFORMATION W.O.No.		POWERGRID CORPORATION OF INDIA LIMITED NAME OF CUSTOMER/PROJECT NAME OF CONSULTANT																	
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DISTRIBUTION OF PRINTS		<table><tr><td>क्रमांक/</td><td>नाम / NAME</td><td>हस्तात /SIGN.</td><td>दि./DATE</td></tr><tr><td>ड्राफ्ट</td><td>AS</td><td>-SD-</td><td>19.04.24</td></tr><tr><td>जांचा</td><td>JK</td><td>-SD-</td><td>19.04.24</td></tr><tr><td>स्वीकृत</td><td>VK</td><td>-SD-</td><td>19.04.24</td></tr></table>		क्रमांक/	नाम / NAME	हस्तात /SIGN.	दि./DATE	ड्राफ्ट	AS	-SD-	19.04.24	जांचा	JK	-SD-	19.04.24	स्वीकृत	VK	-SD-	19.04.24
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जांचा	JK	-SD-	19.04.24																
स्वीकृत	VK	-SD-	19.04.24																
REV. 01	DATE 22.04.24	ALTERED CHECKED APPROVED	डिजाइन DEPT. कोड CODE																
ZONE		SLD IS UPDATED AS PER PGCIL COMMENTS DT. 19.04.2024.																	
		राज्य/राज्य RAICHUR S/S-765KV SWITCHYARD SINGLE LINE DIAGRAM																	
		POWERGRID DRAWING NO. TB202362-1002353-SC1113-765KV-SY-SLD																	
		ड्राफ्टिंग.क./BHEL DRAWING NO. TB-425-316-201																	
		पृष्ठ क्र./SHEET No. अगला पृष्ठ/NEXT SHEET																	
		उपलब्ध / SCALE कार्ड कोड CARD CODE																	
		पुनः/REV. 01																	

DRG. NO. TB-425-316-203

BELGAUM

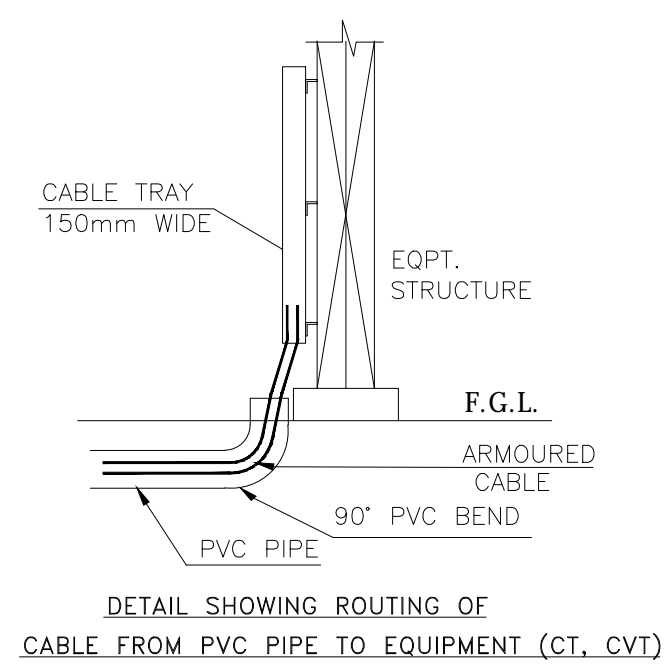
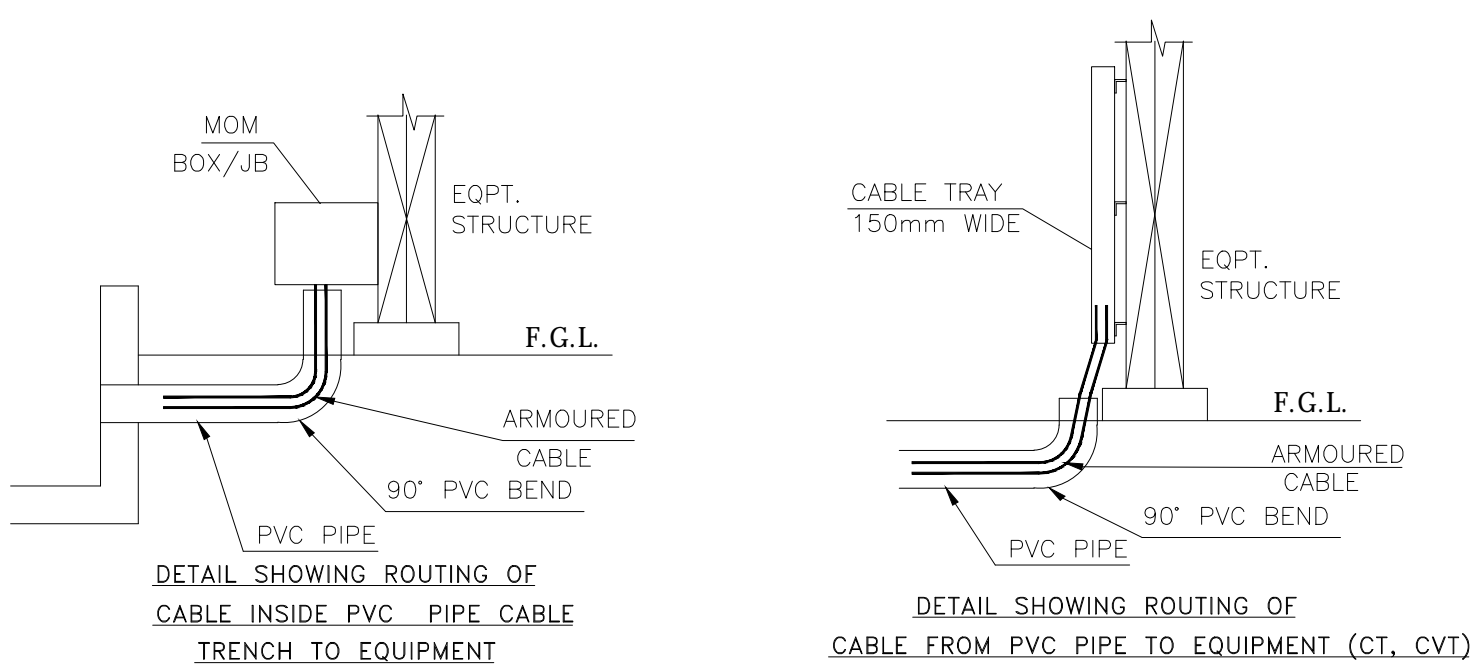
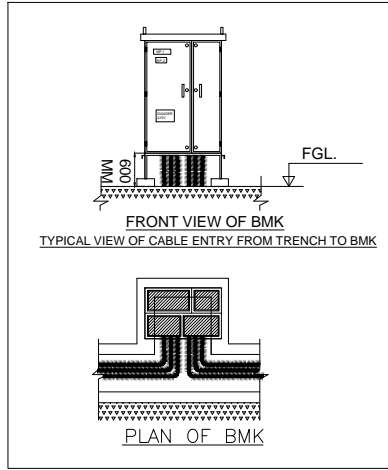
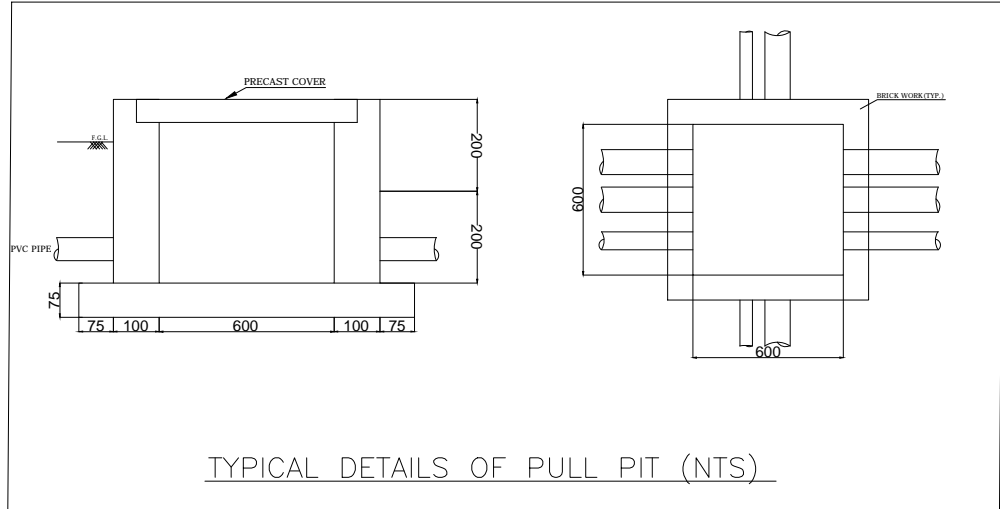
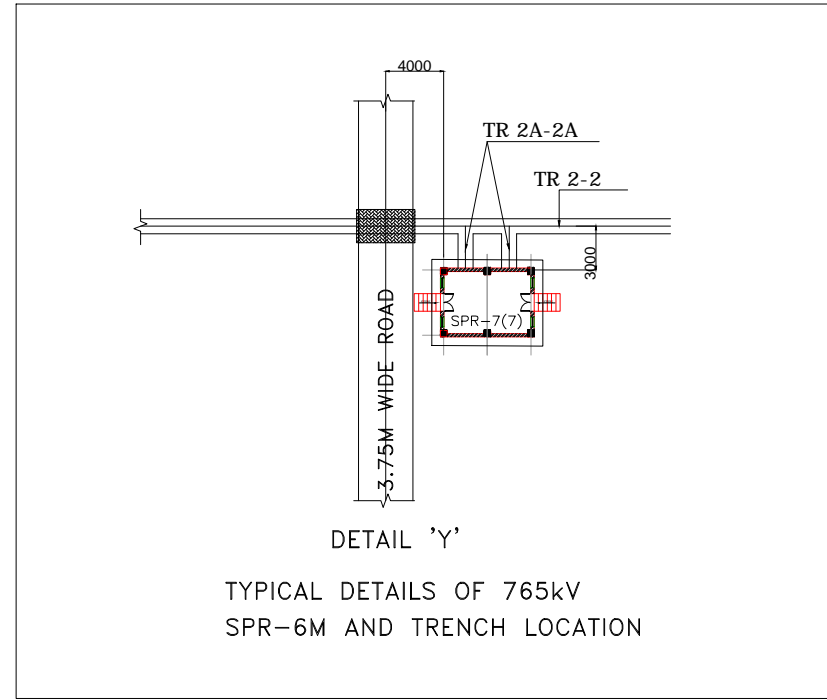
RAICHUR



NOTES:-

1. ALL DIMENSIONS ARE IN MM.
2. REFER DWG NO.-TB202362-1002353-SS1113-I-S/Y-CABLE TRENCH-C/S-DRG: RAICHUR S/S-CABLE TRENCH CROSS SECTION DRG FOR STANDARD SECTION OF CABLE TRENCH.
3. THE LOCATION OF CABLE TRENCHES MARKED IN THIS DWG MAY BE SLIGHTLY MODIFIED TO SUIT SITE CONDITIONS.
4. OPENINGS FOR TAKING OUT PVC PIPES TO EQUIPMENTS SHALL BE PROVIDED IN CABLE TRENCHES OPENING OF SIZE SUITABLE TO DIA. 50/110 PIPE SHALL BE PROVIDED BELOW TOP CABLE SUPPORT.
5. BMB - INDICATES BAY MARSHALLING BOX. BMBs SHALL BE PLACED IN THE LOCATION SHOWN. EXACT COORDINATES TO BE SUITABLY DECIDED AT SITE.
6. CABLES SHALL BE LAID IN MULTILAYER ON CABLE SUPPORT (ANGLES).
7. CABLE SUPPORT SHALL BE PROVIDED AT EVERY 0.75m INTERVAL.
8. INSERTS MUST BE EMBEDDED AT EVERY 0.75m INTERVAL FOR FIXING CABLE SUPPORT.
9. AUXILIARY POWER CABLES SHALL BE LAID IN TOP TIERS AND CONTROL CABLES IN BOTTOM TIERS, AS PER TECHNICAL SPECIFICATION.
10. BURIED CABLES SHALL BE DONE AS PER SPECIFICATION (INSTALLATION OF CABLES).
11. BURIED CABLES FOR LIGHTING PURPOSE SHALL BE AS PER LIGHTING LAYOUT.
12. LOCATION OF CABLE TRENCHES INSIDE CONTROL ROOM/SPP SHALL BE SHOWN SEPARATELY.
13. EARTH CONDUCTOR 80x6 MS FLAT SHALL BE RUN ALONG THE TOP TIER AND TO BE WELDED ON THE CABLE SUPPORT BEFORE INSTALLATION OF CABLES.
14. CABLES CROSSING ROAD/RAIL TRACK SHALL BE LAID IN BOX CULVERT.
15. FOR POWER & CONTROL SEPARATE PIPES SHALL BE USED CONSIDERING 60% VOID FOR EACH PIPE I.E., 40% FILLING CRITERIA. ACCORDINGLY, ADDITIONAL PIPES (IF REQUIRED) WILL BE PROVIDED AS PER SITE CONDITION.
16. PLACEMENT OF SPR/JMK AND ITS CABLE TRENCH IS TENTATIVE. EXACT COORDINATES TO BE SUITABLY DECIDED AT SITE.
17. - INDICATES CABLES LAID IN PVC PIPES OF 50/110mm OUTER DIA AT DEPTH OF 300mm (MAX.) CABLE FROM EQUIPMENT TO CABLE TRENCH SHALL RUN IN PVC PIPES.
18. MARKED THUS () INDICATES CABLE ENTRY/EXIT FROM EQUIPMENT.
19. ALL OTHER DETAILS PERTAINING TO CIVIL WORKS SHALL BE REFLECTED IN THE RESPECTIVE CIVIL DRAWINGS.
20. PVC PIPES SHALL BE SECURELY FIXED AT BOTH ENDS, EITHER EMBEDDED IN CONCRETE OR PROPERLY CLAMPED.
21. AFTER LAYING THE CABLES THE ENDS OF PIPES SHALL BE FULLY SEALED TO PREVENT INGRESS OF WATER INSIDE THE PIPE. SEPARATE DRG FOR SEALING ARRANGEMENT SHALL BE SUBMITTED.
22. CONTROL CABLES & POWER CABLES MUST BE LAID IN SEPARATE PVC PIPES.
23. CABLE TRENCH SHALL BE PROVIDED ON MARSHALLING BOX SIDE OF EQUIPMENT.
24. THE PURPOSE OF TRENCH LAYOUT DRAWING IS FOR USE AS FOLLOWS:- TO BE USED AS CIVIL INPUT FOR CABLE TRENCHES, - FOR ERECTION OF CABLE RACKS AT SITE, - FOR CABLE LAYING AND ROUTING AT SITE.
25. CABLE RACK AND SUPPORT SHALL BE PAINTED AFTER INSTALLATION WITH 2 COATS OF METAL PRIMER (COMPRISING OF RED OXIDE & ZINC CHROMATE IN A SYNTHETIC MEDIUM) FOLLOWED BY TWO FINISHING COAT OF ALUMINIUM PAINT.
26. SUITABLE PULL OUT BOX SHALL BE PROVIDED IF REQUIRED WHERE CABLE SHALL BE LAID IN PVC PIPE.
27. LONGITUDINAL SLOPE IN CABLE TRENCH SHALL BE TYPICALLY 1:500.
28. - INDICATE PIPE CULVERT.
29. CABLE ASSEMBLIES FOR CABLE TRENCHES SHALL BE PROVIDED ON THE FACE OF TRENCH WALL MARKED THUS.
30. FOR ALL CIVIL WORKS EXECUTION POWER GRID APPROVED/RELEASED DRGS SHALL BE FOLLOWED.
31. BURIED CABLE TRENCH.
32. PERFORATED TYPE CABLE TRAY SHALL BE USED FOR VERTICAL RUN OF CABLES ALONG THE SUPPORT STRUCTURE FROM EQUIPMENT JB/ TERMINALS. THIS SHALL BE SHOWN SEPARATELY (PICTORIAL VIEW).
33. PROVISION FOR CONNECTING EARTH FLAT TO EXTERNAL EARTH GRID AT AN INTERVAL OF 30 METRE SHALL BE PROVIDED.
34. ALL CABLE FROM BAY CABLE TRENCH TO EQUIPMENT (EXCLUDING 765KV CIRCUIT BREAKER) AND ALL INTERPOLAR CABLES (BOTH POWER & CONTROL) FOR ALL EQUIPMENT SHALL BE LAID IN PVC PIPE.
35. VERTICAL RUN OF CABLES ON EQUIPMENT SUPPORT STRUCTURE SHALL BE SUPPORTED ON PERFORATED CABLE TRAYS OF SUITABLE WIDTH WHICH SHALL BE SUITABLY BOLTED/CLAMPED WITH THE EQUIPMENT SUPPORT STRUCTURE.
36. ALL CABLE ENTRY POINT SHALL BE SEALED.
37. CABLE TRENCH/PVC CONDUIT NEAR ISOLATOR WILL BE ROUTED SUCH THAT LOCATION OF AUX. EARTH MAT FALLS UNDER OPERATING BOX.
38. NECESSARY OPENING SHALL BE PROVIDED IN CABLE TRENCH FOR PVC PIPES AT APPROPRIATE LOCATION.
39. INVERT LEVELS FOR CABLE TRENCH UNDER PRESENT SCOPE SHALL BE MARKED IN CIVIL DWG.
40. PULL PITS SHALL BE PROVIDED FOR 765KV EQUIPMENT CABLES BETWEEN MAIN TRENCH TO EQUIPMENT IF CABLE ROUTED THROUGH PIPE.

PVC PIPES : CLASS IV (AS PER IS:4985)				
FOR 765KV EQUIPMENTS				
S.NO	FROM	TO	FOR POWER CABLES	FOR CONTROL CABLES
1.	TRENCH	JB (CVT/CT)	50MM OD/10MM OD	50MM OD/10MM OD
2.	JB (CVT/CT)	EACH POLE OF CVT / CT	-	-
3.	TRENCH	LCC OF 400KV CB	1	2
4.	TRENCH	765KV ISO/ES MOM "Y"	1	1
5.	765KV ISO/ES MOM "Y"	765KV ISO/ES MOM "R"	1	1
6.	765KV ISO/ES MOM "Y"	765KV ISO/ES MOM "B"	1	1
7.	765KV ISO/ES MOM "R"	765KV ISO/ES MOM "B"	-	-
8.	TRENCH	SA	1	1




LEGEND:

NEW MAIN CABLE TRENCH UNDER CONSTRUCTION BY POWERGRID

REF DRAWINGS:-

1. PGCL DWG NO.-TB202362-1002353-SS1113-I-S/Y-CABLE TRENCH-C/S-DRG: RAICHUR S/S-CABLE TRENCH CROSS SECTION DRG.
2. BHEL DWG NO.-TB-425-316-202: RAICHUR S/S-765KV ELECTRICAL LAYOUT PLAN.

NOA NO. :		CC/TW-AIS/DOM/A04/23/04597/NOA-1/24-102662/01 & CC/TW-AIS/ DOM/A04/23/04597/NOA-2/24-102662/02 DATED : 23.02.2024		POWERGRID CORPORATION OF INDIA LIMITED	
ADDITIONAL INFORMATION W.O.No.		NAME OF CUSTOMER/PROJECT NAME OF CONSULTANT		SUBSTATION PACKAGE -SS 09T FOR (I) EXTENSION OF 765KV KOPPAL-II S/S AND (II) EXTENSION OF 765KV RAICHUR S/S ASSOCIATED WITH TRANSMISSION SCHEME FOR INTEGRATION OF RENEWABLE ENERGY ZONE (PHASE-II) IN KOPPAL-II (PHASE-B) IN KARNATAKA	
STATUS OF DRAWING					
DISTRIBUTION OF PRINTS					
		<div><div><div>ಶಿಲ್ಪದ ನಕ್ಷೆ</div><div></div></div><div>ಭಾರತ ಹೆವಿ ಇಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್ ಕುಳುವಿಷಾಣ ಪರ್ಯಾಯಾಣ ವಿಭಾಗ BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP</div></div>		<div><div><div>ಕಡತದ DRAWN</div><div>AS</div></div><div><div>ತಯಾರಿಸಿದ CHECKED</div><div>JK</div></div><div><div>ಪರಿಶೀಲಿಸಿದ APPROVED</div><div>JK</div></div></div> <div><div>ಹೆಸರು /NAME</div><div>ಹಂಸರು /SIGNED</div><div>ದಿನ./DATE</div></div> <div><div>30.09.24</div><div>30.09.24</div><div>30.09.24</div></div>	
REV. 01	DATE 19.11.24	ALTERED CHECKED APPROVED	ಪರಿಶೀಲಿಸಿದ DEPT.	ತುಲನಾ / SCALE	ಕಾರ್ಡ್ ಕೋಡ್ CARD CODE
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RAICHUR S/S- CABLE TRENCH LAYOUT				TB-425-316-203	
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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 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.

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.

ACCEOTANBCE 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.

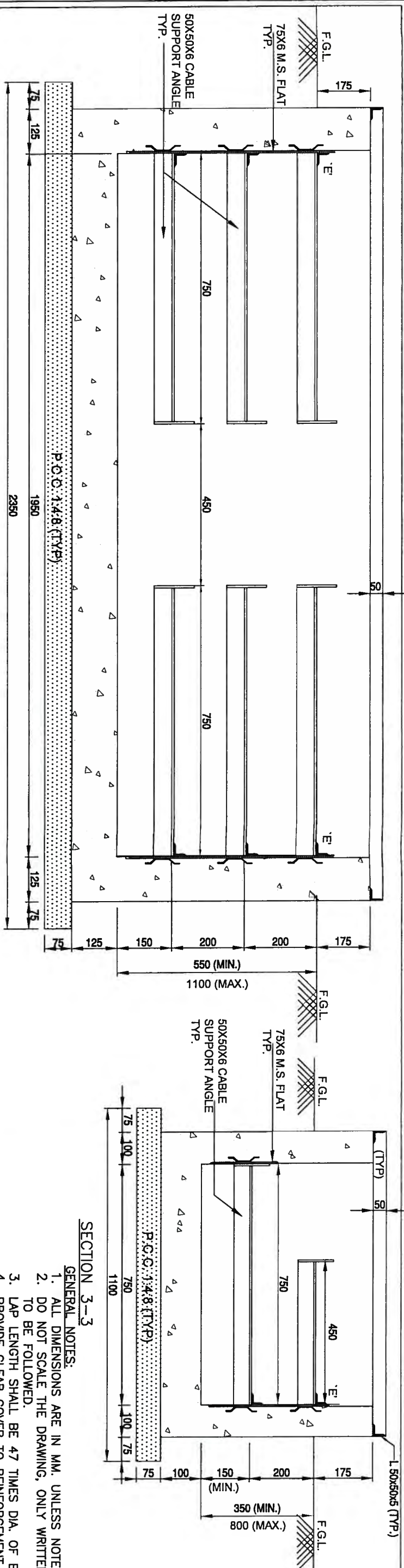
4. Excess penetration shall be permitted provided it does not exceed 25% of the wall thickness or 4 mm whichever is smaller.
5. Weld reinforcement: Build up in excess of 25% of the effective throat thickness shall be dressed. Any reinforcement shall be substantially symmetrical about the center line 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% 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.
 - c) Where pore sizes are generally 0.8 mm dia or less, but occasional 1.6 mm dia/pores are present, up to 9 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:

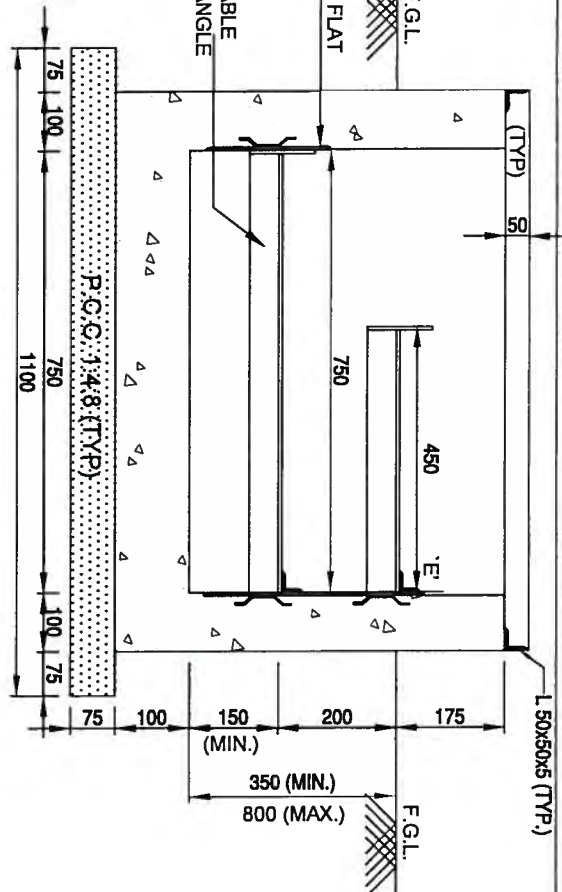
- i. In all cases, t thickness of the thinnest section of the weld under examination.
- ii. Unacceptable weld defects shall be repaired in accordance with the original welding procedure. All repairs shall be 100% inspected in accordance with original testing procedure.

TECHNICAL SPECIFICATION
FOR INSULATING MAT

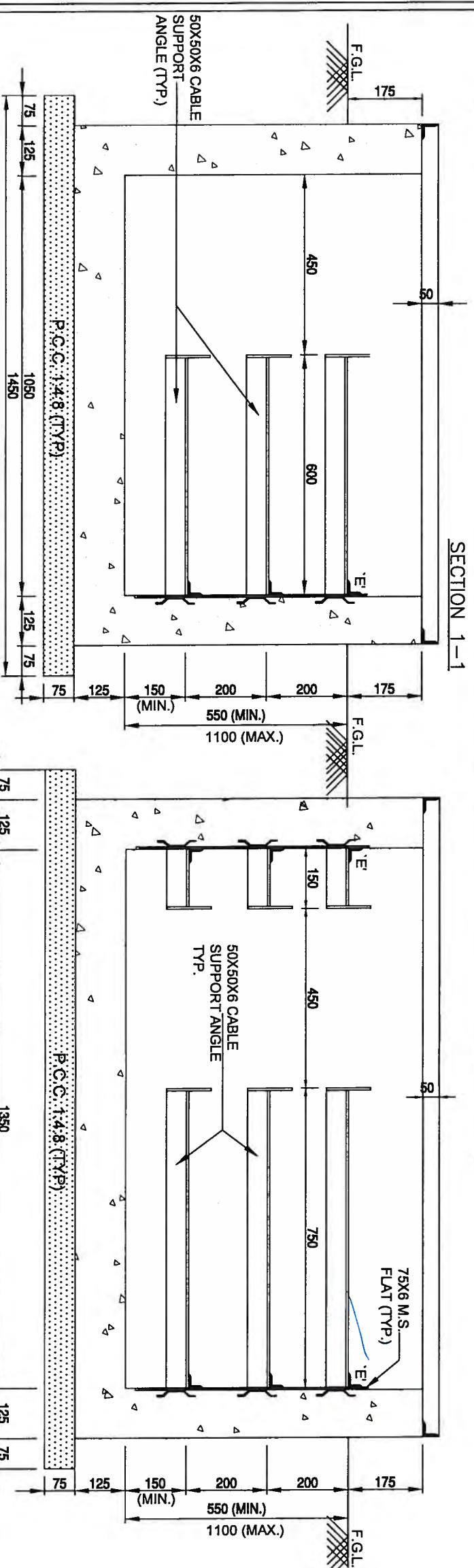
- 9.11 **Insulating mats**
- 9.11.1 The scope covers supply and laying of insulating mats of “class A” conforming to IS: 15652-2006.
- 9.11.2 These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control **& relay** panels located in control room building/**Switchyard panel room**.
- 9.11.3 The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature.
- 9.11.4 Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat.
- 9.11.5 Insulating mat **(wherever applicable)** shall be of pastable type, to be fixed permanently on the front and rear side of the panels except for the chequered plate area which shall not be pasted **as per requirement**. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652.
- 9.11.6 Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements.
- 9.11.7 The insulating mats offered shall conform to IS: 15652-2006.



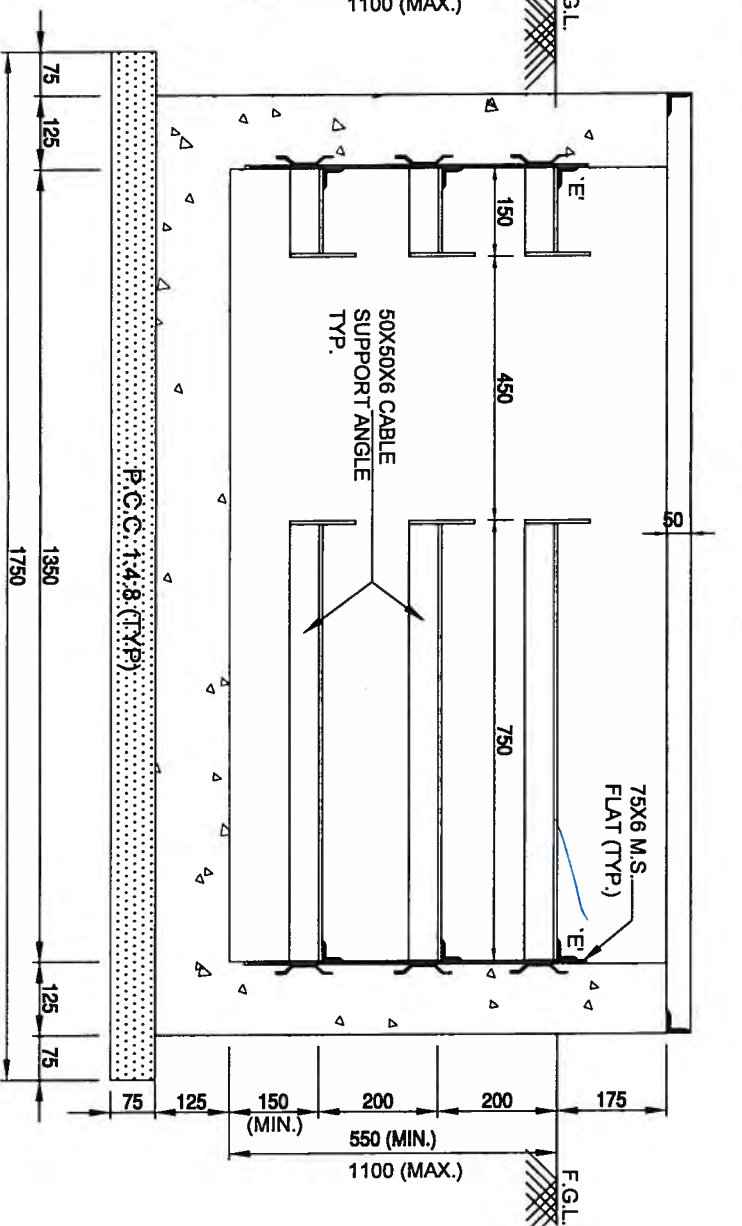
SECTION 3-3



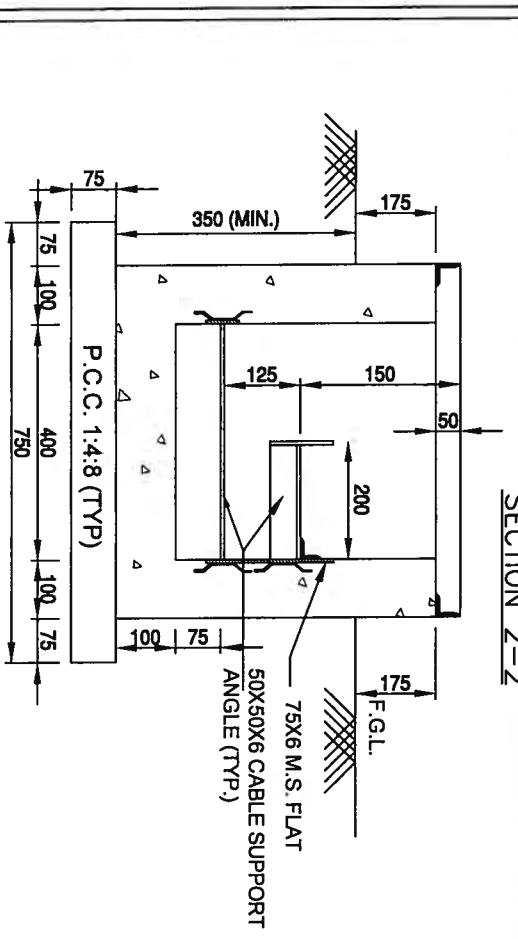
SECTION 1-1



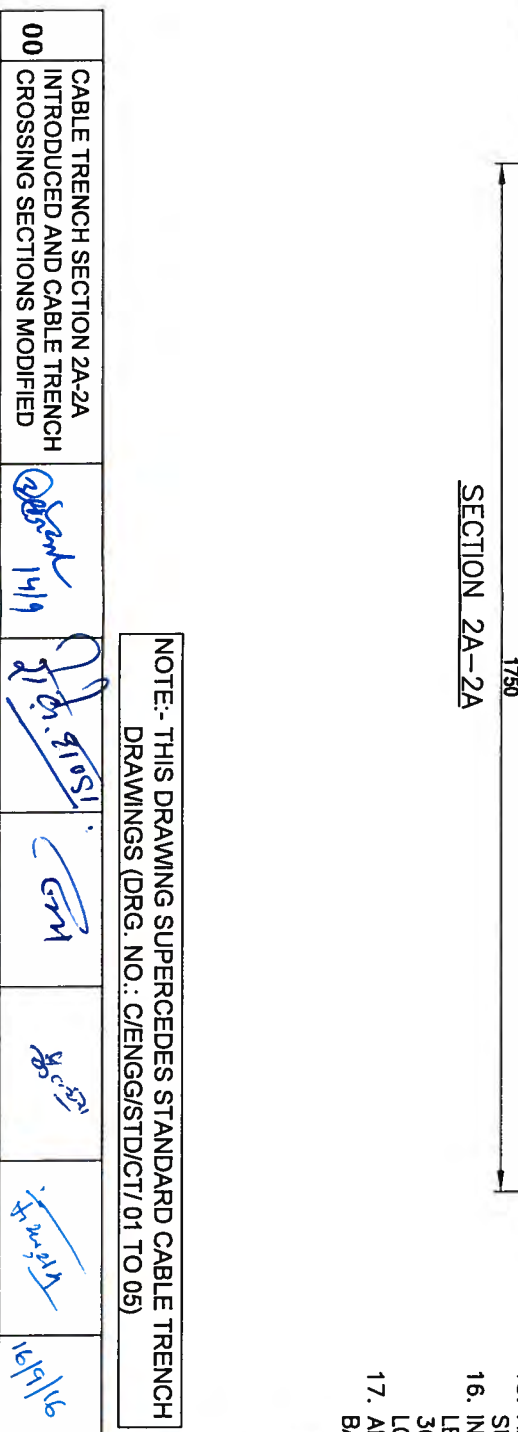
SECTION 2-2



SECTION 2A-2A



SECTION 4-4



NOTE:- THIS DRAWING SUPERCEDES STANDARD CABLE TRENCH DRAWINGS (DRG. NO.: C/ENGG/STD/CT/01 TO 05)

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE.
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED.
3. LAP LENGTH SHALL BE 47 TIMES DIA. OF BAR.
4. PROVIDE CLEAR COVER TO REINFORCEMENT AS UNDER.
5. 25MM FOR INNER SIDE OF CABLE TRENCH.
6. 50MM FOR OUTER SIDE AND BOTTOM OF CABLE TRENCH.
7. ALL R.C.C. SHALL BE AS PER BPS ITEMS UNLESS NOTED OTHERWISE.
8. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
9. NECESSARY OPENINGS SHALL BE PROVIDED AT APPROPRIATE LOCATIONS TO TAKE OUT CABLES.
10. FOR ACTUAL DEPTH OF TRENCHES REFER APPROVED CABLE TRENCH LAYOUT.
11. F.G.L. DENOTES FINISHED GROUND LEVEL.
12. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
13. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE. EARTHING CONDUCTOR 'E' SHALL BE PROVIDED ON THE TOP TIER OF EACH CABLE TRENCH SECTION.
14. ALL STEEL STRUCTURES PLATES SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT TO AN EVEN SHADE TWO OR MORE COATS OVER A COAT OF SUITABLE STEEL PRIMER BEFORE INSTALLATION OF CABLES AND EARTHING CONDUCTOR SHALL BE PAINTED RED.
15. CONSTRUCTION JOINT SHALL BE PROVIDED AT 30M OR AS PER SITE REQUIREMENT BUT NOT EXCEEDING 30M.
16. ALL SUPPORT ANGLES SHALL BE 50x50x6 ANCHORING FLAT (75x6) SHALL BE PROVIDED AT EACH SUPPORT ANGLE POINT.
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL, IT SHALL BE REMOVED TO A MINIMUM DEPTH OF 300 MM AND SHALL BE REPLACED BY WELL COMPACTED LOCALLY AVAILABLE C.N.S. MATERIAL OR LOCAL SAND.
18. ALL REINFORCEMENT STEEL BARS SHALL BE TMT OR HYSD BARS CONFORM TO IS:1786-1985 OF GRADE Fe500

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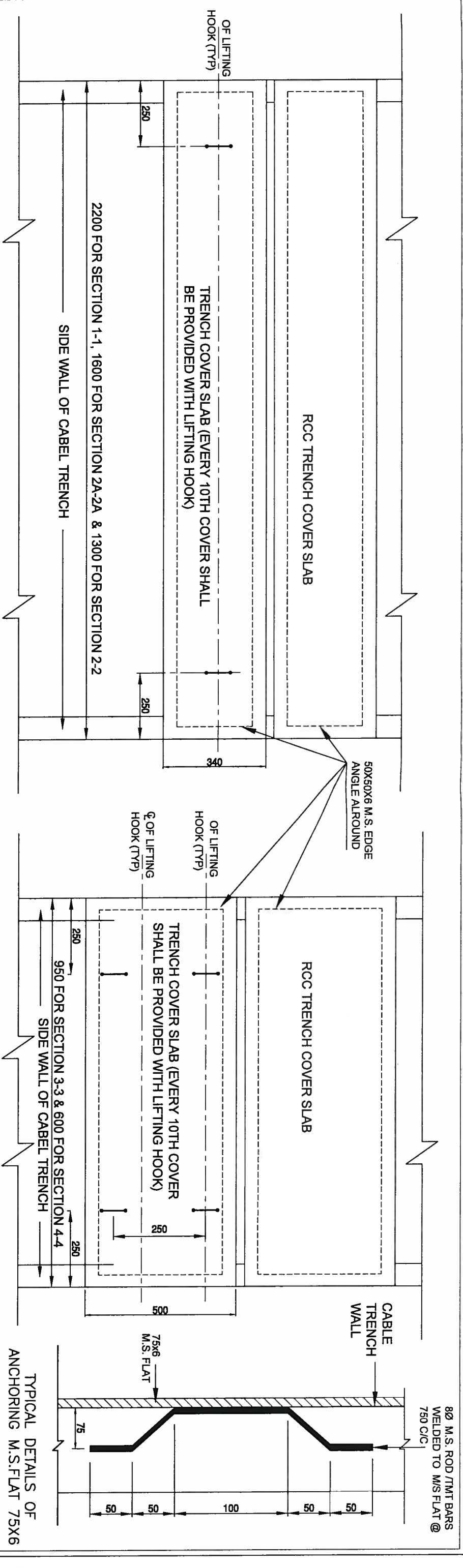
PROJECT :
STANDARD CABLE TRENCH FOR SUBSTATION
SWITCH YARD

TITLE :
DETAILS OF CABLE TRENCHES AND CABLE
TRENCH ROAD CROSSING

DRG. NO.: C/ENGG/STD/2016/RCT/01 (Sheet 01 of 04)

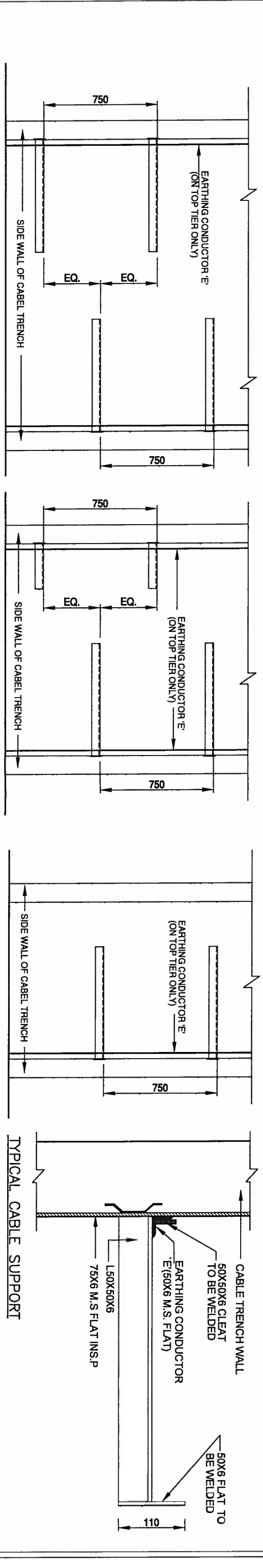
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SCALE: NTS



RCC COVER PLAN FOR SECTION (1-1), (2-2) & (2A-2A)

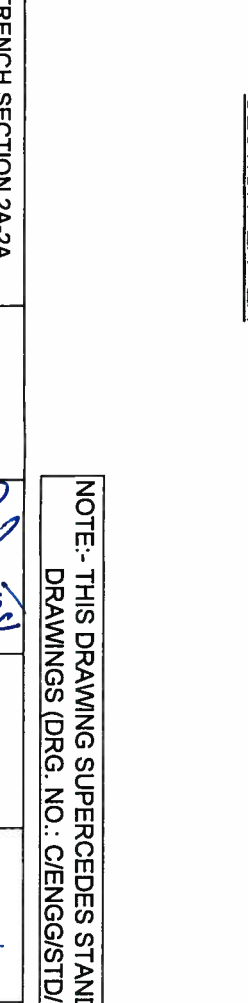
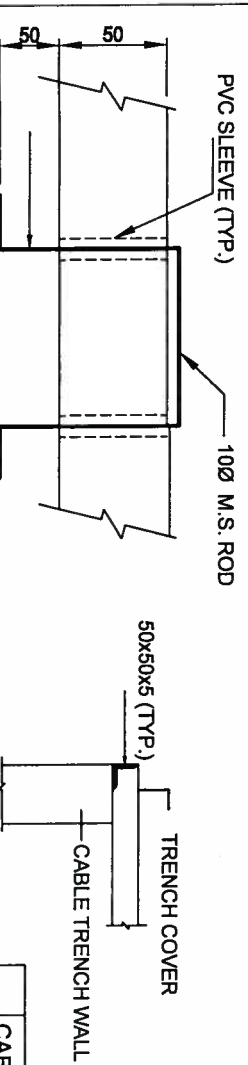
DETAIL OF TRENCH COVER SLAB FOR SECTION (3-3) & (4-4)



CABLE TRAY SUPPORT FOR SECTION 1-1

CABLE TRAY SUPPORT FOR SECTION 2A-2A

CABLE TRAY SUPPORT FOR SECTION 2-2 & 3-3



NOTE:- THIS DRAWING SUPERCEDES STANDARD CABLE TRENCH DRAWINGS (DRG. NO.: C/ENG/STD/CT/01 TO 05)

