

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1 INTRODUCTION

- 1.1 The scope of work under this specification is Civil works, Erection, Testing and Commissioning for re-routing and diversion of existing 220kV and 132kV transmission lines emanating from existing PTPS generation switchyard at 3x800MW Patratu Thermal Power Station Expansion Phase-I being executed by BHEL for Patratu Vidyut Utpadan Nigam Limited (A Subsidiary of NTPC Ltd in Joint Venture with Jharkhand Bijli Vitran Nigam Ltd).

Major items like structure, earthing material, conductor, foundation bolts, cables, etc will be supplied by BHEL. However material required for erection purpose like ferrules, lugs, cable ties/starps etc as per BOQ are in contractor's scope.

- 1.2 Total seven nos. charged 220kV and 132kV transmission lines are passing through the area proposed to be used for PTPS expansion Phase-I project. These lines are required to be diverted to start site enabling activities.
- 1.3 Tentative Detail of transmission lines to be diverted:
- (i) 220kV PTPS –Hatia D/C Transmission Line
 - (ii) 220kV PTPS-Tenughat S/C Transmission Line
 - (iii) 132kV PTPS-Hatia D/C Transmission Line
 - (iv) 132kV PTPS-Ramgarh D/C Transmission Line
- 1.4 Existing route of the above lines along-with the location where these respective lines are crossing the land boundary of PTPS station along-with suggestive corridor to be used for diversion of these transmission lines are indicated in preliminary survey report/drawing attached at **Annexure-2A & 2B**. However final route survey report shall be issued to successful bidder after completion of Detail Survey.
- 1.5 Location of project: Patratu Thermal Power station (PTPS) is located just outside the coal belt of South Karanpura in Ramgarh District of Jharkhand State. The nearest Railway Station is Patratu which is at a distance of about 4 km on Barkakhana-Barwadih Railway line. The nearest commercial airport is Ranchi at about 45 km by road.

2 SCOPE

The detailed scope of work shall be as per following:

2.1 CIVIL AND ETC WORKS.

- (a) Assisting check survey along with agency engaged by BHEL for check survey. Check survey report shall be issued by BHEL.
- (b) Necessary modification in route alignment, if required, due to site condition/customer instruction.
- (c) Site clearance/ jungle clearing/tree cutting required for civil works, Erection and stringing work.
- (d) Submission of Filed Quality Plan for Civil and Erection works.
- (e) Unloading, storing, handling including watch & ward of BHEL supplied material is included in the scope.
- (f) Civil works for 132kV and 220kV Transmission line tower foundations and switchyard equipment foundations including excavation including dewatering, shoring, structting and filling under and around structures, backfilling with suitable available excavated earth around completed structures, disposal of surplus soil, backfilling, formwork, foundation bolts, grouting, providing necessary steel embedment and other setting of template, stub fixing including supply of all material, T&P, labour etc. complete as per approved drawings.
- (g) Erection of 220kV & 132kV Transmission Line towers including extensions, Auxiliary Cross arms, bolts and nuts, stub setting template including all tower accessories (phase plate, caution plate, number plate, circuit plate, anti-climbing device, bird guard, aviation signal etc).
- (h) Complete erection of 220kV single/double/multi circuit transmission line, 33kV single/double/multi circuit transmission line (upto four circuits) including erection of towers with all extensions, Tower accessories, stringing of conductor, ground wire and their accessories, earthing of towers, insulator hoisting, String hardware, OPGW, earthing work etc. for successful commissioning of line.
- (i) Tack welding of bolts & nuts along with supply & subsequent application of zinc coating on the welded portion as required.
- (j) Dismantling of existing towers, gantry, switchyard equipment including structure, cables, OPGW, conductor, Earth wire etc. and shifting of unused material to store/place designated by customer.
- (k) Re-erection of switchyard equipment and structure including modifications as required.
- (l) ETC of switchyard equipment including structure, control and relays panel, GI pipe laying, cabling, augmentation/modification in existing control panels etc.

- (m) Since the transmission line to be re-routed are charged at present, therefore re-routing work will involve shut down which will be provided by customer as per required raised by contractor time to time based on the availability. There may be requirement of additional manpower / idling of manpower during shut down related activities. The same are to be arranged by contractor without any extra financial implication.
- (n) Compliance to all safety regulations and arrangement of all safety equipments for proper safety of persons, T&P and existing structures etc.
- (o) Obtaining clearance from electrical inspector & submitting any relevant drawing/document shall be responsibility of bidder.
- (p) Right of way and way leave clearance is not in Bidder's scope. However necessary document/drawings required for right of way and way leave clearances shall be submitted by bidder to NTPC/BHEL. Bidder shall also facilitate in getting such clearances.
- (q) Any other work required for successful completion of the work shall be scope of contractor. Bidders are visit site for proper acquaintance of work and site conditions before quoting.

3 SPECIFIC TECHNICAL REQUIREMENTS

- 3.1 The specific technical requirements for the execution of transmission line work shall be as per NTPC/BHEL specification and relevant IS codes.
- 3.2 For switchyard equipment foundation and structures and other works in existing switchyard, customer technical specification related with switchyard shall be followed.

4 SCHEDULE/BOQ OF ITEMS

- 4.1 The Schedule/BOQ of Items shall be as per **Annexure 1B & 1C**. The Bidder is required to quote his most competitive rate for these items. However, payment will be done on actual executed quantity. Quantity of any item may vary upto any extent but the overall contract value may vary by $\pm 30\%$.

5 METHOD OF MEASUREMENT :

- 5.1 Excavation shall be measured in cubic meters. The lateral dimensions to be considered for working out excavation quantity shall be the PCC dimension below the footing as per approved drawing. Nothing extra shall be paid for working space/slope cutting, etc. Backfilling & disposal qtys shall be worked out based on the above dimensions only. However the contractor shall maintain the required slope and working space as per the safety /statutory requirement and its cost is deemed to be included in the quoted rate.
- 5.2 For other items, unless otherwise described the method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS:1200 (Part I to XXV) latest edition of BIS shall be followed.

6 TENTATIVE LIST DOCUMENTS TO BE SUBMITTED

- 6.1 FQP for Civil and ETC works is required to be furnished after successful award of contract.
- 6.2 Any additional drawing/ document necessary of system understanding or mentioned in NTPC specification shall be submitted by bidder for NTPC/BHEL approval.

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 1B

BILL OF QUANTITY – ETC

220kV & 132kV TRANSMISSION LINE DIVERSION AT PATRATU

BILL OF QUANTITY - ETC

Project : 3X800MW PATRATU THERMAL POWER PLANT

Customer : PVUNL Ltd.

S. No.	Item / Work description	Unit	Quantity	Rate	Amount (Rs)	
1	Erection, Testing and Commissioning (ETC) of 220/132kV Transmission Line					
1.1	Erection of various type of tower angles, tower parts and tower body / leg (equal & unequal) extensions (complete) including bolts and nuts, step bolts, hangers, D-Shackles, stubs & cleats etc., including tack welding and supply and application of zinc rich paint (excluding tower accessories) for both Tension and Suspension type 132/220 kV Double/ Multi Circuit transmission line towers	MT	365			
1.2	Installation of tower accessories for all towers (phase plate, caution plate, number plate, circuit plate, anti-climbing device, bird guard, aviation signal etc) as per NTPC/ BHEL specification	Set*	16			
1.3	ETC of ACSR Panther/ Zebra Conductor complete with stringing hardware, disc insulators, Clamps (tension, suspension, cleat, PG etc), Preformed armour rod, Vibration dampers, Mid span compression joint, Repair sleeves, rigid & flexible spacers etc. to complete for entire route length as per NTPC/ BHEL spec.	km	32			
1.4	ETC of GS Earth Wire on transmission line tower with Vibrations dampers, Clamps (Tension Clamps, suspension clamp, cleat clamp, PG clamp etc), flexible copper bond, Mid span compression joint, Repair sleeves etc to complete for entire route length as per NTPC/ BHEL spec.	km	3			
1.5	ETC of OPGW on transmission line tower along with all its accessories to complete for entire route length as per NTPC/ BHEL spec.	km	3			
1.6	Complete earthing of all towers as per approved drawings (Scope includes complete work including testing to show that the tower resistance meets the acceptable limits.)					
a	3 m long, 40 NB pipe electrode	Nos.	16			
b	Counterpoise type (120 m long)	Nos.	16			
2	Dismantling of Existing 220/132kV Transmission Line Tower/ Equipments					
2.1	Dismantling of existing 132/220/400kV Transmission Line tower complete with Shield wire/OPGW associated with it.	MT	15			
2.2	Dismantling of existing 132/220kV gantry and switchyard tower/LM structure including shield wire associated with it.	MT	50			
2.3	Dismantling of existing 220kV Switchyard equipment lattice type structure	MT	1			
2.4	Dismantling of existing 220kV Switchyard equipment pipe type structure	MT	1			
2.5	Dismantling of existing conductor (Bus/jumper/droppers) including stringing hardware, accessories etc.	km	2			
2.6	Dismantling of existing 220kV Post Insulators complete with terminal connectors excluding support structure	Nos.	6			
2.7	Dismantling of existing 220kV, 1 Phase Surge Arrester complete with surge counter, leakage current meter, insulating base, connecting cable and terminal connectors but excluding support structure.	Nos.	6			
2.8	Dismantling of existing 220kV, 1 Ph CVT/PT complete with terminal connector, JB and associated cables excluding support structure.	Nos.	6			
2.9	Dismantling of existing 220kV, 1 phase, Wave Trap (gantry mounted) complete with terminal connectors	Nos.	4			
3	Erection, Testing and Commissioning (ETC) of 220kV Switchyard Equipment & associated works					
3.1	ETC of 220kV Post Insulators complete with terminal connectors without support structure	Nos.	6			
3.2	ETC of 220kV, 1 Phase Surge Arrester complete with surge counter, leakage current meter, insulating base, connecting cable and terminal connectors.	Nos.	6			
3.3	ETC of 220kV, 1 Ph CVT complete with terminal connector without support structure.	Nos.	6			
3.4	ETC of 220kV, 1 phase, Wave Trap (gantry mounted/ pedestal mounted) complete with terminal connectors. In case of pedestal mounted Wave Trap, ETC work will include ETC of associated support BPI.	Nos.	4			
3.5	ETC of Galvanised steel Pipe/ Lattice Structures including hardwares for equipment support	Nos.	22			
3.6	ETC of ACSR Conductor complete with Tee/ PG connectors for droppers to equipment connections, PG clamps for busbar jumpering, Twin bundle spacers etc to complete.	km	1			
3.7	ETC of GI Stranded Shield wire including tension clamp, PG clamp and clamping on structure for down conductor, fixing/bolting with earth strip etc to complete.	km	0.5			

220kV & 132kV TRANSMISSION LINE DIVERSION AT PATRATU

BILL OF QUANTITY - ETC

Project : 3X800MW PATRATU THERMAL POWER PLANT

Customer PVUNL Ltd.