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POWER GRID CORPORATION OF INDIA LIMITED
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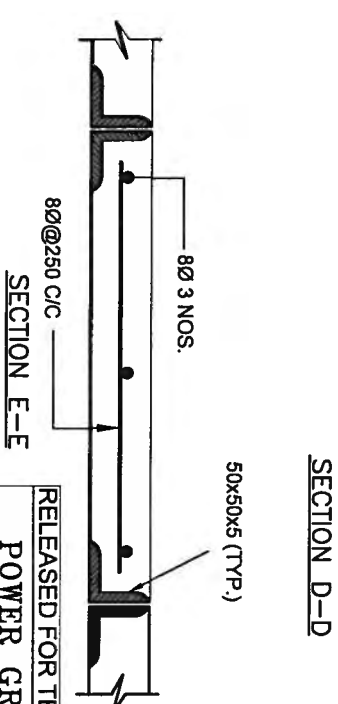
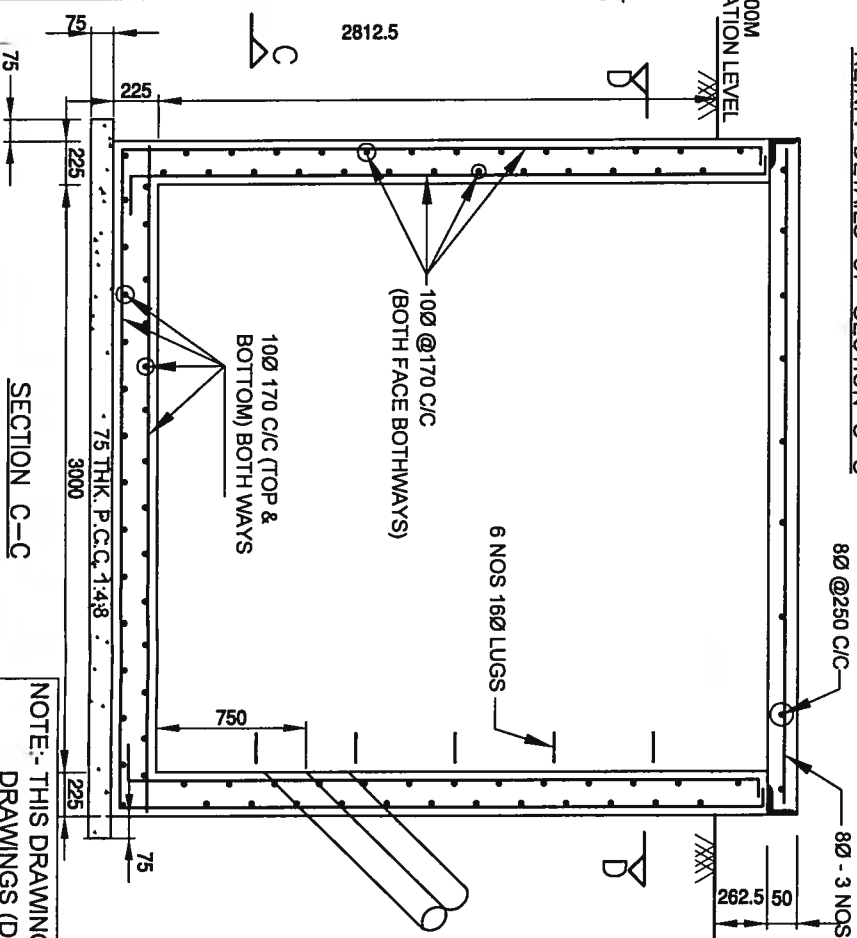
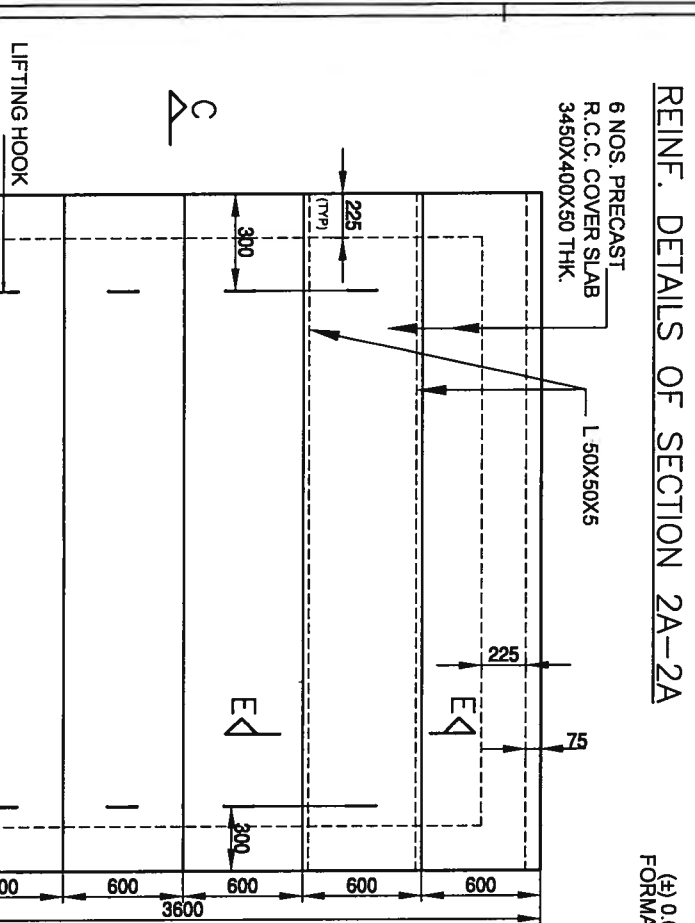
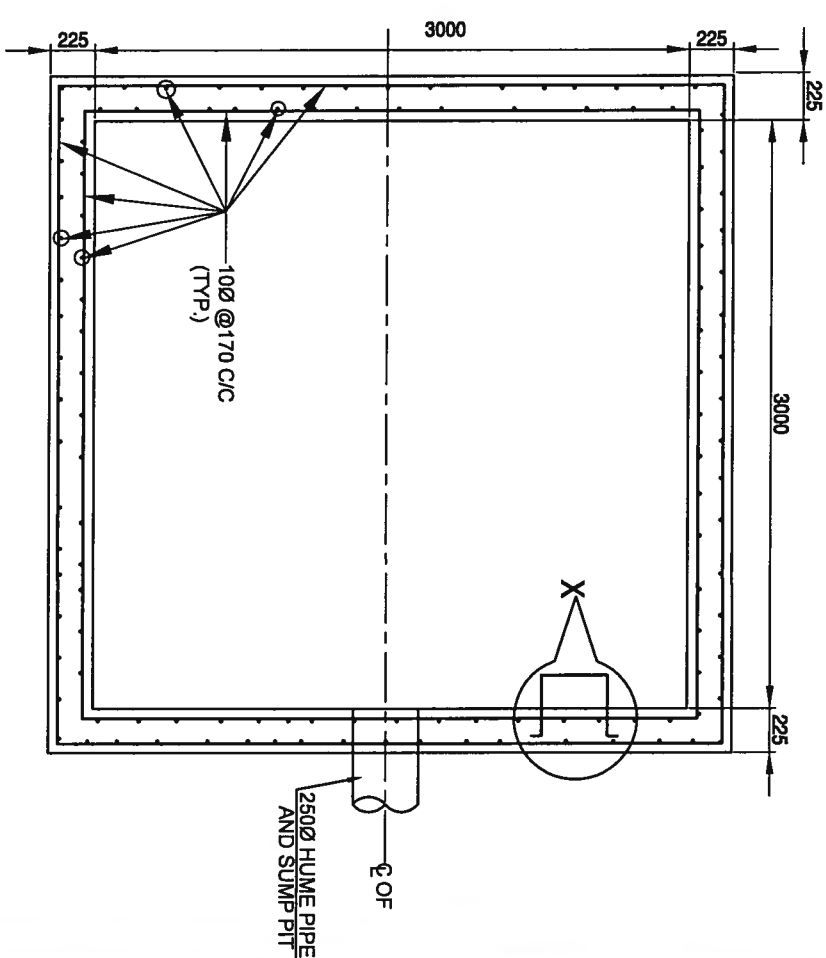
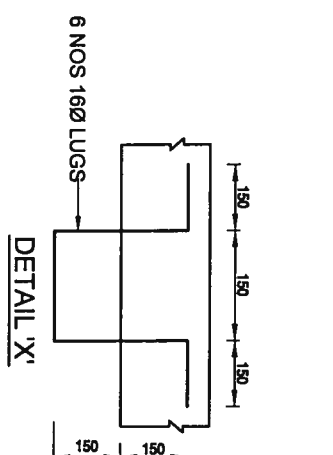
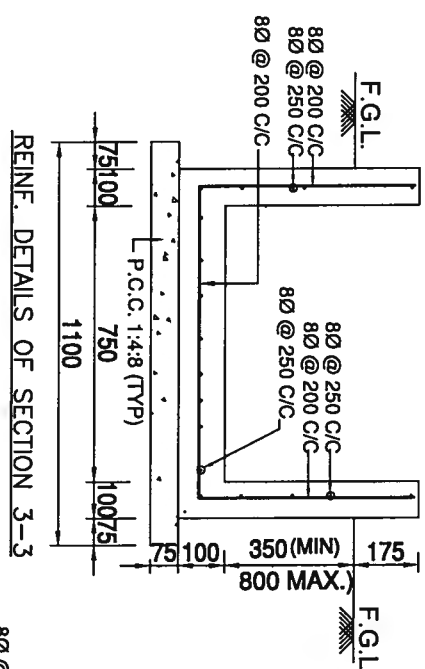
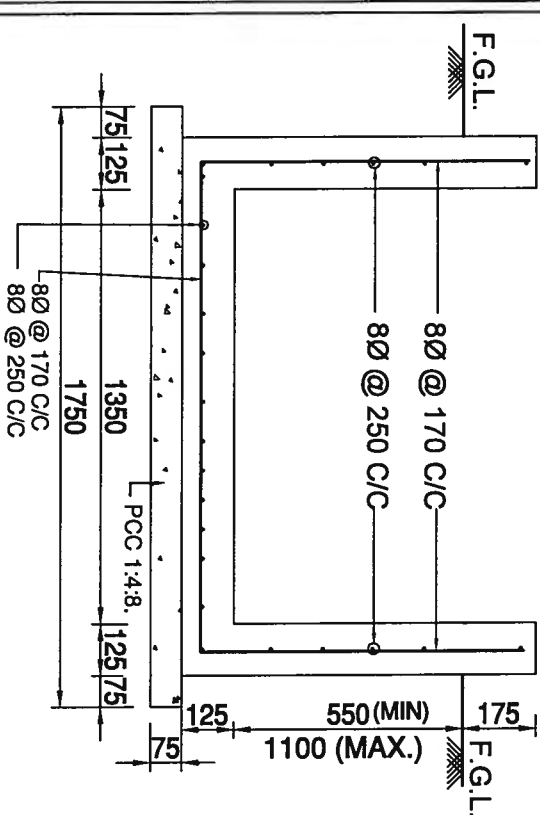
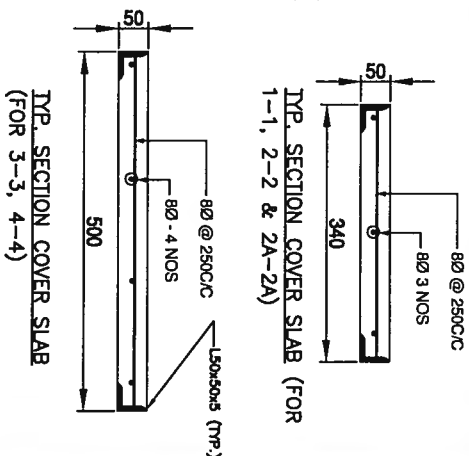
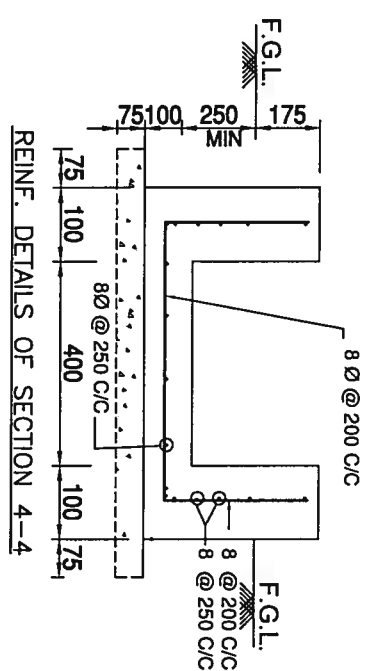
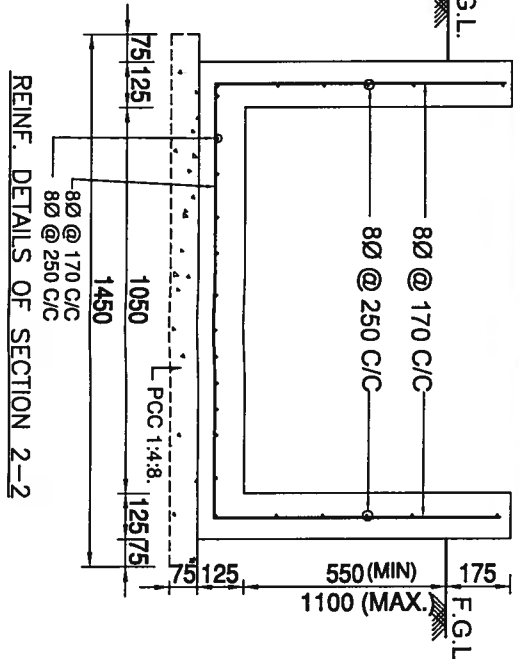
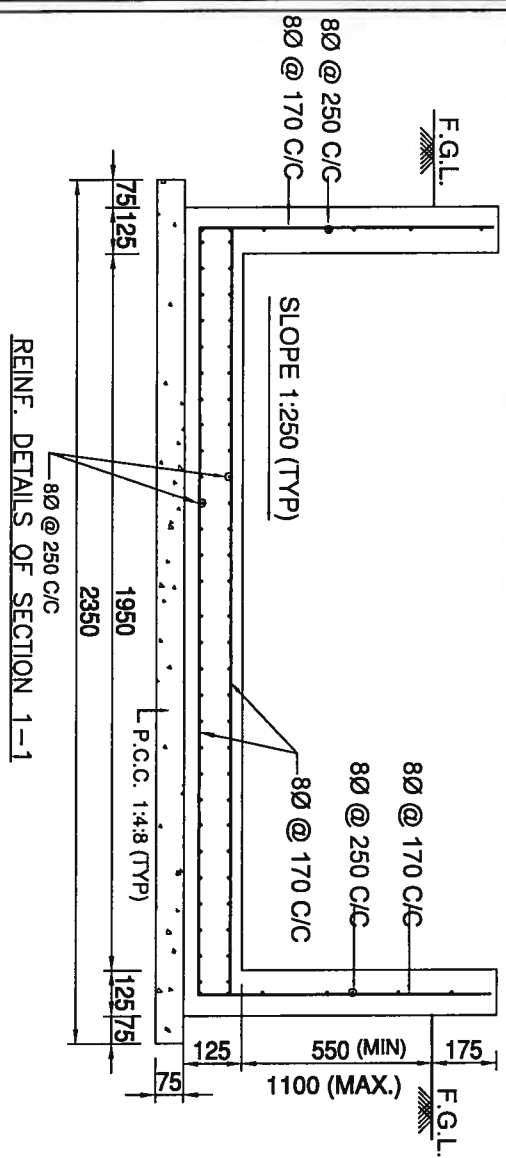
PROJECT :
STANDARD CABLE TRENCH FOR SUBSTATION SWITCH YARD

TITLE :
DETAILS OF CABLE TRENCHES AND CABLE TRENCH ROAD CROSSING

DRG. NO.: C/ENG/STD/2016/RCT/01 (Sheet 02 of 04)

SCALE: NTS

REV	DESCRIPTION	CDE (ENGG-CIVIL)	AGM (ENGG-CIVIL)	AGM (ENGG-S/S)	GM (ENGG-S/S)	APVD. BY GM (ENGG-CIVIL)	DATE	DRG. NO.	SCALE
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REV	DESCRIPTION	CDE (ENGG-CIVIL)	AGM (ENGG-CIVIL)	AGM (ENGG-S/S)	GM (ENGG-S/S)	APVD. BY GM (ENGG-CIVIL)	DATE
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NOTE:- THIS DRAWING SUPERCEDES STANDARD CABLE TRENCH DRAWINGS (DRG. NO.: C/ENG/STD/CT/01 TO 05)

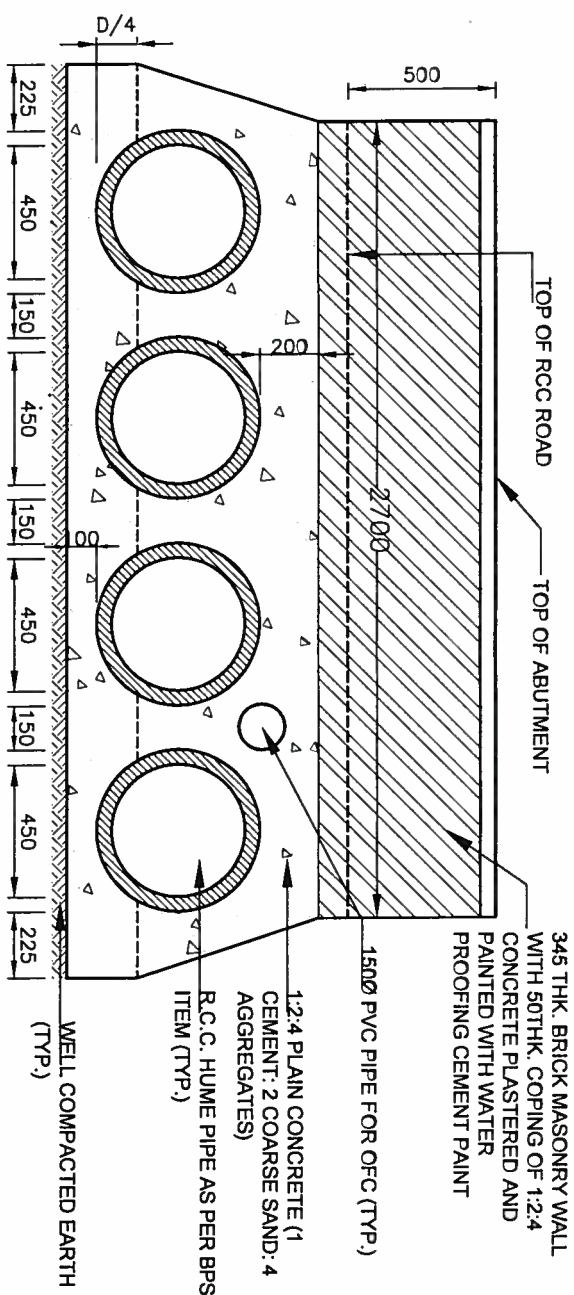
PROJECT : STANDARD CABLE TRENCH FOR SUBSTATION SWITCH YARD

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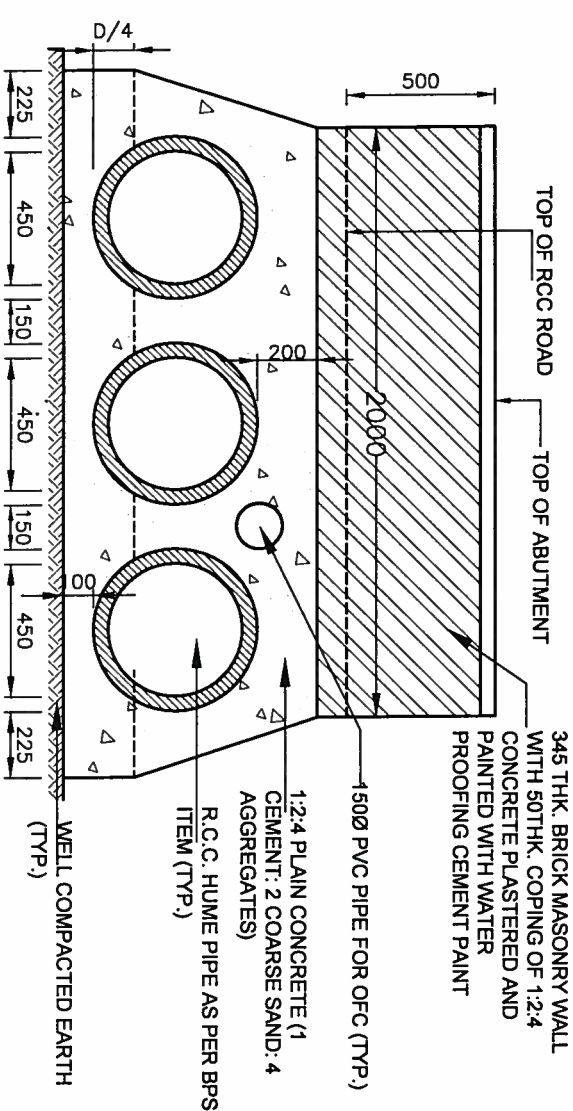


TITLE: DETAILS OF CABLE TRENCHES AND CABLE TRENCH ROAD CROSSING

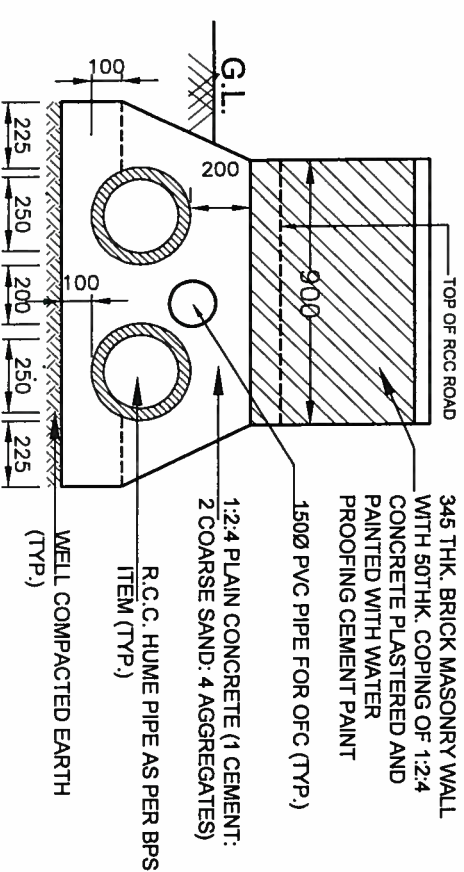
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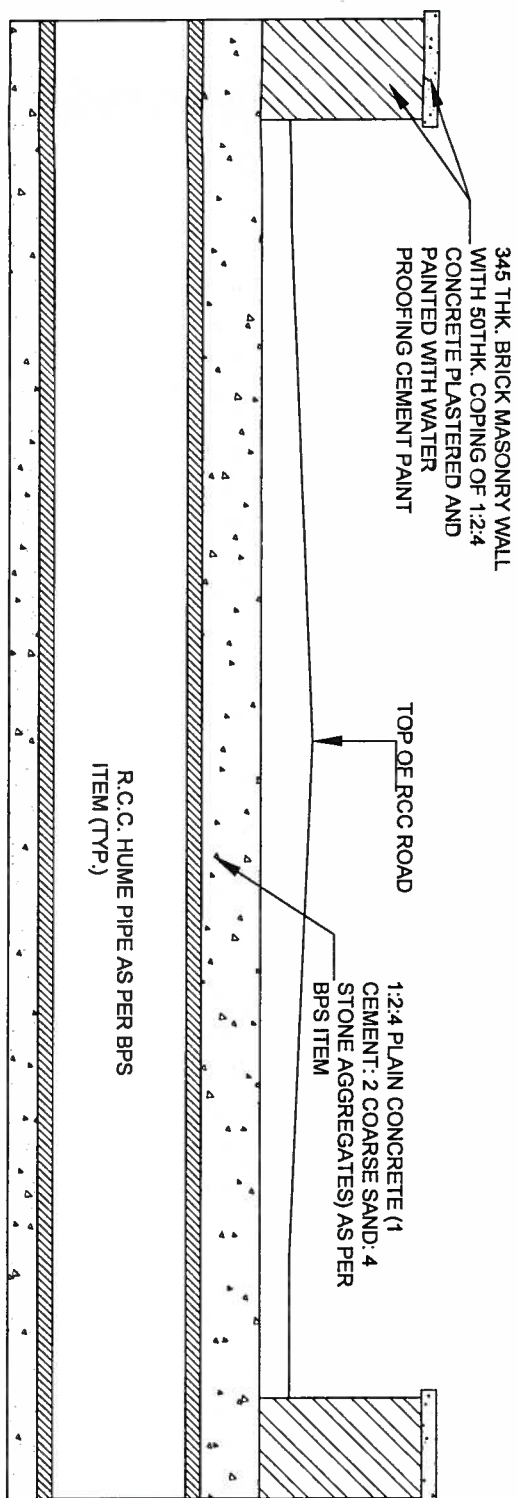
ROAD CROSSING SECTION FOR CABLE TRENCH FOR "SEC-1-1 & 2A-2A"



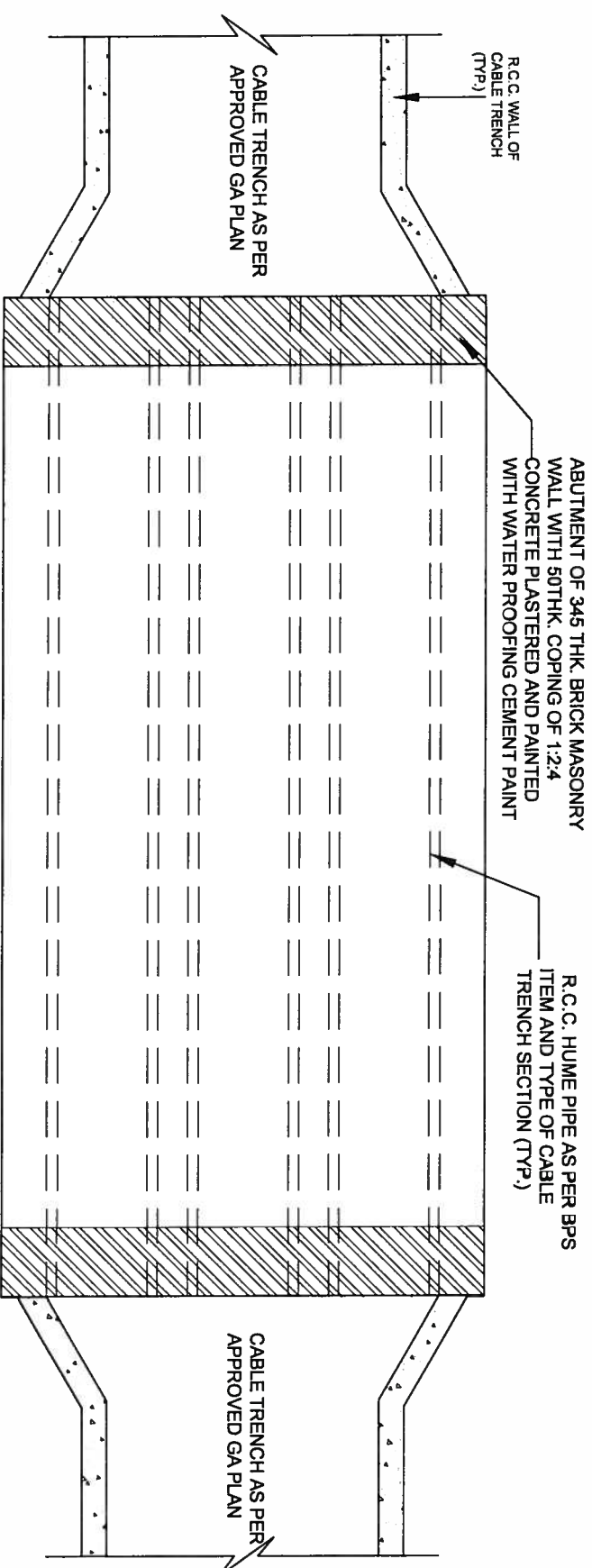
ROAD CROSSING SECTION FOR CABLE TRENCH "SEC-2-2"



ROAD CROSSING SECTION FOR CABLE TRENCH "SEC-3-3"



TYPICAL LONGITUDINAL ROAD CROSSING SECTION OF CABLE TRENCH THROUGH RCC PIPE



TYPICAL PLAN OF CABLE TRENCH WITH ROAD CROSSING

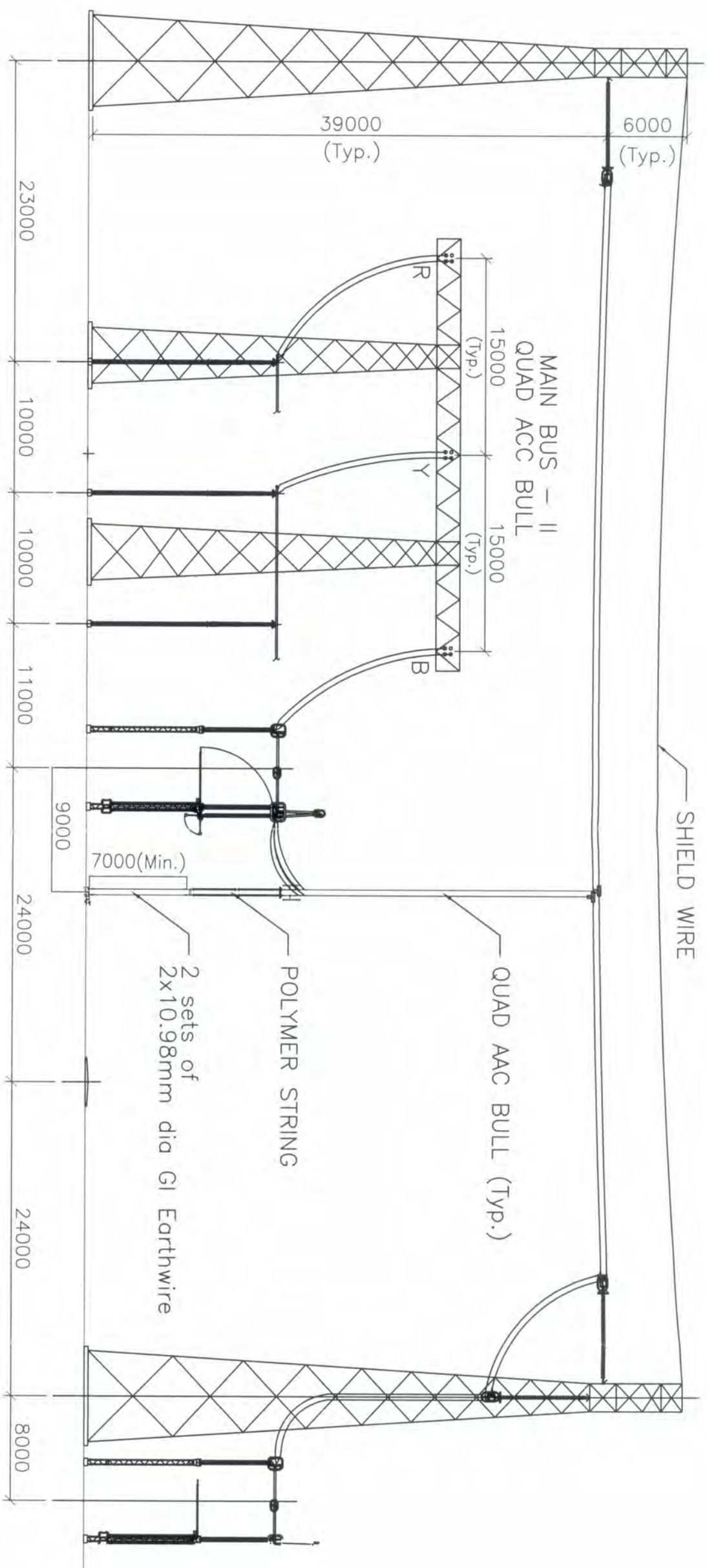
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POWER GRID CORPORATION
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PROJECT: STANDARD CABLE TRENCH FOR SUBSTATION SWITCH YARD
TITLE: DETAILS OF CABLE TRENCHES AND CABLE TRENCH ROAD CROSSING
DRG. NO.: C/ENGG/STD/2016/RCT/01 (Sheet 04 of 04)
SCALE: NTS



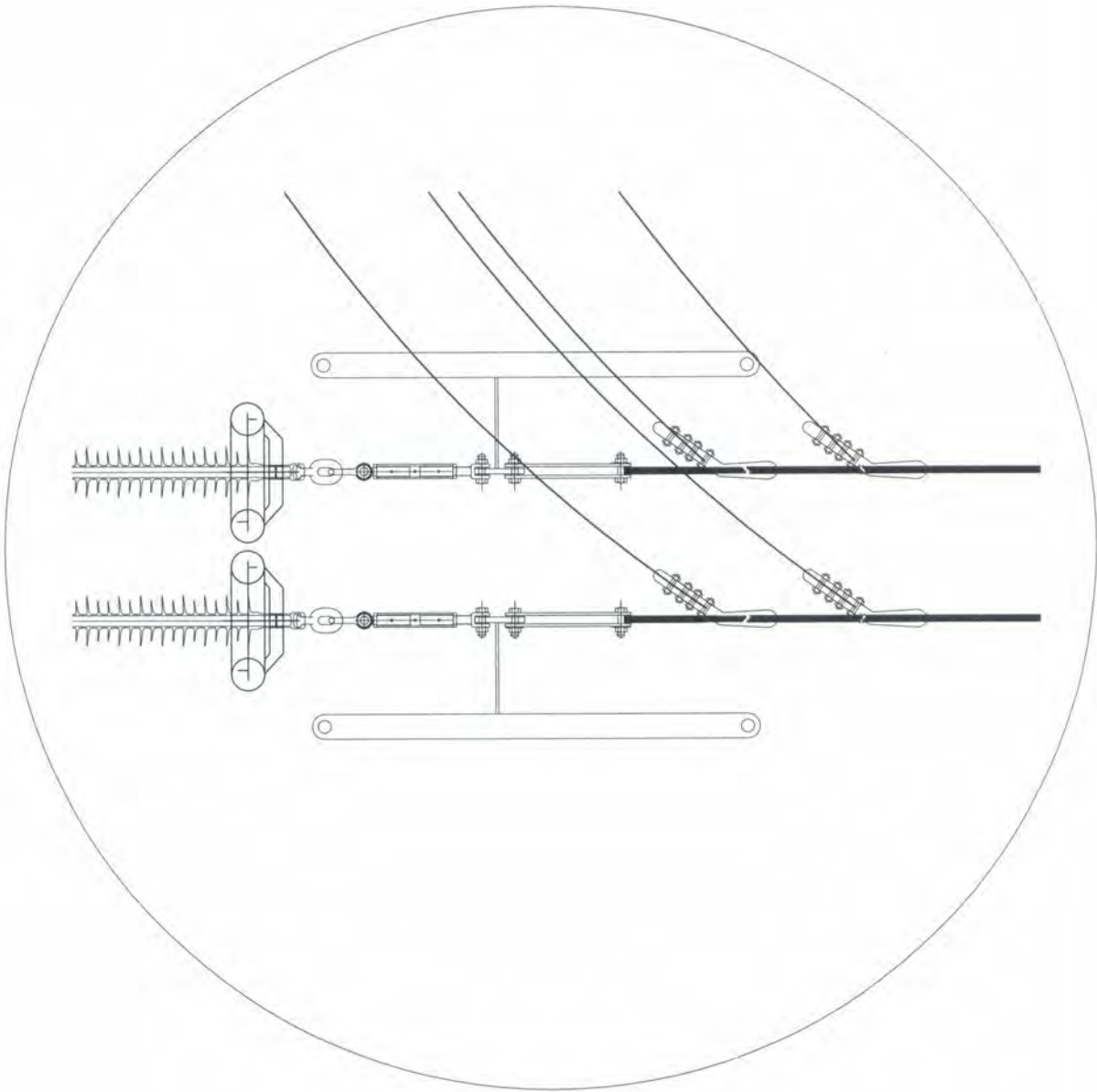
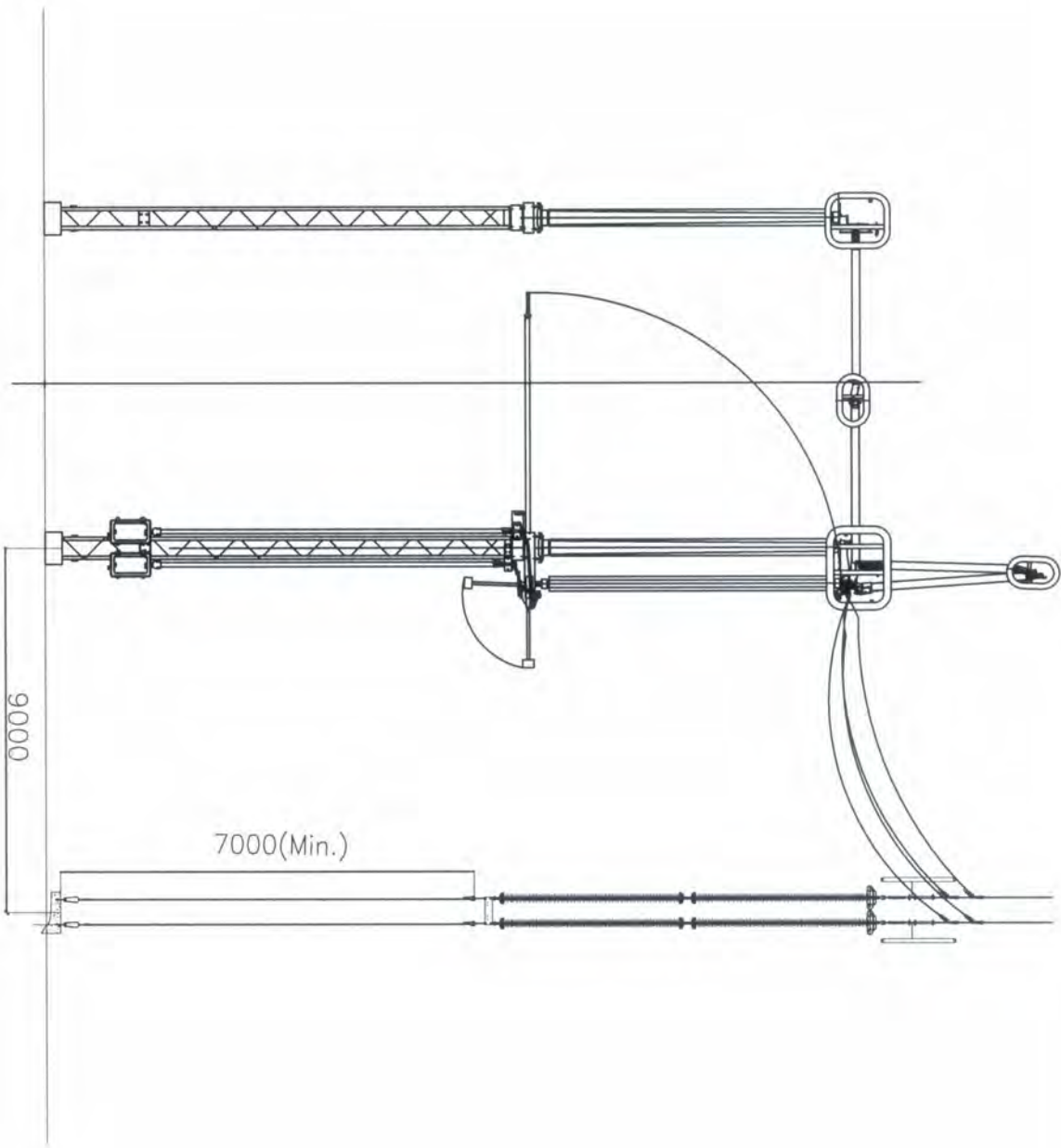
POWER GRID CORPORATION
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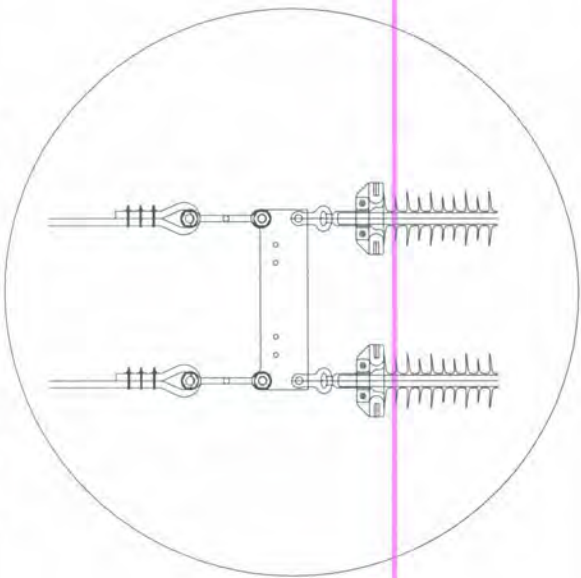
PROJECT :- STANDARD

TITLE:- GUY ARRANGEMENT (765kV)

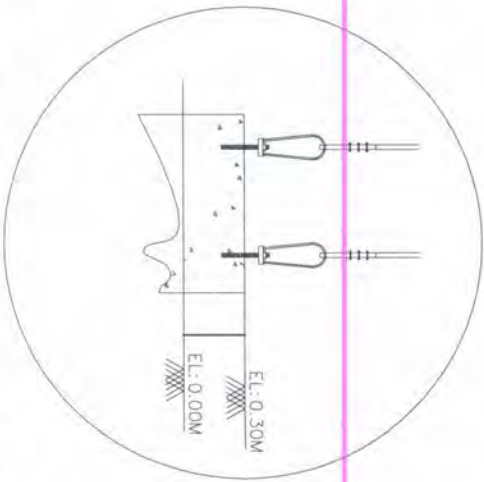
APPD	REVIEWED	CKD	PRPD	Date	Drawing No.: C/ENG/STD/GUY ARR SHEET 1 of 2	Rev. 00
				Oct-2013		




CONNECTION ARRANGEMENT



ANCHORING DETAILS



FOUNDATION DETAILS

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)						
PROJECT :- STANDARD						
TITLE:- GUY ARRANGEMENT (765kV)						
APPD	REVIEWED	CKD	PRPD	Oct-2013	Drawing No.: C/ENG/STD/GUY ARR SHEET 2 of 2	
					Date	Rev. 00

TECHNICAL SPECIFICATION
SECTION: SWITCHGEAR-CB
REVISION-11

17.0 PRE-COMMISSIONING TESTS

- 17.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. For Pre-commissioning tests, procedures and formats for circuit breakers, POWERGRID document no. CF/CB/03/R-4 dated 01/04/2013 of document no. D-2-01-03-01-04 dated 01-04-2013 will be the reference document. This document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor

shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation resistance of each pole.
- (b) Check adjustments, if any suggested by manufacturer.
- (c) Breaker closing and opening time.
- (d) Slow and Power closing operation and opening.
- (e) Trip free and anti pumping operation.
- (f) Minimum pick-up voltage of coils.
- (g) Dynamic Contact resistance measurement.
- (h) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
- (i) Insulation resistance of control circuits, motor etc.
- (j) Resistance of closing and tripping coils.
- (k) SF6 gas leakage check.
- (l) Dew Point Measurement
- (m) Operation check of pressure switches and gas density monitor during gas filling.
- (n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- (o) Testing of grading capacitor.
- (p) Resistance measurement of main circuit.
- (q) Checking of operating mechanisms
- (r) Check for annunciations in control room.
- (s) Point of wave switching test (wherever applicable)

17.2 The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative.

MODEL TECHNICAL SPECIFICATION
SECTION-SWITCHGEAR-INST
(INSTRUMENT TRANSFORMERS)
(REV. NO. 11)

9.0 PRE-COMMISSIONING TESTS

- 9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Employer without any extra cost to the Employer. **The Contractor shall arrange all instruments**

required for conducting these tests alongwith calibration certificates at his own cost.

9.2 Current Transformers

- (a) Insulation Resistance Test for primary and secondary
- (b) Polarity test
- (c) Ratio identification test - checking of all ratios on all cores by primary injection of current
- (d) Dielectric test of oil (wherever applicable)
- (e) Magnetizing characteristics test
- (f) Tan delta and capacitance measurement
- (g) Secondary winding resistance measurement
- (h) Contact resistance measurement (wherever possible/accessible)
- (i) Test for SF₆ (for SF₆ filled CTs) – Dew point measurement, SF₆ alarm/lockout check
- (j) DGA test of oil

Dissolved Gas Analysis (DGA) shall be carried out twice within the first year of service, first within the first month of commissioning/charging and second between six months to one year from the date of commissioning/charging.

CTs/IVTs must have adequate provision for taking oil samples from the bottom of the CT/IVT without exposure to atmosphere. Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. ~~Bidder~~/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

Bidder shall supply 2 nos. oil sampling device for every 20 nos. oil filled CT supplied with a minimum of 2 nos. oil sampling device for each substation.

9.3 Inductive Voltage Transformers/Capacitive Voltage Transformers

- (a) Insulation Resistance test for primary (if applicable) and secondary winding
- (b) Polarity test
- (c) Ratio test
- (d) Dielectric test of oil (wherever applicable)

- (e) Tan delta and capacitance measurement of individual capacitor stacks
- (f) Secondary winding resistance measurement

For pre-commissioning procedures and formats for Current Transformers, Doc.No.: CF/CT/04/R-4 dtd-01.04.2013 and for Voltage Transformers, CF/CVT/05/R-4 dtd-01.04.2011 under POWERGRID document no. D-2-01-03-01-04 will be the reference document. **This document will be available at respective sites and shall be referred by the contractor.**



SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE

8.3.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site www.powergridindia.com after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per **Annexure-F** shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-G** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item.


Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order.

Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian/International standards.

Inspection Levels: For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:

Level -I: Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 
- Level - II:** Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates.
- Level - III:** Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections (if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.
- Level - IV:** Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G****MQP & INSPECTION LEVEL REQUIREMENT**

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
1 A	Transformer /Reactor	Yes	IV
1 B	Circuit Breakers	Yes	IV
2	Current transformer	Yes	IV
3	Capacitive voltage transformers/Potential transformer	Yes	IV
4	Isolators	Yes	IV
5	Lightening Arrestors	Yes	III
6	Line Trap	Yes	III
7	Control & Relay Panels	Yes	III
8	Power Cables	Yes	III
9	Control Cables	Yes	III
10	LT Switchgear & ACDB/DCDB/MLDB/ELDB/ Lighting Panels	Yes	III
11	Fire protection system		
11-A	Panels, Deluge valve, Hydro pneumatic tank.	No	III
11-B	Strainers, extinguishers, MS/GI pipes, Pumps, motors, air compressor, and other valves, Diesel Engines	No	II
11-C	Others	No	I
12	Insulator (Disc, Long Rod, Solid Core)	Yes	IV
13	Conductor	Yes	IV
14	Clamps & Connectors (including equipment connectors)	Yes	III
15	Junction Box / Lighting Switch Boards / Bay MB/Telecom Equipment Cabinet	No	II
16	Cable lugs	No	I
17	Lighting Fixtures ,Lamps & fans	No	I
18	Switches	No	I
19	Conduits	No	I
20	Lighting Poles	No	II
21	MS/GI /PVC Pipes for cable trenches and lighting	No	I
22	Hume Pipes	No	I
23	Galvanized Cable trays	No	II
24	MS/ GI Flat and earthing material	No	II
25	MS Round for Earthmat (40mm dia)	No	I
26	Lighting Earthwire	No	I
27	Aluminium Tube & Busbar materials	No	II
28	Outdoor Receptacle	No	I
29	Nut / Bolts / Spring Washers (Gr 5.6/5)	No	II
30	LT Transformer	Yes	III
31	Battery	No	II
32	Battery Charger	Yes	III

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
33	D. G. Set	No	II
34	Split A.C/window A.C.	No	I
35	Substation Automation system	No	III
36	Telephone wires	No	I
37	Telephone sockets	No	I
38	Aluminium ladder	No	I
39	Occupancy sensors for control of lighting	No	I
40	Sub Station Structure (lattice/pipe type)	Yes	III
41	HG fuse	No	II
42	PLCC equipment Viz PLCC Terminal ,Carrier equipment, Protection Coupler , Coupling Device but excluding EPAX / HF Cable/ SDH Equipment	Yes	III
43	HF Cable / GPS Clock	No	I
44	EPAX	No	I
45	Cable Glands / Joints /Clamps/ Termination	No	I
46	Video Monitoring System	No	II
47	Controller for switching	No	IV
48	Solar based street lighting pole including solar panel as per technical specification	No	III
49	Event Logger	No	III
50	Lighting transformers	Yes	II
51	String Hardware	Yes	IV
52	Test Equipment	No	I *
53	GS Earthwire	Yes	IV
54	Oil Storage Tank	Yes	III
55	Insulating Oil	No	III
56	Flow sensitive conservator isolation valve	No	II **
57	On-Line insulating oil drying system	No	II **
58	On line DGA & Moisture Analyzer	No	II **
59	WAMS-(PMU & Accessories)	Yes	III
60	FO Cable	Yes	III
61	Re-rollers of MS/HT Angle Section and galvanized tower parts.	Yes	IV
62	Hardware fittings & Earthwire Accessories	Yes	IV
63	OPGW & H/W	Yes	III
64	Bolts & Nuts Gr up to 5.6/5	Yes	II
65	Bolts & Nuts of Gr 8.8 / 8	Yes	IV
66	D-shackle/ Hanger / Links	Yes	IV
67	Danger Plate /Phase Plate / Number Plate / Circuit plate	No	I
68	Pipe Type & Counter Poise Earthing	No	II
69	Spring Washer	No	II
70	ACD & Barbed wire for ACD/Bird guard	No	II

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

Annexure-G

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
71	Span Marker & Obstruction Light	No	III
72	GIS including spares	Yes	IV
73	GIS Bus Duct	Yes	IV
74	GIS Bushing	Yes	IV
75	SF6 Gas processing Unit	No	II
76	Partial Discharge Monitoring System	No	II
77	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	Yes	IV
78	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	Yes	IV
80	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	Yes	IV
81	Pass Harmonic filters	Yes	IV
82	Valve cooling system	Yes	III
	FODP including pigtail	No	II
	Radio link Telecom	Yes	III
	Hardware Fittings for Fibre Optic approach cable	Yes	III
	SDH Equipments (ADM), PDH, Primary Multiplexer	Yes	IV
	Drop & Insert Multiplexer	Yes	IV
	DACS	Yes	IV
	Main Distribution Frame	No	I
	HDPE Pipe	No	II
	NMS, TMN	Yes	IV
	Synchronization Equipment	No	Level-I
93	HT Capacitor	Yes	IV
94	PLC Capacitor	Yes	III
95	48V DCPS	Yes	III
96	Nitrogen Injection system	Yes	III
97	Foundation/Anchor bolts	Yes	III
98	EOT crane/Lift	No	II
99	Optical Signal Column	No	II
100	Maintenance Platform	No	II
101	Spark Gap	Yes	III
102	Thyristor Valve	Yes	III
103	DC current & voltage measuring device	ITP	III
104	Furniture	No	I

Note:

- * MICC for test and measuring equipment shall be issued only after actual verification/demonstration of satisfactory performance at site.
- ** Though level-2 items, CIP can be issued also on review of TCs and visual inspection of these items.

12.0 PRE-COMMISSIONING TESTS

- 12.1 Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment manufacturer or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates at his own cost.

An indicative list of tests on isolator and earthswitch is given below. For pre-commissioning procedures and formats for Isolators and Grounding switch, Doc.No.: CF/ISO/07/R-4, dtd-01.04.2013 under POWERGRID Document no. D-2-01-03-01-04 will be the reference document. This document will be available at respective sites and shall be referred by the contractor.

- (a) Insulation resistance of each pole
- (b) Manual and electrical operation and interlocks
- (c) Insulation resistance of control circuits and motors
- (d) Ground connections
- (e) Contact resistance
- (f) Proper alignment so as to minimize vibration during operation
- (g) Measurement of operating Torque for isolator and Earth switch
- (h) Resistance of operating and interlocks coils
- (i) Functional check of the control schematic and electrical & mechanical interlocks
- (j) 50 operations test on isolator and earth switch

12.2 The Contractor shall ensure that erection, testing and commissioning of Isolators above 72.5 kV class shall be carried out under the supervision of the Isolator manufacturer's representative and the cost of the same shall be included in the erection price of the respective equipment.

GENERAL INSTRUCTION FOR EARTHING:

1. Location of earthing conductors / risers shown in the earthing drawing may change to suit the site condition.
2. Two different risers of one structure/equipment shall be connected to different conductors of main earthmat.
3. Earthing conductor around the building shall be buried at a minimum distance of 1500 mm from the outer boundary of the building.
4. Minimum distance of 6000 mm shall be maintained between two treated (pipe) electrode.
5. For surge arrester, earthing lead from surge counter to main earthmat shall be shortest in length as practically as possible. Earthing lead from surge arrester shall not be passed through any pipe.
6. No welding is allowed in the over ground earthing leads/risers if the length is less than 6m .
7. All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
8. All arc welding with MS ROD shall be done with low hydrogen content electrodes. the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
9. Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.
10. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.
11. Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit the site conditions.
12. Earthing conductors embedded in the concrete shall have approximately 50mm concrete cover

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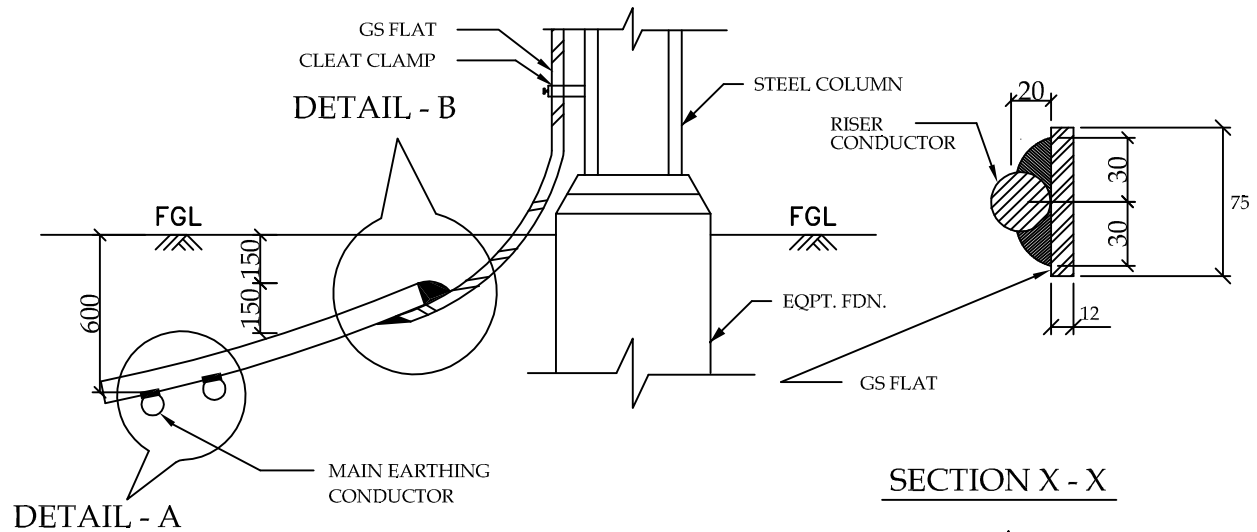
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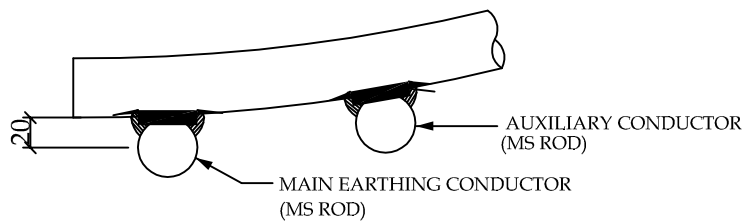
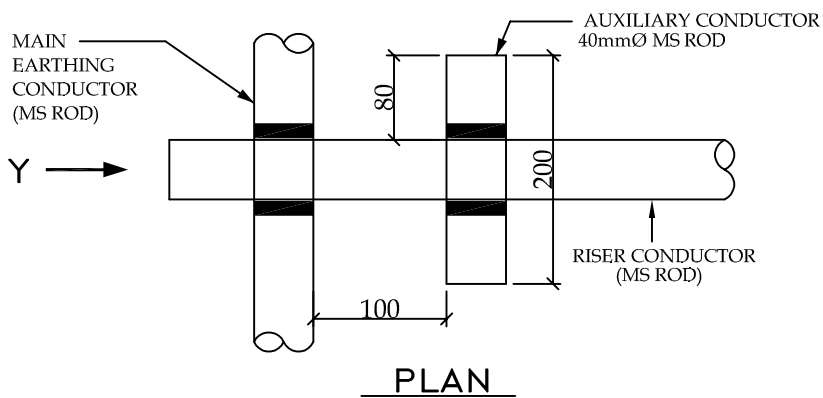
PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

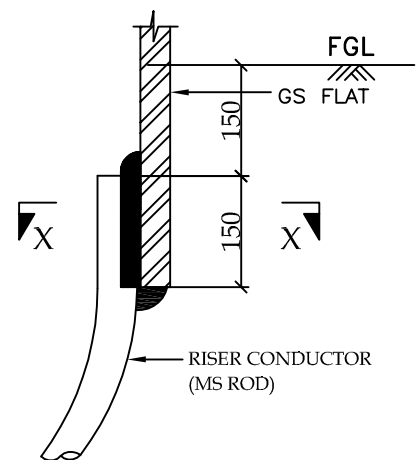
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CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 1



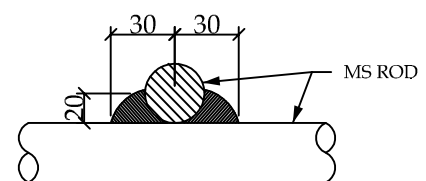
TYPICAL DETAILS OF RISER



ELEVATION
DETAIL - A



ELEVATION
DETAIL - B



VIEW - Y

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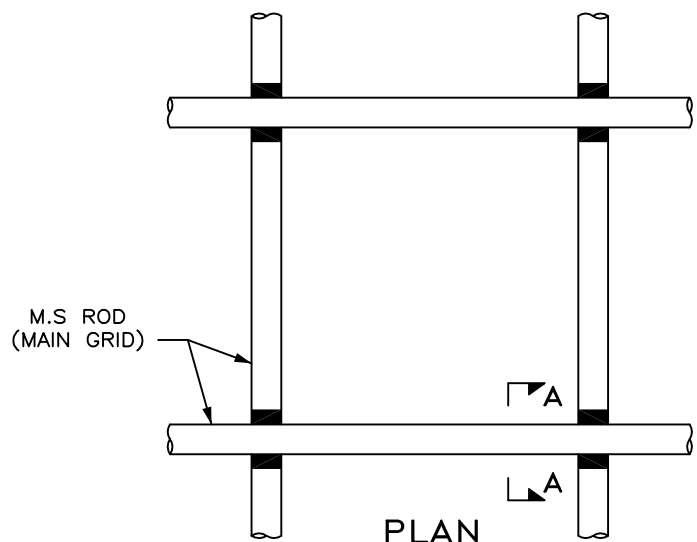
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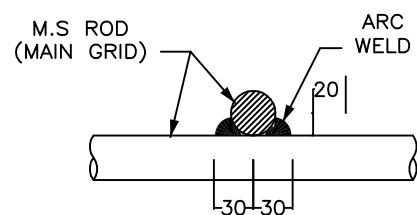
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SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

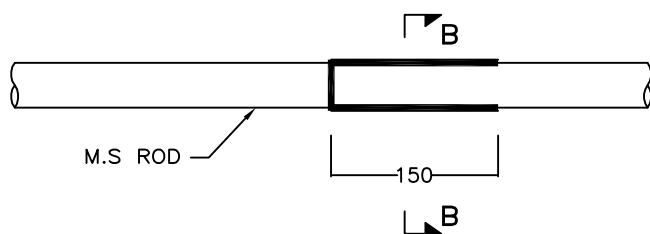
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<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	



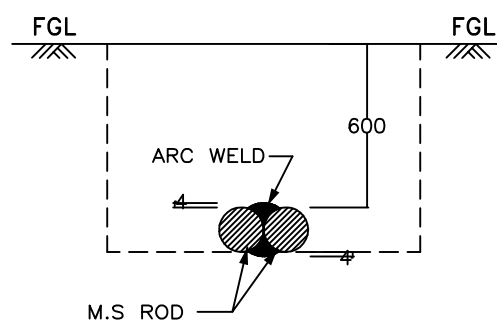
DETAIL OF CROSS JOINT



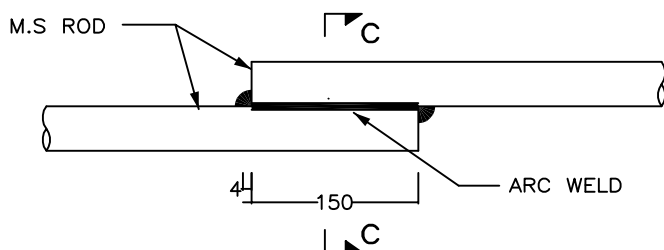
SECTION A - A



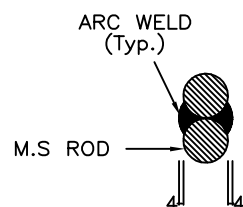
(CONDUCTORS KEPT ON SIDES)



SECTION B - B



(CONDUCTORS ONE ABOVE THE OTHER)



SECTION C - C

DETAIL OF LAP JOINT

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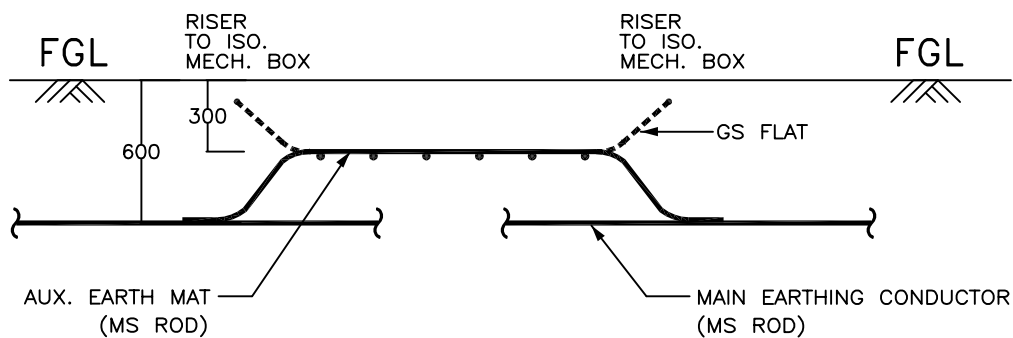
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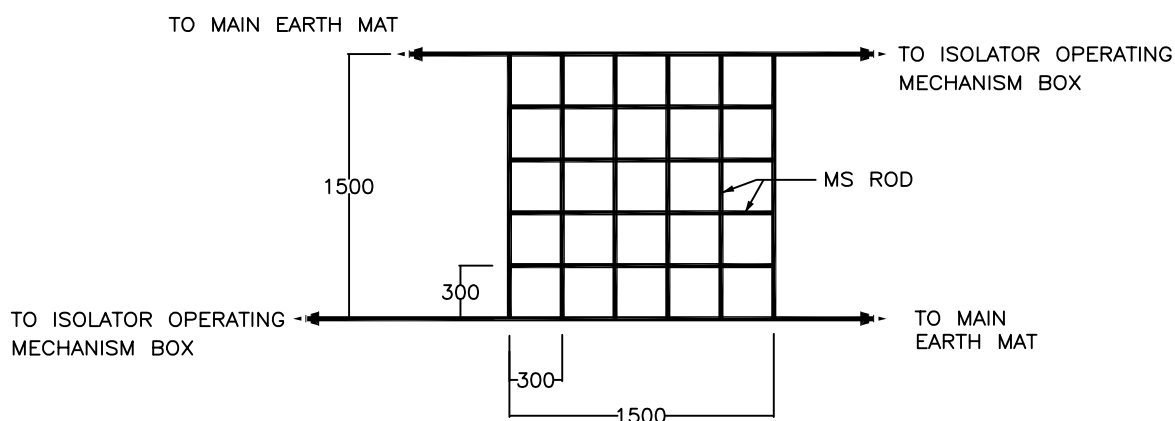
PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

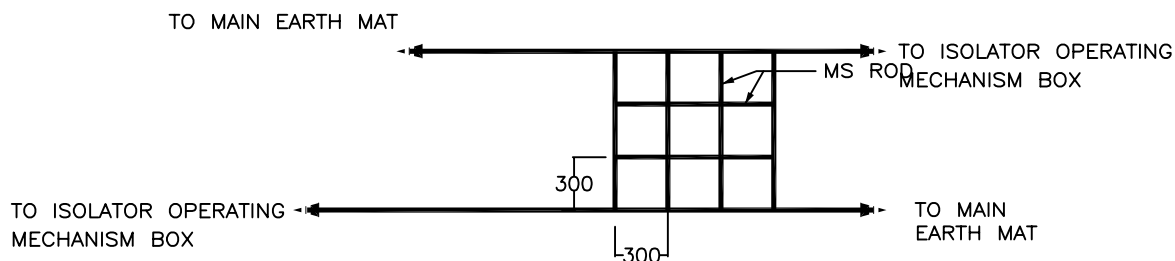
<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 3



ELEVATION



PLAN (For 220kV & above class isolators)



PLAN (For 132kV & below class isolators)

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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KK Parkar

KK Parkar

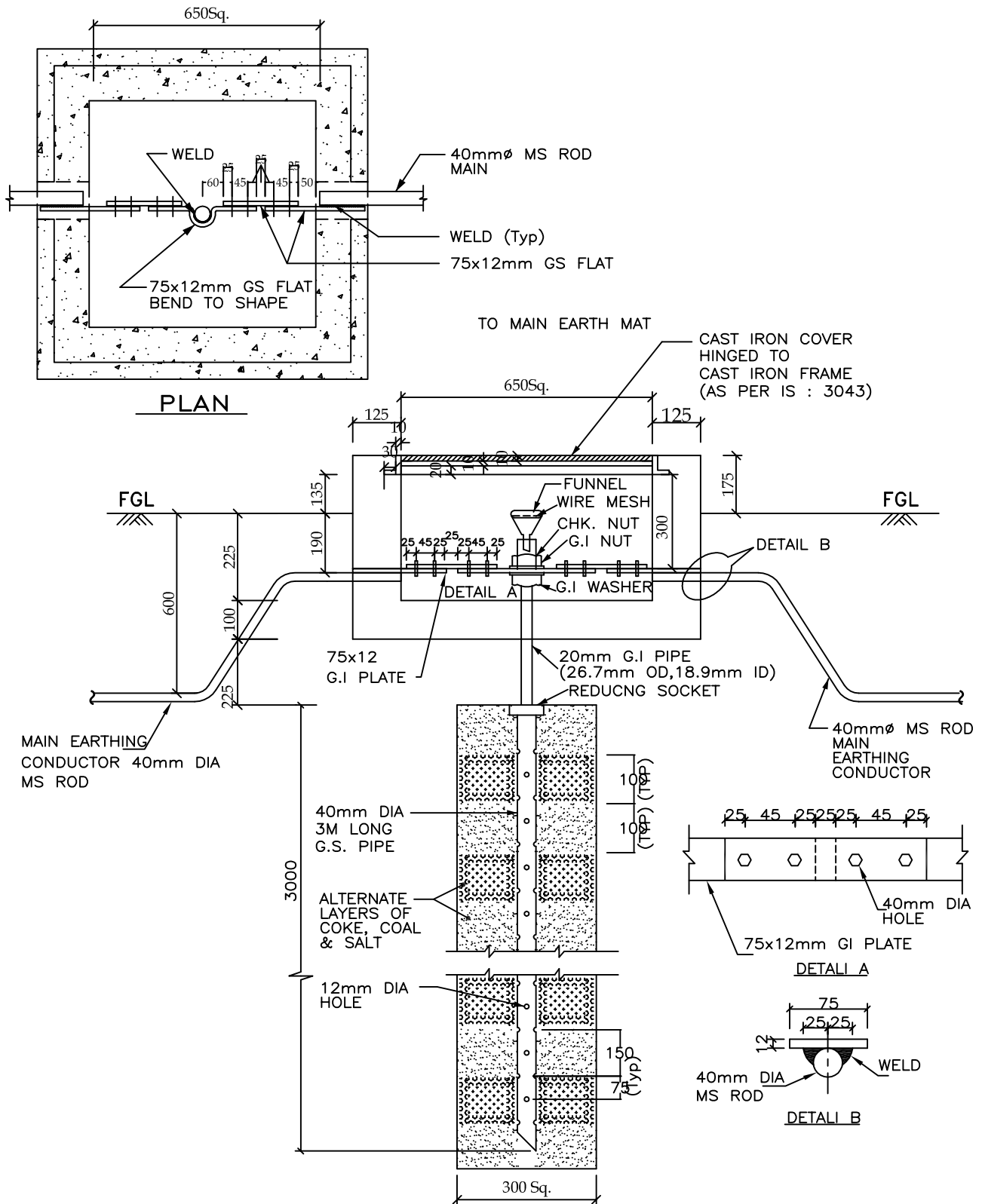
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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

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Technical drawing of a square column cross-section showing reinforcement details. The column has a 40mm diameter main reinforcement rod. A 75x12mm GS flat is welded to the main rod. The drawing shows the column's cross-section with reinforcement bars and welds. Dimensions are given in mm: 60, 45, 25, 45, 50. Labels include 'WELD', '75x12mm GS FLAT', and '40mm Ø MS ROD MAIN'.

Technical drawing of a 11kV switchgear earthing pit. The drawing shows a cross-section of a concrete pit with a cast iron cover and frame. Dimensions include a total width of 650mm, a depth of 3000mm, and various internal clearances and thicknesses. Key components labeled include the cast iron cover, cast iron frame, cement concrete (1:4:8), welds, and 40mm diameter MS rods. The pit is connected to the main earthing conductor and equipment ground (FGL).

Labels and dimensions:

- 650Sq.
- 125
- 30
- 20
- 125
- 175
- 75
- 365
- 75
- 150
- 150
- 60
- 45
- 25
- 45
- 50
- 10
- FGL
- 225
- 100
- 600
- TO EQUIPMENT
- WELD (Typ)
- CEMENT CONCRETE 1:4:8
- 14mm \varnothing HOLE (Typ)
- 40mm \varnothing MS ROD MAIN EARTHING CONDUCTOR
- 40mm \varnothing 3M LONG M.S. ROD
- 3000
- CAST IRON COVER HINGED TO CAST IRON FRAME (AS PER IS : 3043)

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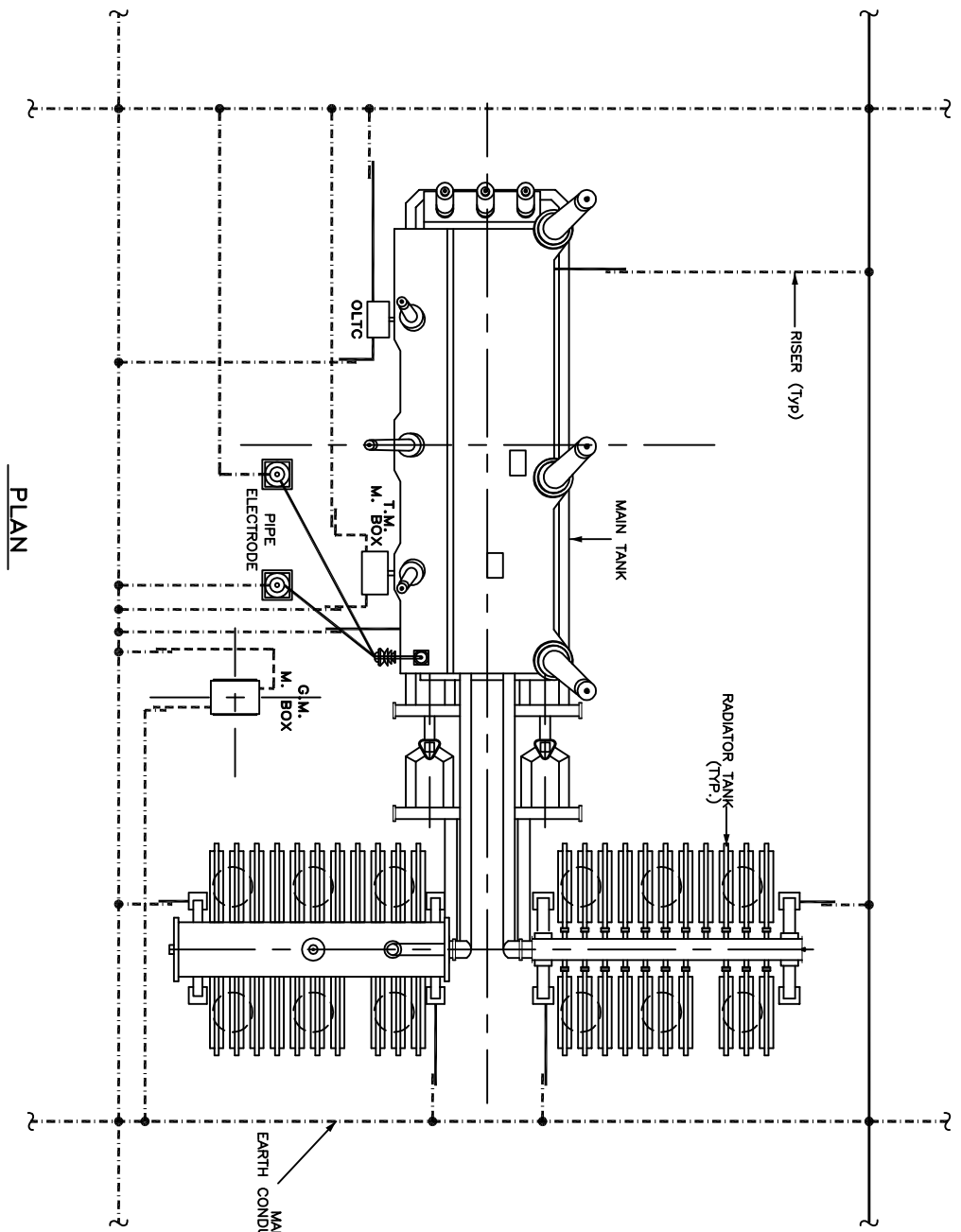


पावरग्रिप

TITLE:- STANDARD EARTHING DETAILS

<i>KKParkar</i>	<i>KKParkar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 6
CKD BY	PRPD BY	Date	

EARTHING OF TRANSFORMER / REACTOR



PLAN

LEGEND

- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

NOTES :-

- No. OF RISERS :-
 - MAIN TANK - 2 Nos.
 - RADIATOR TANK - 4 Nos.
 - O.L.T.C. - 2 Nos. (ICT only)
 - M.T.M. BOX - 2 Nos./M. BOX
 - NEUTRAL EARTH ELECTRODE - 2 Nos.
- No. OF PIPE ELECTRODE REQUIRED = 2 Nos.
- PYLON SUPPORTS SHALL BE EARTHED TO THE MAIN EARTHING CONDUCTOR BY GS FLAT.

RELEASED FOR CONTRUCTION

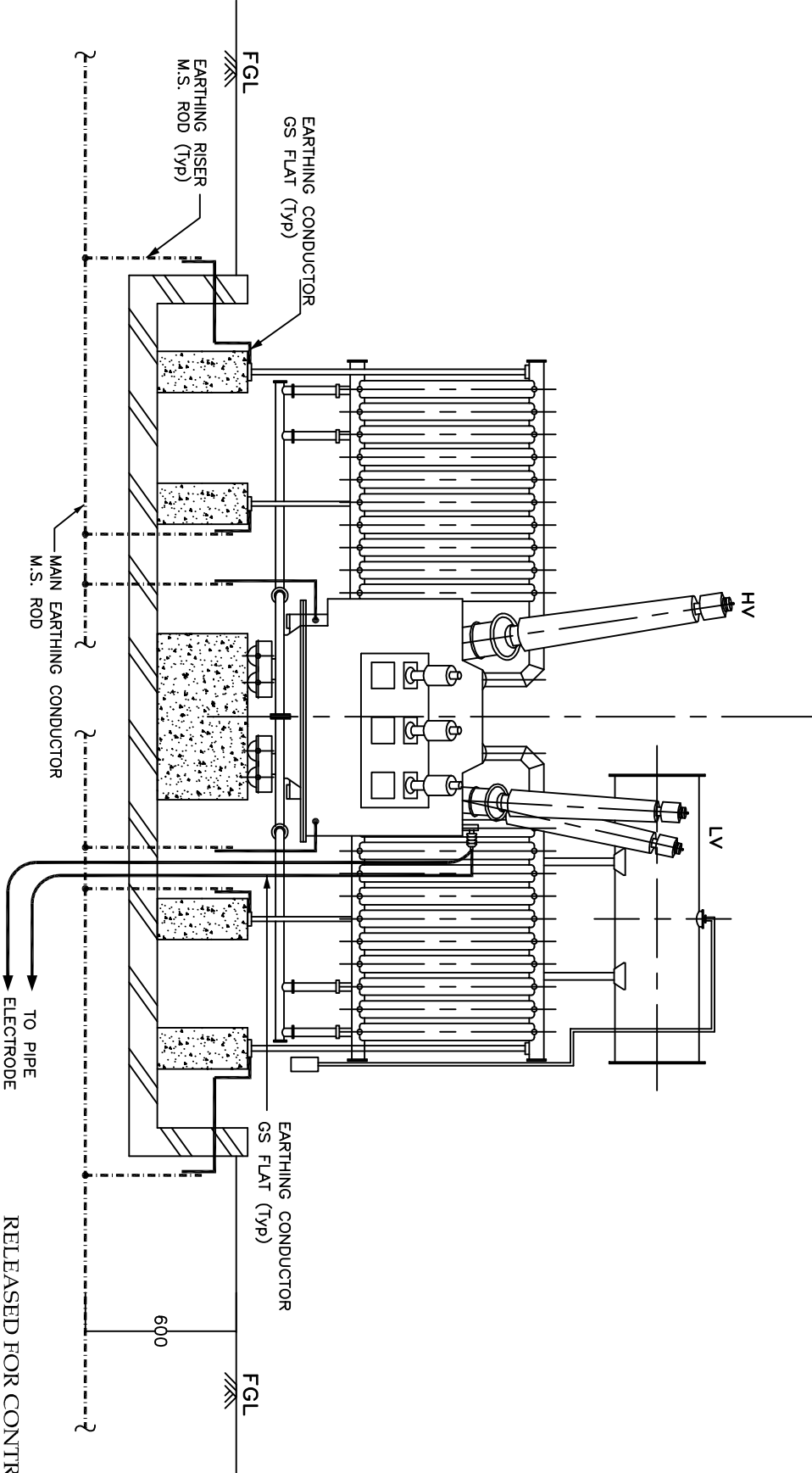
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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

CKD BY	PRPD BY	Date	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 7
SKG/Indus	SKG/Indus	Dec-2013	

EARTHING OF TRANSFORMER / REACTOR



LEGEND

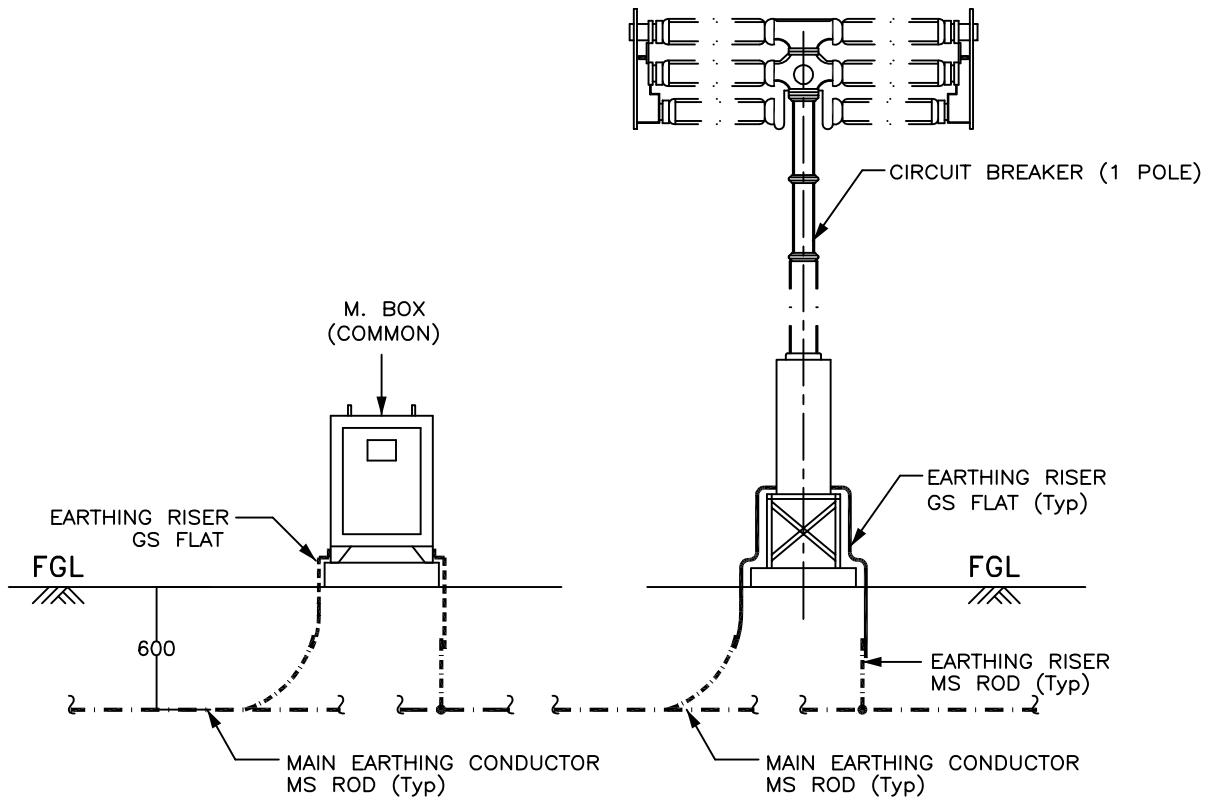
- 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

END VIEW

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise) पुनर्विभाग			
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
CKD BY	PRPD BY	Date	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 8
JK/Grades	JK/Grades	Dec-2013	

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EARTHING OF CIRCUIT BREAKER



ELEVATION

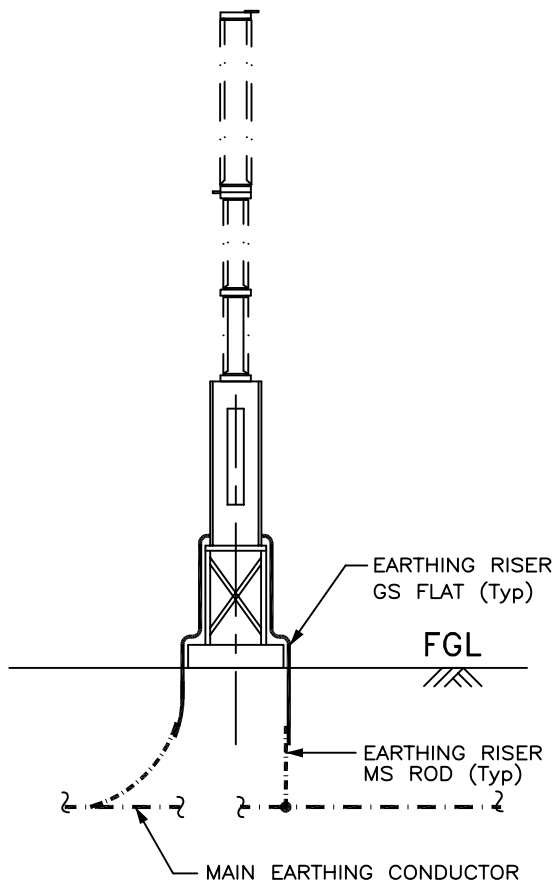
NOTES :-

1. No. OF RISERS FOR CIRCUIT BREAKER = 2 Nos. / PHASE
1. No. OF RISERS FOR LADDER (IF Applicable) = 2 Nos.
2. No. OF RISERS FOR MAR. BOX = 2 Nos.
3. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

LEGEND

	40mm \varnothing MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm GS FLAT

RELEASED FOR CONTRUCTION



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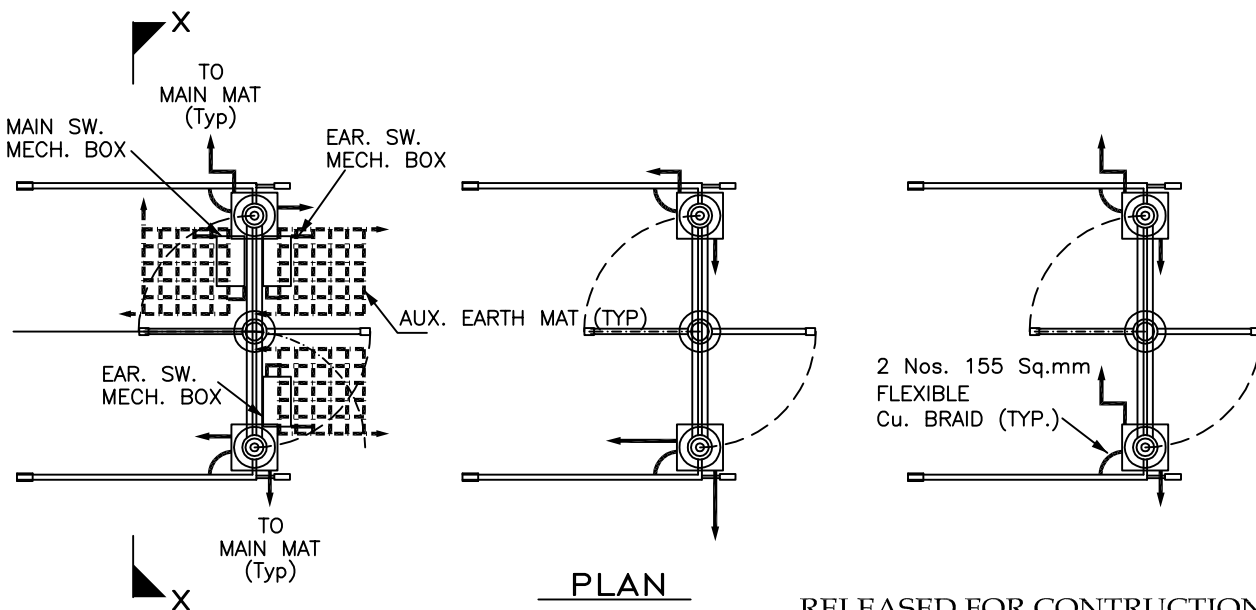
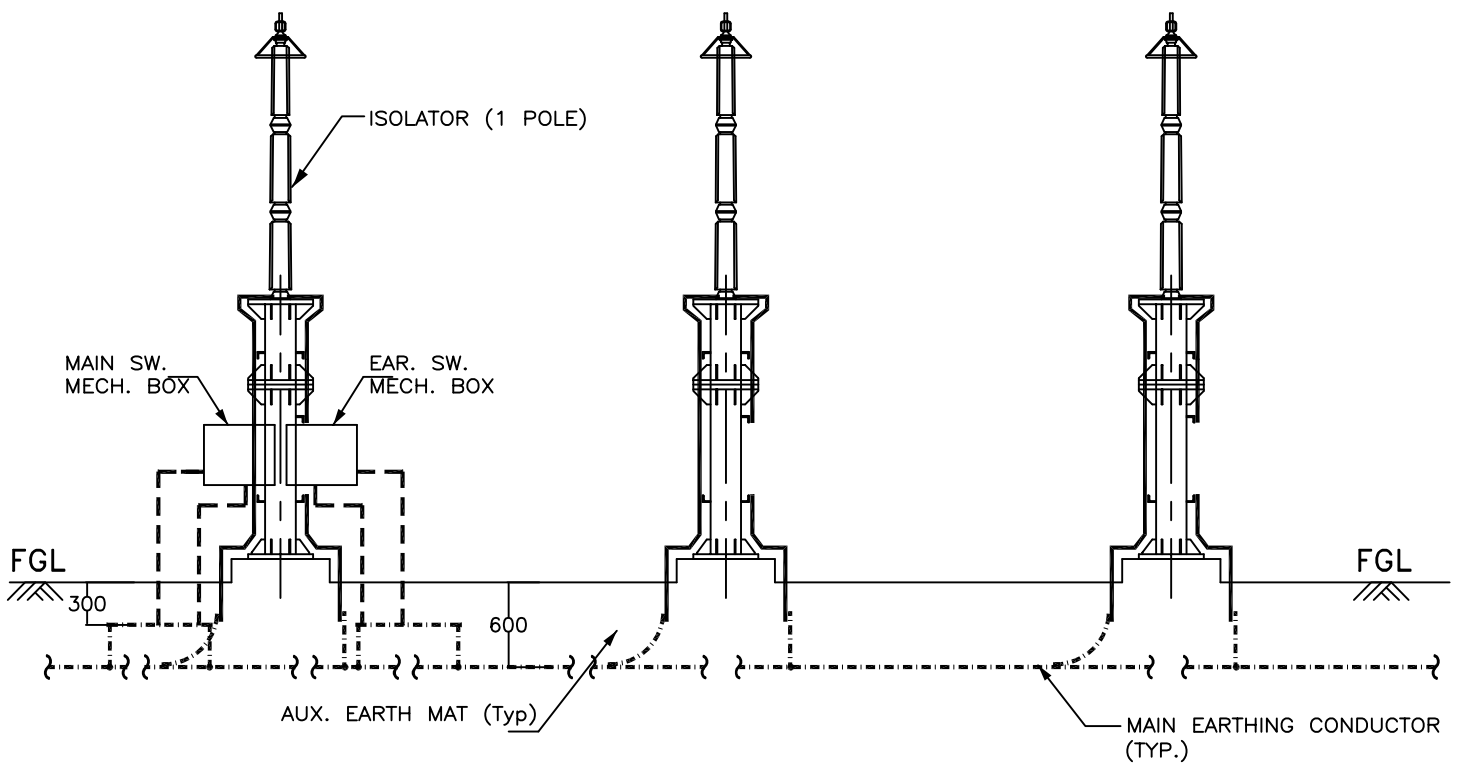


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parkar</i>	<i>KK Parkar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 9

EARTHING OF ISOLATOR



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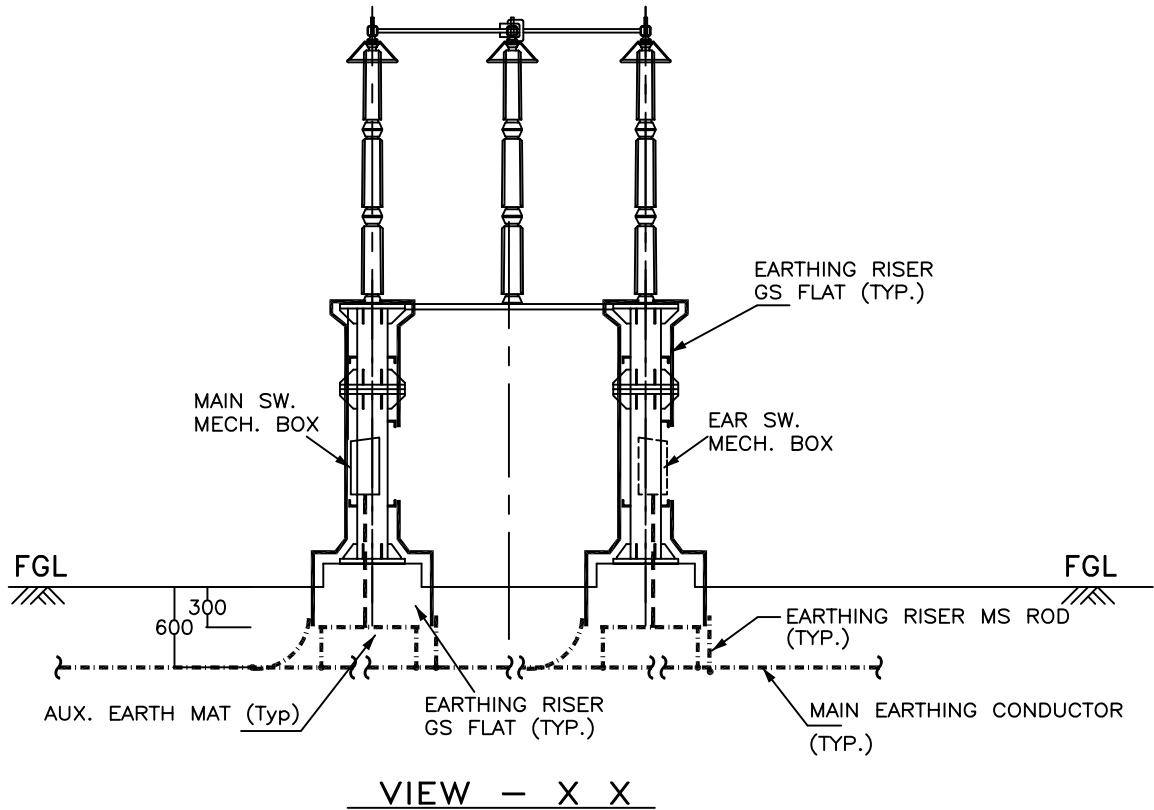


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 10

EARTHING OF ISOLATOR (1 PH)



LEGEND

	40mm ϕ MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS FOR ISOLATOR = 4 Nos. / PHASE.
2. No. OF RISERS FOR MAIN MECH. BOX = 2 Nos.
3. No. OF RISERS FOR EARTH SW. MECH. BOX = 2 Nos. / BOX.
4. No. OF AUXILIARY EARTH MAT = 1 Nos. FOR EACH MB
5. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.
6. NO. OF AUX. EARTH MAT IS INDICATIVE ONLY. IT SHALL BE EXECUTED AS PER ACTUAL NUMBER/POSITION OF EARTH SWITCHES.