S. No.	Item / Work description	Unit	Quantity	Rate	Amount (Rs)	
3.8	ETC of Al Tube including Aluminium welding and bending to be included. (Aluminium Tube, sleeve, pins shall be supplied by BHEL)	m	200			
3.9	ETC of 220/132kV, Tension/Suspension insulator string with double/single anchoring point with hardware set with all accessories including clamp with/without Turn Buckle set suitable for single/ twin conductor.	Nos.	24			
3.10	Cabling including laying, tagging, dressing, ferruling, Glanding, lugging, soldering, tapping, jointing, crimping, termination, and drilling/ cutting holes in cable gland plates- laying can be either on trays, supports, underground, buried in ground or through GI pipe over ground, through wall etc. All erection materials viz. ferrules, copper lugs, cable ties / straps, Al. tags, markers, GI / PVC wall sleeves with rubber / nylon bushes and flexible steel conduits shall be supplied by bidder. Minor repair of trench is also in ETC contractor's scope.					
3.10.1	Control cables					
a	5Cx2.5 sqmm Cu	km	1			
b	4Cx10 sqmm Cu	km	1			
c	10Cx2.5 sqmm Cu	km	1			
d	14Cx2.5 sqmm Cu	km	1			
e	19Cx2.5 sqmm Cu	km	1			
3.10.2	Auxiliary Power cables					
a	2Cx6 sqmm Al	km	1			
b	4Cx6 sqmm Al	km	1			
c	4Cx16 sqmm Al	km	1			
d	3.5Cx70 sqmm Al	km	0.5			
3.11	Laying of GI conduits at a depth of 300mm including excavation, backfilling, making holes in RCC/ brick walls and repairing of walls in trenches, cutting, threading, fixing of sockets/ bends where required etc. complete. Both ends of GI conduits shall be closed by suitable material as per instruction of site-in-charge. (Payment will be made for the as erected pipe length)					
a	GI pipe, 50 NB	m	200			
b	GI Pipe, 100 NB	m	100			
3.12	Fixing of GI Pipes on Lattice/ Pipe Structure including clamping, fixing of sockets/ bends as required etc. complete. Both ends of GI Pipes shall be closed by plastering. (Payment will be made for the as erected pipe length)					
3.12.1	50 mm dia	m	50			
3.12.2	100 mm dia	m	30			
3.13	Earthing - Earthing includes earthing of all Switchyard equipment, Panels, towers, lattice structure, cable trenches, fence, electrode for LA, CVT & towers with peak using necessary Connectors for earthing flats. Earthing clamping shall be carried out by ETC contractor. GS strip including cutting, bending, welding with 40 mm dia MS rod riser/earth strip, applying zinc rich paint, clamping to structure/building wall etc. to complete. Hardware required for connecting flat on pads of structure & equipment included in scope. The Earthing of equipments shall be carried out as per approved drawings.					
3.13.1	75 x 12 mm GI Flat	m	60			
3.13.2	50 x 6 mm GI Flat	m	30			
3.14	Installing of 40 mm diameter Rod Electrode without test pit/link as per Equipment Earthing drawing including following works including following works: - excavation/hammering of rod in earth - installing the rod electrode - backfilling and compaction - any other work necessary to complete the work	Nos.	12			
3.15	ETC of Control and Relay Panels - Supervision of testing and commissioning of relays in scope of panel supplier. Necessary manpower, support, tools, tackles and testing equipment to be in scope of ETC contractor. Panel testing excluding relay testing is in Bidder's Scope.					
3.15.1	220kV Line Protection Panel	Nos.	4			
3.15.2	220kV Circuit Breaker Panel	Nos.	2			
3.15.3	Modification/Augmentation of Existing Control Panels	Nos.	2			
3.15.4	Panel/cable supporting angles/channels etc on cable trench in control room buildings/yard including vertical support for cables (including supply)	MT	0.5			
Total ETC						

Notes:-

1	'**' – One (1) Set means items for one (1) no. complete tension/ suspension, DC/MC tower.
2	ETC of OPGW (including accessories) shall be done by the contractor under the supervision of Original Equipment Manufacturer (OEM).

220kV & 132kV TRANSMISSION LINE DIVERSION AT PATRATU

BILL OF QUANTITY - ETC

Project : 3X800MW PATRATU THERMAL POWER PLANT

Customer PVUNL Ltd.

S. No.	Item / Work description	Unit	Quantity	Rate	Amount (Rs)	
3	The quantities mentioned in the BOQ are tentative and Quantity of any item may vary upto any extent but the overall contract value may vary by +- 30%.					
4	Any material/services required for successful completion of the project but not covered in the BOQ shall be deemed to be included in the scope of contractor without any cost implications to BHEL. <u>The bidder is advised to visit Patratu site before submission of bid.</u>					
	The work is to be executed inside/ nearby charged area of switch yard and transmission line. All necessary safety precaution are to be taken care by the subcontractor.					
5	Make of items and their sources to be supplied/used under this contract shall be subject to acceptance by customer/BHEL at contract stage.					
6	Handling, storage, transportation, loading, unloading, shifting etc. of all materials to required locations shall be in the scope of the bidder.					
7	Bidder may note that owner (NTPC/BHEL) shall not pay any compensation for any loss or damage to the properties during work of execution of transmission line job or for tree cutting due to bidder's work.					
8	MS welding - apply red lead paint then aluminium paint then bitumen after welding.					
9	GI welding - apply 2 coats of cold galvanising anti corrosive paint after welding.					
10	10% welding joints in earthing shall be tested for dye penetration test.					
11	Quoted rates are deemed to be inclusive of miscellaneous works, viz. erection of clamps and connectors, phase colour discs/phase marking on structure etc.					
12	Right of Way and most of the tree cutting shall be arranged by customer. However Site Clearance, small/unmarked tree cutting, vegetation removal required for the completion of work are included in the bidder's scope.					
13	Complete earthing of all towers shall be as per approved drawings (Scope includes complete work including testing to show that the tower resistance meets the acceptable limits.)					
14	For scope of supply items in contractor scope following should be followed . (1) The approval of makes shall be obtained from BHEL/Customer . (2) Drawings and MQP shall be submitted for approval in line with specification and relevant IS. (3) Quality - Inspection & dispatch clearance shall be given by BHEL/Customer.					
15	All dismantled material including structure, equipments, cables, conductor, stringing hardware etc are to be shifted to customer store within plant boundary as per instruction of Engineer-In-charge.					

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 1C

BILL OF QUANTITY - CIVIL

220kV & 132kV TRANSMISSION LINE DIVERSION AT PATRATU

BILL OF QUANTITY - CIVIL

Project : 3X800MW PATRATU THERMAL POWER PLANT

Customer : PVUNL Ltd.

S. No.	Item / Work description	Unit	Quantity	Rate	Amount (Rs)	
Civil Works						
1	Earthwork in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30cm in depth 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and disposal of excavated earth upto 100m and lift upto 4 m, disposed earth to be levelled and neatly dressed.					
1.1	All kinds of soil.	Cum	13800			
1.2	Ordinary rock	Cum	200			
2	Filling available excavated earth (including rock) in trenches, plinth, sides of foundations, etc., in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead upto 100m and lift upto 3.5m.	Cum	12200			
3	Carriage & disposal of surplus excavated earth/rock beyond initial lead by mechanical means not necessarily all the times on pucca roads, including loading, unloading, dressing of excavated material, etc., complete as per specifications -.					
3.1	Lead upto 1 km.	Cum	1500			
4	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work upto plinth level.					
4.1	1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size)	Cum	65			
5	Providing and laying in position specified grade of reinforced cement concrete, excluding the cost of centering, shuttering, finishing and reinforcement-All work up to plinth level:					
5.1	M20 Grade	Cum	1200			
5.2	M25 Grade	Cum	25			
6	Centering and shuttering including strutting, propping, etc., and removal of form for:					
6.1	Foundations, footings, bases of columns, etc., for mass concrete.	sqm	800			
6.2	Columns, Pillars, Piers, Posts and Struts .	sqm	700			
6.3	RCC walls at all levels (any thickness).	sqm	200			
7	Steel reinforcement -Cold twisted bars /TMT- Fe 500/Fe500D (to be procured from NTPC approved sources)					
7.1	Supplying and Fixing including straightening, cutting and bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete. Reinforcement steel shall be supplied by BHEL free of cost at site. The quoted rate should be inclusive of unloading at site , watch and ward, shifting to required location etc. also.	kg	100000			
8	Fixing of stub angles in position with template assembling and dismantling all complete as per drawing and directions of Engr-in-Charge.(weight of stub only shall be measured for payment of this item)	kg	27000			
9	Providing and fixing (all dia & length) GI foundation bolts in position with help of proper templates including supply of templates, nuts and washers all complete as per specs, drawings & directions of Engr-in-Charge. (Note: For payment purpose the weight of Template will not be considered)	kg	500			
10	Providing and laying non-pressure NP3 class RCC pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) including testing of joints etc., complete.					
(a)	300mm dia. RCC pipe	RM	10			
(b)	450mm dia. RCC pipe	RM	50			
11	Grouting of block outs, pockets, foundations, bolts holes and underside of base plates with cement, sand aggregate (of size 6 mm and down) grout M-30 with non-shrink additive and shall be of strength not less than M30 including placing, curing, cleaning, surface preparation, testing, etc. complete with labour, materials, equipment, handling, testing, etc. all complete as per specifications, drawings and instructions of the Engineer.	cum	10			
12	Demolishing RCC work manually/ by mechanical means including stacking of steel bars and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-charge.	cum	10			
13	Dismantling and re-fixing MS rails	MT	1			
				TOTAL		

Notes

1 The quantities mentioned in the BOQ are tentative and may undergo a change to any extent for individual items.

2

The work is to be executed inside/nearby charged area of switchyard and transmission line. All necessary safety precaution are to be taken care by the subcontractor.

- 3 Any material/services required for successful completion of the project but not covered in the BOQ shall be deemed to be included in the scope of contractor without any cost implications to BHEL. **The bidder is advised to visit site before submission of bid.**
- 4 The route / check survey and geo-technical investigation and soil resistivity measurement shall be done by separate agency appointed by BHEL. Bidder shall associate himself with the agency during the route/check survey.
- 5 Loading / Unloading, handling, shifting to & from stores, proper storage, assembly, installation are included in the scope.
- 5 Right of Way and most of the tree cutting shall be arranged by customer. However Site Clearance, small/unmarked tree cutting, vegetation removal required for the completion of work are included in the bidder's scope.
- 6 MS welding at site- apply red lead paint then aluminium paint then bitumen after welding.
- 7 GI welding at site - apply 2 coats of cold galvanising anti corrosive paint after welding.
- 8 Bidder may note that any damage of material at site during erection work shall be avoided. Further, owner (NTPC/BHEL) shall not pay any compensation for any loss or damage to the material/properties during work of execution of transmission line job or for tree cutting due to bidder's work.

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

SECTION -2

TECHNICAL SPECIFICATION

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2A

PRELIMINARY ROUTE SURVEY DONE BY NTPC

PATRATU VIDYUT UTPADAN NIGAM LIMITED

(Government of INDIA, Undertaking)



CONCEPTUAL PLAN

SHIFTING OF ROUTE ALIGNMENT FOR 7 NOS. 3 PHASE TRANSMISSION LINE

**TO ACCOMMODATE SPACE FOR ELECTRICAL CORIDOR & OUT SIDE CONNECTIVITY IN
CONSULTATION WITH JUSNL.**

SHIFTING & OUTSIDE BOUNDARY CONNECTIVITY PLAN

- a) 132 kV D/C PATRATU- RAMGARH TRANSMISSION LINE.
- b) 132 kV D/C PATRATU- HATIA TRANSMISSION LINE.
- c) 220kVD/C PATRATU- HATIATRANSMISSION LINE.
- d) 220 kV S/C PATRATU- TENUGHAT TRANSMISSION LINE.

PATRATU VIDYUT UTPADAN NIGAM LIMITED

Name of Transmission Line:

SHIFTING & OUTSIDE BOUNDARY CONNECTIVITY PLAN

- a) 132 kV D/C PATRATU- RAMGARH TRANSMISSION LINE.
- b) 132 kV D/C PATRATU- HATIA TRANSMISSION LINE.
- c) 220 kV D/C PATRATU- HATIA TRANSMISSION LINE.
- d) 220 kV S/C PATRATU- TENUGHAT TRANSMISSION LINE.

Block : Patratu
District : Ramgarh
State: : Jharkhand

Programmed Implementing Unit:

PVUNL

VIDE PO NO 5500026814 DTD.01.06.2017

Prepared by:-

GLOBAL PROJECTS & ENGINEERING CONSULTANTS

58/D, ROAD NO-01

Ashok Nagar , Ranchi, Jharkhand,834002

TABLE OF CONTENTS

- 1. CERTIFICATE OF COMPLETION**
- 2. INTRODUCTION**
- 3. PROJECT DESCRIPTION**
- 4. ASSUMPTIONS**
- 5. PROCESS OF FINALIZATION**
- 6. FINAL TRANSMISSION LINE ENGINEERING**
- 7. AERIAL SURVEY**
- 8. SITE SURVEY**
- 9. GEOTECHNICAL SERVICES**
- 10. MATERIAL SUPPLIERS**
- 11. CONSTRUCTION SERVICES**
- 12. EPC PROJECT MANAGEMENT**
- 13. PROPOSED TOWER SPOTTING DETAILS & DISMANTLE & DESTRINGING TOWER.**
- 14. INDEX MAP SHOWING PROPOSED ROUTE ALIGNMENT OF TRANSMISSION LINE & DISMANTLING EXISTING LINES.**

CERTIFICATE

THIS IS TO CERTIFY THE PROJECT AWARDED VIDE PO NO 5500026814 DTD.01.06.2017 BY PVUNL IS COMPLETED IN ALL RESPECT. THE ALL SUGGESTIONS GIVEN BY PVUNL & JUSNL TIME TO TIME DURING EXECUTION OF THIS PROJECT INCORPORATED. THERE IS NO FURTHER SCOPE OF AMMENDMENT WHATSOEVER AGAINST THIS CONTRACT IS FEASIBLE.