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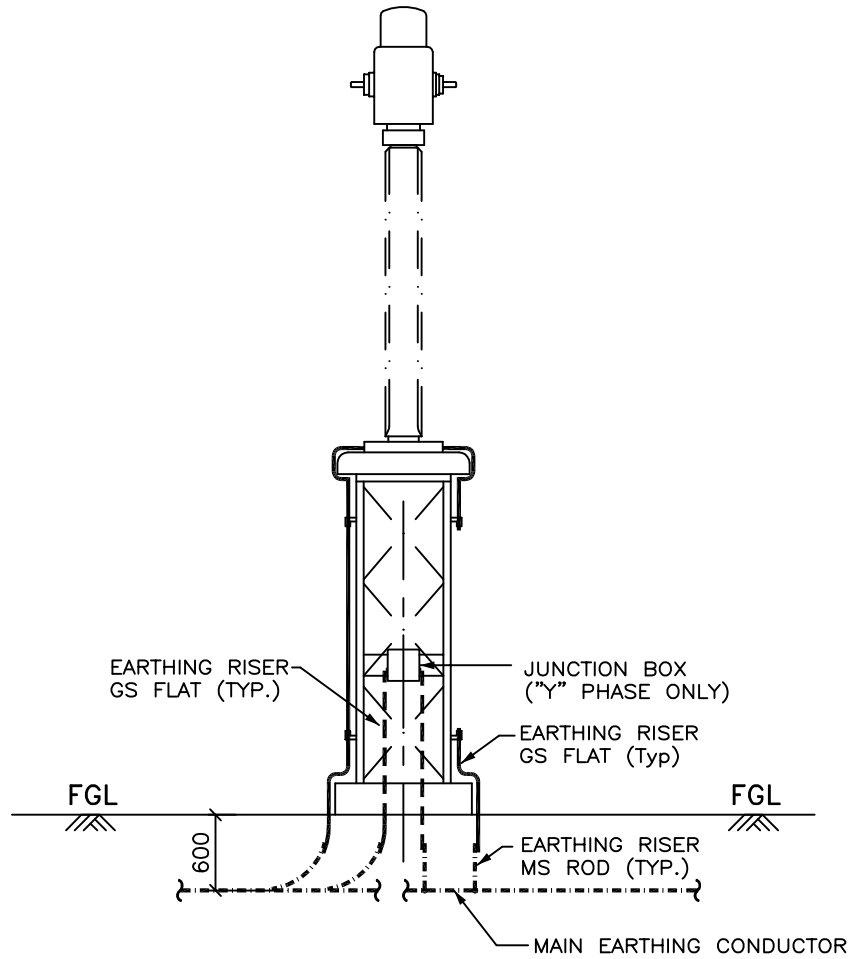


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parhar</i>	<i>KK Parhar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 11

EARTHING OF CURRENT TRANSFORMER (1 PH)



ELEVATION

LEGEND

	40mm \varnothing MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos. / PHASE.
2. No. OF RISERS FOR JUN. BOX = 2 Nos.
3. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

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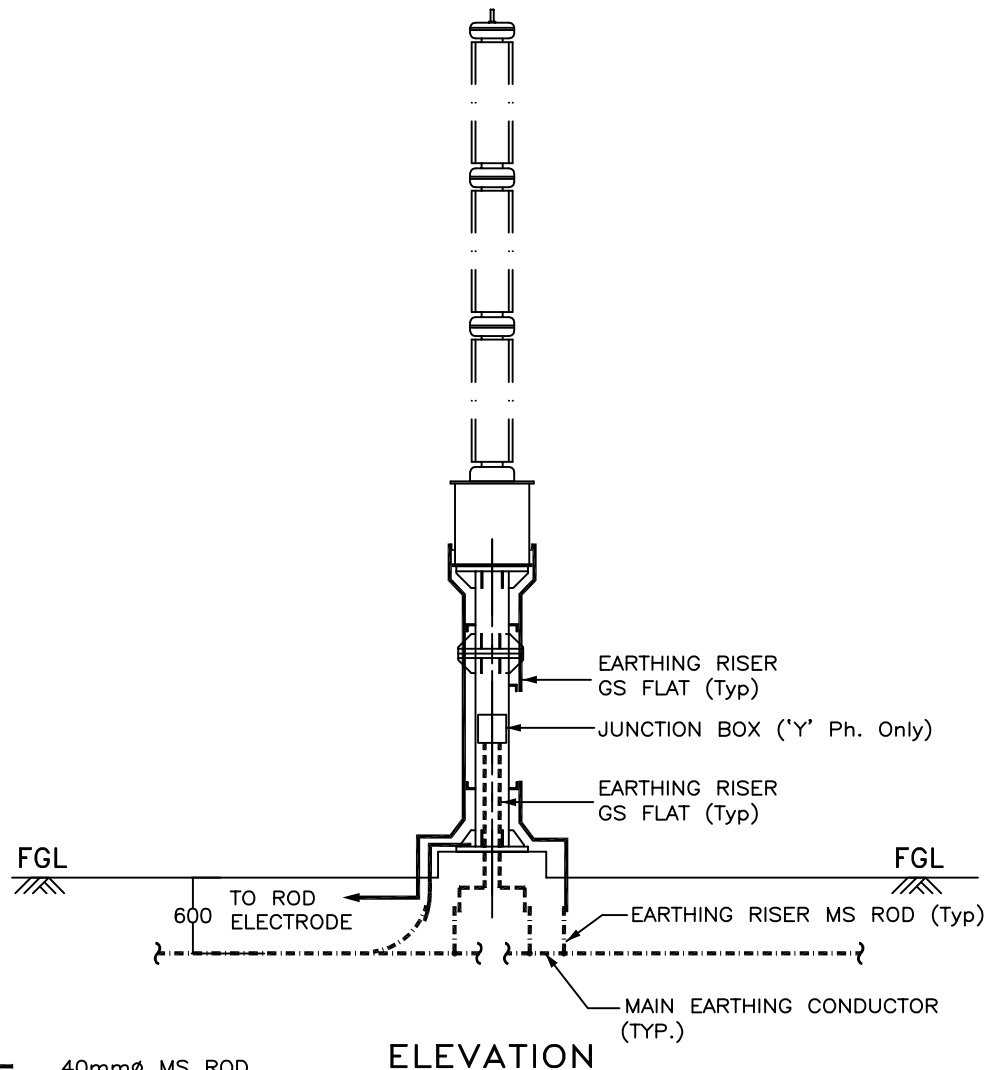


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parkar</i>	<i>KK Parkar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09 SHEET # 12

EARTHING OF CAPACITIVE VOLTAGE TRANSFORMER (1 PH)



LEGEND

	40mm ϕ MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS = 3 Nos. / PHASE.
2. No. OF RISERS FOR J. BOX = 2 Nos.
3. No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
4. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

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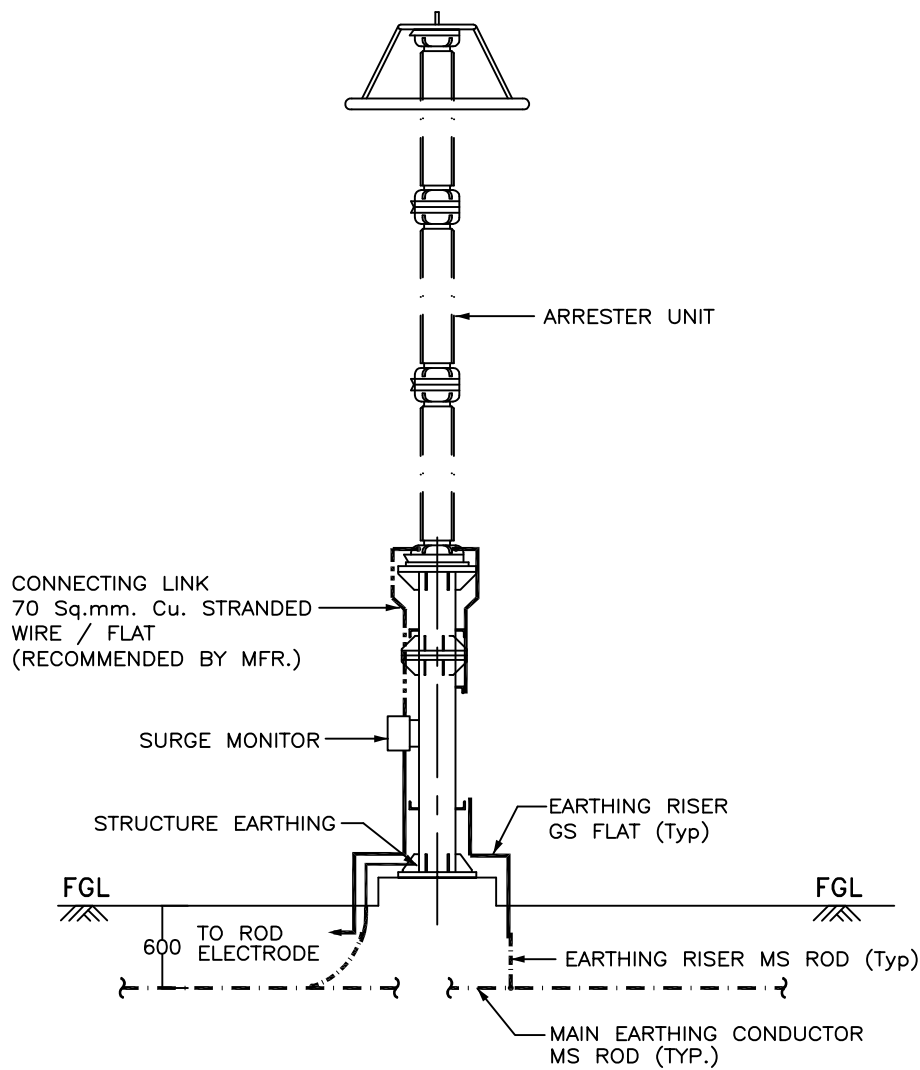


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parkar</i>	<i>KK Parkar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 13

EARTHING OF SURGE ARRESTER (1PH)



ELEVATION

LEGEND

- · — · — 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

NOTES :-

- 1 . No. OF RISERS = 3 Nos. / PHASE.
- 2 . No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
- 3 . CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

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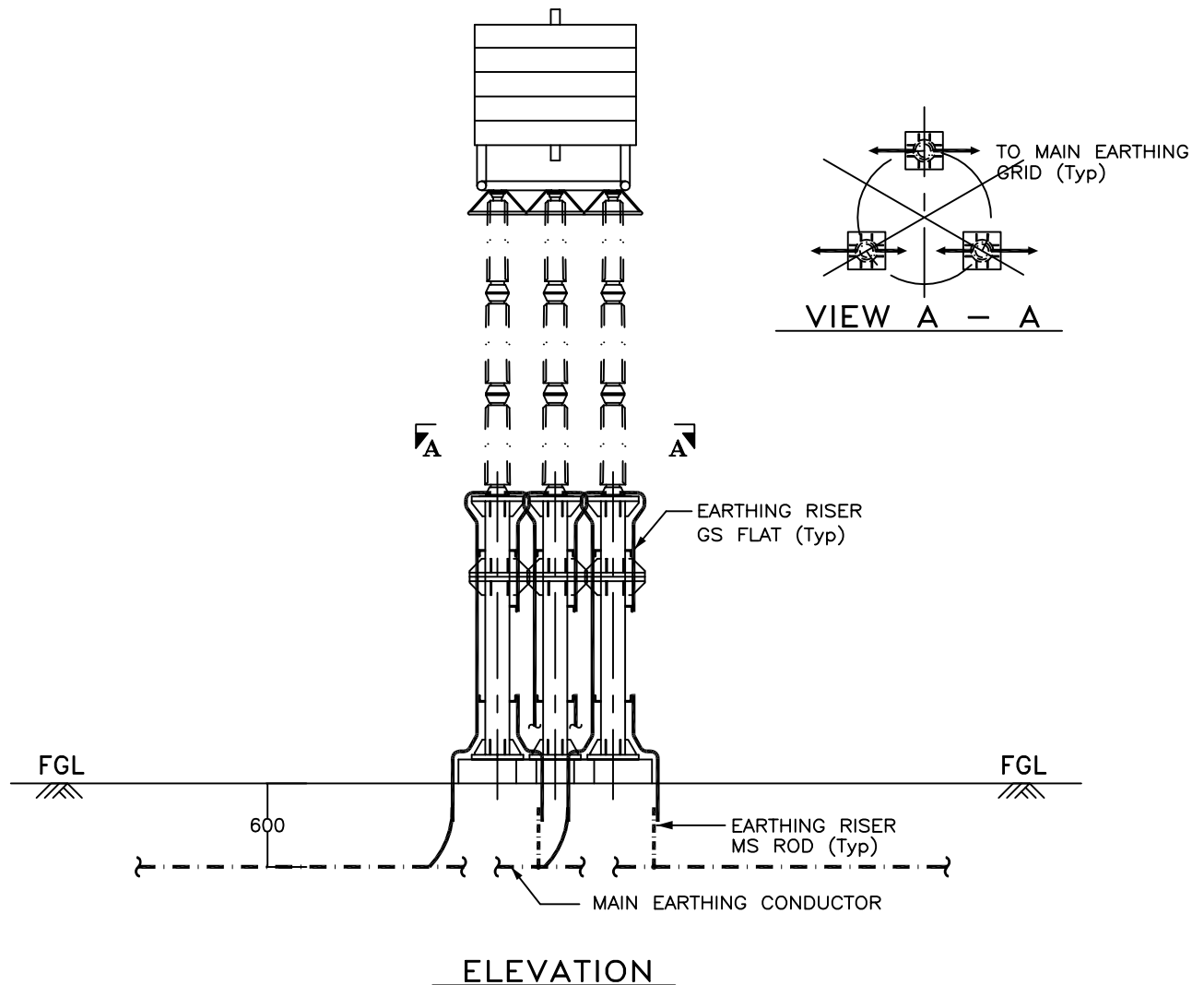


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

<i>KK Parkar</i>	<i>KK Parkar</i>	Dec-2013	Drawing No.:
CKD BY	PRPD BY	Date	C/ENG/STD/EARTHINGS/09
			SHEET # 14

EARTHING OF WAVE TRAP (1PH)




LEGEND

- 40mm ϕ MS ROD
 75 x 12 mm GS FLAT

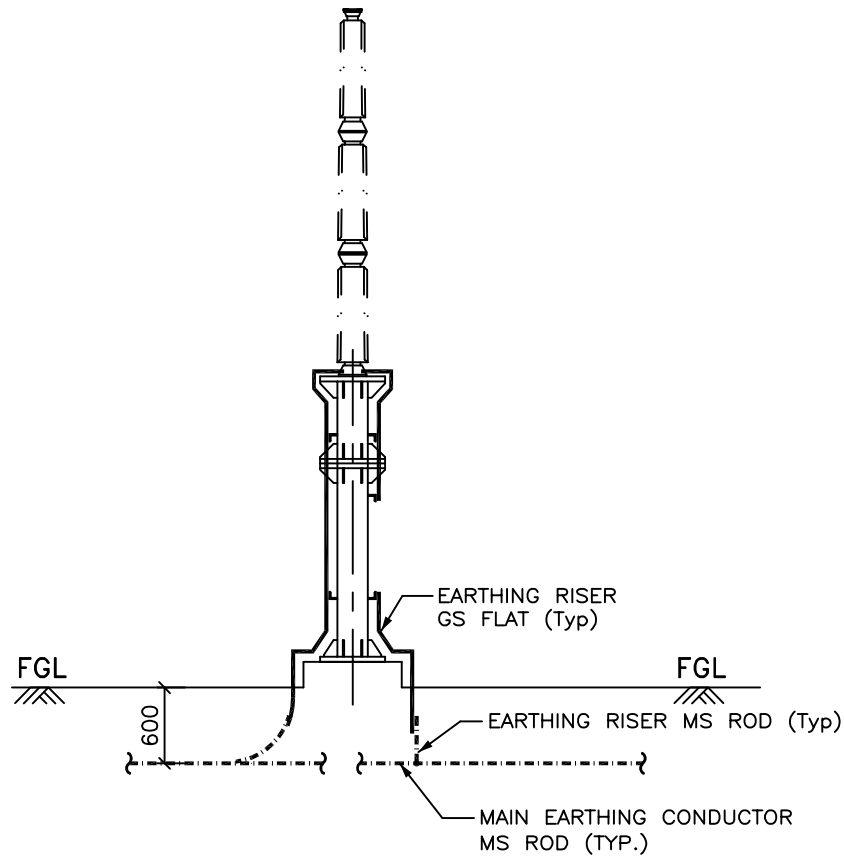
NOTE :-

1. No. OF RISERS = 6 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

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PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
<i>KK Parshar</i>	<i>KK Parshar</i>	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 15
CKD BY	PRPD BY	Date	

EARTHING OF POST INSULATOR (1PH)



ELEVATION

LEGEND

- · — · — 40mm ϕ MS ROD
———— 75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

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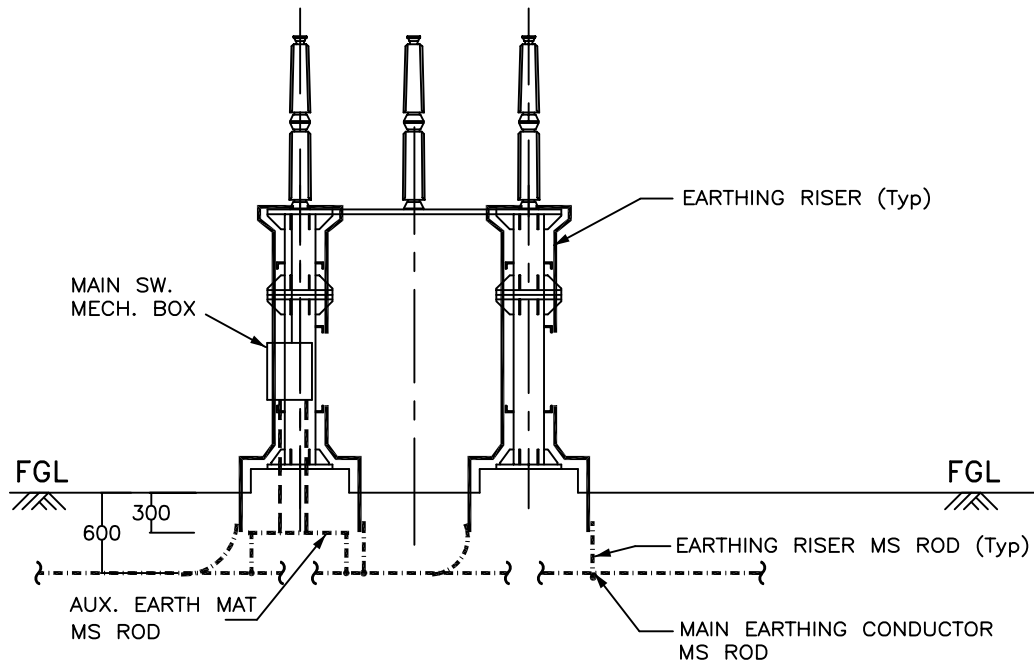


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

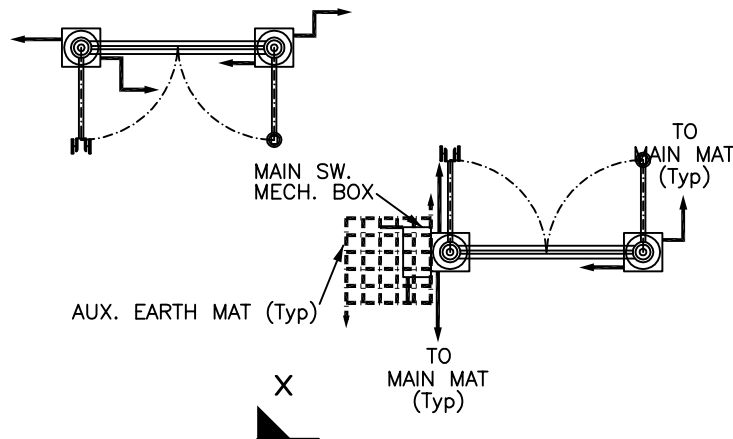
TITLE:- STANDARD EARTHING DETAILS

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TANDEM ISOLATOR



VIEW - X X



PLAN

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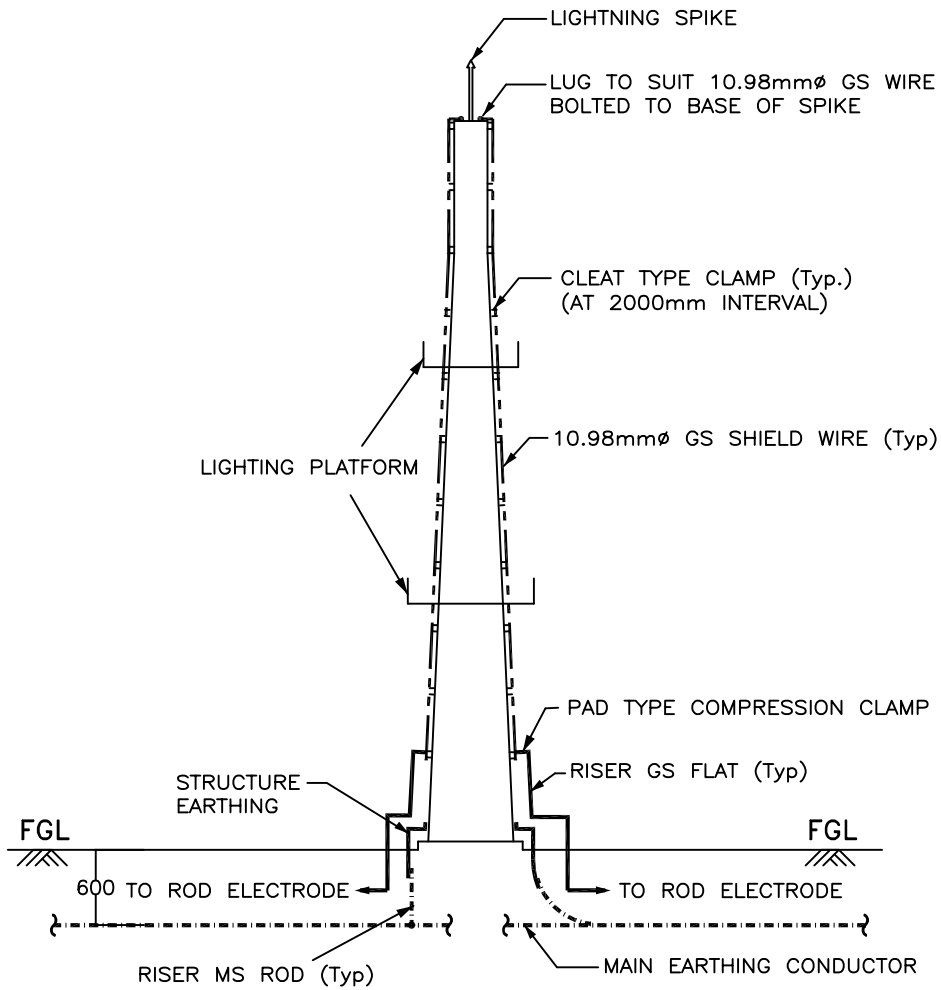


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EARTHING OF LIGHTNING MAST



ELEVATION

NOTES :-

1. No. OF RISERS = 4 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 2 Nos.
3. No. OF PAD TYPE CLAMP = 2 Nos.

LEGEND

- · — · — 40mm ϕ MS ROD
- 75 x 12 mm GS FLAT

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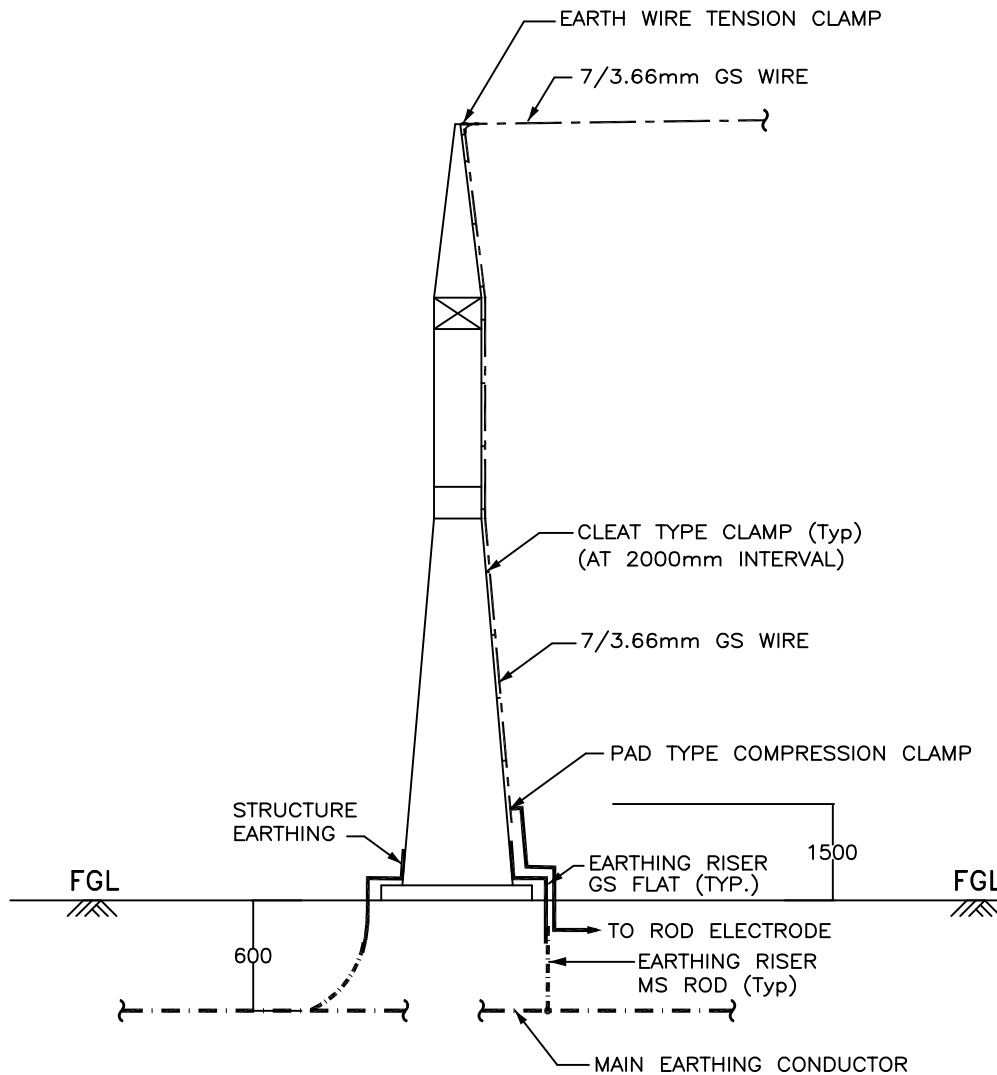


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SWITCHYARD ERECTION

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EARTHING OF TOWER WITH PEAK



ELEVATION

LEGEND

--- 40mm ϕ MS ROD

— 75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 3 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 1 No.
3. No. OF PAD TYPE CLAMP = 1 No.

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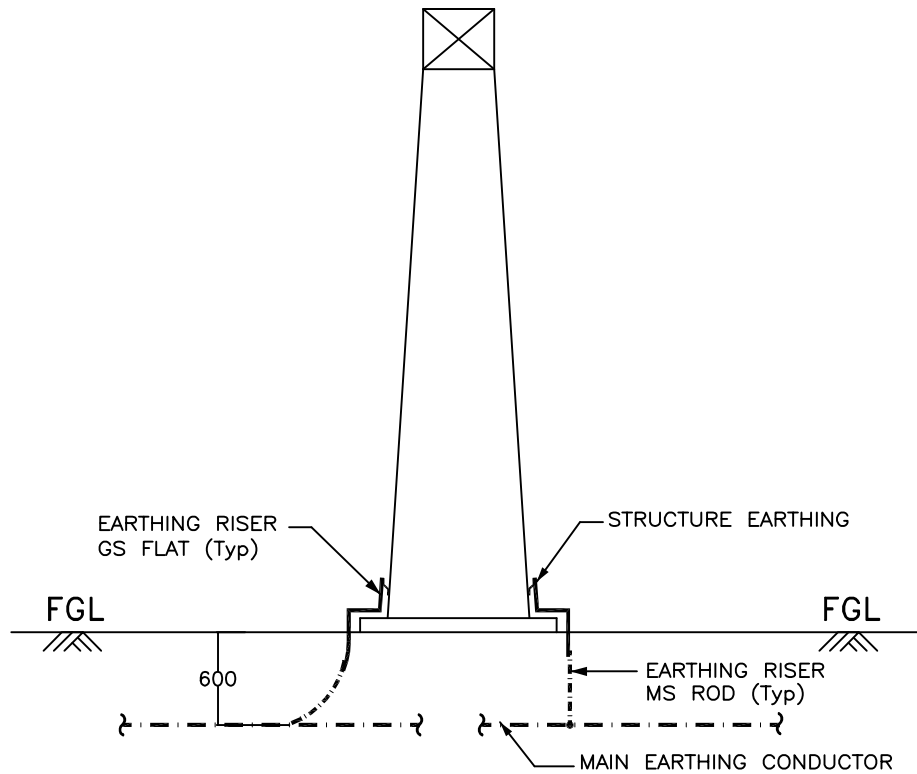


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS



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EARTHING OF TOWER WITHOUT PEAK



ELEVATION

LEGEND

	40mm \varnothing MS ROD
	75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos.

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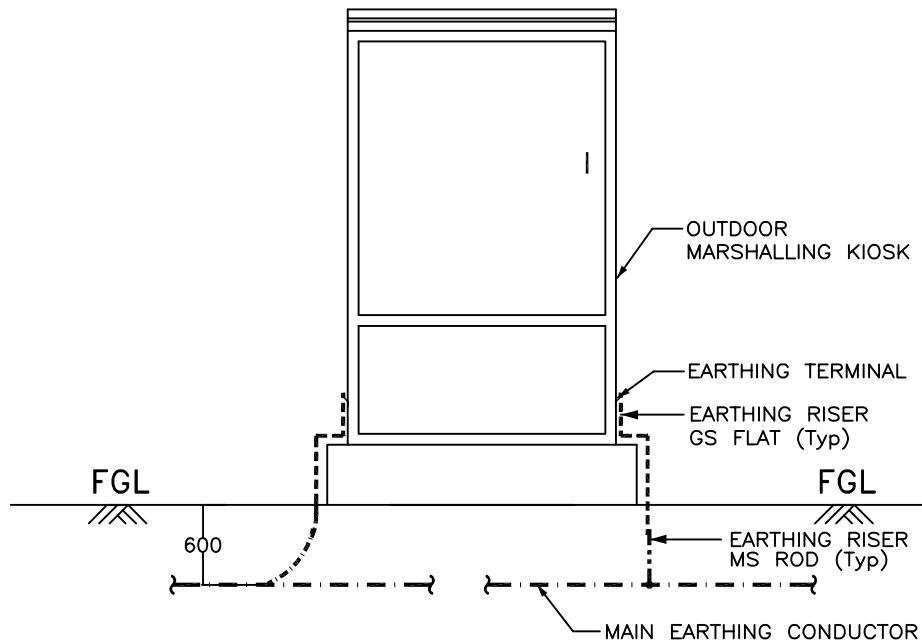


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SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

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EARTHING OF BAY MARSHALLING BOX



ELEVATION

LEGEND

— · — · — · —	40mm \varnothing MS ROD
—————	75 x 12 mm GS FLAT
-----	50 x 6 mm GS FLAT

NOTE :-

- No. OF RISERS = 2 Nos.

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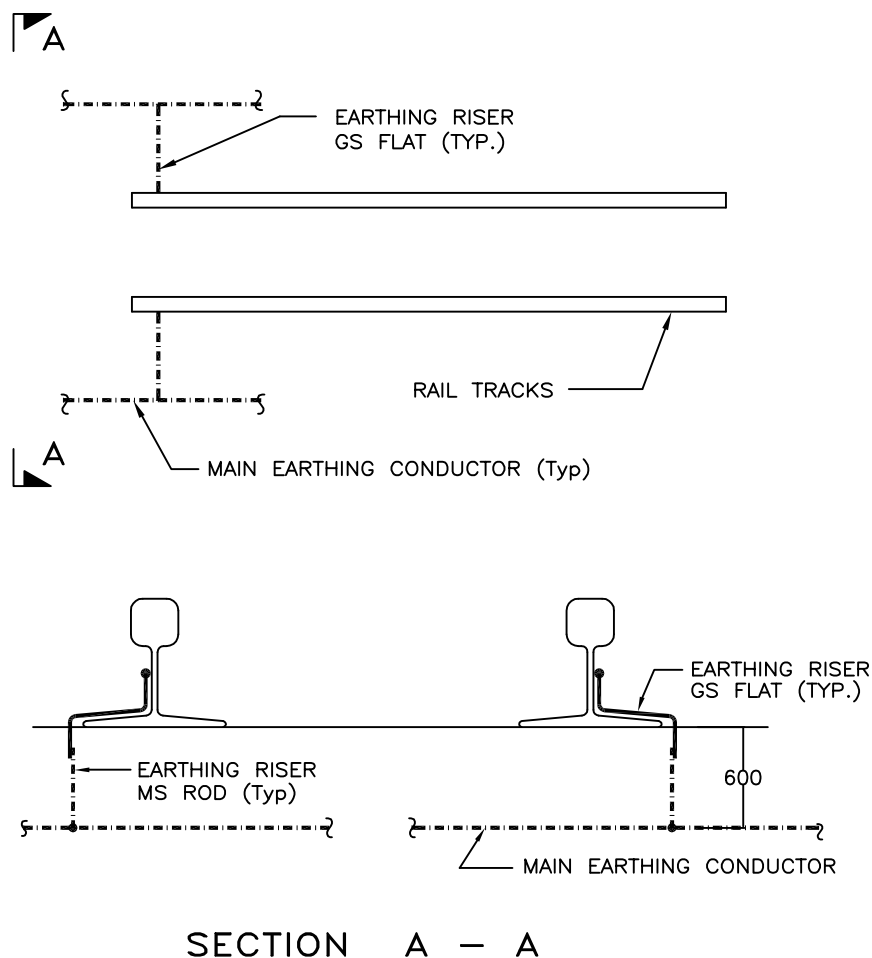


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SWITCHYARD ERECTION

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EARTHING OF RAIL TRACK



LEGEND

	40mm ϕ MS ROD
	75 x 12 mm GS FLAT

NOTES :-

1. EACH RAIL SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

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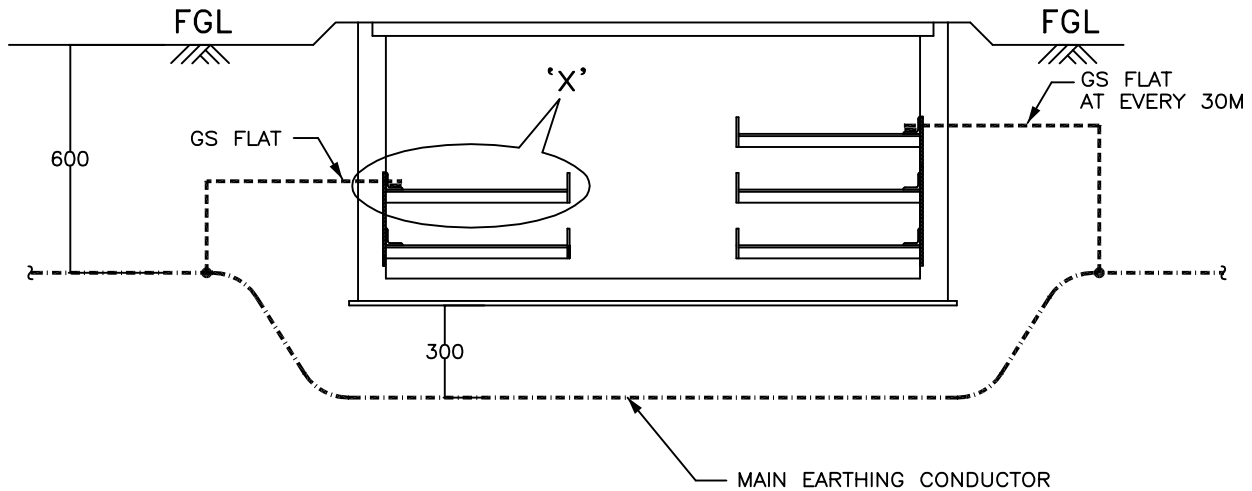


PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

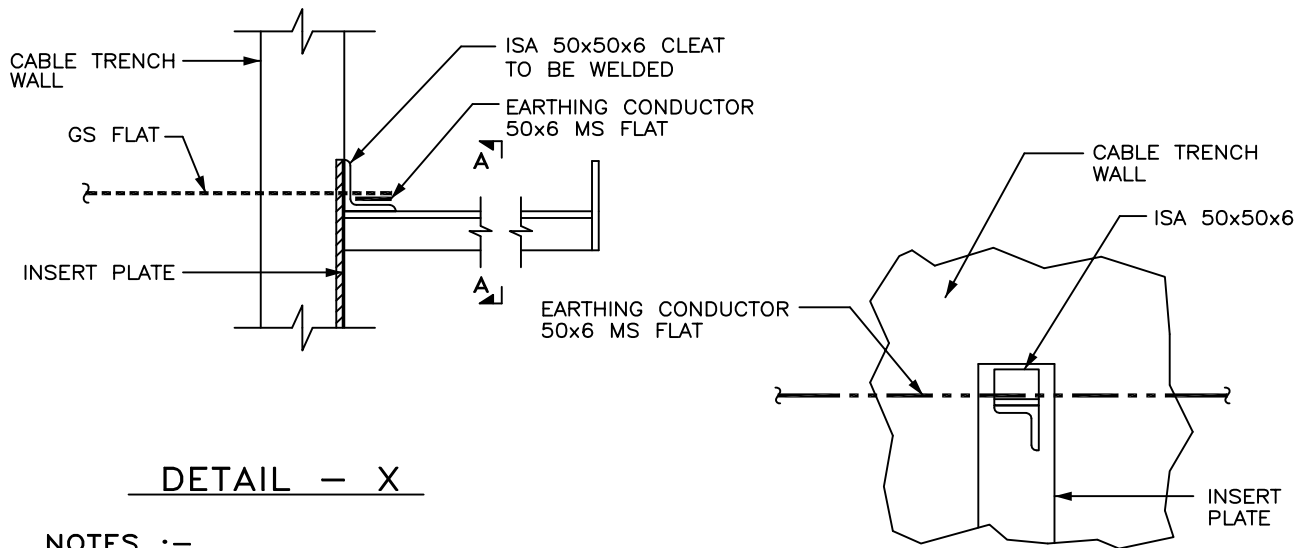
TITLE:- STANDARD EARTHING DETAILS

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EARTHING OF CABLE TRENCH



TYPICAL CROSS SECTION OF CABLE TRENCH



DETAIL - X

SECTION A - A

NOTES :-

1. MS FLAT SHALL RUN ON TOP TIER ALL ALONG THE CABLE TRENCHES & WELDED TO EACH OF THE RACKS.
2. MS FLAT SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

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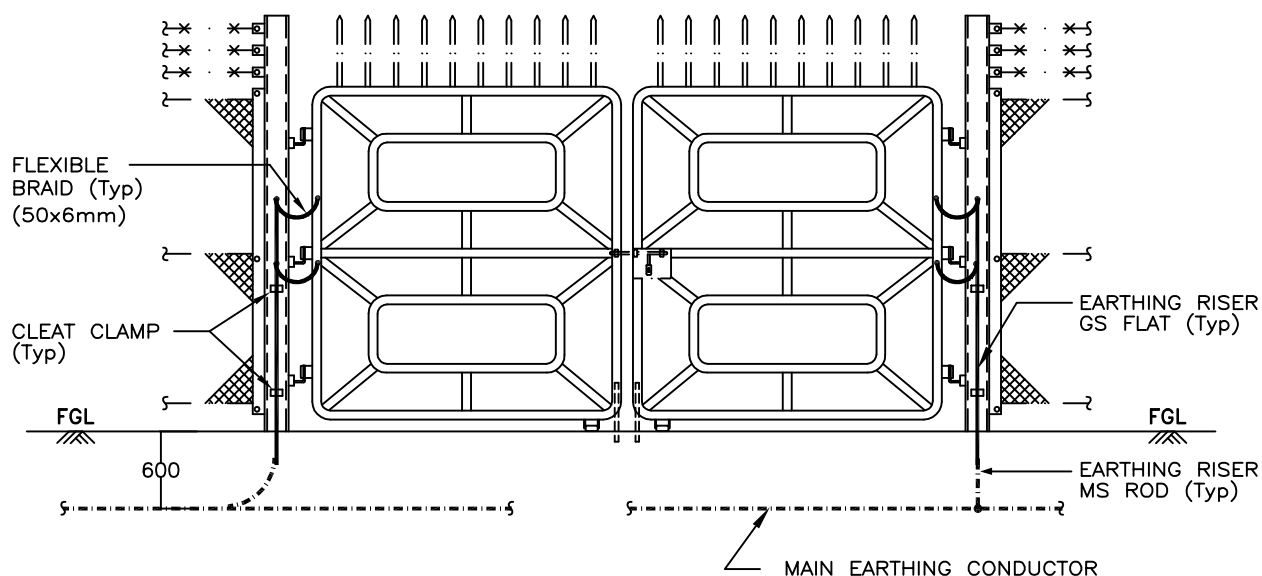


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

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EARTHING OF GATES



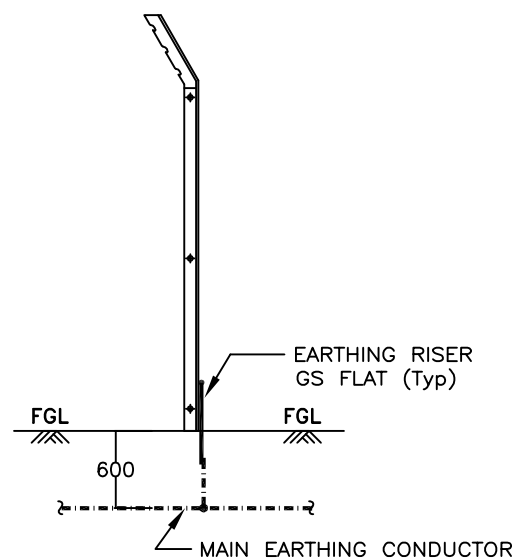
MAIN GATE

LEGEND

	40mm ϕ MS ROD
	75 x 12 mm GS FLAT
	50 x 6 mm MS FLAT

NOTES :-

	FENCE POST	MAIN GATE
1 . No. OF RISERS REQUIRED	1	2
2 . No. OF FLEXIBLE BRAID	—	4
3. ALL GATES & EVERY ALTERNATE FENCE SHALL BE CONNECTED TO EARTHING GRID.		