SIGNATURE

**ON BEHALF OF
GLOBAL PROJECTS & ENGINEERING CONSULTANTS**

INTRODUCTION

Global Projects & Engineering. Consultants, Ranchi conducted a preliminary engineering study to develop a conceptual design (Shifting Plan) for rerouting of 7 Nos. 3 Phase transmission line of from the Existing Switch Yard as the existing lines are crossing the upcoming main plant area of 3x800 MW Power Plant. This project has explored the options for rerouting the existing lines without crossing upcoming main plant area passing through the minimal space available between existing switchyard and upcoming main plant area. The project is critical in view of unavailability of sufficient space for line corridor. The study against this PO is limited up to boundary wall of PVUNL. However, this will provide the scheme for connectivity from plant boundary to external tower. This report includes a general description of the project, the assumptions made during engineering, and a detailed description of the preliminary design developed during this project.

Our Team have already designed 132 kV line to 1200 kV line in India & abroad.

PROJECT DESCRIPTION

The purpose of this project is to develop a conceptual design (Tower Spotting) and provide opinion of probable route alignment & fixing of transmission line as PVUNL showing space of Electrical Corridor Engineering planning of proposed PVUNL plant area.

The proposed 132kV & 220kV transmission line Proposed tower line will be designed to support single circuits, Double Circuit, Multi circuit. The line will cross over owned properties (PTPS/JUSNL). The proposed line route has been discussed & Co-ordinated with PVUNL (NTPC) & JUSNL. The detailed study is attached to this report in INDEX MAP. (Drawing No-01/option-3/ date -10/06/2017).

The line study performed evaluated transmission line routes from the view of Shifting of Existing Patrattu-Hatia, Patrattu-Ramgarh & Patrattu-Tenughat route of a 132kV & 220kV transmission line.

After studying the options with available space & with coordination of **PVUNL (NTPC) & JUSNL**, Global projects & Eng. Consultants developed Suitable routes for connection showing INDEX MAP details of the final options of selection of Route Alignment of shifting Transmission Line.

PROCESS OF FINALIZATION OF ROUTE SHIFTING ALIGNMENT OF TRANSMISSION LINE.

Due to proposed upcoming PVUNL power plant at Patratu in existing Plant area ,existing 132 kv & 200 kv lines are rerouted, in view of conceptual alignment with JUSNL & PVNL (As per discussion and meeting with JUSNL & PVNL (NTPC) engineering team dated _____)

We try to find out best route in your provided electrical corridor and upcoming features like Railway & other which is showing in layout drg.

Due to narrow corridor we proposed 2 alternatives---

Option -1 we already submitted proposal-1 ,all narrow base tower & D/C near the existing 132 kv/220kv lines and that is through with MCT line which through correct outside boundary wall.

Option-2 we are did minor modification as per joint discussion with client officials ,now Ramgarh 132 kv & Hatia 132kv Dead end tower proposed near the existing DE tower, which will be used new connectivity, both dc connect through MCT up to near boundary wall and after MCT again both lines are divide into DCT.

We change a small modification in 220 kv Hatia line in view of upcoming rail line.

The same orientation is adopted in 220 kv lines, Tenughat 220 kv line is single CKT gantry to be used, and 220 double CKT Hatia also used existing Gantry and it through MCT .MCT line through upto boundary ,again it divide into DC tower.

After discussion with JVUNL & PVNL & NTPC has **OPTION-2** Finalized & may be adopted in future.

Due to narrow corridor all MCT towers we proposed with Narrow Base/ Monopole may use. FDN volume may increase but it may suit & safe with the narrow corridor.

ASSUMPTIONS

Some notable assumptions were made during the preliminary engineering of this line. Descriptions of these are listed here: • Conceptual Design – The contents of this report are for conceptual and budgetary purposes only and are not intended to be used for final design purposes. • Local transmission utility Standards – Structure type, conductor and shield wire types as well as stringing strength and ruling spans conform to local transmission utility standards.

LAND ACQUISITION

Land Acquisition was not included as part of this project. PVUNL will be providing land acquisition services for both permanent and construction services.

CONCEPTUAL LINE DESIGN

Global Projects& Eng. Consultants performed the process of conceptual line designing with respect to the direction of PVUNL (NTPC) . A picture of final line route can be seen in Appendix – A (Index Map). The proposed line utilizes Indian Electric model engineering and (CBIP) Manual. The standards referenced can be found in Appendix B (Typical Section).

Consultants created plan and profile drawings which are located in Appendix C (Profile Map). Global ProjectsprovideLattice Tower steel structures to support the single circuit, double circuit line& Multi circuit. The tangent structure used is Transmission Overhead Material specification **IERule**.

We are finalized the Route alignment as your providing space for Electrical Co-corridor from your provided Layout Drawing in soft copy in **New upcoming Plant of PVUNL at Patratu**& as well maintained Standard IE Design Rule &(CBIP Manual) in Road Crossing.

The Conductors were selected as per **IS: 398 (II):1996** standards,The conductor selected was a **ACSR MOOSE**. The power conductor shall conform to the following Indian/ International Standards. Purity of AluminumRods, 99.5% Minimum, Percentages of Carbon in steel wire/rods, 0.50 to 0.85 (Preferably 0.65%), Purity of Zinc, 99.95%.

Global Projectsphase power equation to calculate the capacity of the line to ensure that connecting to shifting purposes, it would be sufficient for existing connection needsof 132 kV &220kV Lines. The conductor information can be found in specification **IS: 398 (II):1996**. As part of this study consultants investigated the blowout of this conductor to determine the right of way width needed. The shield wire proposed is a GSW ground wire. The shield wire attribute information can be found in specification IS **5613**.

PVUNL 132kV &220kV Transmission Line was modeled in PLS CADD. The model utilizes a basic digital elevation model purchased by Global Projects. A more detailed model would be obtained by aerial survey which would be used to produce a final design. Elevation and global plane information was used to create a three dimensional map where the Lattice Towerstructures are placed. The aerial maps were then viewed and structures were moved along the decided path to avoid existing obstacles. Global Projects traveled to Project Site- **Patratu**, to verify preliminary structure locations and take pictures of areas of concern. After all the locations of the towers were confirmed, the conductors were placed into the model and towersheights were adjusted to satisfy ground clearance requirements. In a final engineering model, new structures for each height will be placed in the model to obtain reactions to pass on to a material supplier for design and fabrication. This number was taken from the (IE-1957) Rule Design Clearances for Overhead Transmission Lines which can be found in Appendix B.

Minimum Ground Clearance& other Technical specification followas Per IE-1956(Rule 77)& CBIP Rules, which Global Projects rounded up and added an additionalbuffer requirement as per common industry practice.

- Minimum Ground Clearance As Per IE-1956(Rule 77):-

Minimum Ground Clearance As Per IE-1956(Rule 77)	
Voltage in KV	To ground in M
132	6.1
220	7
400	8.84
800	12.4

- Minimum Working Clearance:-

Minimum Working Clearance:		
OUTDOOR SWITCHYARD		
Voltage in KV	To ground in mm	Between section(mm)
11	2750	2500
33	3700	2800
66	4000	3000
132	4600	3500
220	5500	4500

- Minimum Electrical Clearance As Per BS:162.

Minimum Electrical Clearance As Per BS: 162.		
OUTDOOR		
Voltage in KV	Phase to earth in mm	Phase to phase in mm
6.6	139.7	177.8
11	177.8	228.6
22	279.4	330.2
33	381	431.8
66	685.8	787.4
110	863.6	990.6
132	1066.8	1219.2
220	1778	2057.4

- Minimum Clearance between Lines Crossing Each Other (IE-1957)

Minimum Clearance between Lines Crossing Each Other (IE-1957)				
System Voltage	132KV	220KV	400KV	800KV
Low & Medium	3.05	4.58	5.49	7.94
11-66KV	3.05	4.58	5.49	7.94
132KV	3.05	4.58	5.49	7.94
220KV	4.58	4.58	5.49	7.94
400KV	5.49	5.49	5.49	7.94
800KV	7.94	7.94	7.94	7.94

- Minimum Height above Railway As Per IE-1957**

Voltage	Broad Meter & Narrow Gauges
Above 66KV up to 132KV	14.60 Meter
Above 132KV up to 220KV	15.40 Meter
Above 220KV up to 400KV	17.90 Meter
Above 400KV up to 500KV	19.30 Meter
Above 500KV up to 800KV	23.40 Meter

- Various Air clearances to be provided as per IE rule 64**

Various Air clearances to be provided as per IE rule 64.					
Voltage KV	33KV	66KV	110KV	220KV	400KV
BIL (KVp)	170	325	550	1050	1425
P-E (cm)	30	63	115	240	350
P-P(cm)	40	75	135	210	410
P-G (Meter)	3.7	4	4.6	5.5	8
Section Clearance(Mt)	2.8	3	3.5	4.3	6.5

- Clearances from Buildings of HT and EHT voltage lines IE Rule 80**

Clearances from Buildings of HT and EHT voltage lines IE Rule 80	
Vertical Distance	
High voltage lines up to 33KV	3.7 Meter
Extra High Voltage	3.7 Meter + Add 0.3 meter for every additional 33KV
Horizontal clearance between the conductor and Building	
High Voltage Up to 11 KV	1.2 Meter
11KV To 33KV	2.0 Meter
Extra High Voltage	2.0 Meter + Add 0.3 meter for every additional 33KV

- Clearance above ground of the lowest conductor As per IE Rule 77**

Clearance above ground of the lowest conductor As per IE Rule 77	
Over head Line Across Street	
Low and Medium Voltage	5.8 Meter
High Voltage	6.1 Meter
Over head Line Along Street (Parallel To Street)	
Low and Medium Voltage	5.5 Meter
High Voltage	5.8 Meter
Over head Line Without Across or Along Street	
Low/Medium /HT line up to 11KV If Bare Conductor	4.6 Meter
Low/Medium /HT line up to 11KV If Insulated Conductor	4.0 Meter
Above 11 KV Line	5.2 Meter
Above 33KV Line	5.8 Meter + Add 0.3 meter for every additional 33KV

- **Clearance between conductors and Trolley / Tram wires (IE Rule 78)**

Clearance between conductors and Trolley / Tram wires (IE Rule 78)	
Low and Medium Voltage	1.2 Meter
High Voltage Line Up to 11KV	1.8 Meter
High Voltage Line Above to 11KV	2.5 Meter
Extra High Voltage Line	3.0 Meter

- **Clearances from Buildings of low & medium voltage lines(IE Rule 79)**

Clearances from Buildings of low & medium voltage lines(IE Rule 79)	
For Flat roof, Open Balcony, Verandah Roof and lean to Roof	
Line Passes Over Building Vertical Clearance	2.5 Meter
Line Passes Adjustment of Building Horizontal Clearance	1.2 Meter
For pitched Roof	
Line Passes Over Building Vertical Clearance	2.5 Meter
Line Passes Adjustment of Building Horizontal Clearance	

Both circuits were strung in the model to ensure that Towers will be designed to support future expansion. After structures were modeled, a typical foundation size was calculated. IE & CBIP Rules require Lattice Tower for 132 kV & 220kV lines are placed on foundations. Different size structures have different size foundations. A structure check was performed inside the PLS CADD model to obtain base reactions on a typical tangent structure. These base reactions were inserted into PLS Caisson along with some conservative values for soil properties. The size of dead end foundations will be larger. Both tangent and dead end foundations will need to be designed with specific soil properties obtained from a geotechnical study.

FINAL TRANSMISSION LINE ENGINEERING

The final transmission line engineering will be done in accordance with the IE and/or applicable codes such as CBIP Rules. This work will expand on the conceptual design discussed above and develop the complete and final transmission line design. The design will include such items as: • Route verification • Survey coordination • Structure placement • Structure loading • Foundation design • Conductor stringing Transmission Line • Material selection • Permit coordination • Construction coordination • Project close out including as-built Engineering deliverables would include: • Stringing charts • Staking reports • Specifications o Material procurement , Construction , Geotechnical • Bill of materials • Drawings o Structure load and design o Plan and profile o Hardware assemblies Consultants has developed an estimate to complete this design. This estimate incorporates all tasks and deliverables mentioned above. It also includes time and expenses for meeting attendance, phone conferences, site visits, and contacting and supporting other subcontractors. Anticipated site visits would include; initial route walk down, follow up review of areas that require special considerations, and verification of staking locations.

AERIAL SURVEY

Various companies were contacted to provide estimates for aerial survey and topographic mapping activities for the final engineering. An aerial survey company will provide color digital imagery of line area and data files for PLS model production. The current survey map used for PLS CADD model is accurate enough for proposals but the data is spread out and of a general variety. It is important when designing large expensive structures that the information used is as accurate as possible because small discrepancies can result in expensive redesign. Two different methods to produce this survey information are Photogrammetric and Lidar. Photogrammetric is a method of obtaining topographic information using aerial photograph to develop terrain information. Lidar is a traditional method for collecting topographic information using a laser to scan the area to produce point coordinates. Both technologies have the ability to develop elevation contours in 0.3 M intervals. They take the collected data and convert it into 132kV & 220kV Transmission Line, that can be placed into a PLS CADD model. It also separates out the different ground points into various features such as vegetation, roads, ground features and bodies of water. There are many other features that can be collected by aerial survey. Some of these features include taking video of the route, taking still pictures of structures in the line area, converting data to a GIS format and many other services.

SITE SURVEY

Site survey is another necessary activity for design and construction of the final transmission line. Survey activities will include: • Real-estate investigation • Survey and determine property lines & owners • New easement exhibits for the owners • Verification of aerial obstacles • Staking activities for the right of way as well as two occasions of construction staking. Various companies were contacted to provide budgetary estimates for site survey activities which can be seen in Appendix E. The approximate price for site survey can be seen in the cost summary. To be conservative the highest budgetary estimate was used.

GEOTECHNICAL SERVICES

Various companies were contacted to provide estimates for soil boring and soil lab activities. It is important to perform testing on soils in the location of each structure because soil conditions vary from location to location. Different locations will show different conditions over the 14-mile line and a foundation could be sufficient for one location and not for another. Standard practice is to obtain a general condition that works for a majority of the tangent structures and custom design the dead end foundations and other outliers. To obtain estimates, contractors were asked to estimate costs of approximately 28 soil borings to a depth of 20 M or refusal. The typical foundation depth will not be greater than 10 M, but deeper foundations will be utilized at dead end locations. The contractors were asked to include all associated cost with producing a geotechnical report of the encountered conditions and provide foundation recommendations. Subcontractors were informed that all locations would be staked, cleared and that access approvals would be provided to perform work. The estimates we received covered a wide range therefore a calculated cost was derived by averaging the highest two estimates to be conservative. Adjustments can be made to the scope of soil study such as soil borings can be taken at less frequent intervals to cut costs. The approximate price for geotechnical services is included in the cost summary.

MATERIAL SUPPLIERS

Various companies were contacted to provide estimates for total material cost. The materials included in these estimates are conductors, optical shield wire, Lattice Tower, grounding, insulators, and other hardware. It is important to note that prices of these items will fluctuate, especially the Lattice Tower. Materials also vary by when delivery is needed. Prices in this section reflect a projected value of steel for mid-2017 with an average delivery time, approximately 20 weeks. The most significant cost will be the Lattice Tower. The estimated cost is shown in the cost summary. From the estimates we received, one contractor appeared to have the best understanding of the needs for this project. Therefore, their value was used for all hardware. For Lattice Tower a cost was averaged from suppliers with similar estimates.

CONSTRUCTION SERVICES

Various companies were contacted to provide estimates for construction services. Construction activities are as follows: • Unloading and storage of materials • Constructing foundations • Framing poles • Setting poles • Pull/string conductor • Restoration of area Included with construction costs & the clearing cost. Consultants contacted clearing subcontractors and obtained a cost of clearing from two different contractors. The right of way must be cleared for various reasons, one of the most important being electrical clearance. Trees represent hazards to the transmission line. Construction, surveying, and soil boring activities are all greatly impeded by non-cleared locations. Construction costs will differ depending on soil conditions and structure size. Poor soil conditions will result in larger foundations. Large structure sizes result in larger foundations as well as added difficulty in placement. Some contractors have broken up estimates for specific activities such as pole framing and pole setting while other contractors elected to submit an estimate as a cost per mile of construction. Approximate price for construction services can be seen on the cost summary. In determining the final budgetary estimate one contractor was abnormally low and was therefore not included in our determination. The remaining two contractors' numbers were similar and were averaged and combined with the clearing cost.

EPC PROJECT MANAGEMENT

Project management for this project consists of working with all parties communicating PVUNL(NTPC) needs. The engineer will purchase required materials and contract the subcontractors. Project management would also develop and maintain a construction schedule. The estimated total time to complete this project is 6 to 12 months. One of the most critical tasks is ordering the materials. The lead time on Lattice Tower alone is approximately 10 weeks. Other crucial tasks include aerial and site survey because they need to be completed before most of the engineering can be done. The total cost of this activity is a percentage of the various project activities and can be viewed in the project cost summary.

TOWER SPOTTING DETAILS

PRPOSED TOWER DETAILS:-

132KV RAMGARH & HATIA ROUTE					
In Boundary Part					
SL NO	LOC NO	COMMENT	TWR TYP	ANGLE	SPAN(mtr)
1	1R-N-3	COMMON MCT PORTION	MD+0 (MCT-D TYPE)	12D	
					185
2	1R-N-4		MD+0(MCT-D TYPE)	47D	
					218
3	1R-N-5		MA+0(MCT-SUSPENSION)	0D	
					241
4	1R-N-6		MA+0(MCT-SUSPENSION)	0D	
					306
5	1R-N-7		MD+0(MCT-D TYPE)	0D	
					104
6	1H-N-2		D60+0 (DCT) AUX -X ARM	90D	
					50
7	GTU				
TOTAL LENGTH:-					
8	1H-N-1		MD+0(DCT- SUSPENSION)	17D	
					77
7	1H-N-2		D60+0 (DCT) AUX -X ARM	74D	
					27
7	GTU				
TOTAL LENGTH:-					104

220 KV PAT/ TENUGHAT (IN BND) New Route					REMARK
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)	
1	220-TENNU-N-7	D60+0	3D		
				172	
2	2H-N2	MD+0 (MCT)	8D		COMMON PART
				271	
3	2H-N3	MD+0(MCT)	0		
				182	
4	2H-N4	MD+0(Aux-X-Arm)(MCT)	90D		
				79	
5	2T-N5	DD+0	90D		
				40	
6	GTY	EXISTING			
TOTAL LENGTH:-				744	

220 KV HATIA (IN BND) New Route					REMARK
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)	
1	2H-N-1C	D60+0	34D		
				295	
2	2H-N-1B	D60+0	45D		
				151	
3	(IN)2H-N-1A	D60+0	56D		
	Rly Xing			246	
4	(IN)2H-N1	D60+0	34D		
				189	
5	2H-N2	MD+0 (MCT)	8D		COMMON PART
				271	
6	2H-N3	MD+0(MCT)	0		
				182	
7	2H-N4	MD+0(Aux-X-Arm)(MCT)	90D		
				40	
8	GTY	EXISTING			
TOTAL LENGTH:-				1374	

DISMANTLE & DESTSTRINGING TOWER DETAILS (in Boundary Part):-

132 KV HATIA (IN BND) Dismantle & Destringing				
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)
1	2H0a	D0 (SUSPENSION)	0	
				350
2	2H0	D60+0	67D	
				168
3	2H1	D30+0	8D	
				177
4	2H2	D0 (SUSPENSION)	0D	
				220
5	2H3	D60+0	58D	
				310
6	2H4	D60+0	53D	
				96
7	2H5	D60+0(DEAD END)	24D	
				280
8	GTY			
TOTAL LENGTH:-				1601

220 KV TENUGHAT (IN BND) Dismantle & Destringing				
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)
1	2T5	D60+0	17D	203
				132
2	2T6	D0+0	0D	
				182
3	2T7	D30+0	14D	
				87
4	2T8	D60+0(DEAD END)	0D	
TOTAL LENGTH:-				634

132 KV RAMGARH (IN BND) Dismantle & Destringing				
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)
1	1R2	D0+0	0D	
				322
2	1R3	D0+0	5D	
				223
3	1R4	D0+0	0D	
				225
4	1R5	D60+0	70D	
				242
5	1R6	D0+0	0D	
				256
6	1R7	D60+0(DEAD END)	0D	
TOTAL LENGTH:-				1168

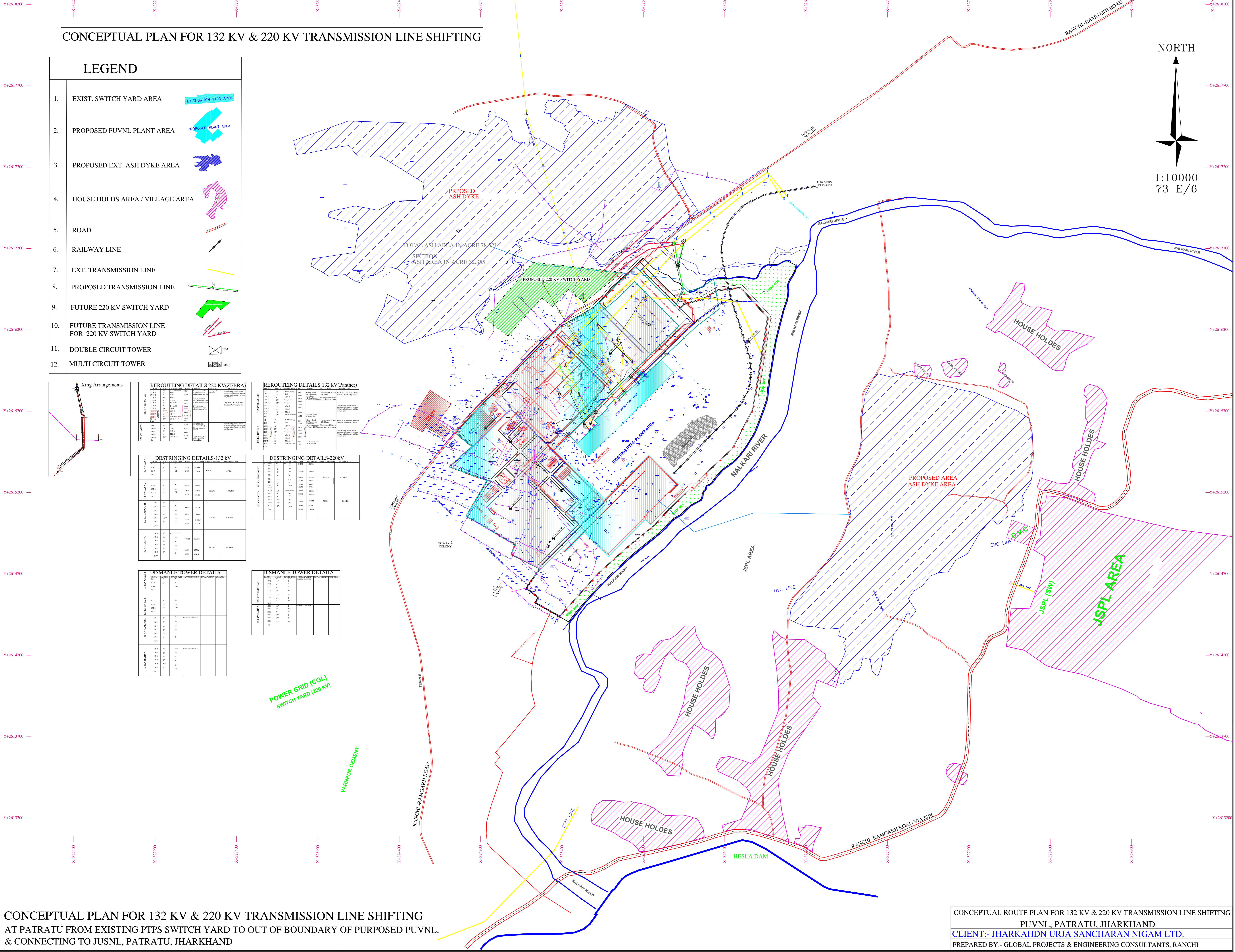
132 KV HATIA (IN BND) Dismantle & Destringing				
SL NO	LOC NO	TWR TYP	ANGLE	SPAN(mtr)
1	1H2	D0+0	0D	
				340
2	1H3	D0+0	0D	
				329
3	1H4	D0+0	0D	
				254
4	1H5	D60+0	69D	
				205
5	1H6	D30+0	1D	
				207
6	1H7	D60+0(DEAD END)	60D	
TOTAL LENGTH:-				1335