FENCE POST (ALTERNATE FENCE POST)

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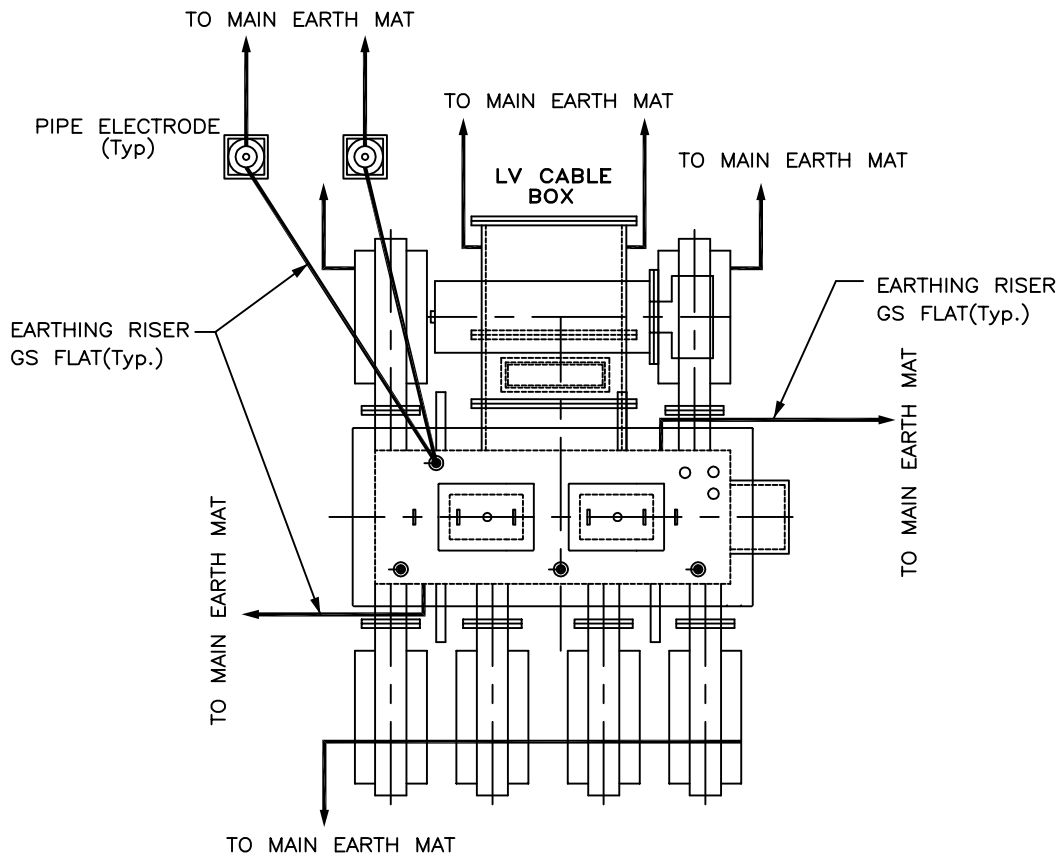


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

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EARTHING OF LT TRANSFORMER



PLAN

LEGEND

— · — · — · —	40mm \varnothing MS ROD
—————	75 x 12 mm GS FLAT
-----	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS FOR MAIN TANK & T.M. MAR. BOX = 4 Nos.
2. No. OF RISERS FOR LV CABLE BOX & RADIATOR = 4 Nos.
3. No. OF RISERS FOR PIPE ELECTRODE = 2 Nos.
4. No. OF PIPE ELECTRODES REQUIRED = 2 Nos.

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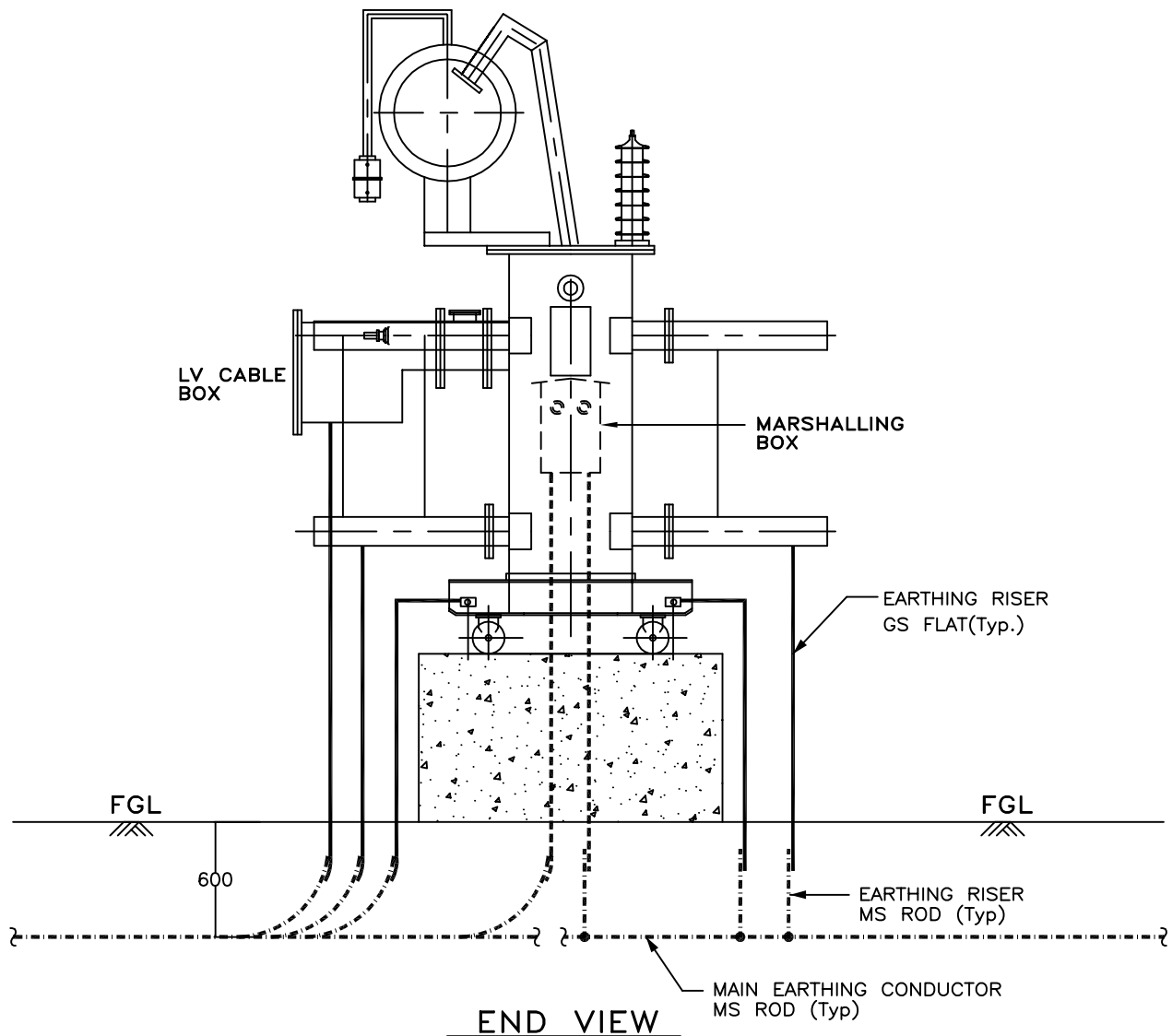


**PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION**

TITLE:- STANDARD EARTHING DETAILS

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EARTHING OF LT TRANSFORMER



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PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

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<i>KK Parshar</i>	<i>KK Parshar</i>	Dec-2013	

EARTHING OF PYLON SUPPORTS

Pylon supports shall be grounded through 50x6mm GI flat to the ring around the Pylon supports of 75x12mm GI flat which in turn is connected to the main grid (40 mm dia MS rod) at 2 to 3 points as available.

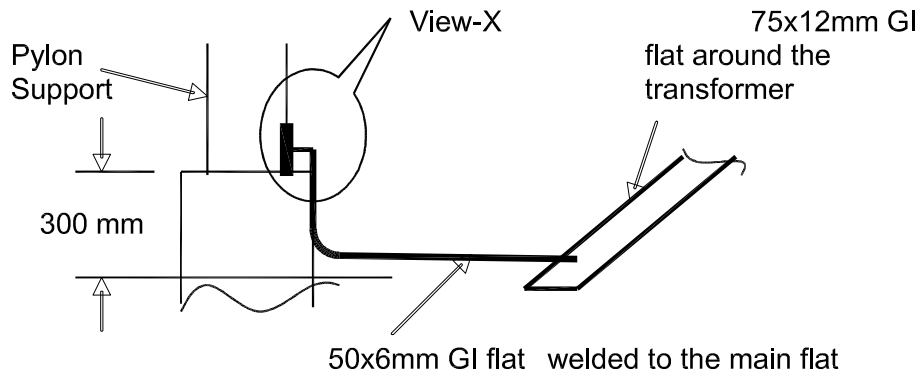


Fig.- Elevation (Earthing of Pylon Supports)

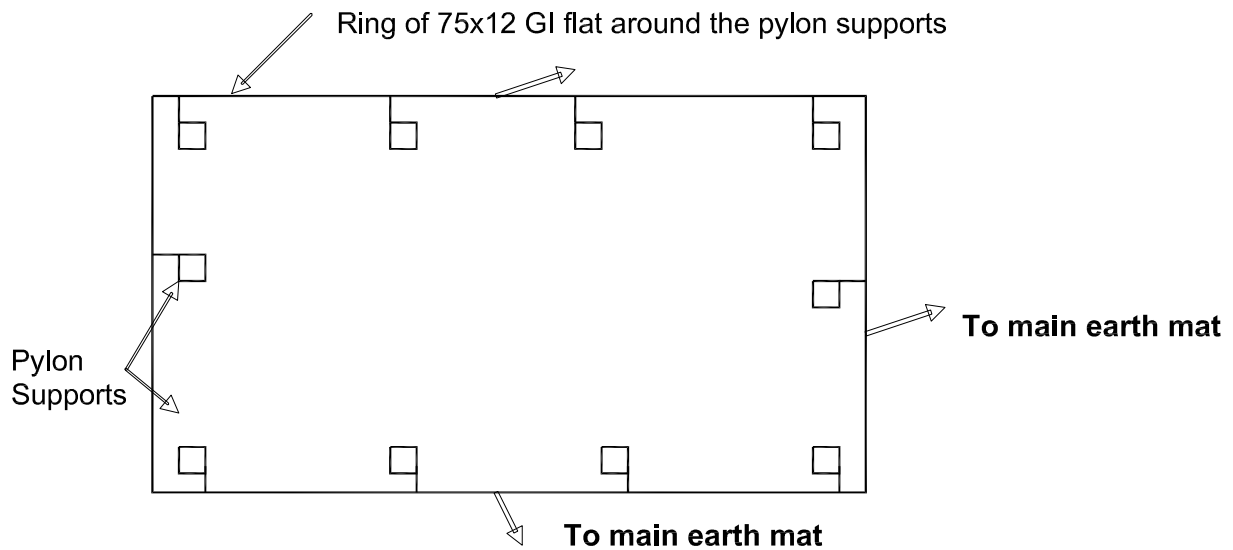


Fig.- Layout (Earthing of Pylon Supports)

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SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

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HK Pashar	HK Pashar	Dec-2013	

EARTHING OF HYDRANT/ HVW SPRAY PIPING

These pipes shall be grounded at pump house through 50x6mm GI flat connected to the main flat, 75x12mm running around the room.

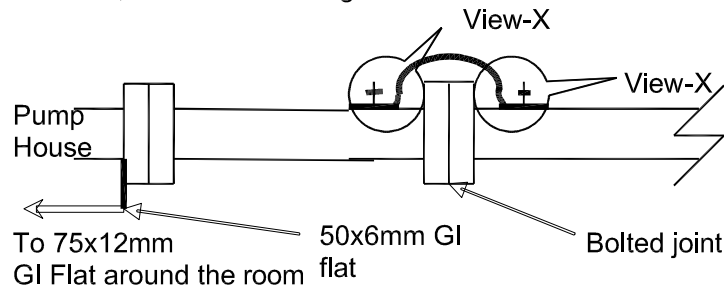


Fig.-Earthing of Hydrant / HVW Spray Piping

EARTHING OF HYDRANT POST/ HOSE BOX

A bolt shall be welded to these structures at the time of installation which can be used to connect them to the nearest riser or main 75x12mm GI flat through 50x6mm GI flat.

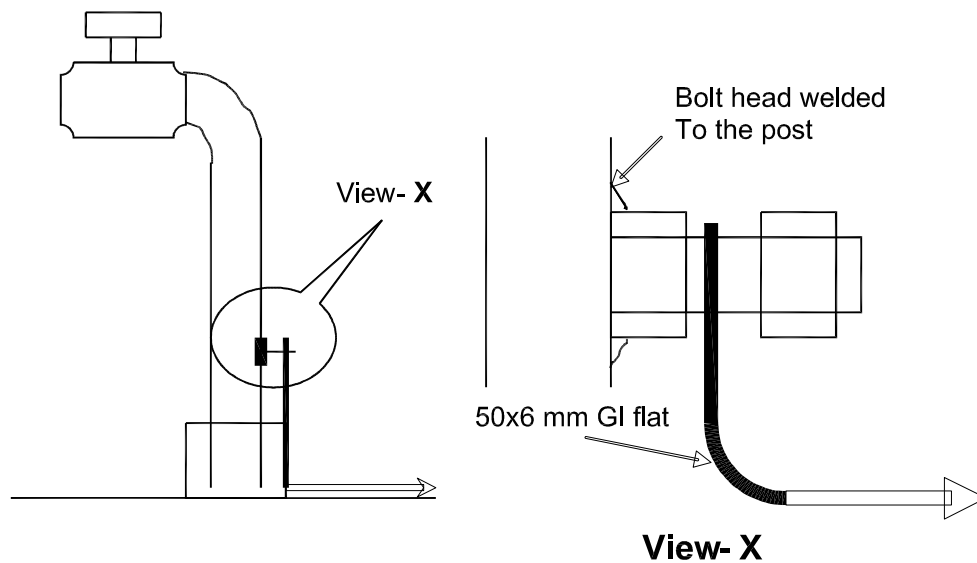


Fig.- Earthing of hydrant box / hose box

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SWITCHYARD ERECTION

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<i>KKPashar</i>	<i>KKPashar</i>	Dec-2013	

8.0 PRE-COMMISSIONING TESTS

8.1 An indicative list of tests is given below.

- (a) Operation check of LA counters.
- (b) Insulation resistance measurement
- (c) Capacitance and Tan delta measurement of individual stacks.
- (d) Third harmonic resistive current measurement (to be conducted after energisation.)
- (e) Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment **manufacturer** or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates **at his own cost**.

For pre-commissioning procedures and formats for Surge Arresters, Doc.No.: CF/SA/08/R-4 dtd-01/04/2013 under POWERGRID Document no. D-2-01-03-01-04 will be reference document. **This document will be available at respective sites and shall be referred by the contractor.**

TECHNICAL SPECIFICATION SECTION-SWITCHYARD ERECTION



पावरग्रिड

पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड

(भारत सरकार का उद्यम)

Power Grid Corporation of India Limited

(A Government of India Enterprises)

TECHNICAL SPECIFICATION

SECTION- SWITCHYARD ERECTION REVISION - 10

SECTION-(SE)
SWITCHYARD ERECTION

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SECTION-(SE)
SWITCHYARD ERECTION

1.0 GENERAL

This section covers erection of all equipment such as circuit breakers, isolators, current transformers, voltage transformers, surge arresters etc. This section also covers design, engineering, manufacture, testing at works, supply, insurance, handling, storage, erection, testing and commissioning of supply & erection of following items.

- String insulators and hardware
- AAC / ACSR conductor
- Galvanised Steel Earthwire
- Aluminium Tube
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

2.0 String Insulators & Hardware

The insulators for suspension and tension strings shall conform to IEC-60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486. Composite long rod polymer insulator shall conform to IEC:61109. Further, the contractor shall supply insulators as per details mentioned below:

A. Tension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations in coastal, pollution affected areas as identified in Section-Project and for all substations in Northern Region)	Composite Long Rod Polymer with 31mm/kV Creepage
2.	765kV, 400kV, 220kV & 132kV (for substations not covered in 1. above)	Composite Long Rod Polymer/Porcelain/Glass with 31mm/kV Creepage

B. Suspension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations)	Composite Long Rod Polymer with 31mm/kV Creepage

SECTION - (SE)

SWITCHYARD ERECTION

2.1 Construction Features (Porcelain & Glass Insulators)

2.1.1 Porcelain insulators

- a) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength, manufacturer's logo, month & year of manufacturing markings on porcelain printed and applied before firing.
- b) Porcelain used in insulator manufacturing shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- c) Glazing of the porcelain shall be of uniform brown colour, free from blisters, burrs and other similar defects.

2.1.2 Glass insulators

It **shall** be made of toughened glass. Glass used for the shells shall be sound, free from defects, flows bubbles, inclusions, etc and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.

2.1.2.1 When operating at normal rated voltage, there shall be no electric discharge between conductor and insulator which would cause corrosion or **damage** to conductors or insulators by the formation of substances due to chemical action.

2.1.2.2 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS-209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

2.1.2.3 Contractor shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

2.1.3 Hardware Fittings

2.1.3.1 Clamps for insulator strings and Corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.

2.1.3.2 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

2.1.3.3 The tension Insulator hardware assembly shall be designed for minimum 21000 kg tensile load for 765kV and minimum 12000 kg tensile load for hardware

SECTION - (SE)

SWITCHYARD ERECTION

assembly below 765kV. Earth wire tension clamp shall be designed for minimum 1000 kg tensile load with a factor of safety of two (2).

2.1.3.4 The tension string assemblies shall be supplied alongwith suitable turn buckle. Sag compensation springs if required may also be provided.

2.1.3.5 All hardware shall be bolted type.

2.2 Tests

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

2.2.1 Type Tests on Insulator Strings: The test reports for following type tests shall be submitted for approval as per clause 9.0 of Section - GTR.

- a) Power frequency voltage withstand test with corona control rings (**if applicable**) under wet condition as per IEC- 60383.
- b) Switching surge voltage withstand test [400 kV and above class only] under wet condition as per IEC-60383.
- c) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383
- d) Voltage distribution test (Dry) [**applicable for disc insulator string only**]

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 6.5% for 765 kV suspension and tension insulator strings, 9% and 10% for 400KV suspension string and tension insulator string respectively, 13% for 220KV suspension and tension insulator strings, 20% and 22% for 132KV suspension and tension insulator strings respectively.

- e) Corona Extinction Voltage test (Dry) [**220kV** and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage **as specified at clause 2.3.2**. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

- f) RIV Test (Dry) [**220kV** and above class only]

Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage as **specified in clause 2.3.2 of this section**. The test procedure shall be in accordance with IS 8263/IEC 60437.

- g) Mechanical strength test: The test shall be carried out as per following procedure.

SECTION - (SE)

SWITCHYARD ERECTION

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.2.2 Type Tests on String Insulator Units

Type test report for Thermal Mechanical Performance tests (**applicable for porcelain type insulators**) as per IEC-60575, Clause 3 shall be submitted for approval as per clause 9.2 of Section - GTR.

2.2.3 Acceptance Tests for Insulators:

- a) Visual examination as per IEC-60383/ IEC-61109 clause no. 7.2 (for composite long rod insulators).
- b) Verification of Dimensions as per IEC- 60383.
- c) Temperature cycle test as per IEC- 60383.
- d) Puncture Test as per IEC-60383 (Applicable only for porcelain insulators).
- e) Galvanizing Test as per IEC- 60383.
- f) Mechanical performance test as per IEC-60575 Cl. 4 / IEC-61109 clause no. 7.2 (for composite long rod insulators).
- g) Test on locking device for ball and socket coupling as per IEC-60372(2).
- h) Porosity test as per IEC- 60383 (Applicable only for porcelain insulators).
- i) Thermal shock test as per IEC-60383 (Applicable only for glass insulators)

2.2.4 Acceptance Test on Hardware Fitting

- a) Visual Examination as per Cl. 5.10 of IS: 2486 (Part-I).
- b) Verification of Dimensions as per Cl. 5.8 of IS:2486 (Part-I)
- c) Galvanising/Electroplating tests as per Cl. 5.9 of IS:2486 (Part-I).
- d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)
- e) Shore hardness test **by** the Elastometer

SECTION - (SE)

SWITCHYARD ERECTION

- f) Mechanical strength test for each component (including corona control rings and arcing horns).

The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 2.2.1.(g) above should be followed.

- g) Test on locking devices for ball and socket coupling as per IEC -60372(2).

2.2.5 Routine Test on Insulator

- a) Visual Inspection as per IEC-60383
- b) Mechanical Routine Test as per IEC-60383
- c) Electrical Routine Test as per IEC-60383

2.2.6 Routine Test on hardware Fittings

- a) Visual examination as per Cl 5.10 of IS:2486 (Part-I)
- b) Mechanical strength Test as per Cl. 5.11 of IS:2486 (Part-I)

2.2.7 Test during manufacture on all Components as applicable on insulator

- a) Chemical analysis of zinc used for galvanising: Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209. The purity of zinc shall not be less than 99.95%.
- b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:

The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Program.

2.2.8 Test during manufacture on all components as applicable on hardware fittings:

- a) Chemical analysis of zinc used for galvanising:
- Samples taken from the zinc ingot shall be chemically analyzed as per IS:209. The purity of zinc shall not be less than 99.95%
- b) Chemical analysis, hardness tests and magnetic particle for Forgings/
fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for forgings/fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

SECTION - (SE) **SWITCHYARD ERECTION**

2.3 Guaranteed technical Particular For

2.3.1 Disc Insulators

Sl. No.	Description	For 765kV	For 400/220/132kV
a)	Type of insulators	Anti Fog type	Anti Fog type
b)	Physical Size of insulator units		
(i)	Diameter of Disc	As per IEC	As per IEC
(ii)	Ball to ball spacing between discs	170 mm	145 mm
c)	Electro mechanical strength	210 kN	120 kN
d)	Minimum Creepage distance of individual insulator units	460 mm	430 mm
e)	Markings		
i)	For Porcelain insulators	Markings on porcelain	Markings on porcelain
ii)	For toughened glass insulators	Markings shall be done on initial parts	Markings shall be done on initial parts
f)	Power frequency puncture withstand voltage	1.3 times the actual wet flashover voltage	1.3 times the actual wet flashover voltage

2.3.2 INSULATOR STRING

Sl. No.	Description	765 kV	400kV	220kV	132kV
a)	Power frequency withstand voltage of the complete string with corona control ring (wet) – KV rms	870	680	460	275
b)	Lightning impulse withstand Voltage of string with corona control rings (dry) - kVp	± 2100	± 1550	± 1050	± 650
c)	Switching surge withstand voltage of string with corona control rings (wet) - kVp	± 1550	± 1050	NA	NA
d)	Minimum corona extinction voltage level of string with Corona Control rings (dry) - kV rms	508	320	156	NA
e)	Maximum RIV level in micro volts of string with Corona Control rings across 300 Ohms resistor at 1 MHz	1000 (Max) at 508 kV	1000 (Max) at 320 kV	1000 (Max) at 156 kV	NA
f)	Minimum total creepage distance of the insulator string (mm)	24800	13020	7595	4495
g)	Minimum no. of discs per string (for tension string if applicable)	54	31	18	11

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h)	Electromechanical strength of Insulator Unit. (KN)	210	120	120	120
----	---	-----	-----	-----	-----

For tension application:-

Double insulator strings for 765kV, 400kV, 220kV and single insulator strings for 132 kV systems shall be used.

For suspension application:-

V-type polymer insulator string shall be used for 765kV system and single suspension polymer insulator string shall be used for 400kV, 220kV & 132 kV systems.

2.4 COMPOSITE LONG ROD POLYMER INSULATOR

Bidder shall offer composite long rod polymer insulators with suitable hardware fittings.

2.4.1 Details of Composite Long Rod Insulators

2.4.1.1 Insulators shall have sheds of the "open aerodynamic profile without any under ribs" with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

2.4.1.2 Ball and socket shall be 20mm designation for 120kN & 24mm designation for 210kN Insulators in accordance with the standard dimensions stated in IEC:60120/ IS:2486 (Part-II). Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have laser markings on housings for manufacturer's name, month & year of manufacturing, rated strength markings on each composite insulator rod unit. No negative tolerance shall be applicable to creepage distance of composite insulators

2.4.1.3 **All ferrous parts shall be hot dip galvanized as per Section-GTR with minimum weight of zinc coating as 610 gm/sq.m for normal area and 900 gm/sq.m for coastal area as specified in Section-Project.**

2.4.2 Material

2.4.2.1 Core

It shall be a glass-fiber reinforced (FRP) epoxy resin rod of high strength. The rod shall be resistant to hydrolysis. The rod shall be of electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

2.4.2.2 Housing & Weathersheds

The FRP rod shall be covered by a sheath of a silicone rubber compound of a thickness of minimum **5mm**. The housing & weathersheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-

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destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core.

The weathersheds of the insulators shall be of alternate shed profile. The weathersheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

2.4.2.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron/ spheroidal graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The sealing shall stick to both housing and metal end fitting. The sealing must be humidity proof and durable with time.

End fittings shall have suitable provisions for fixing grading rings at the correct position as per design requirements.

2.4.2.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The insulator supplier shall furnish design calculations using appropriate electric field software showing electric field at surface of housing, inside housing & core and at the interface of housing and metal fittings with the proposed placement and design of corona **rings**. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The design & supply of grading rings shall be in the scope of the composite insulator supplier.

2.4.3 Tests

2.4.3.1 Type Tests

The test reports for following type tests on long rod units, components, materials or complete strings shall be submitted for approval as per clause 9.2 of Section - GTR.

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2.4.3.1.1 On the complete composite Long Rod Polymer Insulator String with Hardware Fittings:-

- a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns (if provided) under wet condition as per IEC:60383-1993.
- b) Switching surge voltage withstand test under wet condition as per IEC:60383-1993.
- c) Impulse voltage withstand test under dry condition as per IEC:60383-1993
- d) Corona and RIV test under dry condition. [132kV and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage as specified in clause 2.3.2 of this section. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

Under the conditions as specified above the insulator string along with complete hardware fittings shall have a radio interference voltage level as specified in clause 2.3.2 of this section. The test procedure shall be in accordance with IS 8263/IEC-60437.

- e) Mechanical Strength test: The test shall be carried out as per following procedure.

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

- f) Salt-fog pollution withstand test as per IEC: 60507. The salinity level for composite long rod insulators shall be 160 Kg/m³ NaCl.

2.4.3.1.2 On Composite Polymer Insulator Units

- a) Tests on interfaces and connections of metal fittings as per IEC: 61109-2008.
- b) Assembled core load time test as per IEC: 61109-2008.
- c) Damage limit proof test and test of tightness of interface between end fittings and insulator housing as per IEC: 61109-2008
- d) High Pressure washing test

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The washing of a complete insulator of each E&M rating is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, the washing shall be carried out for 10minutes. There shall be no damage to the sheath or metal fitting to housing interface. The verification shall be done by 1 minute wet power frequency withstand test at 680kV r.m.s for 400KV.

e) Brittle fracture resistance test

The test arrangement shall be according to Damage limit proof test with simultaneous application of 1N-HNO₃ acid directly in contact with naked FRP rod. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm. The rod shall withstand 80% of SML for 96 hours.

f) Dye penetration test as per IEC: 61109-2008

g) Water diffusion test as per IEC: 61109-2008

h) Tracking and erosion test as per IEC: 61109-2008.

i) Hardness test as per IEC: 61109-2008.

j) Accelerated weathering test as per IEC: 61109-2008.

k) Flammability test as per IEC: 61109-2008.

l) Silicone content test

Minimum content of silicone shall be 30% and the same shall be verified through FT-IR spectroscopy & TGA analysis or any other approved/ acceptable method.

m) Recovery of Hydrophobicity test

1. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.
2. Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.
3. Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.
4. Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

n) Torsion test

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Three complete insulators of each electrical and mechanical rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

- o) Accelerated ageing test of 5000hrs as described in appendix-C of IEC 61109 or Test at multiple stresses of 5000 hrs as described in Annex-B of IEC - 62217

2.4.3.2

Acceptance Tests:

For Composite Long Rod Polymer Insulators

a.	Verification of dimensions	IEC : 61109-2008
b.	Galvanizing test	IEC : 60383
c.	Verification of end fittings	IEC : 61109-2008
d.	Recovery of Hydrophobicity	As per Cl. 2.4.3.1.2.m) above
e.	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109-2008
f.	Silicone content test	As per Cl. 2.4.3.1.2.l) above
g.	Brittle fracture resistance test	As per Cl. 2.4.3.1.2.e) above
h.	Dye penetration test	IEC : 61109-2008
i.	Water diffusion test	IEC : 61109-2008

In the event of failure of the sample to satisfy the acceptance test(s) specified in **2.4.3.2** above, the **re-test** procedure shall be as per IEC 61109.

2.4.3.3

Routine Tests

For Composite Long Rod Polymer Insulator Units

a)	Visual Examination	As per IEC:61109-2008
b)	Mechanical routine test	As per IEC:61109 -2008

2.4.4

Guaranteed Technical Particulars for Composite Long Rod Polymer Insulators

The technical parameters for composite long rod polymer insulator string shall be same of the insulator string specified in clause 2.3.2 of this section.

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3.0 AAC / ACSR CONDUCTOR

3.1 Details of AAC Conductor

- 3.1.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

The contractor shall supply the conductor as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.2 Details of ACSR Conductor

- 3.2.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

- 3.2.2 The details of the ACSR Bersimis, ACSR Moose, ACSR Zebra and ACSR Panther conductors shall be as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.3 Workmanship

- 3.3.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (**protrusion** of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

- 3.3.2 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions, etc., after drawing.

- 3.3.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the guaranteed technical particulars. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 60888.

- 3.3.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanisation during pre-forming and post-forming operation.

3.4 Joints in Wires

3.4.1 Aluminium Wires

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

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

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

3.4.2 Steel Wires

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

3.5 Tolerances

The manufacturing tolerances to the extent indicated in the guaranteed technical particulars shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

3.6 Materials

3.6.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC:60889.

3.6.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the guaranteed technical particulars.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

3.6.3 Zinc

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

3.7 Standard Length

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

3.8 Tests:

3.8.1 The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

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3.8.1.1 Type Tests

In accordance with the stipulation of specification, the following type tests reports of the conductor shall be submitted for approval as per clause 9.2 of Section -GTR.

- | | | | |
|-----|--|---|-------------------|
| a) | UTS test on stranded conductor. |) | |
| | |) | |
| | |) | |
| b) | Corona extinction voltage test (dry) |) | As per Annexure-A |
| | |) | |
| | |) | |
| (c) | Radio Interference voltage test (dry) |) | |
| | |) | |
| | |) | |
| (d) | DC resistance test on stranded conductor |) | |
| | |) | |

3.8.1.2 Acceptance Tests

- | | | | |
|----|--|---|--------------------------|
| a) | Visual check for joints, scratches etc. and lengths of conductor |) | As per Annexure - A |
| | |) | |
| | |) | |
| b) | Dimensional check on steel and aluminium strands |) | |
| | |) | |
| | |) | |
| c) | Check for lay ratios of various layers |) | -do- |
| | |) | |
| | |) | |
| d) | Galvanising test on steel strands |) | |
| | |) | |
| | |) | |
| e) | Torsion and Elongation test on steel strands |) | |
| | |) | |
| | |) | |
| f) | Breaking load test on steel and aluminium strands |) | |
| | |) | |
| | |) | |
| g) | Wrap test on steel and aluminium strands |) | As per IEC:60888 & 60889 |
| | |) | |
| | |) | |
| h) | DC resistance test on aluminium strands |) | As per IEC:60889 |
| | |) | |
| | |) | |
| i) | UTS test on welded joint of aluminium strands |) | As per Annexure - A |
| | |) | |
| | |) | |

NOTE:

All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.

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3.8.1.3 Routine Tests

- a) Check to ensure that the joints are as per specification.
- b) Check that there are no cuts, fins etc. on the strands.
- c) All acceptance tests as mentioned above to be carried out on each coil/drum (as applicable).

3.8.1.4 Tests During Manufacture

- a) Chemical analysis of zinc used for galvanising)
)
)
- b) Chemical analysis of aluminium used for making aluminium strands) As per Annexure - A
)
)
- c) Chemical analysis of steel used for making steel strands)
)
)

4.0 Galvanised Steel Earth wire

4.1 Details of Earth wire

- 4.1.1** The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IEC:60888/IS: 398 (Part-II)-1976 except where otherwise specified herein.

The contractor shall supply the earthwire as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval **for guaranteed technical particulars** is not required during detailed engineering.

4.2 Workmanship

- 4.2.1** All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.
- 4.2.2** The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.
- 4.2.3** The steel strands shall be hot dip galvanised and shall have minimum Zinc coating after stranding, as stipulated in guaranteed technical particulars attached with. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-74.
- 4.2.4** The steel strands shall be preformed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanisation during preforming and postforming operation.
- 4.2.5** To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

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4.3 Joints in Wires

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

4.4 Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in guaranteed Technical Particulars attached with this specification shall only be permitted in the diameter of the individual steel strands and lay length of the earth wire.

4.5 Materials

4.5.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Guaranteed Technical Particulars attached with.

4.5.2 Zinc

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

4.6 Standard Length

4.6.1 The standard length of the earth wire shall be as stipulated in Guaranteed Technical Particulars attached with, with the specified tolerance on standard length.

4.8 TESTS

4.8.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

4.8.2 TYPE TESTS

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval as per clause 9.2 of Section - GTR.

- | | | | |
|----|--------------------|---|---------------------|
| a) | UTS test |) | |
| | |) | |
| b) | DC resistance test |) | As per Annexure - B |

4.8.3 ACCEPTANCE TESTS

- | | | | |
|----|---|---|---------------------|
| a) | Visual check for joints, scratches etc. and length of Earthwire |) | |
| | |) | |
| | |) | |
| | |) | |
| b) | Dimensional check |) | As per Annexure - B |
| | |) | |
| c) | Galvanising test |) | |
| | |) | |
| d) | Lay length check |) | |
| | |) | |

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

4.8.4 ROUTINE TESTS

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

4.8.5 TESTS DURING MANUFACTURE

- | | | | |
|----|--|---|---------------------|
| a) | Chemical analysis of zinc used for galvanising |) | As per Annexure - B |
| | |) | |
| b) | Chemical analysis of steel |) | |

5.0 ALUMINIUM TUBE

5.1 General

Aluminium used shall be grade 63401 WP (range 2) conforming to IS:5082.

The contractor shall supply the aluminium tubes as per the standard guaranteed technical particulars enclosed in Annexure-E of **this section** and separate approval **for guaranteed technical particulars** is not required during detailed engineering.

5.2 Constructional Features

- 5.2.1 For outer diameter (OD) & thickness of the tube there shall **not** be **any negative** tolerance, other requirements being as per IS: 2678 and IS: 2673.
- 5.2.2 The welding of aluminium tube shall be done by the qualified welders duly approved by the Employer.

5.3 Tests

In accordance with stipulations of the specification, Routine tests shall be conducted on tubular bus conductors as per IS:5082. Also the wall thickness and ovality of the tube shall be measured.

5.4 Technical Parameters

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE	4.5" AL. TUBE	5" AL. TUBE
1.	Type	3" IPS	4" IPS	4.5" IPS	5" IPS

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		(EH Type)	(EH Type)	(EH Type)	(H Type)
2.	Outer diameter	88.9 mm	114.2 mm	120.00 mm	141.30 mm
3.	Thickness	7.62 mm	8.51 mm	12.00 mm	9.53 mm
4.	Cross-sectional area of aluminium	1945.76 sq.mm	2825.61 sq.mm	4071.50 sq.mm	3945.11 sq.mm
5.	Weight	5.25 kg/m	7.7 kg/m	11.034 kg/m	10.652 kg/m

Sl. No.	Description	6" AL. TUBE	8" AL. TUBE	10" AL. TUBE
1.	Type	6" IPS (H Type)	8" IPS (H Type)	10" IPS (H Type)
2.	Outer diameter	150 mm	202 mm	252 mm
3.	Thickness	10 mm	16 mm	17 mm
4.	Cross-sectional area of aluminium	4398.2 Sq mm	9349.3 sq.mm	12550.6 sq.mm
5.	Weight	11.875 kg/m	25.243 kg/m	33.887 kg/m

6.0 **EARTHING CONDUCTORS**

6.1 **General**

All conductors buried in earth and concrete shall be of mild steel. All conductors above ground level and earthing leads shall be of galvanised steel, except for cable trench earthing. The minimum sizes of earthing conductor to be used are as indicated in clause 9.4 of this Section.

6.2 **Constructional Features**

6.2.1 **Galvanised Steel**

- a) Steel conductors above ground level shall be galvanised according to IS:2629.
- b) The minimum weight of the zinc coating shall be **610 gm/sq.m for normal area and 900 gm/sq.m for coastal area as specified in Section-Project** and minimum thickness shall be 85 microns.
- c) The galvanised surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surfaces of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

6.3 **Tests**

In accordance with stipulations of the specifications galvanised steel shall be subjected to four one minute dips in copper sulphate solution as per IS : 2633.

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7.0 SPACERS

7.1 General

Spacers shall conform to IS: 10162. The spacers are to be located at a suitable spacing to limit the short circuit forces as per IEC -60865. Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are being used, the spacer span(s) for different conductor / span configurations and corresponding short circuit forces shall be as per Annexure-D. For strung buses, flexible type spacers shall be used whereas for jumpers and other connections rigid type spacers shall be used. All quad/twin conductors between equipments/ bus shall be provided with at least one spacer.

Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are not being used, necessary spacer span calculation shall be provided by the contractor during detailed engineering for the approval of Employer.

7.2 Constructional Features

7.2.1 No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

7.2.2 Spacer design shall be made to take care of fixing and removing during installation and maintenance.

7.2.3 The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

7.3 Tests

Each type of spacers shall be subjected to the following type tests, acceptance tests and routine tests:

7.3.1 **Type Tests: Following type test reports shall be submitted for approval as per clause 9.2 of Section - GTR.**

a) **Clamp slip tests**

The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2 kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests shall be performed on the other clamps of the same sample.

b) Fault current test as per CI 5.14.2 of IS: 10162. Alternately, the same can be carried by simulated short circuit method for which compressive forces shall be based on IEC-60865.

c) Corona Extinction Voltage Test (Dry).

This test shall be performed on 765 kV, 400 kV and 220 kV spacers as per procedure mentioned at Annexure - C, Minimum Corona Extinction voltage shall be as per clause 2.3.2.

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d) RIV Test (Dry)

This test shall be performed as per procedure mentioned at Annexure - C, Maximum RIV levels shall be as per clause 2.3.2.

e) Resilience test (if applicable)

f) Tension Test

g) Log decrement test (if applicable)

h) Compression test

i) Galvanising test

7.3.2 Acceptance Test (As per IS:10162)

a) Visual examination

b) Dimensional verification

c) Movement test

d) Clamp slip test

e) Clamp bolt torque test (if applicable)

f) Assembly torque test

g) Compression test

h) Tension test

i) Galvanising test

j) Hardness test for neoprene (if applicable)

The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.

k) Ultimate Tensile Strength Test

The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. mm.