**14. INDEX MAP SHOWING PROPOSED ROUTE ALIGNMENT OF
TRANSMISSION LINE & DISMANTLING EXISTING LINES.**

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2B


PRELIMINARY SURVEY REPORT/DRAWING




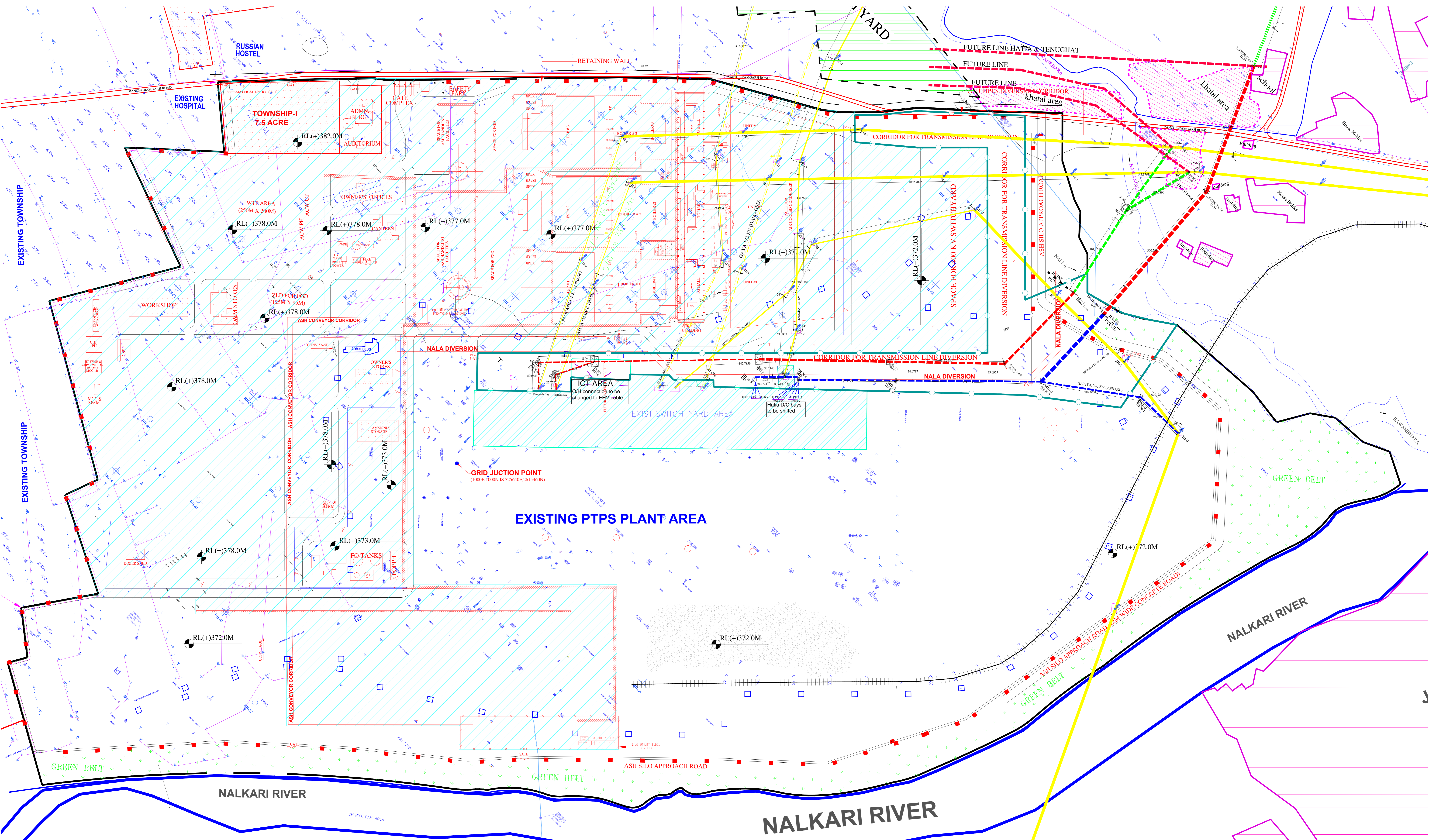
PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2C

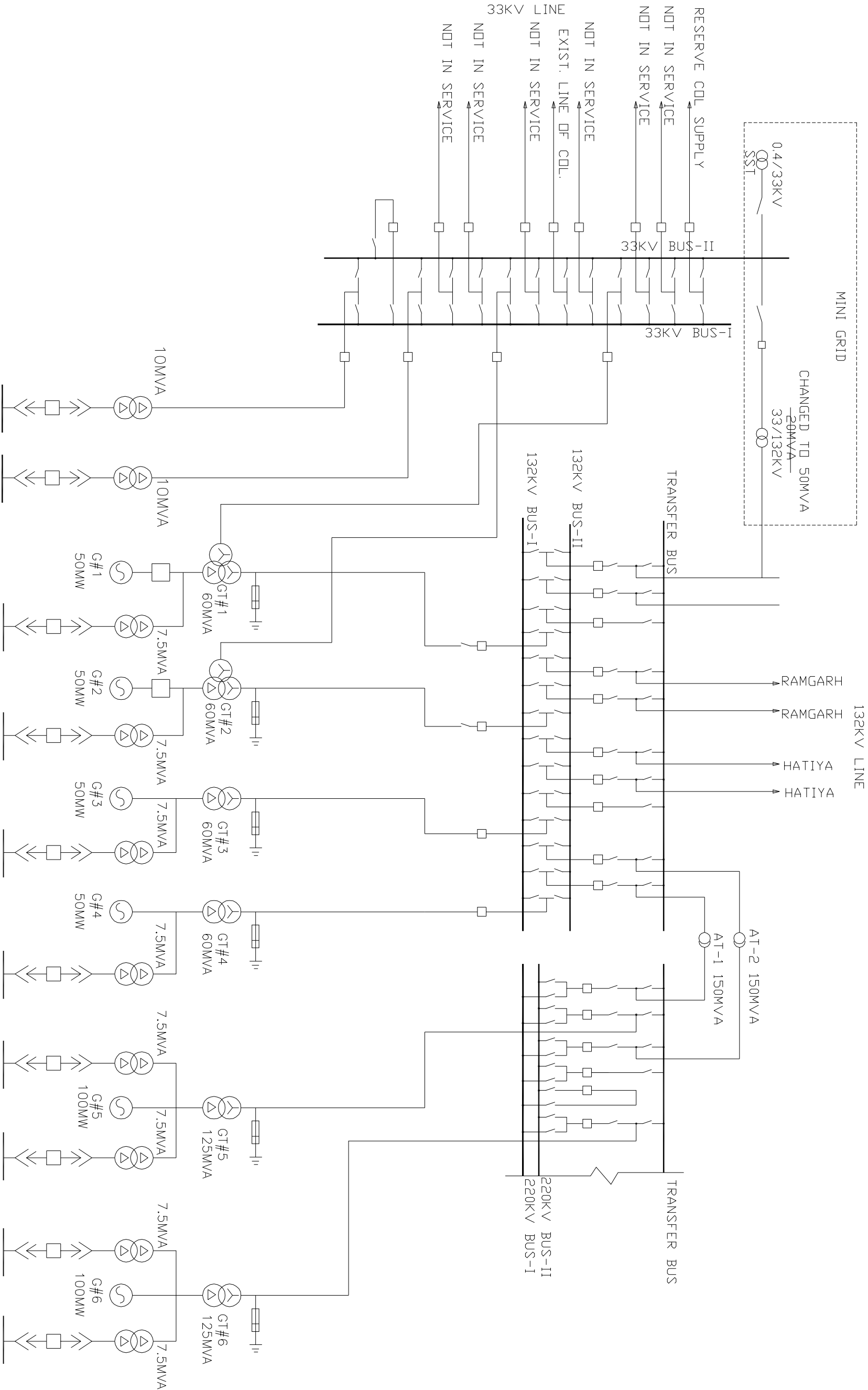
TECHNICAL SPECIFICATION FOR TRANSMISSION LINE

CLAUSE NO.	SCOPE OF SUPPLY AND SERVICES			
1.25.00	Scope related to diversion of existing transmission lines			
	The Scope of work is related to the Re-routing and diversion of existing transmission lines emanating from existing PTPS generation switchyard. Contractor shall be responsible for complete Survey, design, engineering, supply and execution of rerouting work as mentioned below. Total Seven Nos. charged 220kV and 132kV transmission lines are passing through the area proposed to be used for PTPS Expansion Phase-I project. These lines are required to be diverted to start site enabling activities. Contractor shall ensure completion schedule of line diversion and re-routing works, matching with site enabling work schedule.			
	Transmission lines at 220kV:		Transmission lines at 132kV:	
	i) PTPS-Hatia D/C line		i) PTPS-Hatia D/C transmission line	
	ii) PTPC Tenughat S/C line		ii) PTPS-Ramgarh D/C transmission line	
	Existing route of the above lines along with the locations where these respective lines are crossing the Land boundary of PTPS Station along with suggestive corridors to be used for diversion of these transmission lines are indicated in preliminary survey drawing attached at annex-A to this document.			
	Since the space available for line diversion is limited, Contractor may also use multi circuit towers (separate multi-circuit towers for 220kV & 132kV lines) with extra height in order to accommodate these lines in the allocated space wherever necessary. Scope of work shall also include reconnection of the diverted portion of the lines to the towers of original lines outside plant boundary by providing necessary gantries/Dead End towers and replacement of existing towers along with stringing outside plant boundary (if necessary). Provision for adequate space for this purpose shall also be kept by contractor in the layout developed by them.			
	In order to create sufficient space for line diversion in existing switchyard area following activities shall also have to be done as required:			
	1) Shifting of bay for 2 nos. 220kV DC Hatia line to 220kV bays as marked in SLD. Bay details of the existing switchyard are shown in the switchyard Single Line diagram associated with Patratu STPS in drawing attached at annex-B to this document. Any EHV equipment and structure which is required for shifting of the above line bays shall be provided by contractor. Further supply, installation and commissioning of protection panels in line with stipulations in Sub-section B-13, Part B, section VI of technical specifications for line protection and modification of existing control panel shall also be in scope of contractor.			
	2) Connection of ICT's through 220kV and 132kV cables and dismantling of existing connection gantries of ICT's to create adequate space for line diversion. EHV cable along with necessary cable terminations and any other equipment required (such as LA, BPI, Link box etc.) for this purpose shall be in the scope of contractor. EHV cables shall meet technical requirements stated in Sub-sections B-26 and B-28, Part B, section VI of the technical specifications.			
After diversion of these lines and successful interconnection to existing towers, the defunct tower of these lines in the main plant area be dismantled in line with the scope of work of the project as mentioned elsewhere in the specifications.				
The equipment and materials to be supplied by the Contractor shall form complete transmission line re-routing work as per above. All the equipment and services as required for the above scope of work shall be in the scope of the Contractor.				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE -I (3X 800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.		SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS
				PAGE 1 OF 2

CLAUSE NO.	<div style="text-align: center;">SCOPE OF SUPPLY AND SERVICES</div> <div style="text-align: right;"></div>		
	<p>Transmission line work shall confirm to the requirement specified in CBIP Transmission line manual and Indian Standards except to the extent explicitly modified elsewhere in the specification. Contractor shall refer Annex-C to this document for civil works related to transmission line diversion.</p> <p>It is not the intent to specify all the aspect of design, specification and construction of equipment mentioned herein. The system, sub systems and equipment shall confirm in all respect to high standards of engineering, design and workmanship and shall be capable of performing its desired duty. Offered equipment shall confirm to IEC/IS and shall also confirm to type test requirement as per relevant standards.</p> <p>Time frame for the execution of this work is the essence of the contract so, it is in the interest of the contractor to acquaint himself with the site conditions, scope and access the quantum of work involved for line diversion activities before submission of offer. No extra claim shall be entertained due to any change in the scope of supply (Cables, Gantries, Towers and equipment etc.) for this work. The survey drawing attached at annex-A is preliminary in nature for showing conceptual plan for Re-routing of 132 kV and 220 kV transmission lines and defining the scope of work to be done by contractor under this package. However, contractor shall be responsible for carrying out its own detailed survey and tower spotting for line diversion works and any indications in the survey report shall not absolve the contractor from any of its responsibilities related to line diversion works as indicated above.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 2 OF 2

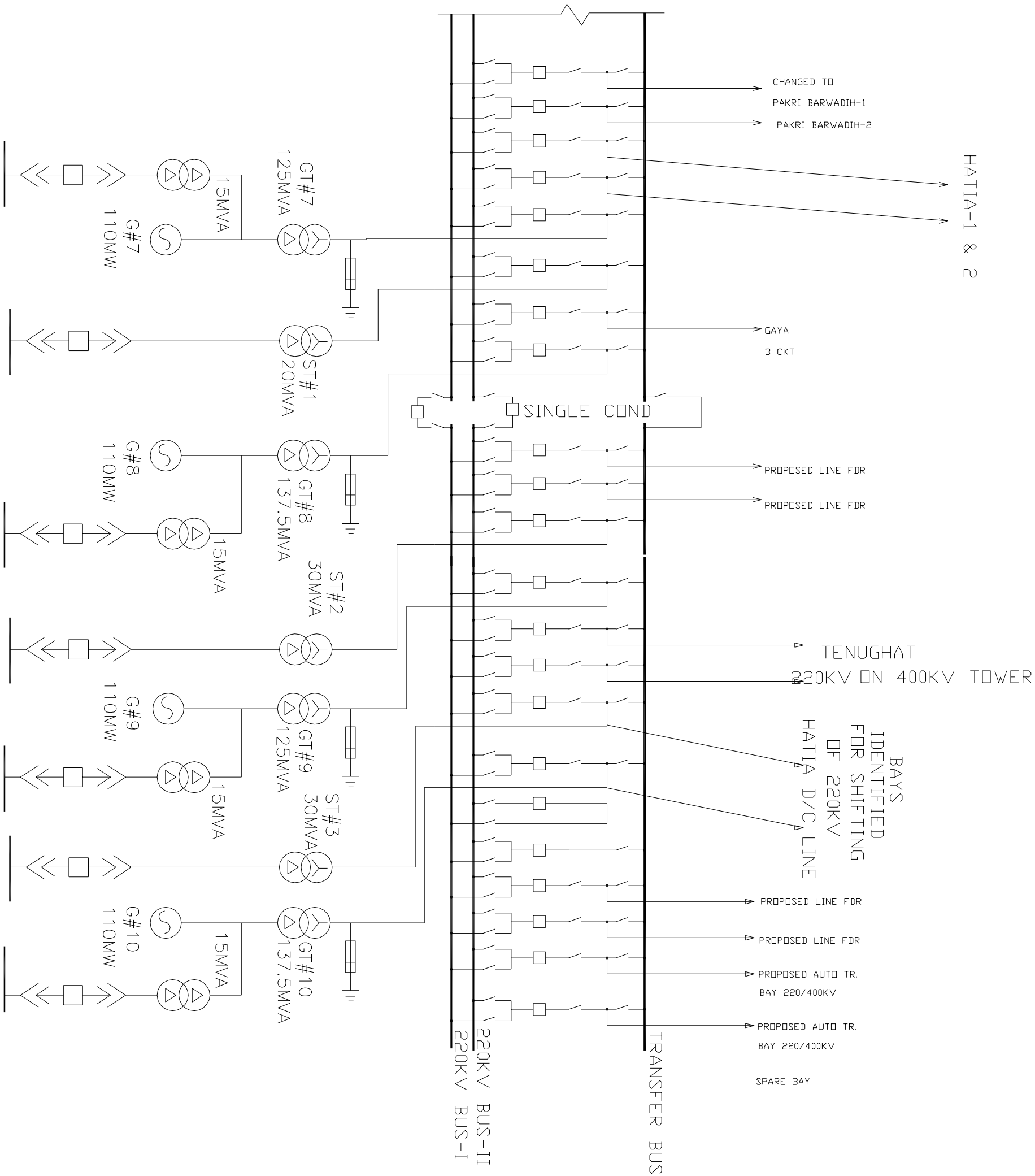



SINGLE LINE DIAGRAM OF PATRATU THERMAL POWER STATION INCLUDING SWITCHYARD




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SINGLE LINE DIAGRAM OF PATRATU THERMAL POWER STATION INCLUDING SWITCHYARD



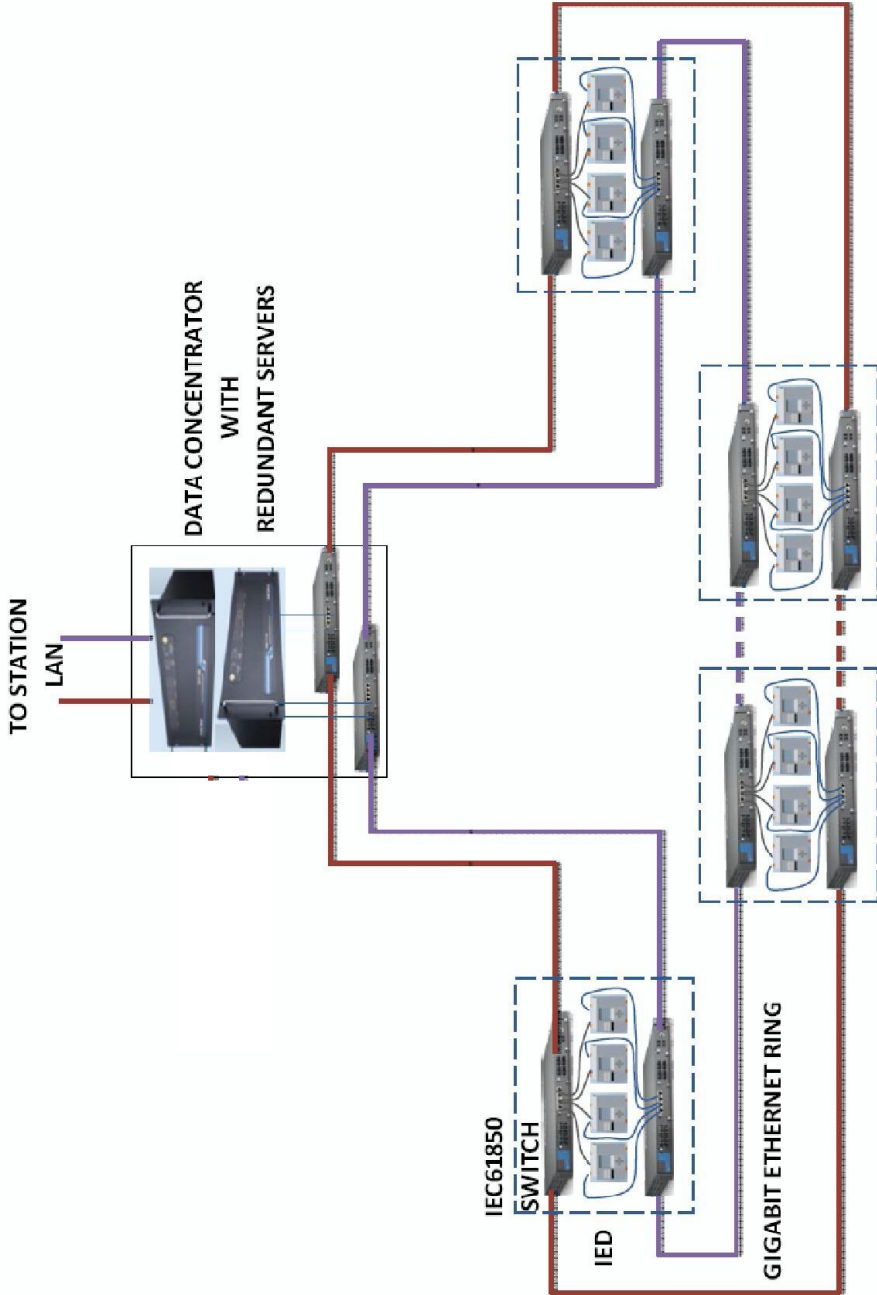
CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p style="text-align: right;">Annex-C</p> <p style="text-align: center;"><u>TRANSMISSION LINE CIVIL WORKS</u></p> <p>1.00.00 This specification covers design, fabrication and supply of all types of transmission line towers including bolts, nuts and washers, step bolts, hangers, D-shackle and all type of tower accessories like phase plate, number plate, danger plates, anti-climbing devices etc, foundation design and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion etc. All materials including cement, reinforcement steel and structural steel etc shall be provided by the bidder.</p> <p>1.01.00 Type tested towers which are already designed and tested for equal or higher loads are preferred. However for tested towers, bidder shall furnish foundation design and drawing meeting the requirements of this technical specification.</p> <p>In case type tested towers are not available, the design of towers shall be carried out for the applicable transverse, longitudinal, vertical and other loads as per IS 802 and CBIP manual with an increased factor of safety of 1.5 as testing of towers are not envisaged in view of the time constraint associated with route diversion works for this project.</p> <p>1.02.00 The transmission line towers shall be fully galvanized self-supporting lattice type mild/high tensile steel structure designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions as per IS 802 and CBIP manual. Bolts and nuts with spring washers shall be used for connections. The towers shall be classified as per IS 802 Part 1 Section 1.</p> <p>1.03.00 The towers shall be designed so as to be suitable for adding 3M, 6M and 9M body extension for maintaining adequate ground clearance without reducing the specified factor of safety in any manner. Special type of towers with higher extensions wherever required, shall also be provided by the bidder.</p> <p>1.04.00 Stub templates shall be designed and arranged by the contractor at his own cost for all types of tower with or without extension and also for leg extension. Stub templates for standard towers and tower with extension shall be of adjustable type. The stub templates shall be painted. One set of stub setting template for each type of tower shall be supplied to the Owner on completion of the project.</p> <p>1.05.00 The minimum thickness of angle sections to be used shall not be less than 5 mm for main corner leg members including the groundwire peak & main cross arm and 4mm for all other members.</p> <p>1.06.00 The bracing pattern, including that of secondary bracings (redundants) shall be identical on transverse and longitudinal faces of the tower, i.e. staggering of primary and secondary bracings are not permitted. Primary bracings and redundants shall be properly triangulated, i.e. the overall pattern of bracing on tower body and cross arms shall be triangular only.</p> <p>1.07.00 IS steel sections of tested quality in conformity with IS: 2062 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. Further more than two (2) grades of steel will not be permitted for any structure.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE -I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 1 OF 1	