7.3.3 Routine test

a) Visual examination

b) Dimensional verification

8.0 BUS POST INSULATORS

The post insulators shall conform in general to latest IS: 2544, IEC-60168, IEC 60273 and IEC-60815.

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8.1 Constructional Features

- 8.1.1 Bus Post insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.
- 8.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 8.1.3 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.
- 8.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-60815 for the specified pollution level.
- 8.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or damage to conductors or insulators by the formation of substance produced by chemical action.
- 8.1.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 8.1.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS: 2633, & IS: 2629. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.
- 8.1.8
- a) Every bolt shall be provided with a hot dip galvanised steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.
 - b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
 - c) All bolts and nuts shall be of steel with well formed hexagonal heads forged from the solid and shall be hot dip galvanised. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.
- 8.1.9 Bidder shall furnish drawings for the essential design features of assembly of shells and metal parts, and number of shells per insulator.

8.2 Tests

In accordance with the stipulations of the specification, the post insulators shall be subjected to type, acceptance, sample and routine tests as per IEC-60168.

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8.2.1 In accordance with the stipulation of specification, the following **type tests** reports of the post insulators shall be submitted for approval as per clause 9.2 of Section - GTR.

- a) Power frequency withstand test (dry & wet)
- b) Lightning impulse test (dry)
- c) Switching impulse test (wet) (For 420 kV and above class Insulator only)
- d) Measurement of R.I.V (Dry) (As per Annexure – C)
- e) Corona extinction voltage test (Dry) (As per Annexure – C)
- f) Test for deflection under load
- g) Test for mechanical strength.

8.2.2 In addition to acceptance/sample/routine tests as per IEC-60168, the following tests shall also be carried out.

- a) Soundness test, metallurgical tests and magnetic particle Inspection (**MPI**) test on MCI/SGI caps as acceptance test.
- b) All hot dip galvanised components shall be subjected to check for uniformity of thickness and weight of zinc coating on sample basis as an acceptance test.
- c) The bending test shall be carried out at 50% minimum cantilever strength load in four directions as a routine test and at 100% minimum cantilever strength load in four directions as an acceptance test.
- d) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

8.3 Technical Parameters of Bus Post Insulators.

Sl. No.	Description	800 kV	420 kV	245 kV	145 kV
a)	Type	Solid Core	Solid Core	Solid Core	Solid Core
b)	Voltage Class (kV)	800	420	245	145
c)	Dry and wet one minute power frequency withstand voltage (kV rms)	830	680	460	275
d)	Dry lightning impulse withstand Voltage (kVp)	±2100	±1425	±1050	±650
e)	Wet switching surge withstand voltage (kVp)	±1550	±1050	—	—
f)	Max. radio interference voltage (in microvolts) - Dry	1000 at 508 kV	500 at 305 kV	500 at 156 kV	500 at 105 kV
g)	Corona extinction voltage (kV rms) (min.)	508	320	156	105

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h)	Cantilever Strength				
(i)	Total minimum cantilever strength (Kg)	800	800	800	600
i)	Minimum torsional moment	As per IEC-60273	As per IEC-60273	As per IEC-60273	As per IEC-60273
j)	Total height of insulator (mm)	5700	3650	2300	1500
k)	P.C.D Top (mm)	225	127	127	127
	Bottom (mm)	325	300	254	254
l)	No. of bolts				
	Top	4	4	4	4
	Bottom	8	8	8	8
m)	Diameter of bolt/holes (mm)				
	Top	M16	M16	M16	M16
	Bottom dia	18	18	18	18
n)	Pollution level as per IEC-60815	Heavy(III)	Heavy(III)	Heavy(III)	Heavy(III)
o)	Minimum total creepage distance for Heavy Pollution (mm)	20000	10500	6125	3165

- 8.3.1 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor. Aluminium used for corona ring shall be of grade 63401 or 19501 conforming to IS:5082.

9.0 EARTHING

- 9.1 The earthing shall be done in accordance with requirements given hereunder and drawing titled 'Earthing Details' enclosed with the specification. The spacing for the main earthmat shall be provided by the Employer and the earthmat layout drawings shall be prepared by the contractor based on the spacing provided by the Employer. The resistivity of the stone for spreading over the ground shall be considered as 3000 ohm-m under wet condition. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the minimum resistivity value of stone considered in earth mat design. For measurement purpose, one sample of stones from each source (in case stones are supplied from more than one source) shall be used. The main earthmat shall be laid in the switchyard area in accordance with the approved earthmat layout.
- 9.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.
- 9.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.
- a) Code of practice for Earthing IS: 3043

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- b) Code of practice for the protection of Building and allied structures against lightning IS: 2309.
- c) CEA Safety Regulations 2010 & Indian Electricity Act 2003 with latest amendments.
- d) National Electricity Safety code IEEE-80.

9.4

Details of Earthing System

Sl. No.	Item	Size	Material
a)	Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod as per IS:2062/SAE1018
b)	Conductor above ground& earthing leads (for equipment)	75x12mm G.S. flat	Galvanised Steel
c)	Conductor above ground& earthing leads(for columns & aux. structures)	75x12mm G.S. flat	Galvanised Steel
d)	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, Junction boxes& Lighting Panels etc.	50x6 mm G.S. flat	Galvanised Steel
e)	Rod Earth Electrode	40mm dia, 3000mm long	Mild Steel as per IS:2062/SAE1018
f)	Pipe Earth Electrode (in treated earth pit) as per IS.	40mm dia, 3000mm long	Galvanised steel
g)	Earthing for motors	25x3mm GS flat	Galvanised steel
h)	Earthing conductor along outdoor cable trenches	50x6mm MS flat	Mild steel as per IS:2062/SAE1018
l)	Earthing of Lighting Poles (for lighting poles outside switchyard)	40 mm dia 3000 mm long	Mild steel rod as per IS:2062/SAE1018
j)	Isolator MOM Box	75X12 mm GS flat & Flexible copper braid	Galvanised steel and copper braid

The sizes of the earthing conductor indicated above are the minimum sizes.

9.5

Earthing Conductor Layout

9.5.1

Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.

9.5.2

Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.

9.5.3

Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on the earthing terminals of the equipment/structure as per –Standard Earthing Details – Drg No. **C/ENG/STD/EARTHINGS/09**” enclosed.

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- 9.5.4 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc., PVC sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- 9.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.
- 9.5.6 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit the site conditions.
- 9.5.7 Earthing conductors embedded in the concrete shall have approximately 50mm concrete cover.

9.6 ELECTRO-MAGNETIC FIELD CONTROL

The contractor shall provide galvanised steel earth wire at 8m level in the area where three interconnection levels (equipment interconnection, bus & jack bus interconnection) are present at 765kV switchyard to limit electric and magnetic field within permissible limit.

9.7 Equipment and Structure Earthing

- 9.7.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Employer.
- 9.7.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.
- 9.7.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
- 9.7.4 Metallic conduits shall not be used as earth continuity conductor.
- 9.7.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- 9.7.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- 9.7.7 Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.
- 9.7.8 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

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The stone spreading shall also be done 2000 mm outside switchyard fence. The criterion for stone spreading shall be followed in line with requirement specified elsewhere in the specification

- 9.7.9 Flexible earthing connectors shall be provided for the moving parts.
- 9.7.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules
- 9.7.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.
- 9.7.12 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Zinc riched enamel paint.
- 9.7.13 One number 40 mm dia, 3000 mm long MS earth electrode with test link, GI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive voltage transformers, lightning masts and towers with peak.
- 9.8 **Jointing**
- 9.8.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.
- 9.8.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.
- 9.8.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 9.8.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 9.8.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 9.8.6 All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.
- 9.8.7 The 75x12mm GS flat shall be clamped with the equipment support structures at 1000mm interval.

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9.9 Power Cable Earthing

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

9.10 Specific Requirement for Earthing Systems

9.10.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two numbers pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a ISI marked cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

9.10.2 Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.

9.10.3 Auxiliary earthing mat comprising of 40mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable.

9.11 Insulating mats

9.11.1 The scope covers supply and laying of insulating mats of "class A" conforming to IS: 15652-2006.

9.11.2 These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control & relay panels located in control room building/ Switchyard panel room.

9.11.3 The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature.

9.11.4 Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat.

9.11.5 Insulating mat (**wherever applicable**) shall be of pastable type, to be fixed permanently on the front of the panels except for the chequered plate area which shall not be pasted as per requirement. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652.

9.11.6 Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements.

9.11.7 The insulating mats offered shall conform to IS: 15652-2006.

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10.0 Bus Bars

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification. The bus bar arrangements are shown in electrical layout drawings enclosed with the bid documents.

10.1 The Contractor shall furnish supporting calculations where the design is to be done by the contractor for the bus bars/conductors to show adequacy of design parameters for:

- a) Fibre-stress (applicable for aluminum tube)
- b) Cantilever strength of post insulators (applicable for aluminum tube)
- c) Aeolian vibrations (applicable for aluminum tube)
- d) Vertical deflection of bus bars (applicable for aluminum tube)
- e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

10.1.1 The welds in the aluminium tubes shall be kept to the minimum and there shall not be more than one weld per span. The procedure and details of welding shall be subject to Employer's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length

10.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminium alloy similar to that of clamps & connectors.

10.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

10.1.4 Details of past experience of the persons proposed to be employed for Aluminium tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished **to Employer**. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX.

10.1.5 Joints shall be avoided in strung bus to avoid joint failure / hot spots and hardwares to be designed accordingly.

11.0 BAY EQUIPMENT

11.1 The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

11.2 Bay Marshalling Kiosk:-

Bay marshalling kiosk shall be fabricated from 304 grade stainless steel of minimum thickness of 1.6mm. For other constructional details, technical specification of section-GTR shall be referred. Further, for stainless steel type bay marshaling kiosk, no painting is envisaged.

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One no. of bay marshalling kiosk shall be provided for each 765 kV, 400 kV, 220 kV and 132 kV bay under present scope. For one and half breaker scheme, one number bay marshalling kiosk shall be provided for each controlling feeder (Line/ transformer/ bus reactor etc) of the diameter and no bay marshalling kiosks are required to be provided for the tie bays. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose:-

A. For 765kV , 400 kV & 220 kV Bays

- (i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum nine (9) numbers outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.
- (ii) To distribute minimum two numbers outgoing 415V, 63Amps three phase supplies to be controlled by MCB to be drawn from above 3 phase incomers for supply to switchyard panel rooms.
- (iii) To distribute minimum ten numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.
- (iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

B. For 132kV & 66 kV Bays

- (i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum four (4) number outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.
- (ii) To distribute minimum six (6) numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.
- (iii) 100 nos. terminal blocks in vertical formation for interlocking facilities for substations without automation system.
- (iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

11.3 Further, all Bay Marshalling Kiosks shall be erected such that a minimum height of 1000mm is maintained between FGL & bottom of the marshalling box. Size of Marshalling box shall be such that cables are properly terminated and wires are dressed with provision of loop.

11.4 BAY AND PHASE IDENTIFICATION

11.4.1 The name plate for the bays shall be provided by the contractor as per standard drawing (Drawing no. C/ENG/STD/BAY NAME PLATE) enclosed in this technical specification.

11.4.2 All the phases are to be identified by painting the structures Red, Yellow and Blue by reflecting colour as per as built condition. Phase identification colour is to be provided around the top of the structure with colour band of 100 mm width at a height of approximately 2000mm from the finished ground level.

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12.0 LIGHTNING PROTECTION

- 12.1 Direct stroke lightning protection (DSLPP) shall be provided in the EHV switchyard by lightning masts and shield wires. The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLPP calculations.
- 12.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.
- 12.3 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- 12.4 Down conductors shall be cleated on the structures at 2000 mm interval.
- 12.5 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earthmat.
- 12.6 Lightning conductors shall not pass through or run inside G.I. conduits.
- 12.7 Lightning protection shall also be provided for various buildings like control building, FFPH, Township buildings as per relevant standard.

13.0 EQUIPMENT ERECTION DETAILS

- 13.1 All circuit breaker and isolator erection shall be done under the supervision of equipment manufacturer and erection of all switchyard equipments shall be done as per POWERGRID approved Field Quality Plan (FQP) and as per provision of Technical Specification.
- 13.2 For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.
- 13.3 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.
- 13.4 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- 13.5 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.
- 13.6 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- 13.7 Handling of equipment shall be done strictly as per manufacturer's/supplier's

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instructions/instruction manual.

13.8 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

13.9 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

14.0 STORAGE

14.1 The Contractor shall provide and construct adequate storage shed as per the Filed Quality Plan for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/Employer shall be strictly adhered to. POWERGRID approved Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.

15.0 CABLING MATERIAL

15.1 CABLE TAGS AND MARKERS

15.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

15.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

15.1.3 Location of cables laid directly underground shall be clearly indicated with cable route marker made of galvanised iron plate.

15.1.4 Location of underground cable joints shall be indicated with cable **route** marker with an additional inscription –Cable joints”.

15.1.5 The **cable route** marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings as per relevant standard.

15.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

15.2 Cable Supports and Cable Tray Mounting Arrangements

15.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

15.2.2 The supports shall be fabricated from standard structural steel members.

15.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other

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places these will be at an interval of 2000 mm.

- 15.2.4 Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure.

15.3 Cable Termination and Connections

- 15.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.
- 15.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.
- 15.3.3 Supply of all consumable material shall be in the scope of Contractor.
- 15.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.
- 15.3.5 Control cable inside control panel/switchgear/MCCB/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.
- 15.3.6 The Contractor shall use printed ferrules for control cable cores at all terminations, as instructed by the Employer. Each cable wire shall be identified with a number and detailed cable schedule may be prepared indicating the wire numbers.
- 15.3.7 Spare cores shall be similarly encased & tagged with cable numbers and coiled up with end cap.
- 15.3.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.
- 15.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.
- 15.3.10 The cable glands shall conform to BIS:6121. They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.
- 15.3.11 The cable glands shall also be suitable for dust proof and weather proof termination.
- 15.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Employer.
- 15.3.13 Crimping tool used shall be of approved design and make.
- 15.3.14 Control Cable lugs shall be tinned copper solderless crimping type conforming to

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IS-8309 & 8394. Aluminium Bimetallic lugs for power cables as required shall be used depending upon type of cables and terminations.

- 15.3.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

15. 4 Storage and handling of Cable Drums

- 15.4.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

16.0 DIRECTLY BURIED CABLES

- 16.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers.

- 16.2 The cable (power and control) between LT station, DG set location and fire lighting pump house and control room shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

- 16.3 Power cables from Main Switchboard to colony shall be laid in buried cable trench. Location of cable termination point at colony shall be as per site condition and shall be decided in consultation with Employer's site-in-charge. Power Cables for oil filtration plant shall be laid in open cable trench or buried trench upto transformer/reactor area and can be looped from adjacent receptacles provided for power supply of oil filtration plant.

- 16.4 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker. Cable markers shall be grounded in a concrete base.

17.0 INSTALLATION OF CABLES

- 17.1 Cabling in the control room shall be done on ladder type cable trays for vertical runs while cabling in switchyard area shall be done on angles in the trench.

- 17.2 All cables from bay cable trench to equipments including and all interpolate cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter of class 4 as per IS 4985 which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables. Cable pull boxes of adequate size shall be provided if required. **For vertical runs on equipments, perforated cable trays shall be provided for all equipments under scope of the contract or any equipment to be provided by the owner (including for owner supplied circuit breakers).**

- 17.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as

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recommended by the cable manufacturer shall be maintained. Embedded pipes shall be dressed properly at the equipment termination points.

- 17.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.
- 17.5 Suitable arrangement should be used between fixed pipe/cable trays and equipment terminal boxes, where vibration is anticipated.
- 17.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.
- a) Power cables preferably on top tiers.
 - b) Control instrumentation and other service cables in bottom tiers.
 - c) For cabling from control room to switchyard in main cable trench, cable shall be laid such that bottom tiers are preferably filled first and top tiers are kept for filling future cables as per the instructions of Engineer-In-Charge.
- 17.7 For Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. Further, for horizontal cables a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables shall be maintained.
- 17.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon-6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.
- 17.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-interlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.
- 17.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:
- | Table of Cable and | Minimum bending radius |
|--------------------|------------------------|
| Power cable | 12 D |
| Control cable | 10 D |
- D is overall diameter of cable
- 17.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth. The size of hume/steel pipe shall be such that approximately 70% area is only occupied. For meeting future requirement, additional hume/steel pipe shall be laid for future bay provision.
- 17.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/ two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.
- 17.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for

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by the drawings, unavoidable or where permitted by the Employer. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.

- 17.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.
- 17.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Employer.
- 17.16 Rollers shall be used at intervals of about two metres while pulling cables to avoid damage.
- 17.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.
- 17.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.
- 17.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of practices.
- 17.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.
- 17.21 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Employer, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.
- 17.22 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.
- 17.23 **Cable trays**
- i) The cable trays shall be of G.S Sheet and minimum thickness of sheet shall be 2mm.
 - ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.
 - a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.
- 17.24 **Conduits, Pipes and Duct Installation**
- 17.24.1 Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland

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sealing fittings, pull boxes etc as required. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

- 17.24.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.
- 17.24.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.
- 17.24.4 Installation of optical cables/ special cables:**
- GI pipe (light grade) of suitable size (minimum 25 mm) along with required bends, joints etc. shall be used for special cables such as cables for visual monitoring system (VMS), substation automation system (SAS). Further, single pipe can be used for laying multiple cables.**
- 17.24.5 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.
- 17.24.6 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.
- 17.24.7 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.
- 17.24.8 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.
- 17.24.9 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.
- 17.24.10 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.
- 17.24.11 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.
- 17.24.12 Spacing of embedded conduits shall be such as to permit flow of concrete between them.
- 17.24.13 Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.
- 17.24.14 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

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- 17.24.15 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.
- 17.24.16 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.
- 17.24.17 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.
- 17.24.18 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
- 17.24.19 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.
- 17.24.20 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 17.24.21 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.
- 17.24.22 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bonding shall be provided around the joint to ensure a continuous ground circuit.
- 17.24.23 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- 17.24.24 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

17.25 Cable Sealing System

Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete bay kiosks/switchyard panel room & control rooms in the substations. Cable sealing system shall consist of multi-diameter type peel-able or adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression, single piece wedge with galvanized steel bolts shall be used. 30% spare blocks on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.

Cable sealing system having earthing strip can alternately be used in place of cable gland arrangement for indoor panels such as LCC, C&R, PLCC panels etc.

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18.0 LIGHTING JUNCTION BOX

The Contractor shall supply and install ISI marked junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

19.0 TESTING AND COMMISSIONING

19.1 All pre/commissioning activities and works work for substation equipment shall be carried out in accordance with Employer's "Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-03)" by the contractor. This document shall be provided to the successful contractor during detailed engineering stage. Test results in the prescribed formats shall be duly filled by the contractor and shall be submitted to the Owner in soft form (CD or Pen Drive)

The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates.

19.2 GENERAL CHECKS

- (a) Check for physical damage.
- (b) Visual examination of zinc coating/plating.
- (c) Check from name plate that all items are as per order/specification.
- (d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
- (e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.
- (f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.
- (g) Check cleanliness of insulator and bushings.
- (h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.
- (i) Check for surface finish of grading rings (Corona control ring).

19.3 STATION EARTHING

- a) Check soil resistivity
- b) Check continuity of grid wires
- c) Check earth resistance of the entire grid as well as various sections of the same.
- d) Check for weld joint and application of zinc rich paint on galvanised surfaces.
- e) Dip test on earth conductor prior to use.

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19.4 AAC/ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS

- a) Physical check for finish
- b) Electrical clearance check
- c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.
- d) Millivolt drop test on all power connectors.
- e) Sag and tension check on conductors.

19.5 ALUMINIUM TUBE WELDING

- a) Physical check
- b) Millivolt drop test on all joints.
- c) Dye penetration test & Radiography test on 10% sample basis on weld joints.
- c) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

19.6 INSULATOR

Visual examination for finish, damage, creepage distance etc.

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ANNEXURE "A"

(Testing Procedure for ACSR/AAC Conductor)

1.0 UTS Test on Stranded Conductor

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

2.0 Corona Extinction Voltage Test

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per Annexure-C, Corona extinction voltage shall not be less than 510 kV (rms) & 320 KV (RMS) Line to ground for 765 kV & 400 kV respectively.

3.0 Radio Interference Voltage Test

Under the conditions as specified under (2.0) above, the conductor samples shall have radio interference voltage as indicated in the guaranteed technical particulars enclosed with. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-60437.

4.0 D.C Resistance Test on Stranded Conductor

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

5.0 Chemical Analysis of Zinc

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

6.0 Chemical Analysis of Aluminium and Steel

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

7.0 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the inspector. The

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

8.0 Dimensional Check for Steel and Aluminium Strands.

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

9.0 Check for Lay-ratios of various Layers.

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

10.0 Galvanising Test

The test procedure shall be as specified in IEC:60888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

11.0 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause No. 10.3 of IEC:60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the GTP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

12.0 Procedure Qualification test on welded Aluminium strands

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

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ANNEXURE “B”

(Testing procedure for Galvanised Steel Earthwire)

1. UTS TEST

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

2. D.C. RESISTANCE TEST

On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. Visual check for joints, scratches etc. and length of earthwire

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

4. TORSION TEST

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

5. DIMENSIONAL CHECK

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

6. LAY LENGTH CHECK

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

7. GALVANISING TEST

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

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checked by wrapping around a mandrel four times the diameter of steel wire.

8. CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING

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

9. CHEMICAL ANALYSIS OF STEEL

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

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ANNEXURE-C

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

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

2. Test Levels:

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

3. Test Methods for RIV:

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

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

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

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

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

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

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

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4

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times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

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

5. Test Records:

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

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

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ANNEXURE – D

A. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 765kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40kA/50 kA for 1 sec.					
1.	54.0 mtr	QUAD AAC BULL	15 mtr	3.96 T	5.98 T	3.5 mtr
2.	56.0 mtr	QUAD AAC BULL	15 mtr	4.52 T	6.77 T	4.0 mtr
3.	87.9 mtr	QUAD AAC BULL	15 mtr	8.35 T	11.22 T	6.5 mtr
4.	104.0 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	7.5 mtr
5.	108.61 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	8.0 mtr

B. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 400kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40 kA for 1 sec.					
1.	54 mtr	QUAD ACSR	7 mtr	4 T	5.64 T	6 mtr
2.	70 mtr	TWIN ACSR	7 mtr	4 T	5.64 T	5 mtr
3.	54 mtr	QUAD ACSR	6 mtr	4 T	5.10 T	5 mtr
4.	70 mtr	TWIN ACSR	6 mtr	4 T	5.10 T	5 mtr
5.	48 mtr	QUAD ACSR	6 mtr	4 T	4.82T	5 mtr
6.	52.5 mtr	QUAD ACSR	6 mtr	4 T	4.85T	5 mtr
7.	56.5 mtr	QUAD ACSR	6 mtr	4 T	4.88T	5 mtr
8.	52.5 mtr	TWIN ACSR	6 mtr	4 T	4.97T	5 mtr
9.	56.5 mtr	TWIN ACSR	6 mtr	4 T	5.00 T	5 mtr
II.	For Fault Level of 50 kA for 1 sec.					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	5.10 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	5.18 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	5.20 T	4 mtr
III.	For Fault Level of 63 kA for 1 sec.					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	6.00 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	6.33 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	6.37 T	4 mtr

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ANNEXURE – D

C. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 40 kA for 1 sec.					
1.	54 mtr	QUAD ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
2.	54 mtr	TWIN ACSR	4.5 mtr	2 T	3.50 T	2.5 mtr
3.	74 mtr	TWIN ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
4.	54 mtr	QUAD ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
5.	54 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.5 mtr
6.	74 mtr	TWIN ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
7.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.30 T	2.5 mtr
8.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.35 T	2.5 mtr
9.	68 mtr	TWIN ACSR	4.0 mtr	4 T	5.20 T	2.5 mtr
10.	56 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.5 mtr
11.	72 mtr	TWIN ACSR	4.0 mtr	4 T	5.27 T	2.5 mtr
II.	For Fault Level of 50 kA for 1 sec.					
1.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.41 T	2.0 mtr
2.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.0 mtr
3.	36 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.0 mtr

NOTE: ACSR conductor as mentioned above indicates that it is suitable for both ACSR MOOSE as well as ACSR BERSIMIS conductor.

D. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 132 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	For Fault Level of 31.5kA for 1 sec.					
1.	36 mtr	Twin Moose/ Zebra ACSR	3 mtr	1 T	2.15 T	2.5 mtr
2.	31.5 mtr	Twin Moose/ Zebra ACSR	2.7mtr	1 T	2.15 T	2.5 mtr
3.	48 mtr	Single Moose/ Zebra ACSR	3 mtr	1 T	2.05 T	NA
4.	42 mtr	Single Moose/ Zebra ACSR	2.7 mtr	1 T	2.03 T	NA

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ANNEXURE-E

**STANDARD TECHNICAL DATA SHEETS FOR AAC/ACSR CONDUCTORS,
GS EARTHWIRE AND ALUMINIUM TUBE**

1.0 GENERAL

Employer has standardised the guaranteed technical particulars for the following AAC/ACSR conductors, Galvanised steel earthwire and aluminum tube. The contractor shall supply the conductors as per the standard GTP mentioned below. Any deviation to the following GTP shall be clearly brought out by the bidder in their bid.

1.1 Guaranteed Technical Particulars (GTP) for conductors:

A. GTP of AAC BULL and AAC TARANTULA conductor:

Sl.	Description	Unit	AAC BULL	AAC TARANTULA
1.0	Applicable Standard		IS:398	
2.0	Raw Materials			
2.1	Steel Wire / Rods			
2.1.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	4.25	5.23
b)	Maximum	mm	4.29	5.28
c)	Minimum	mm	4.21	5.18
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.23	3.44
b)	After stranding	KN	2.12	3.27
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm /KM	3.651	3.627
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.00203	0.001341
4.0	AAC Conductor			
4.1. a)	Stranding		Al – 61/4.25 mm	Al – 37/ 5.23 mm
b)	Number of Strands			
i.	1st Aluminium Layer	Nos.	1	1
ii.	2nd Aluminium Layer	Nos.	6	6

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ANNEXURE-E

Sl.	Description	Unit	AAC BULL	AAC TARANTULA
iii.	3rd Aluminium Layer	Nos.	12	12
iv.	4th Aluminium Layer	Nos.	18	18
v.	5th Aluminium Layer	Nos.	24	-
4.2	Sectional Area of aluminium	Sq. mm	865.36	794.80
4.3	Total sectional area	Sq. mm	865.36	794.80
4.4	Approximate Weight	Kg/m	2.4	2.191
4.5	Diameter of the conductor	mm	38.25	36.60
4.6	UTS of the conductor	kN	139 (Min.)	120 (Min.)
4.7	Lay ratio of the conductor	mm	Max Min	Max Min
a)	6 wire Aluminium layer	mm	16 10	16 10
b)	12 wire Aluminium layer	mm	16 10	16 10
c)	18 wire Aluminium layer	mm	16 10	14 10
d)	24 wire Aluminium layer	mm	14 10	- -
4.8	DC resistance of the conductor at 20°C	ohm/km	0.03340	0.03628
4.9	Standard length of the conductor	m	1000	1000
4.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
4.11	Direction of lay of outer layer		Right Hand	Right Hand
4.12	Linear mass of the conductor			
a)	Standard	kg/km	2400	2192
b)	Minimum	kg/km	2355	2150
c)	Maximum	kg/km	2445	2234
4.13	Modulus of Elasticity	Kg/sq. mm	4709 (Initial) 5869 (Final)	4709 (Initial) 5869 (Final)
4.14	Co-efficient of Linear Expansion	Per Deg. C	23.0×10^{-6}	23.0×10^{-6}
4.15	Minimum Corona Extinction Voltage	KV (rms)	508	320
4.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 508 kV (rms)	Less than 1000 at 320 kV (rms)
5.0	Drum Dimensions		Generally conforms to IS:1778	

SECTION - (SE)
SWITCHYARD ERECTION

ANNEXURE-E

Sl.	Description	Unit	AAC BULL	AAC TARANTULA
a)	Flange Diameter	mm	1855	1855
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	850	850
d)	Flange thickness	mm	50x50	50x50

B. GTP of ACSR BERSIMIS and ACSR MOOSE conductor:

Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
1.0	Applicable Standard		IS:398 / IEC - 61089	
2.0	Raw Materials			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	4.57	3.53
b)	Maximum	mm	4.61	3.55
c)	Minimum	mm	4.53	3.51
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.64	1.57
b)	After stranding	KN	2.51	1.49
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm/ KM	1.738	2.921
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.001738	0.002921

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Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
4.0	Steel strand after stranding			
4.1	Diameter			
a)	Nominal	mm	2.54	3.53
b)	Maximum	mm	2.57	3.60
c)	Minimum	mm	2.51	3.46
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	6.87	12.86
b)	After stranding	KN	6.53	12.22
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
5.0	ACSR Conductor			
5.1.a)	Stranding		Al -42/4.57 mm+ Steel-7/2.54 mm	Al -54/3.53 mm+ Steel-7/3.53 mm
b)	Number of Strands			
i.	Steel centre	Nos.	1	1
ii.	1st Steel Layer	Nos.	6	6
iii.	1st Aluminium Layer	Nos.	8	12
iv.	2nd Aluminium Layer	Nos.	14	18
v.	3rd Aluminium Layer	Nos.	20	24
5.2	Sectional Area of aluminium	Sq. mm	689.50	528.50
5.3	Total sectional area	Sq. mm	725.00	597.00
5.4	Approximate Weight	Kg/m	2.181	2.004
5.5	Diameter of the conductor	mm	35.05	31.77
5.6	UTS of the conductor	kN	154 (Min.)	161.20 (Min.)
5.7	Lay ratio of the conductor	mm	Max Min	Max Min

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ANNEXURE-E

Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
a)	Outer Steel layer	mm	24 16	18 16
b)	8/12 wire Aluminium layer	mm	17 10	14 12
c)	14/ 18 wire Aluminium layer	mm	16 10	13 11
d)	20/24 wire Aluminium layer	mm	13 10	12 10
5.8	DC resistance of the conductor at 20°C	ohm/km	0.04242	0.05552
5.9	Standard length of the conductor	m	1800	1800
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
5.11	Direction of lay of outer layer	-	Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	kg/km	2181	2004
b)	Minimum	kg/km	2142	1965
c)	Maximum	kg/km	2221	2045
5.13	Modulus of Elasticity (Final State)	Kg/sq .mm		6860
5.14	Co-efficient of Linear Expansion	Per Deg. C	21.5×10^{-6}	19.3×10^{-6}
5.15	Minimum Corona Extinction Voltage	KV (rms)	320	320
5.16	RIV at 1 Mhz under dry condition	Micro volts	Max. 1000 at 320 kV (rms)	Max. 1000 at 320 kV (rms)
6.0	Drum Dimensions		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1800	1800
b)	Traverse width	mm	950	950
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

C. B. GTP of ACSR ZEBRA and ACSR PANTHER conductor:

Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
1.0	Applicable Standard		IS:398 / IEC-61089	
2.0	Raw Materials			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	Aluminum strands after stranding			
3.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.21	3.03
c)	Minimum	mm	3.15	2.97
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	1.29	1.17
b)	After stranding	KN	1.23	1.11
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.003626	0.004107
4.0	Steel strand after stranding			
4.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.24	3.06
c)	Minimum	mm	3.12	2.94
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	10.43	9.29
b)	After stranding	KN	9.91	8.85
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
5.0	ACSR Conductor			
5.1.a)	Stranding		Al -54/3.18 mm+ Steel-7/3.18 mm	Al -30/3.00 mm+ Steel-7/3.00 mm
b)	Number of Strands			
i.	Steel centre	Nos.	1	1
ii.	1st Steel Layer	Nos.	6	6
iii.	1st Aluminium Layer	Nos.	12	12
iv.	2nd Aluminium Layer	Nos.	18	18
v.	3rd Aluminium Layer	Nos.	24	NA
5.2	Sectional Area of aluminium	Sq. mm	428.9	212.10
5.3	Total sectional area	Sq. mm	484.5	261.50
5.4	Approximate Weight	Kg/m	1.621	0.974
5.5	Diameter of the conductor	Mm	28.62	21.00
5.6	UTS of the conductor	kN	130.32 (Min.)	89.67 (Min.)
5.7	Lay ratio of the conductor	mm	Max Min	Max Min
a)	Outer Steel layer	mm	28 13	28 16
b)	12 wire Aluminium layer	mm	17 10	16 10
c)	18 wire Aluminium layer	mm	16 10	14 10
d)	24 wire Aluminium layer	mm	14 10	NA NA
5.8	DC resistance of the conductor at 20°C	ohm/km	0.06868	0.140
5.9	Standard length of the conductor	m	1800	1800
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
5.11	Direction of lay of outer layer		Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	kg/km	1621	974
b)	Minimum	kg/	1589	954

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
		km		
c)	Maximum	kg/ km	1653	993
5.13	Modulus of Elasticity	Kg/sq .mm		8158
5.14	Co-efficient of Linear Expansion	Per Deg. C	19.3×10^{-6}	17.8×10^{-6}
5.15	Minimum Corona Extinction Voltage	KV (rms)	154	92
5.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 154 kV (rms)	Less than 500 at 92 kV (rms)
6.0	Drum Dimensions		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1850	1850
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

1.2 Guaranteed technical particulars of Galvanised Steel Earthwire

	Description	Unit	Standard Values
1.0	Raw Materials		
1.1	Steel wires / rods		
a)	Carbon	%	Not more than 0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	Zinc		
a)	Minimum purity of Zinc	%	99.95
2.0	Steel strands		
2.1	Diameter		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.74
c)	Minimum	mm	3.58
2.2.	Minimum breaking load of strand		
a)	After stranding	KN	10.58
2.3	Galvanising		
a)	Minimum weight of zinc coating per sq.m. after stranding	gms.	275
b)	Minimum number of dips that the galvanized strand can withstand	Nos.	3 dips of 1 minute and

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	in the standard preece test		one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18
3.0	Stranded Earth wire		
3.1	UTS of Earth wire	KN	68.4 (min.)
3.2	Lay length of outer steel layer		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	Maximum DC resistance of earth wire at 20° C	Ohm/km	3.375
3.4	Standard length of earth wire	M	2000 or actual quantity whichever is less.
3.5	Tolerance on standard length	%	±5
3.6	Direction of lay for outside layer		Right hand
3.7	Linear mass		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	552
c)	Minimum	Kg/km	600
3.8	Overall diameter	mm	10.98

1.3 Guaranteed Technical Parameters of Aluminum Tube

A. GTP for 3" IPS & 4" IPS AL. TUBE

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE
1.	Size	3" IPS (EH Type)	4" IPS (EH Type)
2.	Material	Aluminium Alloy 6101 T6 confirms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu	0.05 Max	
ii)	Mg	0.4 to 0.9	
iii)	Si	0.3 to 0.7	
iv)	Fe	0.5 Max	
v)	Mn	0.03 Max	
Vi)	Al	Remainder	
4.	Outer diameter	88.90 mm	114.2 mm
5.	Tolerance on outer diameter	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
6.	Thickness	7.62 mm	8.51 mm
7.	Tolerance on thickness	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
8.	Cross-sectional area	1945.76 sq.mm	2825.61 sq.mm
9.	Weight	5.25 kg/m	7.7 kg/m
10.	Moment of Inertia	1621589.99 mm ⁴	3972577.97 mm ⁴
11.	Section Modulus	36481.21 mm ³	69572.29 mm ³

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12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50 mm	10%	
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20.	Minimum Yield point	17.50 Kg/sq.mm	17.50 Kg/sq.mm
21.	Minimum Breaking Strength	20.42 Kg/sq.mm	20.42 Kg/sq.mm

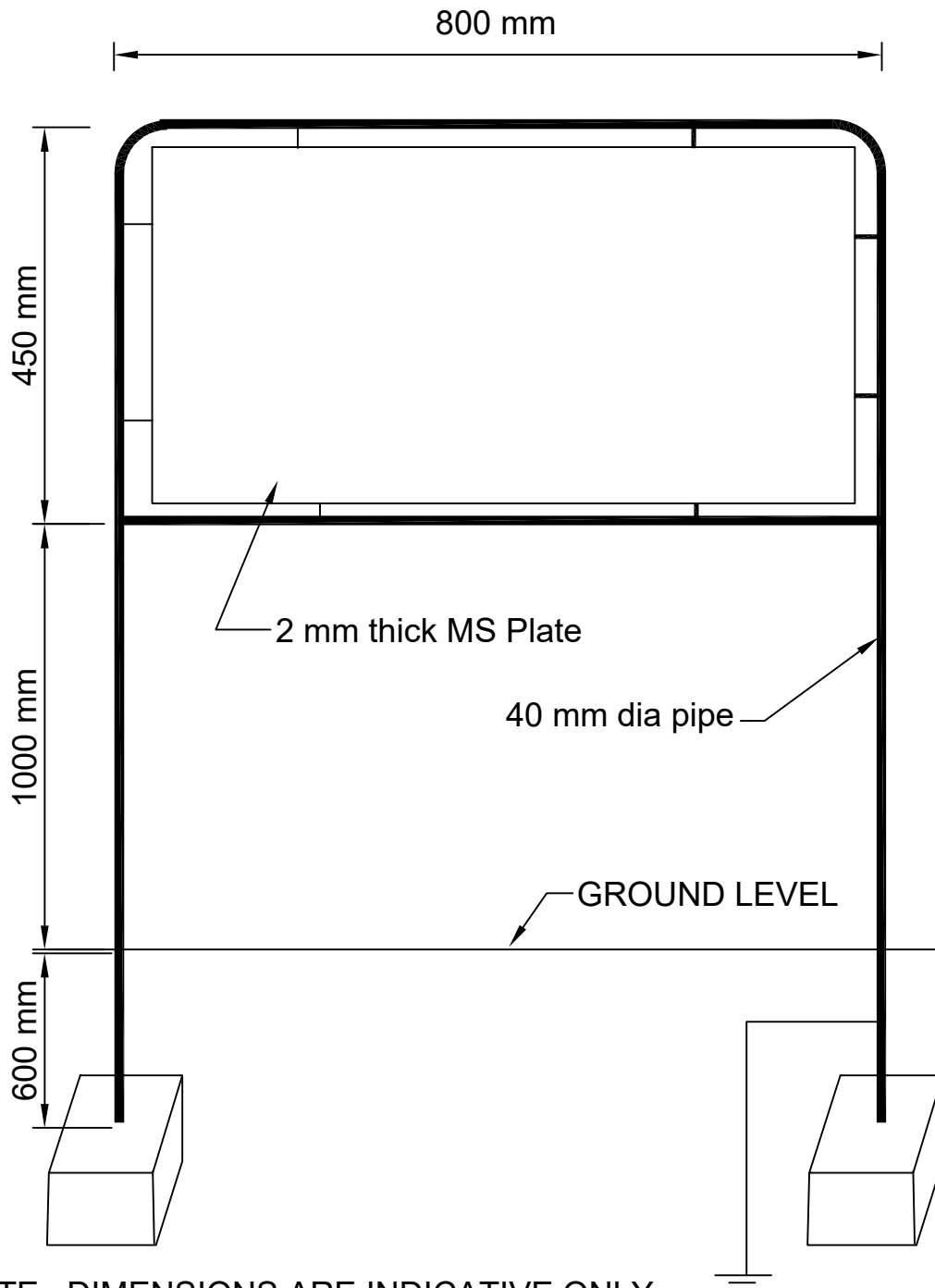
B. GTP for 4.5" IPS & 5" IPS AL. TUBE

Sl. No.	Description	4.5" AL. TUBE	5" AL. TUBE
1.	Size	4.5" IPS (EH Type)	5" IPS
2.	Material	Aluminium Alloy 6101 T6 confirms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu	0.05 Max	
ii)	Mg	0.4 to 0.9	
iii)	Si	0.3 to 0.7	
iv)	Fe	0.5 Max	
v)	Mn	0.03 Max	
Vi)	Al	Remainder	
4.	Outer diameter	120.0 mm	141.3 mm
5.	Tolerance on outer diameter	+1.5 mm, - 0.0 mm	+2.8 mm, - 0.0 mm
6.	Thickness	12.0 mm	9.53 mm
7.	Tolerance on thickness	+1.0 mm, - 0.0 mm	+0.8 mm, - 0.0 mm
8.	Cross-sectional area	4071.50 sq.mm	3945.11 sq.mm
9.	Weight	10.993 kg/m	10.652 kg/m
10.	Moment of Inertia	6011958.58 mm ⁴	8610787.65 mm ⁴
11.	Section Modulus	100199.31 mm ³	121879.51 mm ³
12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50	10%	

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	mm		
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20	Minimum Yield point	14.50 Kg/sq.mm	17.50 Kg/sq.mm
21	Minimum Breaking Strength	17.50 Kg/sq.mm	20.42 Kg/sq.mm



**POWER GRID CORPORATION
OF INDIA LIMITED**
(A Government of India Enterprise)



PROJECT :- STANDARD

TITLE:- STANDARD BAY NAME PLATE

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PRPD BY


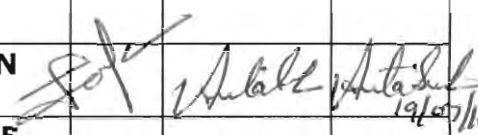
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C/ENG/STD/BAY NAME PLATE

Rev.

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SECTION – I**SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES****1.0 SCOPE**

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 7/9 SWG (10.98mm OD) GS earth wire.

The equipment is required for the following project.

Name of Customer : Power Grid Corporation of India Ltd.

Name of the Project : Substation Package – Substation Package -SS01 for Construction of 765/400/220kV **Bhuj Pool (New) S/S** and **Extension of 765kV Banaskantha S/S** under Green Energy Corridors: Inter-State Transmission Scheme (ISTS) – Part C

1.1 BILL OF QUANTITY

Sl. No	Description	BHUJ	BANASKANTHA
1.	7/9 SWG (10.98mm OD) GS earth wire	9 Km	2.5 Km

Note:

- The Qty may vary upto $\pm 30\%$ before placement of order.
- The Qty. May vary by $\pm 20\%$ during contract stage.

1.2 TYPE TESTING

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of bid opening i.e. **07.04.2015**. The bidder should have conducted type test on identical or similar equipment/ components to those offered. In case type test reports are found to be technically unacceptable to BHEL/PGCIL, the type test shall be conducted without cost and delivery implication to BHEL.

1.3 QUALITY PLAN

Bidder to follow valid PGCIL approved Quality Plan as per PGCIL procedure. In case the bidder don't have PGCIL approved QP, it will be the bidder's responsibility to get its QP approved directly from the ultimate customer.

1.4 DRAWING/DOCUMENTS APPROVAL:

Standardized GTP of POWERGRID is enclosed as Annexure-E, no approval on GTP is required and inspection shall be carried out as per standardized GTP.

SECTION - (SE)
SWITCHYARD ERECTION

Substation Package - Substation Package -SS01 for Construction of 765/400/220kV **Bhuj Pool (New) S/S** and **Extension of 765kV Banaskantha S/S** under Green Energy Corridors: Inter-State Transmission Scheme (ISTS) - Part C

7/9 SWG (10.98mm O.D) GS earth wire

Doc. No. TB-385-316-126 Section- 2

4.0 Galvanised Steel Earth wire

4.1 Details of Earth wire

4.1.1 The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IEC:60888/IS: 398 (Part-II)-1976 except where otherwise specified herein.

The contractor shall supply the earthwire as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval **for guaranteed technical particulars** is not required during detailed engineering.

4.2 Workmanship

SECTION - (SE)

SWITCHYARD ERECTION

- 4.2.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.
- 4.2.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.
- 4.2.3 The steel strands shall be hot dip galvanized and shall have minimum Zinc coating after stranding, as stipulated in guaranteed technical particulars attached with. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-74.
- 4.2.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanisation during preforming and postforming operation.
- 4.2.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

4.3 Joints in Wires

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

4.4 Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in guaranteed Technical Particulars attached with this specification shall only be permitted in the diameter of the individual steel strands and lay length of the earth wire.

4.5 Materials

4.5.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Guaranteed Technical Particulars attached with.

4.5.2 Zinc

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

4.6 Standard Length

- 4.6.1 The standard length of the earth wire shall be as stipulated in Guaranteed Technical Particulars attached with, with the specified tolerance on standard length.

4.8 TESTS

- 4.8.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

4.8.2 TYPE TESTS

SECTION - (SE)
SWITCHYARD ERECTION

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval as per clause 9.2 of Section - GTR.

- | | | | |
|----|--------------------|---|---------------------|
| a) | UTS test |) | |
| | |) | |
| b) | DC resistance test |) | As per Annexure - B |

4.8.3 ACCEPTANCE TESTS

- | | | | |
|----|---|---|--------------------------|
| a) | Visual check for joints, scratches etc. and length of Earthwire |) | |
| | |) | |
| | |) | |
| b) | Dimensional check |) | As per Annexure - B |
| | |) | |
| c) | Galvanising test |) | |
| | |) | |
| d) | Lay length check |) | |
| | |) | |
| e) | Torsion test |) | |
| | |) | |
| f) | Elongation test |) | |
| | |) | |
| g) | Wrap test |) | |
| | |) | |
| h) | DC resistance test |) | |
| | |) | |
| i) | Breaking load test |) | IS:398 (Part-III) - 1976 |
| | |) | |
| j) | Chemical Analysis of steel |) | |

4.8.4 ROUTINE TESTS

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

4.8.5 TESTS DURING MANUFACTURE

- | | | | |
|----|--|---|---------------------|
| a) | Chemical analysis of zinc used for galvanising |) | As per Annexure - B |
| | |) | |
| | |) | |
| b) | Chemical analysis of steel |) | |

SECTION - (SE)
SWITCHYARD ERECTION

ANNEXURE "B"

(Testing procedure for Galvanised Steel Earthwire)

1. UTS TEST

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

2. D.C. RESISTANCE TEST

On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. Visual check for joints, scratches etc. and length of earthwire

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

4. TORSION TEST

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

5. DIMENSIONAL CHECK

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

6. LAY LENGTH CHECK

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

7. GALVANISING TEST

SECTION - (SE)
SWITCHYARD ERECTION

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

8. CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING

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

9. CHEMICAL ANALYSIS OF STEEL

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

**SECTION - (SE)
SWITCHYARD ERECTION**

ANNEXURE-E

Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
		km		
c)	Maximum	kg/km	1653	993
5.13	Modulus of Elasticity	Kg/sq. mm		8158
5.14	Co-efficient of Linear Expansion	Per Deg. C	19.3×10^{-6}	17.8×10^{-6}
5.15	Minimum Corona Extinction Voltage	KV (rms)	154	92
5.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 154 kV (rms)	Less than 500 at 92 kV (rms)
6.0	Drum Dimensions		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1850	1850
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

1.2

Guaranteed technical particulars of Galvanised Steel Earthwire

	Description	Unit	Standard Values
1.0	Raw Materials		
1.1	Steel wires / rods		
a)	Carbon	%	Not more than 0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	Zinc		
a)	Minimum purity of Zinc	%	99.95
2.0	Steel strands		
2.1	Diameter		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.74
c)	Minimum	mm	3.58
2.2.	Minimum breaking load of strand		
a)	After stranding	KN	10.58
2.3	Galvanising		
a)	Minimum weight of zinc coating per sq.m. after stranding	gms.	275
b)	Minimum number of dips that the galvanized strand can withstand	Nos.	3 dips of 1 minute and

**SECTION - (SE)
SWITCHYARD ERECTION**

ANNEXURE-E

	in the standard preece test		one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18
3.0	Stranded Earth wire		
3.1	UTS of Earth wire	KN	68.4 (min.)
3.2	Lay length of outer steel layer		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	Maximum DC resistance of earth wire at 20° C	Ohm/km	3.375
3.4	Standard length of earth wire	M	2000 or actual quantity whichever is less.
3.5	Tolerance on standard length	%	±5
3.6	Direction of lay for outside layer		Right hand
3.7	Linear mass		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	552
c)	Minimum	Kg/km	600
3.8	Overall diameter	mm	10.98

1.3

Guaranteed Technical Parameters of Aluminum Tube

A. GTP for 3" IPS & 4" IPS AL. TUBE

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE
1.	Size	3" IPS (EH Type)	4" IPS (EH Type)
2.	Material	Aluminium Alloy 6101 T6 conforms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu		0.05 Max
ii)	Mg		0.4 to 0.9
iii)	Si		0.3 to 0.7
iv)	Fe		0.5 Max
v)	Mn		0.03 Max
Vi)	Al		Remainder
4.	Outer diameter	88.90 mm	114.2 mm
5.	Tolerance on outer diameter	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
6.	Thickness	7.62 mm	8.51 mm
7.	Tolerance on thickness	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
8.	Cross-sectional area	1945.76 sq.mm	2825.61 sq.mm
9.	Weight	5.25 kg/m	7.7 kg/m
10.	Moment of Inertia	1621589.99 mm ⁴	3972577.97 mm ⁴
11.	Section Modulus	86481.21 mm ³	69572.29 mm ³

SECTION-3

PROJECT DETAILS & GENERAL SPECIFICATION

SITE INFORMATION

	Particular	Details
a)	Owner	POWERGRID
b)	Customer	POWERGRID
c)	Project Title	Substation Package – Substation Package -SS01 for Construction of 765/400/220kV Bhuj Pool (New) S/S and Extension of 765kV Banaskantha S/S under Green Energy Corridors: Inter-State Transmission Scheme (ISTS) – Part C.
d)	Location	Bhuj, Gujrat Banaskantha , Gujrat
e)	Transport Facilities	ROAD/TRAIN, For Bhuj Nearest Rail Head: Bhuj ROAD/TRAIN, For Banaskantha Nearest Rail Head: Palanpur
SITE CONDITIONS		
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient emp.	50°C
d)	Design reference temp.	50°C

e)	Average Humidity	Max. 100%
f)	Special corrosion conditions	No
g)	Solar Radiation	1.2kW/sqmtr
h)	Atmospheric UV radiation	High
i)	Altitude above sea level	Less than 1000meter
j)	Pollution Severity	High Pollution level (31mm/kV) For BHUJ High Pollution (25mm/kV) for Banaskantha
k)	Seismic Zone	As per the seismic zone defined in the relevant BIS / IEC-62271-300 but not less than 0.3g horizontal
WIND DATA		
	Wind velocity	As per IS
	Average No. of thunderstorm days per annum	As per IS
Main Electrical Parameters:		
	Fault Levels:	765kV: 50kA for 1 sec 400kV: 63kA for 1 sec 220kV: 40kA for 1 sec
	Creepage Distance	31mm/kV for 765kV/400kV/220kV BHUJ S/S 25mm/kV for Extn. of 765kV Banaskantha S/S

TECHNICAL CHECK LIST

(INFORMATION TO BE FURNISHED WITH OFFER)

RETURN THIS CHECKLIST AS THE PART OF THE OFFER DULY SIGNED BY THEM.

S.No.		Confirmation Yes/No	Remarks
1.	Compliance to Power grid GTP enclosed(Refer Annexure-E) with specification		
2.	Powergrid approved valid Manufacturing Plan (pls mention date till it is valid)		
3.	Powergrid approved type test report (pls check the date of validity wrt to dated 07.04.2015)		

Date:

Place:

Phone:

Fax:

E-mail:

Mobile:

Website:

ANNEXURE - 1

SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
-------	----------	------------	-----------	------------------------

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

Date:

Tenderer's Stamp & Signature

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NEW DELHI

DOCUMENT No.	TB-XXX-316-041	Rev. No.	02		Prepared	Checked	App.
TYPE OF DOC.	STANDARD TECHNICAL SPECIFICATION			NAME	NK	MK	KK
TITLE PVC PIPE & BENDS				SIGN	Sd/-	Sd/-	Sd/-
				DATE			
				GROUP	TBEM	W.O. No	
CUSTOMER							
CONSULTANT							
PROJECT	RATE CONTRACT						

SCOPE AND SPECIFIC TECHNICAL REQUIREMENT

1.0 SCOPE

This technical specification covers design, manufacture, testing at works, packing and dispatch of 'PVC 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 UPVC Pipe

The UPVC pipes shall be of nominal diameter 50 mm and/ or 110 mm, as per the indent. The pipe shall be of Class-II & Class-IV Grade as per IS 4985: 2000 and shall be of standard length of 6 meters. The pipe shall fully comply with specified standard and carry the BIS certification marking.

1.1.2 Sockets

The sockets shall fully comply with the requirements of IS 7834 (Part-6)-1977.



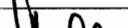
1.1.3 For Bends

The bends shall be of 45°, 60°, 90° and Tee as specified, for above mentioned pipes. The bends shall, in general, comply with the requirement of IS 10124. The specific requirements and BIS certification marking of these bends shall be as per IS 10124 (Part-9) and IS 10124 (Part-10) respectively.

1.2 BILL OF MATERIAL

As per enclosed Annexure-1.

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02	06.09.13				90° Bends added.	
01	30.11.10	-SD-	-SD-	-SD-	Document revised.	
Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS	
Distribution				To	TBMM	OFFICE COPY
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IS : 10124 (Part 10) - 1988

2.2.2 Dimensions — The dimensions of 45° bends shall comply with Table 1 read with Fig. 1.

2.2.3 The bends may either be plain at both ends or socketed either at one end or at both ends as agreed to between the manufacturer and the purchaser. In the case of socketed bends, the socket measurements shall comply with IS : 10124 (Part 1)-1988*.

NOTE 1 — For 0.25 MPa pressure class, fabricated bends should not be made from 0.25 MPa pressure class pipes. For this, bends made from 0.4 MPa pressure class pipe should be used.

NOTE 2 — The drawing is only intended to define the terms used in Table 1 and is not intended to illustrate specific design features.

3. MARKING

3.1 Each 45° bend fitting shall be marked with the following information:

- a) Manufacturer's name or identification mark,

- b) The size of the bend and the appropriate class (working pressure) of IS : 4985-1988* to which the pressure rating of the fitting corresponds,

- c) The degree of bend, and

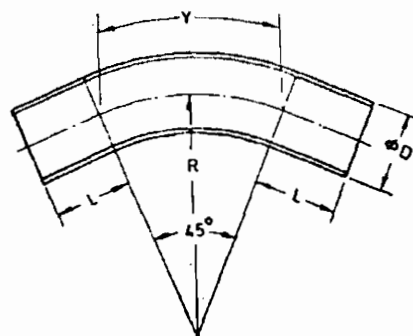


FIG. 1 45° BEND

*Specification for fabricated PVC fittings for potable water supplies: Part 1 General requirements.

*Specification for unplasticized PVC pipes for potable water supplies (second revision).

TABLE 1 DIMENSIONS OF 45° BENDS
(Clauses 2.2.2 and 2.2.3, and Fig. 1)

All dimensions in millimetres.

Size	Y* Min	L Min (Only for plain ends)	R† Min	MINIMUM WALL THICKNESS (t) FOR WORKING PRESSURE		
				0.4 MPa (Class 2)	0.6 MPa (Class 3)	1.0 MPa (Class 4)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
63	149	63	189	1.4	2.0	3.2
75	177	75	225	1.7	2.4	3.8
90	212	90	270	1.9	2.8	4.5
110	259	110	330	2.3	3.4	5.5
125	295	125	375	2.7	3.9	6.3
140	330	140	420	2.9	4.4	7.0
160	377	160	480	3.4	4.9	8.0
180	424	180	540	3.8	5.5	9.0
200	471	200	600	4.2	6.2	10.0
225	530	225	675	4.7	6.9	11.2
250	589	250	750	5.2	7.7	12.5
280	660	280	840	5.8	8.6	13.9
315	742	315	945	6.5	9.7	15.6
355	837	355	1 065	7.3	10.8	17.7
400	842	400	1 200	8.2	12.2	19.8
450	1 060	450	1 350	9.3	13.7	22.4
500	1 178	500	1 500	10.3	15.3	24.8
560	1 319	560	1 680	11.6	17.2	27.8
630	1 484	630	1 890	13.0	19.2	31.3

NOTE — Minimum wall thickness if calculated on the basis of 90 percent of the minimum wall thickness of the corresponding size and pressure class of pipe rounded off to the next higher 0.1 mm.

*Y is calculated from $\frac{45^\circ}{360^\circ} \times 2\pi R$.

†R, radius of the bend, is equal to 3 times the nominal outside diameter (D).

IS : 10124 (Part 8) - 1988

2.2.2 Dimensions — The dimensions of 90° bends shall comply with Table 1 read with Fig. 1.

2.2.3 The bends may either be plain at both ends or socketed either at one end or at both ends as agreed between the manufacturer and the purchaser. In the case of socketed bend, the socket measurements shall comply with IS : 10124 (Part 1)-1988*.

NOTE — For 0.25 MPa pressure class, fabricated bends should not be made from 0.25 MPa pressure class pipes. For this, bends made from 0.4 MPa pressure class pipe should be used.

NOTE — The drawing is only intended to define the terms used in Table 1 and is not intended to illustrate specific design features.

3. MARKING

3.1 Each 90° bend fitting shall be marked with the following information:

- Manufacturer's name identification mark,
- The size of the bend and the appropriate class (working pressure) of IS : 4985-1988* to which the pressure rating of the fitting corresponds,
- The degree of bend, and
- The bend shall be marked in colour as indicated below for different classes of fittings:

Class of Fitting	Colour
Class 2 (0.4 MPa)	Blue
Class 3 (0.6 MPa)	Green
Class 4 (1.0 MPa)	Yellow

*Specification for fabricated PVC fittings for potable water supplies: Part 1 General requirements (first revision).

*Specification for unplasticized PVC pipes for potable water supplies (second revision).

TABLE 1 DIMENSIONS OF 90° BENDS

(Clauses 2.2.2, 2.2.3 and Fig. 1)


All dimensions in millimetres.

SIZE	Y* Min	L Min (Only for plain ends)	R† Min	MINIMUM WALL THICKNESS (t) FOR WORKING PRESSURE		
				0.4 MPa (Class 2)	0.6 MPa (Class 3)	1.0 MPa (Class 4)
				(5)	(6)	(7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
63	297	63	189	1.4	2.0	3.2
75	354	75	225	1.7	2.4	3.8
90	424	90	270	1.9	2.8	4.5
110	519	110	330	2.3	3.4	5.5
125	589	125	375	2.7	3.9	6.3
140	660	140	420	2.9	4.4	7.0
160	754	160	480	3.4	4.9	8.0
180	848	180	540	3.8	5.5	9.0
200	942	200	600	4.2	6.2	10.0
225	1 060	225	675	4.7	6.9	11.2
250	1 178	250	750	5.2	7.7	12.5
280	1 319	280	840	5.8	8.6	13.9
315	1 484	315	945	6.5	9.7	15.6
355	1 673	355	1065	7.3	10.8	17.7
400	1 884	400	1200	8.2	12.2	19.8
450	2 120	450	1350	9.3	13.7	22.4
500	2 355	500	1500	10.3	15.3	24.8
560	2 638	560	1680	11.6	17.2	27.8
630	2 968	630	1890	13.0	19.2	31.8

NOTE — Minimum wall thickness is calculated on the basis of 90 percent of the minimum wall thickness of the corresponding size and pressure class of pipe rounded off to the next higher 0.1 mm.

*Y is calculated from $\frac{90^\circ}{360^\circ} \times 2\pi R$.

†R, radius of the bend, is equal to 3 times the nominal outside diameter (D).

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	DOCUMENT No.	TB xxx 618 002a		Rev 04	Prepared	Checked	Appd
	TYPE OF DOC.	TECHNICAL SPECIFICATION		NAME	BVG	PLK	RMS
	TITLE G I HARDWARES		SIGN	-SD-	-SD-	-SD-	
			DATE				
			GROUP	TBEM			
			W.O. No				
CUSTOMER/CONSULTANT							
PROJECT							
<u>Contents:</u>							
Section No.		Description				No of Pages	
SECTION-1		SCOPE, SPECIFIC TECHNICAL REQUIREMENTS and QUANTITIES				01	
SECTION-2		STANDARD SPECIFICATION				03	
SECTION-3		PROJECT DETAILS AND GENERAL SPECIFICATION				01	
SECTION-4		GUARANTEED TECHNICAL PARTICULARS (Not Applicable)				
SECTION-5		MANUFACTURING QUALITY PLAN (Not Applicable)				
SECTION-6		CHECK LIST				01	
	04	18.11.10				Unit wt of hardware added	
	02	13.4.06.	BVG	PLK	RMS	Eqpt mounting hardwares added.	
	Rev	Date	Altered	Checked	Approved		
	Distribution				To		
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SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1 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 for NTPC, PGCIL, SEBs and other Customers.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

The specific technical requirements shall be as per Standard Technical Specification (Refer Section 2).

1.3 QUANTITIES

The quantities shall be as per attached BOQ.

SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Hardware.

2.1 BOLTS:

M16 bolts shall be used in all types of structures except equipment mounting/ earthing bolts which shall be as per equipment requirement.

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.

Fully threaded bolts should not be used.

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 specified under:

<u>Bolt Diameter</u>	<u>Thickness of Spring washers</u>
16 mm	3.5 mm
12 mm	2.5 mm

These shall be electro-galvanized as per IS: 1573 – 1986.

2.5 UNIT WEIGHT OF BOLTS I/C NUT, PLAIN AND SPRING WASHERS:

For purpose of payment, following unit weights as indicated below shall be considered.

A.) STANDARD BOLTS I/C ONE NUT UNIT WEIGHTS

S. NO.	TYPE	SIZE OF BOLTS	TOTAL WT (KG)
1	M16	16 ϕ X 35 LG	0.117
2	M16	16 ϕ X 40 LG	0.125
3	M16	16 ϕ X 45 LG	0.133
4	M16	16 ϕ X 50 LG	0.141
5	M16	16 ϕ X 55 LG	0.149
6	M16	16 ϕ X 60 LG	0.157
7	M16	16 ϕ X 65 LG	0.164
8	M16	16 ϕ X 70 LG	0.172
9	M16	16 ϕ X 75 LG	0.180
10	M16	16 ϕ X 80 LG	0.188
11	M16	16 ϕ X 85 LG	0.196
12	M16	16 ϕ X 90 LG	0.204
13	M16	16 ϕ X 95 LG	0.212
14	M16	16 ϕ X 100 LG	0.220
15	M12	12 ϕ X 35 LG	0.0620
16	M12	12 ϕ X 40 LG	0.0664
17	M12	12 ϕ X 45 LG	0.0708
18	M12	12 ϕ X 50 LG	0.0753
19	M12	12 ϕ X 55 LG	0.0797
20	M12	12 ϕ X 60 LG	0.0842

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B.) SPRING WASHER

S. NO.	TYPE	TOTAL WT (KG)
1	3.5mm thk (M16 bolt)	0.00891
2	2.5mm thk (M12 bolt)	0.00382

C.) For supplies of bolts i/c nuts, plain washers and spring washer other than those listed above, payment shall be made based on unit weights worked out considering theoretical dimensions & density of steel as 7850kg/cum.

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PRE-COMMISSIONING CHECKS/TESTS FOR OTHER SWITCHYARD EQUIPMENTS

Once erection is completed, various pre-commissioning checks/ tests are performed to ensure the healthiness of the switchyard equipments prior to their energisation. Various major electrical tests to be performed and their significance are given below:

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.1	Tan δ & Capacitance measurement of CT, each stack of CVT & total capacitance, CB voltage grading capacitor & each stack of Surge Arresters	The purpose of the dissipation factor measurement of high voltage insulation is to detect incipient weaknesses in HV insulation. The most important benefit to be gained from this measurement is to obtain a “benchmark reference reading” on costly and high voltage equipment when the equipment is new and insulation is clean, dry and free from impurities. Tan delta & Capacitance values shall be comparable with factory test results and in no case shall be more than 0.5 %.
6.2	Checks/ Tests applicable for CTs	
6.2.1	Polarity test for CT	To ascertain whether the polarity markings are correct or not as per drawing.
6.2.2	Magnetization characteristics of CT	To prove that the turns of CTs secondary windings are not short circuited and to check healthiness of CT cores. The magnetizing currents at KPV (Knee point voltage) shall be less than the specified value. The ratio of secondary and primary voltage shall also be measured.
6.2.3	Ratio test for CT	The ratio errors of the primary to the secondary currents should within specified ratio errors.
6.2.4	IR measurement of CT (Primary & Secondary windings)	Changes in the normal IR value of CT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CT and degradation of insulation.
6.2.5	DGA test of CT oil	This test shall be conducted after 30 days of commissioning. The purpose is to identify evolving faults in the CT and DGA values shall be comparable with factory values (if available)
6.3	Checks/ Tests applicable for Circuit Breakers	
6.3.1	Dew point measurement of SF ₆ gas	Dew point of SF ₆ gas is to measure moisture content in SF ₆ gas which shall indicate whether CB evacuation is done properly or not. This test shall be carried out preferably at rated pressure of SF ₆ gas.
6.3.2	Measurement of Circuit	To measure closing/ tripping/ CO timings. These timings



Sr. No.	Name of Test / Check point	Purpose of test/ check
	Breaker Operating Timings including PIR Timings	should be within permissible limits and shall be comparable with factory values. Pole discrepancies and Break to Break discrepancies shall be less than specified values.
6.3.3	DCRM Contact Travel Measurement / DC injected currents and trip/ close coil currents.	DCRM is the technique for measuring Contact Resistance during operation (Close/ Trip) of a circuit breaker with a delay Tco of 300ms. A DC current of at least 100 Amp is injected through the circuit breaker. The current and voltage drop are measured and resistance is calculated. The resistance and travel versus time data provides useful information on the condition of the circuit breaker contacts and is used as a diagnostic tool. DCRM test signatures shall be approved by Corporate OS.
6.3.4	Operational lockout checking for EHV Circuit Breakers	To ensure various lockout operation of CB by simulating the actual conditions at the specified pressure of oil/ air/ operating medium.
6.3.5	Measurement of static contact resistance	This test is conducted to evaluate healthiness of Main contacts. 100 Amp DC is injected and voltage drop is measured across each CB contact to compute contact resistance.
6.3.6	Checking the Anti-Pumping feature	By giving simultaneous close/ trip commands, CB hunting shall not take place by operation of Mechanical/ Electrical anti pumping feature.
6.3.7	Checking the Anti-Condensation Heaters	To check correct operation of Thermostat provided for anti condensation heaters.
6.3.8	Pole discrepancy relay testing	To test tripping of CB in case of pole discrepancy more than 2.5 seconds or specified value.
6.3.9	Checking the N2 priming pressure	This test is to check healthiness of N2 accumulators provided in Hydraulic drive mechanisms. N2 priming pressure shall be as per the rated pressure.
6.4	Checks/ Tests applicable for CVTs	
6.4.1	CVT polarity, Ratio test	This test is conducted in the same manner as for CT to determine correct CVT polarity, ratio and phasor group.
6.4.2	Insulation resistance measurement of Primary & secondary winding	Changes in the normal IR value of CVT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CVT and degradation of insulation.
6.5	Checks/ Tests applicable for Isolators	
6.5.1	MILLIVOLT Drop test	The voltage drop gives a measure of resistance of current carrying part and contacts by injecting minimum 100 A DC current.

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.5.2	50 operation tests	To test operation of contacts etc with jumpers connected and contact resistance to be measured after 50 operations. There shall not be any change from the previous value.
6.6	Checks/ Tests applicable for Surge Arrestors	
6.6.1	Third Harmonic Resistive Current (THRC) for surge arrestors	To monitor healthiness of Surge arrestors by monitoring third harmonic resistive current from the leakage current. This test is to be conducted after charging of Las. The value of THRC shall be less than 30 μ A.
6.6.2	IR measurement of each stack of LA	Changes in the normal IR value of LA indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of LA and degradation of insulation.
6.6.3	Checking of operation of LA counter	This test is done to check the healthiness of LA counter.
6.7	Checks/ Tests for other areas/ equipments	
6.7.1	Earth resistance measurement	To ensure value of earth resistance is below 1 ohm.
6.7.2	Secondary current injection test	Conducted for testing of protecting devices, circuit breakers, trip coils, motor overloads etc.
6.7.3	Contact Tightness check of Bay contacts by Primary injection method	Since complete bay contact resistance measurement is practically not possible because DC current may not be injected in CT primary, hence contact tightness check by primary injection method has been introduced to check overall contact tightness.
6.7.4	Stability check for Bus Bar	This test is performed to check the proper operation of Bus Bar protection by simulating actual conditions. Any problem in CT connection, wrong cabling, relay setting can be detected by this test.

6.1 TAN DELTA & CAPACITANCE MEASUREMENT OF CT, CVT, CB VOLTAGE GRADING CAPACITORS AND LA STACKS

To measure dissipation factor/loss factor (Tan delta) and Capacitance measurement of EHV class CTs, CVTs, CB Voltage Grading Capacitors & LA stacks by applying test voltages up to 10kV.

A) CURRENT TRANSFORMERS

CTs with test taps

1. Tan delta tap to be disconnected from ground.
2. High voltage lead from tan delta kit to be connected to primary(HV) Terminal and LV lead to be connected to the Tan delta test tap.
3. P1 and P2 to be shorted
4. Porcelain surface to be thoroughly cleaned.
5. Measurements have to be taken in UST mode with fully automatic test kit.
6. Standard procedure(as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed for measurement of capacitance and tan delta values.
7. It is to be ensured to connect the test tap to ground terminal after carrying out the test.

B) CB VOLTAGE GRADING CAPACITOR

1. Connect LV cable to the middle of the double interrupter.
2. Connect HV cable to the other end of the Grading capacitor to be tested.
3. The opposite end of the grading capacitor has to be grounded using earth switch.
4. Measurements have to be taken in UST Mode with fully automatic test kit.
5. Disconnect the HV cable and connect the same to the other grading capacitor and ground the previous grading capacitor. Now the second grading capacitor is ready for testing.
6. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed
7. Measurements are to be carried out at 10 kV/ 12 KV.

C) CAPACITOR VOLTAGE TRANSFORMERS

1. Testing procedure for Top and Middle Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV
 - (c) While measuring Middle/ Bottom stacks, Top/ middle stacks to be shorted.
2. Testing procedure for Bottom Stack connected to EMU PT
 - (a) Connect HV of the test kit at the top flange of bottom stack. HF point to be grounded. Earth connection of the neutral of the PT to be opened/ isolated from ground.
 - (b) Top of CVT to be guarded. LV lead of the kit to be connected at the top of the CVT for guarding.

- (c) Carry out measurements in GSTg mode at 10.0 KV
 - (d) Repeat the Test with neutral of PT connected to ground.
 - (e) In case Tan delta value is negative or erratic, only capacitance values are to be monitored.
 - (f) Measurement to be carried out using fully automatic kit.
3. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.

D) SURGE ARRESTERS

1. Testing procedure for Top, Middle and Bottom Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle/ Bottom stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV with fully automatic test kit.
 - (c) While measuring Middle/ Bottom stacks, the stacks above the HV lead to be shorted.
2. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.
3. While doing measurement of bottom stack the earth connection to be removed.

6.2 CHECKS/TESTS APPLICABLE FOR CTs

6.2.1 POLARITY TEST FOR CT

A centre zero voltmeter is connected across CT secondary. A 1.5 Volt battery is touched to primary of CT. The deflection of pointer should be similar in case of each CT core.

At any instant current entering the primary from P1 the current should leave secondary from the terminal marked S1. A setup shown in the Figure 9 can show whether the polarity markings are correct or not.

When the key is pressed, current enters the primary through terminal P1, the voltmeter connected as shown, should read positive. A general arrangement of polarity test setup is indicated in Fig. 10.

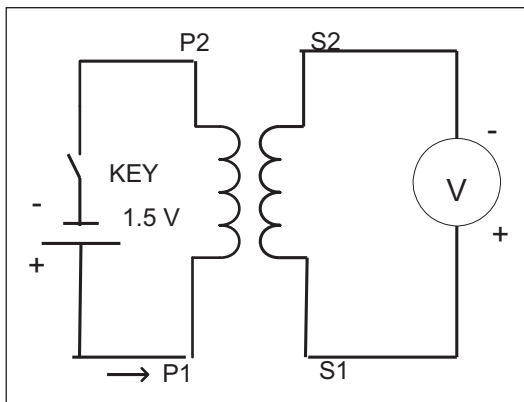


Figure - 9

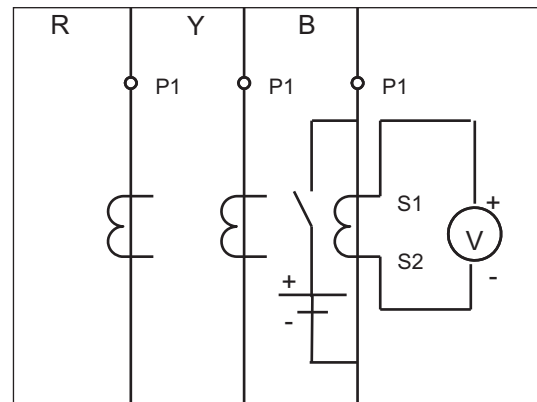


Figure - 10

6.2.2 MAGNETIZATION CHARACTERISTICS OF CTs

PRECAUTIONS

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.

Test Equipment: Voltage source of 5 kV, Voltmeter of range 0 to 5 kV, Ammeter of range 0 to 500 Amps, testing leads/cables etc.

Test Procedure: Make connections as per diagram shown below (Fig- 11). After making proper connections, applied voltage is increased from zero to rated Knee Point Voltage in steps of 25%, 50%, 75% and 100%. Measure the current drawn by the CT secondary core at respective applied voltages and record the test results

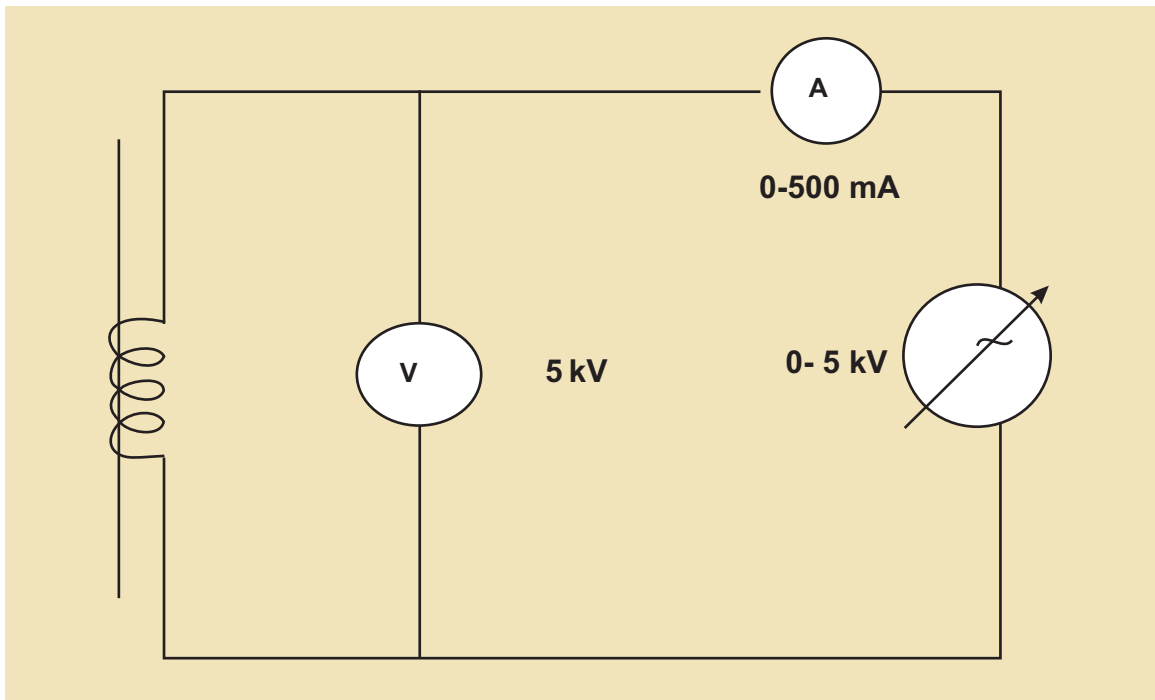


Figure - 11

Knee Point Voltage is normally defined as the voltage at which 10% increase in the applied voltage causes 30 to 50% increase in secondary current. The magnetization current at rated Knee Point Voltage should not be more than the specified/designed value. A curve can be drawn between applied voltage and magnetizing current. Typically, the curve drawn should be like the one given below in Fig.-12.

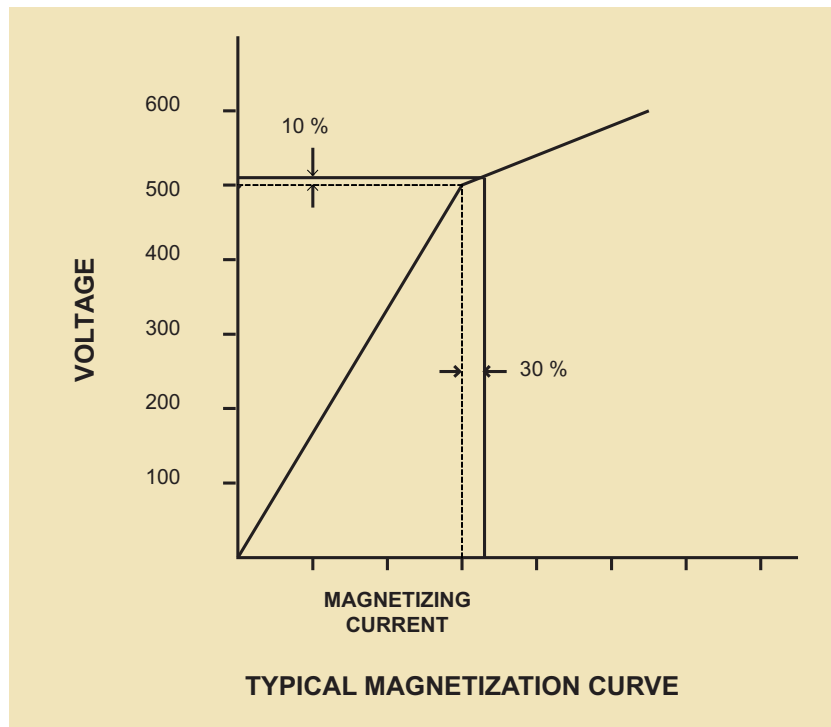


Figure - 12

From the curve it can be implied that up to rated KPV (Knee Point Voltage), the VI curve should be almost a straight line. However, if this line is not linear, this indicates that the magnetizing characteristics are not desirable. If the slope of the curve starts increasing, it indicates that magnetizing induction becomes low and total primary current is utilized in exciting the core alone. Consequently, output of CT secondary disappears.

6.2.3 RATIO TEST FOR CURRENT TRANSFORMER

The ratio check has to be carried out as indicated in Fig-13 below.

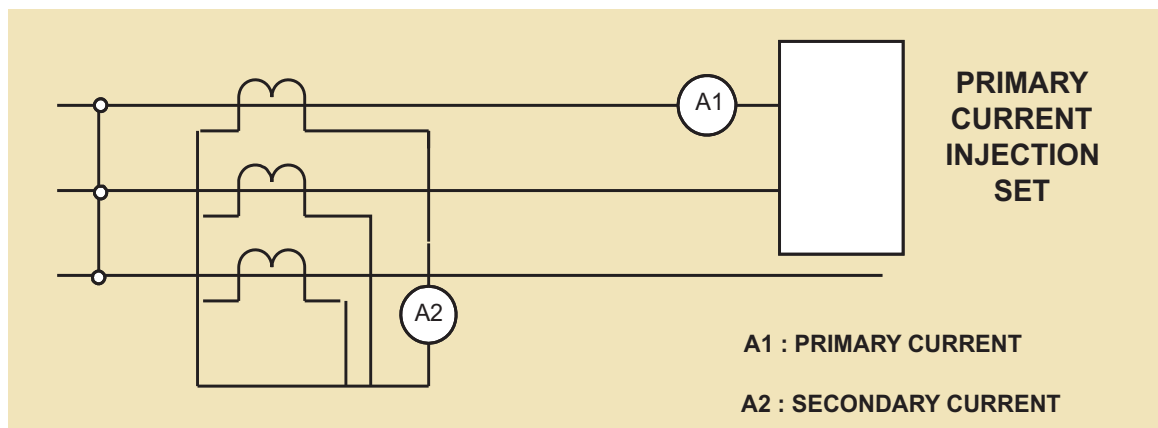


Figure - 13

It is customary to conduct this in conjunction with the primary injection test. Current is passed through the primary circuit with the secondary winding circuit to its normal circuit load. The ratio of the primary to the secondary currents should approximate closely to that stamped under CT identification plate.

Alternatively, ratio test is to be conducted as per the following method (Fig-14).

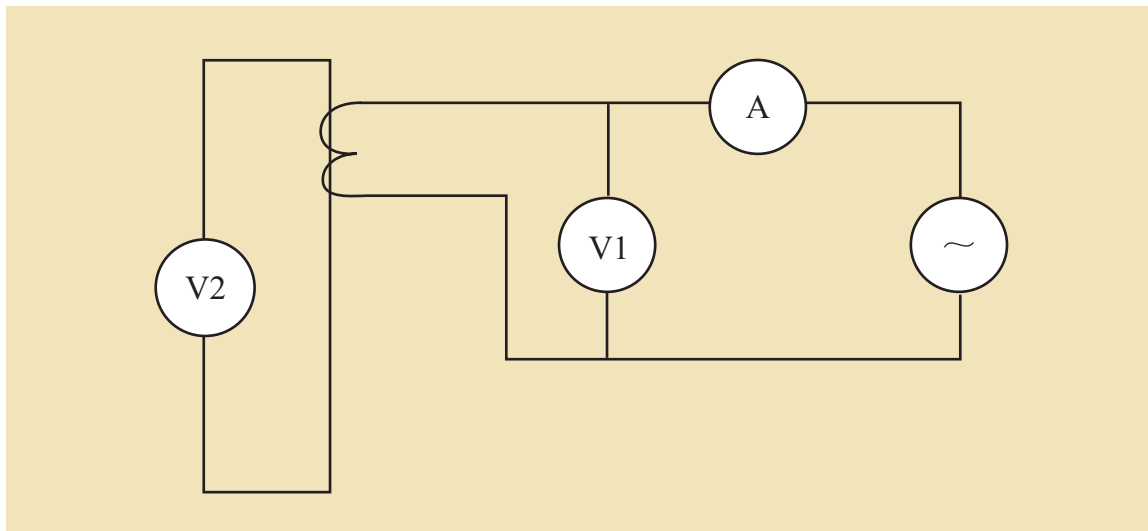


Figure - 14

Apply voltage from secondary of the CT and measure voltage in primary winding. Increase voltage in secondary up to rated KPV/ ISF and by recording Primary Voltage, compute ratio of $V1/V2$. The ratio should match with the specified value.

6.2.4 INSULATION RESISTANCE MEASUREMENT OF CURRENT TRANSFORMER

PRECAUTIONS

- There should be no joints in testing cables.
- Test leads should not touch any live part.
- Megger body should be earthed (if separate terminal is provided).
- Surface/terminals should be cleaned.
- IR measurement should be carried out preferably in dry and sunny weather.
- Never connect the test set to energized equipment.
- The ground terminal must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- If oil traces are found on the surface of CT, the same should be cleaned by Methyl Alcohol only. Petrol or diesel should never be used.
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing engineer only.
- After testing with high voltage, test terminals must be grounded before being touched by any personnel.
- Test leads should be properly screened/ shielded.

Connect the Megger as per figure-15 given below. Connect the HV terminal to the Primary terminal of CT by using crocodile clip for firm grip

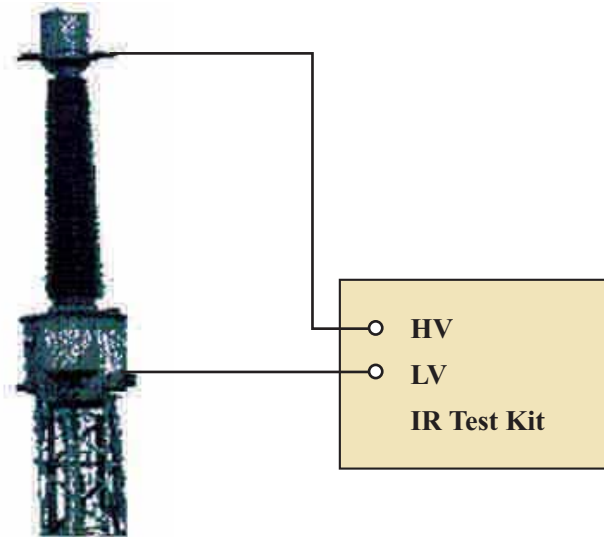


Figure-15 Typical Arrangement for IR measurement

Carry out the measurement as per standard procedure given by the kit supplier.

A test voltage as specified is applied as per the above connections and successive readings are taken. Values of IR should be recorded after 15 seconds, 60 seconds and 600 seconds. Ambient temperature and weather conditions are to be recorded.

6.2.5 DGA Test of CT Oil: Oil samples to be collected in 300ml bottles and to be sent to CIOTL Hyderabad for testing. Test results should be comparable to factory values. In case of any deviation, test results to be forwarded to CC-OS for approval.

6.3 CHECKS/TESTS APPLICABLE FOR CIRCUIT BREAKERS

6.3.1 DEW POINT MEASUREMENT OF SF₆ GAS FOR CIRCUIT BREAKER

Dew Point is the temperature at which moisture content in SF₆ gas starts condensing.

Dew Point at rated pressure of CB: Dew Point when measured keeping regulating valve in service at the outlet of dew point kit to allow required flow rate of gas, is called at rated pressure of CB. Inlet valve is opened completely.

Dew Point at atmospheric pressure : Dew Point when measured by regulating the gas flow at the inlet of dew point kit and keeping outlet regulating valve (if provided) in fully open condition so that flow rate of gas is maintained as required, is called at atmospheric pressure.

TESTING PROCEDURE

- Make the connections to the kit from CB pole ensuring that regulating valve is fully closed at the time of connections of the Dew Point kit.
- By regulating the flow rate of SF₆ gas (0.2 liter/min to 0.5 liter/min - ref. IEC 60480), the value of dew point is observed till it becomes stable.

- c) If the regulating valve is provided at outlet of the dew point kit then values as given in Doc. no. for rated pressures are to be monitored.

Dew Point of SF₆ gas varies with pressure at which measurement is being carried out. This is due to the fact that Saturation Vapour Pressure decreases with increase in Pressure of the SF₆ gas. Hence, dew point of SF₆ gas at higher pressure is lower than dew point at atmospheric pressure. Therefore, it is to be ensured that if measurement has been done at a pressure other than the atmospheric pressure, same is to be converted to the atmospheric pressure as given in the table below used at the time of commissioning for various CB manufacturers: Method for converting dew point at different gas pressures, is given/described in IEC-60480.

Sl. No.	Make of CB	Dew point at rated pressure	Dew point at Atmospheric Pressure (Limit)
1	BHEL	(-) 15° C	- 36° C
2	M & G	-	- 39° C
3	CGL	(-) 15° C	- 35° C
4	ABB	(-) 15° C	- 35° C
5	NGEF	(-) 15° C	- 36° C

6.3.2 MEASUREMENT OF CIRCUIT BREAKER OPERATING TIMINGS INCLUDING PRE INSERTION RESISTOR TIMINGS

PRECAUTIONS

- There should not be any joint in testing cables.
- Test leads should not touch any live part.
- Never connect the test set to energised equipment.
- The ground cable must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- Circuit Breaker Analyser body should be earthed (if separate earth is provided).
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- Surface/terminals should be cleaned where the connections for testing are to be made.
- Clean earth point with sand paper/wire brush where earth terminal is to be provided.
- Ensure that all the poles trip simultaneously through single close/trip command.