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC		
1.08.00	All connection bolts shall conform to IS: 6639 and IS: 12427. The minimum diameter of bolt shall be of 16 mm and of property class 5.6 as specified in IS: 1367 and matching nut of property class 5 as specified in IS:1367. Bolts should be provided with washer face in accordance with IS:1363 to ensure proper bearing. To ensure uniformity of galvanizing, bolts and nuts should be galvanized by high temperature hot-dip galvanizing. The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.			
1.09.00	Each tower shall be provided with step bolts of not less than 16mm diameter and 175 mm long, spaced not more than 450mm apart and extending from about 3.5 meters above the ground level to the top of the tower. Step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special structures, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 3.5 m to 30 m height of super structure step bolts shall be provided. Suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the groundwire support shall be fixed on tower by using countersunk bolts.			
1.10.00	Fabrication of structure shall conform to IS:802 (Part-II). Butt splices shall be used and the inside Angle and outside plate shall be designed to transmit the load and inside cleat angle, shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal size and the inside angle of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main panel point as possible.			
1.11.00	Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plates required to transmit stress shall not be less than that of members connected.			
1.12.00	The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.			
1.13.00	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.			
1.14.00	No angle member shall have the two leg flanges brought together by closing angle.			
1.15.00	The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets depression are likely to hold water.			
1.16.00	All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE -I (3X 800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 2 OF 2

CLAUSE NO.	TECHNICAL REQUIREMENTS			
<p>1.17.00</p> <p>2.00.00</p> <p>2.01.00</p> <p>2.02.00</p> <p>2.03.00</p> <p>2.04.00</p> <p>2.05.00</p> <p>2.06.00</p>	<p>methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact through out. No rough edges shall be permitted in the entire structure.</p> <p>Fully galvanised towers and stub shall be used for the line. Galvanisation of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanisation shall be 610 gms/sqm. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanised as per Grade 4 of IS:1573.</p> <p>TOWER FOUNDATIONS:</p> <p>Reinforced concrete footing shall be provided for all type of tower in conformity with the IS Codes and the specifications. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift. The over load factor for foundation design shall be 1.10 for all loads except dead loads. In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation. Structural design of the foundations shall be done by limit State method conforming to IS 456.</p> <p>For foundation design purposes:</p> <p>(a) The angle of repose shall be considered as zero.</p> <p>(b) Water table shall be considered up to the ground level.</p> <p>(c) Net safe bearing capacity shall be considered as 12.5T/m² at a founding level of 3.0 M below NGL.</p> <p>Pile foundation, wherever necessitated as per site conditions, shall be provided by the bidder.</p> <p>The minimum grade of concrete used for the tower foundations shall be of grade M20 (nominal mix) with 20mm coarse aggregate. All the properties of concrete regarding its strength under compression tension, shear, punching and bending etc. as well as workmanship will conform to IS:456. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances.</p> <p>The material properties for cement, aggregate and reinforcement steel shall be as specified in “Switchyard Civil Works” chapter.</p> <p>The chimney should have all around clearance of 150mm from any part of stub angle. However, minimum 450mm square chimney/pedestal shall be provided. The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower.</p> <p>To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations.</p> <p>The portion of the stub in the chimney and foundation slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE -I (3X 800MW)		TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.	SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS	PAGE 3 OF 3

CLAUSE NO.	TECHNICAL REQUIREMENTS			
<p>2.07.00</p> <p>2.08.00</p> <p>2.10.00</p> <p>2.11.00</p> <p>3.00.00</p>	<p>Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided.</p> <p>The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stub templates for standard towers and towers with extension upto 9 M shall be of adjustable type.</p> <p>The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and compacted properly before another layer is deposited.</p> <p>All necessary protections including stone revetments, RCC retaining walls etc shall be provided wherever required for protection of foundations close to or in nallah, river bed, water ways, hilly region etc.</p> <p>Design criteria for equipments and gantry structures associated with re-routing of existing 220kV/132 kV Transmission lines outside switchyard area.</p> <p>a) Design and fabrication of Structures shall be carried out as per IS 802, IS 806 and other relevant codes.</p> <p>b) For design of foundations, soil parameters shall be as specified at clause no. 3.01.00 of this chapter.</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC NO. : 9585-001-2.</p>	<p>SUB-SECTION-IIB ELECTRICAL SYSTEM / EQUIPMENTS</p>	<p>PAGE 4 OF 4</p>	

RING ARCHITECTURE

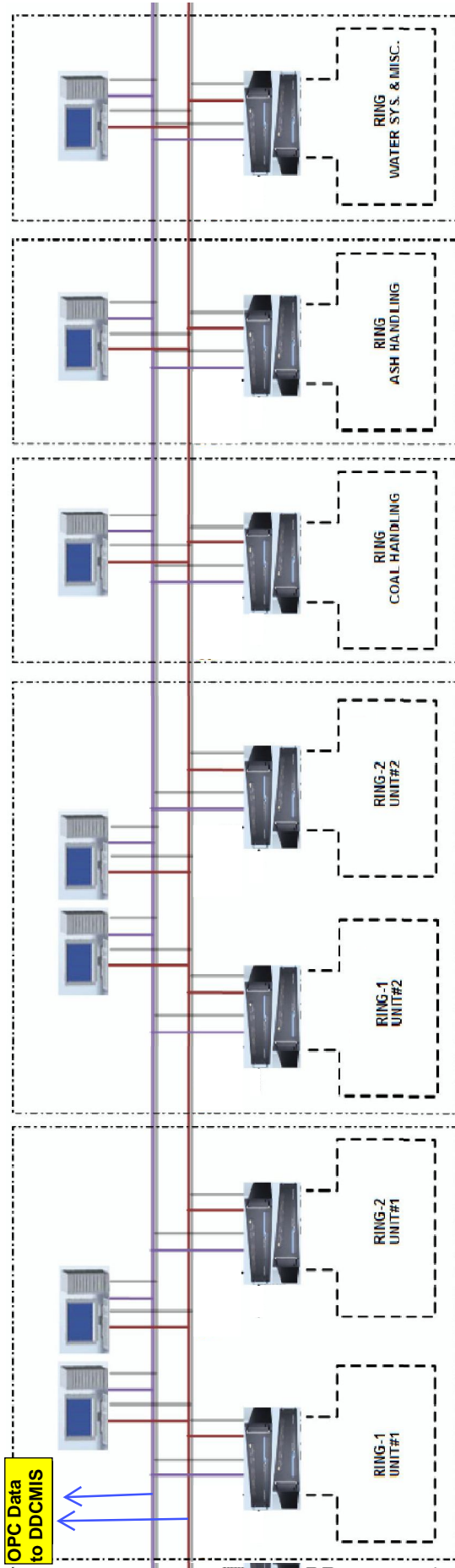


- NOTES:
1. THIS IS THE TYPICAL ARCHITECTURE OF A SINGLE RING. ACTUAL NUMBER OF RELAYS / PORTS / SWITCHES SHALL BE IN LINE WITH THE RELEVANT CLAUSES OF TECHNICAL SPECIFICATIONS. THE NUMBER OF DATA CONCENTRATORS & NETWORK RINGS SHALL BE AS PER THE OVERALL ARCHITECTURE SHOWN IN DRAWING NO 0000-205-POE-A-001. TYPICALLY, EACH RING SHALL HAVE NOT MORE THAN 100 RELAYS.
 2. NR, NUMERICAL RELAY WITH TWO REAR PORTS FOR COMMUNICATION ON IEC61850 MOUNTED IN MV & LV SWITCHGEAR PANELS
 3. IEC61850 SWITCH - ETHERNET SWITCH ON IEC61850 PROTOCOL WITH 8 / 16 COOPER PORTS AND 2 SINGLE-MODE 10Gbps FIBRE OPTIC PORT, MOUNTED IN MV & LV SWITCHGEAR PANELS
 4. EACH RELAY TO BE CONNECTED TO TWO IEC61850 SWITCHES THROUGH CAT5e ETHERNET CABLE.
 5. LOOPING OF IEC61850 SWITCHES SHALL BE THROUGH FIBRE OPTIC CABLE.

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-		11/11/18		11/11/18	
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PLC/DWG		A4		210X297	

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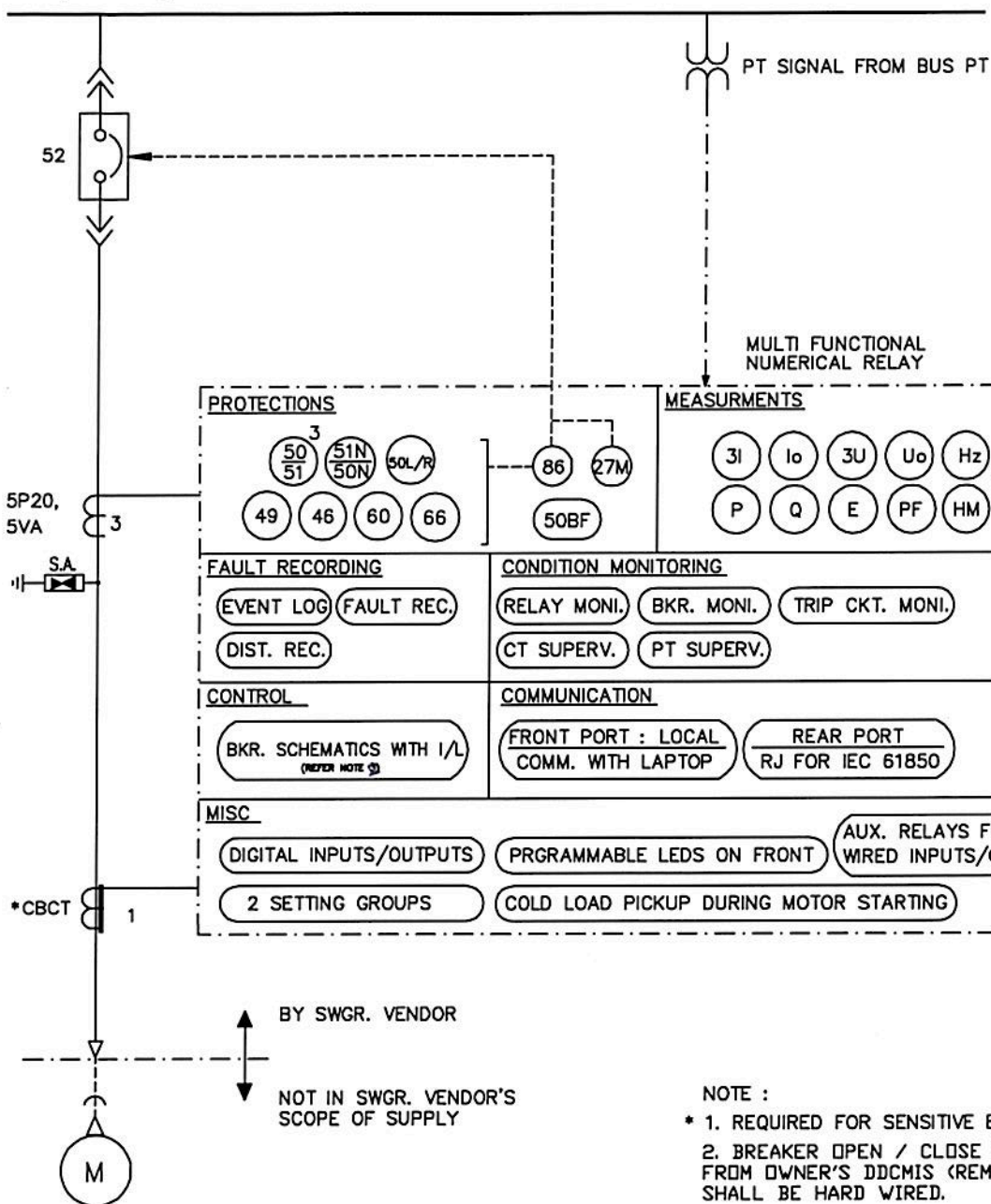
NOTES:

1. EACH DATA CONCENTRATOR SHALL CONSIST OF DUAL REDUNDANT SERVERS ON HOT STANDBY ALONG WITH ALL NECESSARY COMPONENTS TO MAKE THE SYSTEM COMPLETE IN LINE WITH THE TECHNICAL SPECIFICATIONS
2. EACH RING SHOWN ABOVE SHALL CONSIST OF DUAL REDUNDANT FIBRE OPTIC LOOPS AS SHOWN IN DRAWING NO 0000 -205-POE-A-002
3. EACH RING SHALL HAVE NOT MORE THAN 100 IEDs
4. LOOPING OF IEC61850 SWITCHES IN EACH RING, CONNECTIONS BETWEEN DATA CONCENTRATORS AND HMI STATIONS, CONNECTIONS AMONG DATA CONCENTRATORS & CONNECTIONS BETWEEN DATA CONCENTRATORS AND DDCMIS SHALL BE THROUGH FIBRE OPTIC CABLE

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11KV / 6.6 kV / 3.3 kV MV BUS



NOTE :

- * 1. REQUIRED FOR SENSITIVE E/F PROTN.
- 2. BREAKER OPEN / CLOSE COMMAND FROM OWNER'S DDCMIS (REMOTE) SHALL BE HARD WIRED.