TESTING PROCEDURE

- Make connections as shown in the figure-16 below. It is to be ensured that R, Y, B phase marking cables are connected with the proper place in the CB analyser and colour codes are to be maintained for all the three poles of CB.
- Make connections for recording operating timings of Auxiliary contacts.
- Extend power supply to Circuit Breaker Analyzer.
- Give closing command to closing coil of CB and note down the PIR and main contact closing time. Take the print out from the Analyzer.

- e) Give tripping command to trip coil-I of CB & note down the main contact tripping time.
- f) Give tripping command to trip coil-II of CB & note down the main contact closing time.
- g) Note down the timings for 'CO', and 'OCO' by giving respective commands. CO command to be given without time delay but 300ms time delay to be given between O and CO operation in testing for OCO.
- h) To find out opening time of PIR contacts, PIR assembly has to be electrically isolated from Main contacts and then PIR contacts are to be connected to separate digital channels of the Analyzer.

EVALUATION OF TEST RESULTS

A) CLOSING TIMINGS

Closing timings and Discrepancy in operating times of PIR and main contacts should not exceed the permissible limits as specified in the DOC NO: D-5-02-XX-01-03. In any case, main contacts should not close prior to closing of PIR contacts and PIR contacts should not open prior to closing of main contacts. In case, contact bouncing is observed in operating timings for PIR and main contacts, same should be rectified by tightening the cable connections.

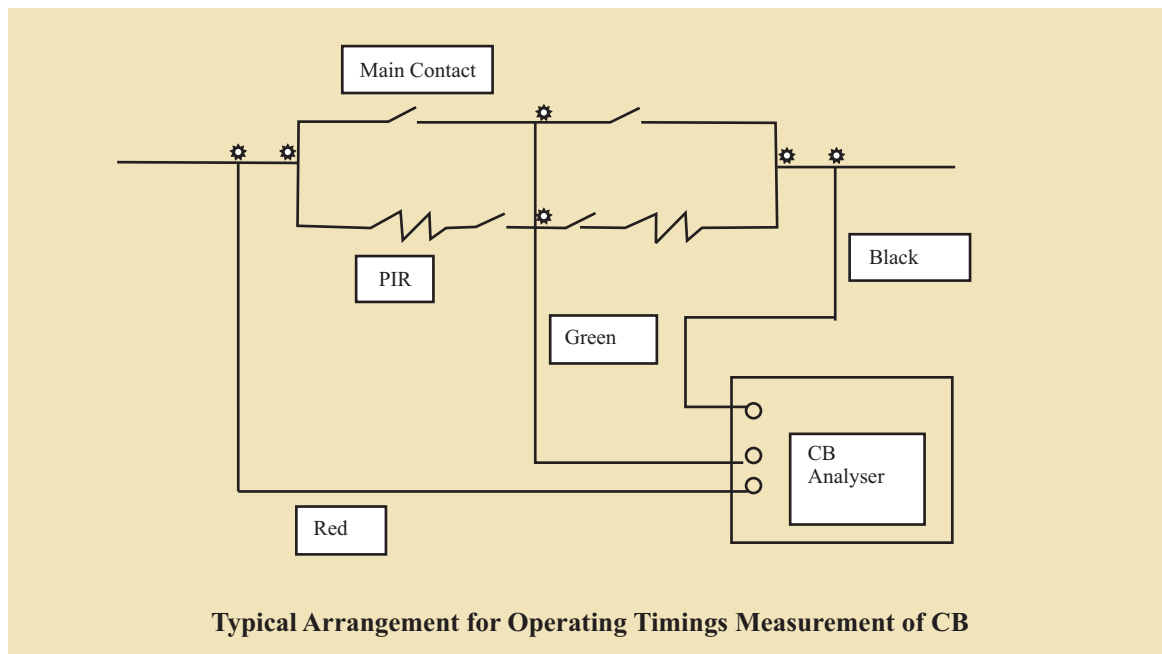


Figure - 16

B) TRIPPING TIMINGS

Trip time and pole discrepancy in operating timings should not exceed beyond permissible value given in Doc. No. D-5-02-XX-01-03. In case of ABB, NGEF and CGL make CBs, while tripping, PIR contacts should not open after opening of main contacts.



C) 'CO' TIMINGS

CO timings should be within permissible limits as specified by different manufacturers.

If operating timings of CB poles are not within limits, same may be corrected by:

1. Equalizing the SF6 gas pressure in all the poles
2. Adjusting plunger movement of trip/ close coils
3. Adjustment in operating mechanism
4. Changing of trip/ close coils (if required)

It is also important to measure timings of auxiliary contacts from the point of view of variations w.r.t. the main contacts.

6.3.3 DYNAMIC CONTACT RESISTANCE MEASUREMENT (DCRM) AND CONTACT TRAVEL MEASUREMENT OF EHV CIRCUIT BREAKERS

Test Equipment: 100 Amp. DCRM kit with CB operational analyzer with 10k Hz sampling frequency.

Isolation Required

- a) CB should be in open position.
- b) Isolator of both sides of CB should be in open position.
- c) Earth switch of one side of CB should be in open position.

Precautions

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- c) Current leads should be connected such that voltage leads are not outside area of current flow.

Testing Procedure

1. Follow the standard procedure as given in instruction manual of DCRM kit.
2. The tightness of connections at CB flanges is most important to ensure error free measurement. CB during CO operation generates lot of vibrations and failure of connections during this period can dramatically change the dynamic signature of CB resistance.
3. DCRM signatures should be recorded for CO operation. Open command should be extended after 300 ms from the close command.
4. Clean portions of incoming and outgoing flanges of CB with polish paper to remove paint, oxidation etc, at points where Current clamps are mounted.
5. Select this point of connection, as close as possible to the end of porcelain insulator to ensure that minimum resistance is offered by flanges, bolts, terminal connectors etc.
6. It should be ensured that Travel Transducers are properly fitted.
7. Sampling frequency during measurement should be 10 KHz.
8. Resistance, travel, injected current and Trip/ Close coil currents are to be recorded.

The variations in the measured resistance versus time will be seen as a finger print for the breaker contacts and can be used as a bench mark for comparing with future measurements on the same breaker. This provides information on the condition of the breaker contacts, driving mechanism, operating levers etc.

Dynamic Contact Resistance Measurement for CB healthiness

By application of Dynamic Contact Resistance Measurement, condition of arcing contact, main contact, operating levers, driving mechanism can be predicted. If DCRM signature shows wide variations and also there is change in arcing contact insertion time, it indicates erosion of the arcing contacts to main contacts and subsequent failure.

Contact Travel Measurement

Transducers are attached to the operating rod or interrupting chamber in order to record the contact travel. When CB closes, contact travel is recorded. Contact bounces or any other abnormality is also clearly indicated by the Contact Travel Measurement.

If contact travel, contact speed and contact acceleration signature are compared with the original signatures, then it may indicate problems related with the operating mechanism, operating levers, main/ arcing contacts, alignments etc.

DCRM along with Contact Travel measurement is useful in monitoring length of Arcing contacts. Erosion of Arcing contacts may lead to commutation failures and current may get transferred to Main contacts. Due to heat of arc, main contacts may get damaged.

6.3.4 OPERATIONAL LOCKOUT CHECKING FOR EHV CIRCUIT BREAKERS

6.3.4.1 TESTING PROCEDURE:

A. SF6 GAS PRESSURE LOCKOUT

a) LOW PRESSURE ALARM

Close Isolation Valve between CB Pole(s) and density monitor. Start releasing SF₆ gas from density monitor till the low pressure gas alarm contacts are actuated which is detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated.

b) OPERATIONAL LOCKOUT:

Continue releasing SF₆ gas from isolated zone till the operational lockout Alarm Contacts are actuated which are detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated. This is called operational lockout pressure.

B. PNEUMATIC OPERATING SYSTEM LOCKOUT

a) COMPRESSOR START/STOP SWITCH

Close the isolating valve of CB. Release air into atmosphere from the compressor. Note down the value of pressure at which Compressor starts building up air pressure and pressure at which Compressor stops.



b) CBAUTO RECLOSE LOCKOUT

Close isolation valve between pneumatic system and pressure switches. Release air from the isolated zone to atmosphere. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter. The leads of the Multimeter should be connected to the contactor where the AR L/O of CB are made.

c) CB CLOSING LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

e) MECHANICAL CLOSING INTERLOCK (FOR ABB & BHEL CBs ONLY)

CB should be in closed position. Release air from pneumatic system of CB to atmosphere and observe whether CB poles start opening, if so, note down the pressure at which tie rod starts coming down. In such case the closing interlock is to be opened for inspection and if required, replace the closing interlock.

C. HYDRAULIC OPERATING SYSTEM LOCKOUT

a) Pump START/STOP

By opening pressure release valve, note down the pressure at which Pump starts building up oil pressure and pressure at which pump stops.

b) CBAUTO RECLOSE LOCKOUT

Close Isolation valve between hydraulic system and pressure switches. Release oil from the isolated zone to oil tank. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter.

c) CB CLOSING LOCKOUT

Release oil from the isolated zone to oil tank. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release oil from the isolated zone to container. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

D. OPERATING PRESSURE DROP TEST:

For Pneumatic/ Hydraulic operating system, operating pressure drop test to be performed during OCO operation of CB, keeping AC supply of Hydraulic pump/ Compressor in off condition. Hydraulic/ Pneumatic pressure drop should be within limits (as recommended by Manufacturer)

6.3.4.2 EVALUATION OF TEST RESULTS

A. SF6 GAS PRESSURE LOCKOUT

All the SF6 gas pressure switches settings should be checked and corrected with ambient temperature. Settings of SF6 gas pressure switches should be within ± 0.1 bar/ Kg/cm² of the set value (after taking into account the temperature correction factor).

B. AIR PRESSURE LOCKOUT

All the air pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

C. OIL PRESSURE LOCKOUT

All the oil pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

6.3.5 MEASUREMENT OF STATIC CONTACT RESISTANCE

The Static contact resistance of main circuit of each pole of a circuit breaker is of the order of a few tens of micro ohms. 100 A DC is injected and milli volt drop is measured across each CB contact to compute contact resistance. The values should be within specified limits.

6.3.6 CHECKING THE ANTI-PUMPING FEATURE

When the breaker is in open position and closing and opening commands are given simultaneously the breaker first closes and then opens, but does not reclose even though the closing command is maintained.

6.3.7 CHECKING THE ANTI-CONDENSATION HEATERS

Check the supervisory circuit of the anti-condensation heaters for correct functioning. With the heaters switched ON, measure their current output.

6.3.8 POLE DISCREPANCY RELAY TESTING

Pole Discrepancy is defined as the difference in closing & opening timings of different poles of CB.

A. WHEN CB IN OPEN POSITION

Closing Command is extended to close one pole, say R-Pole, of CB. After closing R-Pole of CB, this Pole should automatically open after 2.5 seconds (as per pole discrepancy timer settings). Repeat the test for remaining two poles of CB.

B. WHEN CB IN CLOSED POSITION

Tripping Command is extended to trip one pole, say R-Pole, of CB. Remaining Y and B- Poles of CB should automatically open after 2.5 seconds. Repeat the same test for remaining two poles of CB.

C. EVALUATION OF TEST RESULTS

Permissible value of pole discrepancy between two poles of CB is 3.33 msec. from system point of view and it should not be confused with the setting of pole discrepancy timer which is generally 1.0 or 2.5 sec. depending on Auto-reclose scheme.

6.3.9 CHECKING THE NITROGEN PRIMING PRESSURE

Close the pressure release valve. Shortly after the oil pump starts, the priming pressure (200 bar at 20 °C) in the accumulator can be read. The relationship between the pressure and temperature is indicated in Fig. 17.

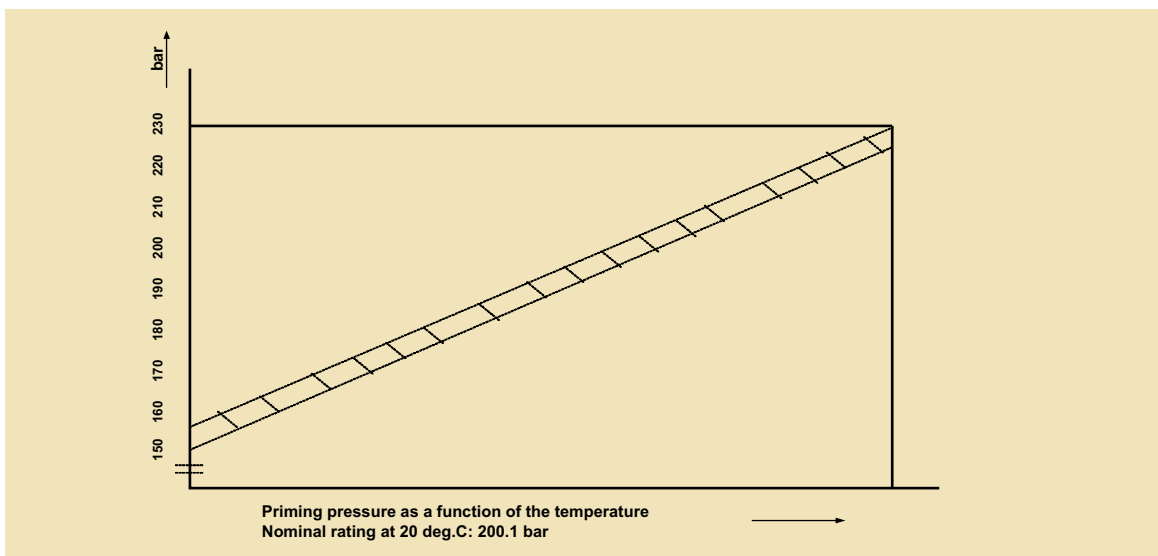


Figure - 17

6.4 CHECKS/TESTS APPLICABLE FOR CVTs

6.4.1 CVT POLARITY, RATIO TEST

CVT polarity is checked in the same manner as for CT, taking care to ensure that the battery is connected to the primary winding. In case of star/star winding configuration care has to be taken to ensure that the primary and secondary neutral points are not connected together. It is necessary to verify that the phase rotation sequence of the 3 phase CVT is correct. The secondary voltage between phases and neutral are measured and then phase rotation meter is connected across the three phase terminal.

6.4.2 INSULATION RESISTANCE MEASUREMENT OF PRIMARY & SECONDARY WINDING

6.5 CHECKS/TESTS APPLICABLE FOR ISOLATORS

6.5.1 MILLIVOLT DROP TESTS

The milli volt drop across the isolator is measured using DC current. The voltage drop gives a measure of resistance of current carrying part and contacts.

The DC current should be equal to or more than 100 A. The resistance of isolator should be measured at ambient air temperature. The temperature of specimen/environmental temperature should be recorded. The value of measured resistance should be converted to the value of temperature at which factory test results are taken. Temperature corrected value of resistance should be comparable to the factory value.

6.5.2 50 OPERATION TESTS

6.6 CHECKS/TESTS APPLICABLE FOR SURGE ARRESTERS

6.6.1 MEASUREMENT OF THIRD HARMONIC RESISTIVE CURRENT FOR SURGE ARRESTERS

Testing Procedure

- Make the connections as per the diagram given below (Fig.18)
- The kit should be properly earthed.
- Clamp On type CT should be placed above the surge monitor to pick up the total leakage current.
- Carryout the measurements as per standard procedure supplied by the test kit manufacturer.
- Note down the system voltage and ambient temperature along with the test current value.
- Avoid measurement during monsoon.

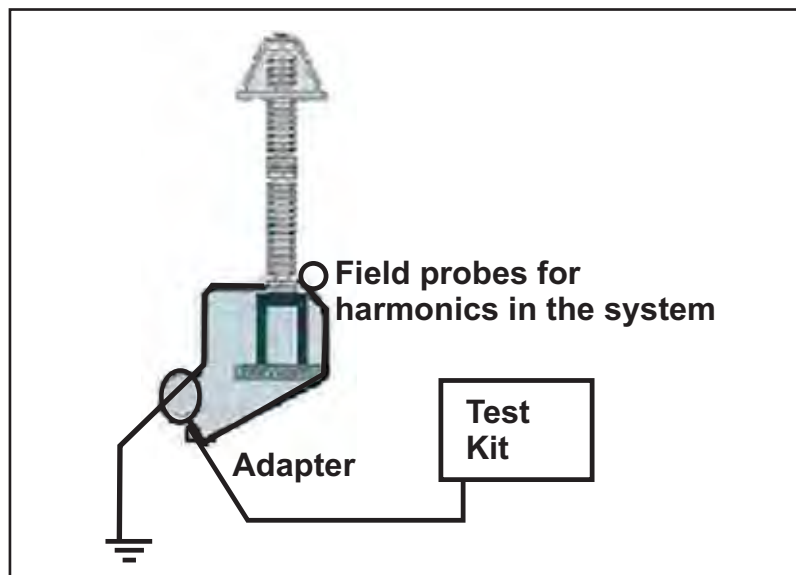


Figure- 18 Typical arrangement for THRCM Test

EVALUATION OF TEST RESULTS

- A. ZnO Surge Arrester continuously conducts a small leakage current (Fig.19). The resistive component of this leakage current may increase with time due to different stresses causing ageing and finally cause arrester failure.
- B. If Harmonics are present in the system voltage, it affects the value of measured third harmonic current. Compensating device provided to be used to nullify the effect. The value of Third Harmonic Resistive current shall be less than 30 μA

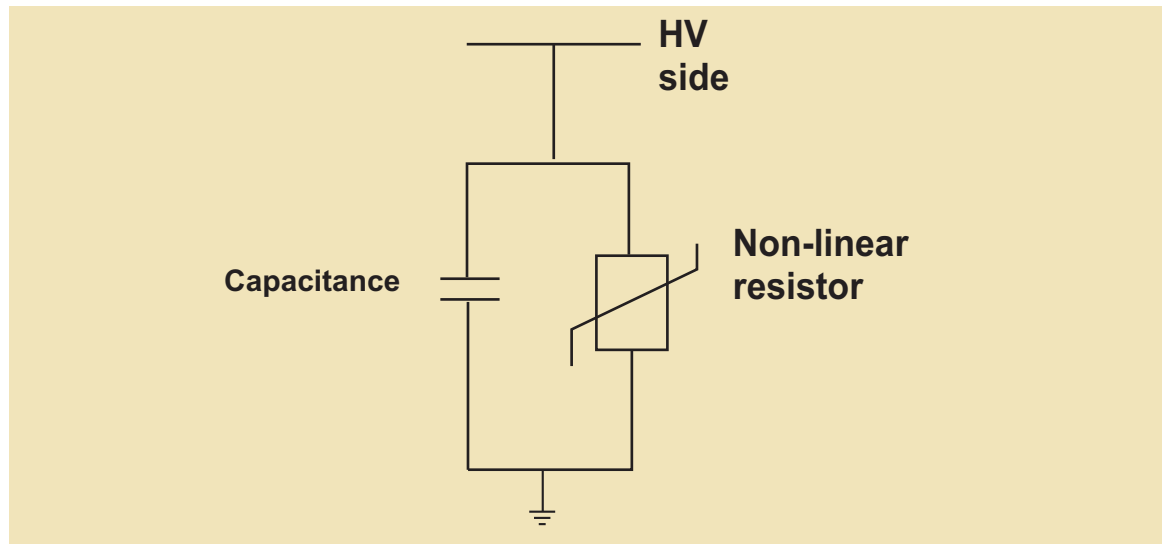


Figure-19 Arrester equivalent circuit

6.7 CHECKS/ TESTS FOR OTHER AREAS/ EQUIPMENTS

6.7.1 EARTH RESISTANCE MEASUREMENT

Normally Earth tester is used for measuring

- (a) Soil resistivity
 - (b) Earth resistance
- a. Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred for procedures to be adopted for measurement of soil resistivity and earth resistance.
A typical earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1, P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the scale of the instrument. If R is the resistance measured then

$$\text{Specific Resistivity} = 2\pi a R$$

Where 'a' is the distance between the electrode

And R is the resistance in ohms measured on the earth tester.

- b. In order to measure earth resistance of the electrode of the substation, it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the Insulation tester. This will give the earth resistance. The value as far as possible should be around 1 ohm. To improve the value, water should be spread at the earth pit.

6.7.2 SECONDARY CURRENT INJECTION TEST SETS

The primary test is essential when commissioning and new installation as a test the whole protection system and will detect current transformers connected with incorrect polarity or relays that have been set in the wrong sequence in differential system. Secondary current injection sets are very useful for conducting these tests. The standard secondary current injection test equipment consists of a 1/5 A current injection set, separate wave form filter unit and a digital counter. The equipment is designed in a portable kit for on site testing of protecting devices, circuit breakers, trip coils, motor overloads, and similar apparatus. The filter unit should be used when testing saturating core type relays to ensure that the test current has a substantially sinusoidal waveform. The typical test setup is shown in fig. 20. Details of the testing will be elaborated in the relay testing.

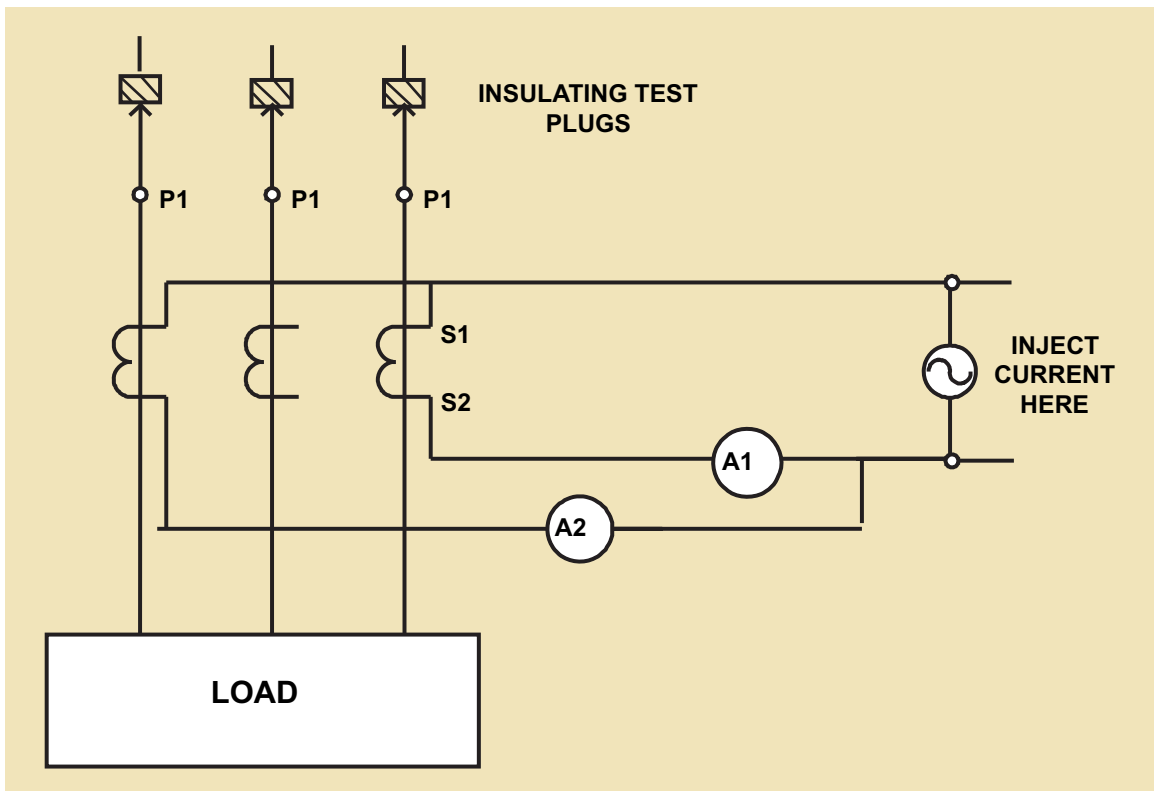


Figure - 20

6.7.3 CONTACT TIGHTNESS TEST OF BAY CONTACTS:

- Isolate the Bay from Bus–Side and line side as shown in Fig.-21.
- Ensure that all the secondary cores are connected or short if not in use.
- Inject the Current at Point 1 (200A) from primary injection kit (w r t earth) and return current via earth point at 2 as shown in Fig.-21.
- Check that we are able to inject current at point 1 and measure the current at point 2.
- Injection of current is the indication of contact tightness.
- Repeat the procedure for point 1 & 3
- Repeat the procedure for point 1 & 4

Note: Above tests can be aborted if individual contact resistances are within satisfactory limit and physical phase checking is satisfactory.

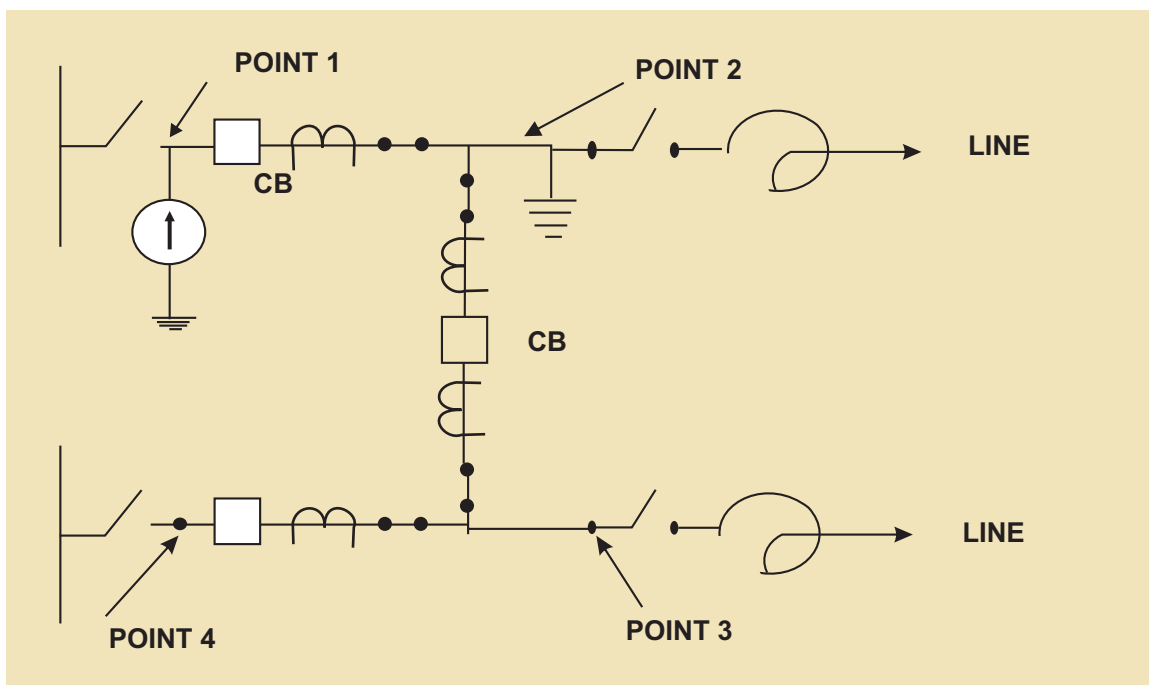


Figure-21 : Primary injection test to check contact tightness of Bay/ feeders

RISH Ducer PT 602, 1 or 2 channels **Configurable transmitter for Pt 100**

Data Sheet

Transducer for measuring
Temperature (Equivalent resistance)



Fig. 1 RISH Ducer PT 602, 1 channel version, in housing S17 clipped on to a top - hat rail.



Fig. 2 RISH Ducer PT 602, 2 channel version, in housing S17 hole mounting brackets pulled out.



Application

The transmitter RISH *Ducer* PT 602 (Fig. 1 and 2) Converts the input variable-a signal from a resistance thermometer Pt 100- to a temperature linear output signal.

The analogue output signal is either an impressed current or superimposed voltage which is processed by other devices for purposes of displaying, recording and / or regulating a constant.

Versions are available for two, three or four - wire connection.

DIP switches are provided for the coarse setting of the measuring range and the fine adjustment is accomplished using the potentiometers.

Red LED's signal an open or short-circuit feeler. In both cases, the output signal adopts its maximum value.

In the case of an current output, provision is made for switching between 0... 20 mA and 4... 20 mA.

The transmitter fulfil all the important requirements and regulations concerning electromagnetic compatibility EMS & safety (IEC 1010 resp. EN 61 010). It was developed & is manufactured & tested in strict accordance with the quality assurance standard & ISO 9001

Features / Benefits

- Measuring ranges configurable with DIP switch and potentiometer .
- Non - Standard user - specific ranges available .
- Red LED's indicator : an open or short - circuit.
- Electric isolation between input & output 2.3 kV and power supply & all other circuits 3.7 kV - Fulfils EN 61 010.
- Universal (DC / AC) power supply.
- Provision for either snapping the transmitter onto top-hat rails or securing it with screws to a wall or panel.
- Housing only 17.5 mm wide (size S17) / low space requirement

Technical data

Measuring input resp. measuring inputs—⊕

Resistance thermometer	Type Pt 100 (DIN IEC 751)
Measuring current	< 1 mA
Input resistance	R _i > 4 MΩ
Lead resistance	Two - wire connection ≤ 25 Ω per lead (total 50 Ω) Three - / four - wire connection ≤ 25 Ω per Lead
Temperature range	Two - wire connection - 150 ... 800°C Three - / four - wire connection - 170 ... 800°C
Min. span	50°C
Max. span	700°C

Example 1 : Range -150°C to 800°C

Lower side possible range is -150°C to 550°C (Span=700°C)

Higher side possible range is 100°C to 800°C (Span=700°C)

Example 2 : Range 0°C to 45°C or -20°C to 10°C

These ranges are not possible because Min span required is 50°C whereas available span is less than 50°C

Max. initial value : Two - wire connection 400°C
Three-/four - wire connection 500°C

Max. ratio between offset and span

$$\frac{T_A}{T_E - T_A} < 10 \quad (T_A \text{ and } T_E \text{ in } ^\circ\text{C})$$

Measuring range settings

— Coarse setting with DIP switches
— Fine adjustment with potentiometer "Zero" and "Span"
Dependent on temperature range, typical values :
— Span, approx. ± 60% of full scale
— Offset, approx. ± 100°C
(12 - turn helical potentiometer)

Potentiometer setting range

Measuring output resp. measuring outputs ⊕➡

DC current	0 / 4 ... 20 mA switchable by plug - in jumper
Burden voltage	10 V
Open-circuit voltage	< 20 V
External resistance	R _{ext} max. ≤ 500 Ω
Residual ripple	< 1.5% p.p., DC...10 kHz
DC voltage	0...10 V
Short-circuit current	≤ 40 mA
Load capacity	R _{ext} min. ≥ 2 kΩ
Residual ripple	< 1.5% p.p., DC...10 kHz
Response time	≤ 500 ms

Open-circuit sensor circuit and short-circuit supervision

Pick-up level	— At open - circuit approximately 1 to 400 kΩ — At short - circuit approximately 0...30 Ω
Fault signaling mode	— Frontplate signals Red LED for signaling fault — Output signal at 0 / 4...20 mA, output approx. 25 mA at 0...10V, output approx. 12.5 V

Accuracy data (acc. to DIN/IEC 770)

Basic accuracy	Max. error ≤ + 0.5% including linearity and repeatability errors for a standard range 0 ... 100° C and for reference conditions.
Additional error (additive)	< ± 0.35 % for linearised characteristic.
Influence of lead resistance	— Two - wire connection : Compensated by potentiometer — Three - wire connection : 0.15 K of measuring range per 10 Ω Lead resistance ≥ 0.375 K total — Four - wire connection : 0.1 K of measuring range per 10 Ω Lead resistance ≥ 0.375 K total
Selector switch for 0...20 / 4...20 mA	± 0.1%

Reference conditions

Ambient temperature	23°C, ± 2 K
Power supply	24 VDC $\pm 10\%$ and 230 VAC $\pm 10\%$
Output burden	Current: $0.5 \cdot R_{ext}$ max. Voltage: $2 \cdot R_{ext}$ min.
An external supply fuse must be provided for DC supply voltages supply > 125 V.	

Influencing factors

Temperature	< ± 0.2 % per 10 K
Burden	< ± 0.1 % for current output < 0.2 % for voltage output, if $R_{ext} > 2 \cdot R_{ext}$ min.
Long-term drift	< ± 0.3 % / 12 months
Switch-on drift	< ± 0.5 %

Power supply H \rightarrow ○ :

AC/DC power pack (DC and 45...400 Hz)

Table 3: Rated voltages and permissible variations

Nominal voltages U_N	Permissible variation
24... 60 V DC / AC	DC -15... + 33%
85...230 V ¹ DC / AC	AC $\pm 15\%$

Power consumption	1 Channel version ≤ 1.2 W respectively ≤ 2.3 VA 2 channel version ≤ 1.8 W respectively ≤ 3.4 VA
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Environmental Conditions

Commissioning temperature	—10 to + 55 °C
Operating temperature	—25 to + 55 °C
Storage temperature	—40 to + 70 °C
Annual mean relative humidity	$\leq 75\%$

Standard

Electromagnetic Compatibility	The standard DIN EN 50 081-2 & DIN EN 50 082-2 are observed
Protection (acc. to IEC 529 resp. EN 60 529)	Housing IP 40 Terminals IP 20
Electrical standards	Acc. to IEC 1010 resp. EN 60 010
Operating voltages	< 300 V between all insulated circuit
Pollution degree	2

Electrical insulation

All circuits (measuring inputs / measuring outputs / power supply) are electrically insulated

Permissible vibrations	2 g acc. to EN 60 068-2-6
Shock	50 g 3 shocks each in 6 directions acc. to EN 60 068 - 2 - 27
Weight	1 channel approximately 180 g 2 channel approximately 200 g

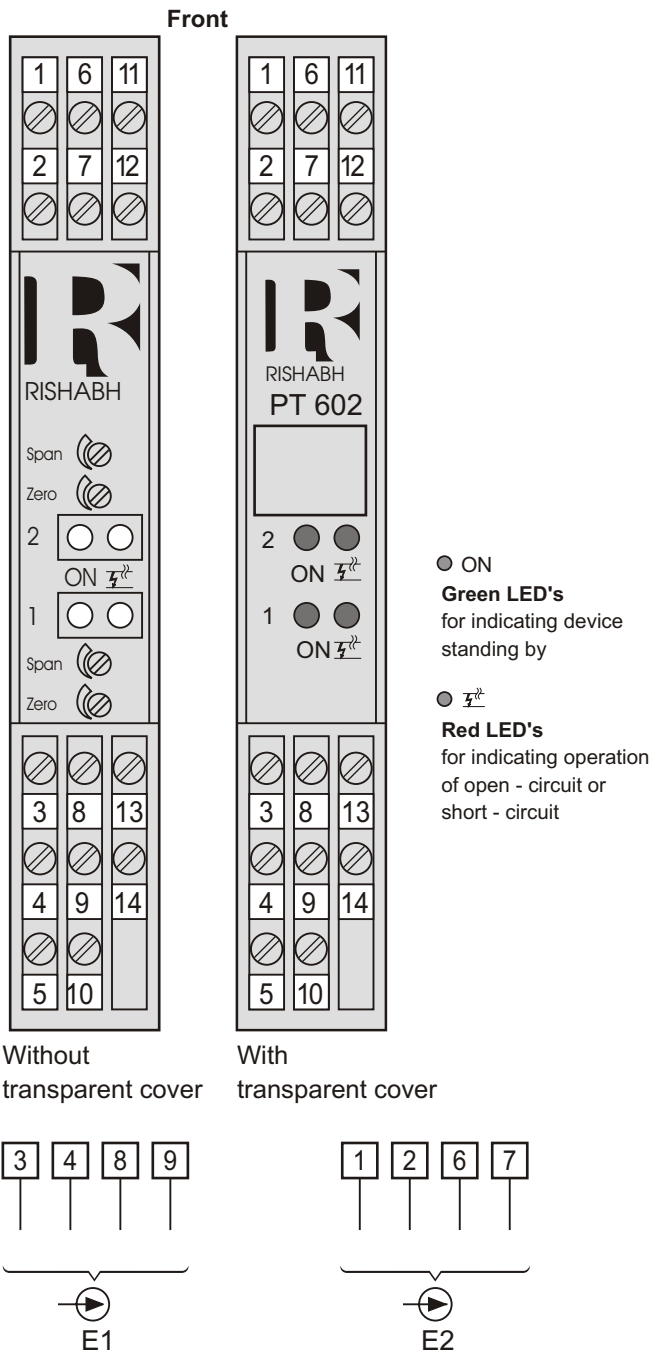
Installation Category

acc. to IEC 664	III for power supply II for measuring input and measuring output
Double insulation:	– Power supply versus all circuits – Measuring input versus measuring output
Test voltage:	Power supply versus: – all 3.7 kV, 50 Hz, 1 min. Measuring inputs versus: – measuring outputs 2.3 kV, 50 Hz, 1 min. Measuring input 1 versus: – measuring input 2 2.3 kV, 50 Hz, 1 min. Measuring output 1 versus: – measuring output 2 2.3 kV, 50 Hz, 1 min.

Installation Data

Mechanical design	Housing S17 Refer to Section "Dimensional drawings" for dimensions
Material of housing	Lexan 940 (Polycarbonate) Flammability class V-0 acc. to UL 94, self - extinguishing, non - dripping, free of halogen
Mounting	For snapping onto top - hat rail (35X15 mm or 35X7.5 mm) acc. to EN 50 022 or directly onto a wall or panel using the pull - out screw hole brackets
Mounting position	Any
Terminals	DIN / VDE 0609 Screw terminals with wire guards for light PVC wiring and max. 2 X 0.75 mm ² or 1 X 2.5 mm ²

Electrical connections



E1 = Measuring input 1 } Terminal allocation acc. to
E2 = Measuring input 2 } Connection mode, see Table 4
A1 = Measuring Output 1
A2 = Measuring Output 2
H = Power supply

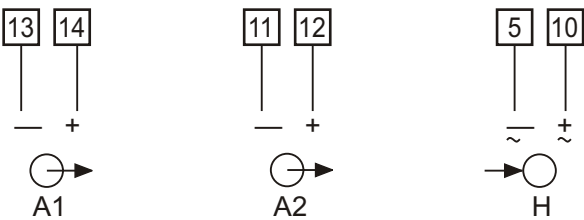


Table 4 : Connection of the measuring input leads E1 and E2

	Measuring inputs	Connection mode*	Wiring diagram Terminal arrangement
Version with 1 input	Measuring input → E1	Two-wire connection	
		Three-wire connection	
		Four-wire connection	
Version with 2 inputs	Measuring input → E1	Two-wire connection	
		Three-wire connection	
		Four-wire connection	
	Measuring input → E2	Two-wire connection	
		Three-wire connection	
		Four-wire connection	

* RISH Ducer PT 602 units with type designations 602-1XX 1 and 602-1XX 2 can operate with either two or three-wire connections, but units with the type designation 602-1XX 3 only operate with a four-wire connection.

Dimensional Drawings

(All dimensions are in mm)

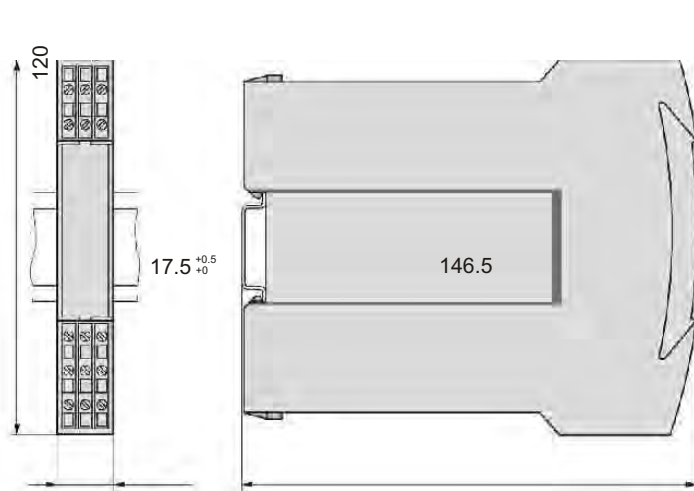


Fig. 3 **RISH Ducer** PT 602 in housing S 17 clipped onto a top-hat rail (35 X 15 mm or 35 X 7.5 mm, acc. to EN 50 022).

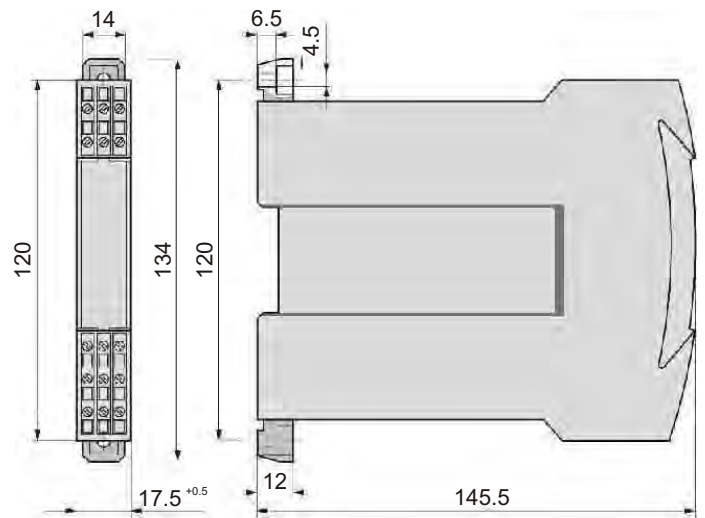


Fig. 4 **RISH Ducer** PT 602 in housing S 17 with screw hole brackets pulled out for wall mounting.

Standard Versions

Inputs (s) set to a range of 0...100°C and output (s) to a range of 4... 20 mA. Configured for three - wire connection. DIP switches enable the temperature range to be configured between a minimum of - 170°C to a maximum of + 800°C; potentiometer for fine calibration of " Zero " and " Span ".

Table 1: Standard version with 1 input 1 output

Input	Output	Power supply DC/AC
0...100 °C	0/4...20 mA	24... 60 V
configurable	$R_{ext.} \leq 500 \Omega$	85...230V



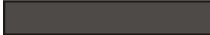

Table 2: Standard version with 2 input 2 output

Inputs 1 & 2	Outputs 1 & 2	Power supply DC/AC
0...100 °C	0/4...20 mA	24...60 V
configurable	$R_{ext.} \leq 500 \Omega$	85...230V

Standard accessories

- 1 Operating Instructions
- 2 Pull out clamp S17 (for opening the housing)
- 3 Front label

Table 5 : Ordering Information (See also Table 1 and 2 : "Standard Version")

DESCRIPTION	MARKING
1. Mechanical design Housing S17 for rail and wall mounting	602 - 1
2. Number of measuring inputs / measuring ranges 1) With 1 measuring input / measuring range 2) With 2 measuring inputs / measuring ranges	1 2
3. Version / Power supply 1) Standard, / 24 ... 60 V DC/AC 2) Standard, / 85 ... 230 V DC/AC	1 2
4. Connection mode (applies to inputs 1 and 2) 1) Two-wire connection RL1 [Ω]  RL2 [Ω]  2) Three-wire connection 3) Four-wire connection	1 2 3
5. Measuring input 1 1) Measuring range 0...100°C 9) Measuring range [°C]  Line 1: Measuring ranges configurable, see Operating Instructions Line 9: —170 to + 800 °C, span min. 50 °C, max. 700 °C, see technical data	1 9
6. Measuring input 2 0) Measuring input 2 not used 1) Measuring range 0...100°C 9) Measuringrange2 [°C]  Line 1: Measuring ranges configurable, see Operating Instructions Line 9: Possible measuring ranges see measuring input 1	0 1 9
7. Measuring outputs 1 or 2 (applies to outputs 1 and 2) 1) Output 0/4 ... 20 mA (configurable by plug-in jumper(s), set to 4 ... 20 mA) 2) Output 0 ... 10 V 3) Output 4/0 ... 20 mA (configurable by plug-in jumper(s) set to 4...20mA)	1 2 3
8. Certificate 0) Without test certificate 1) With test certificate	0 1

Possible special Version, e.g. increased climatic rating on inquiry.