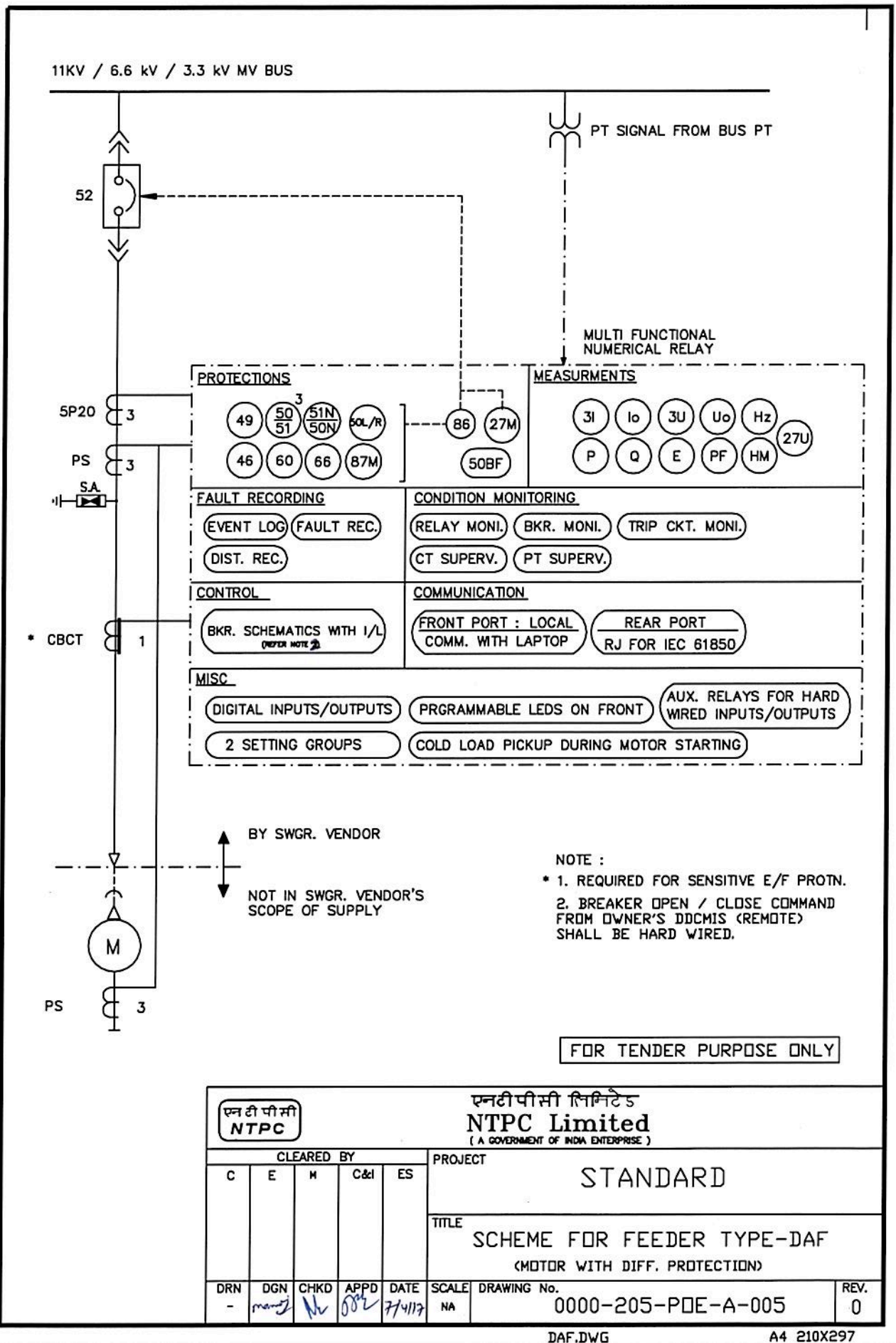
FOR TENDER PURPOSE ONLY

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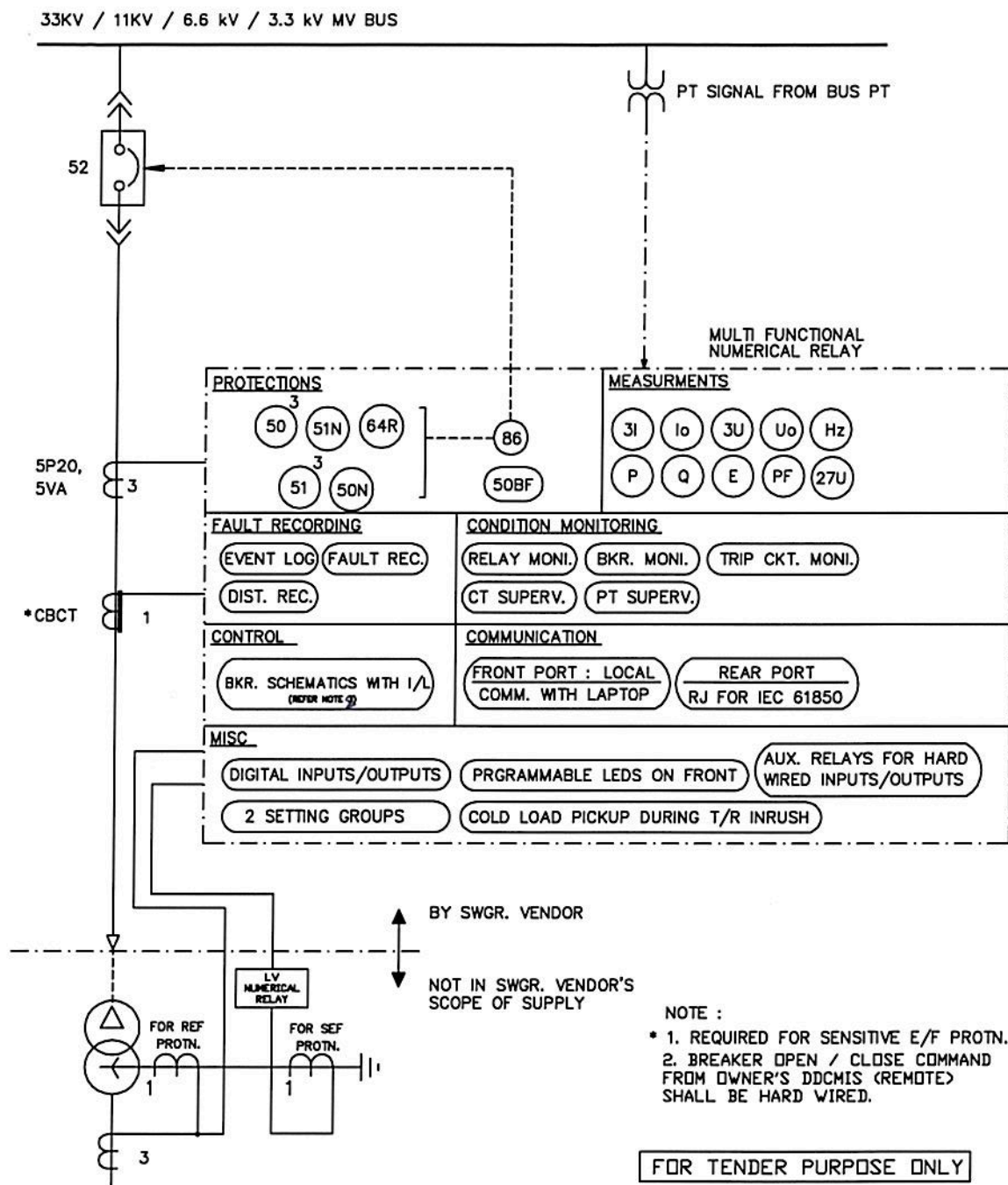
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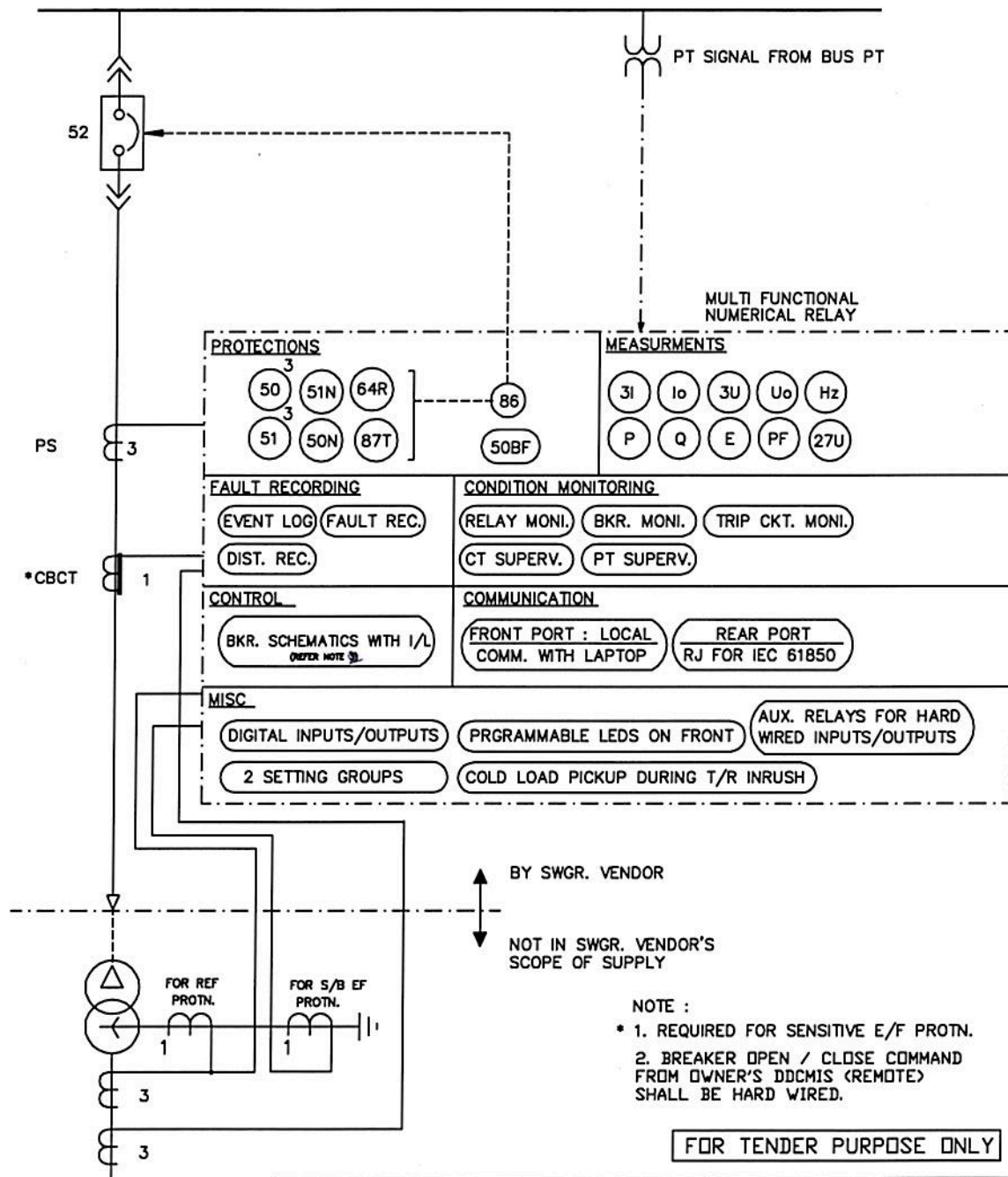


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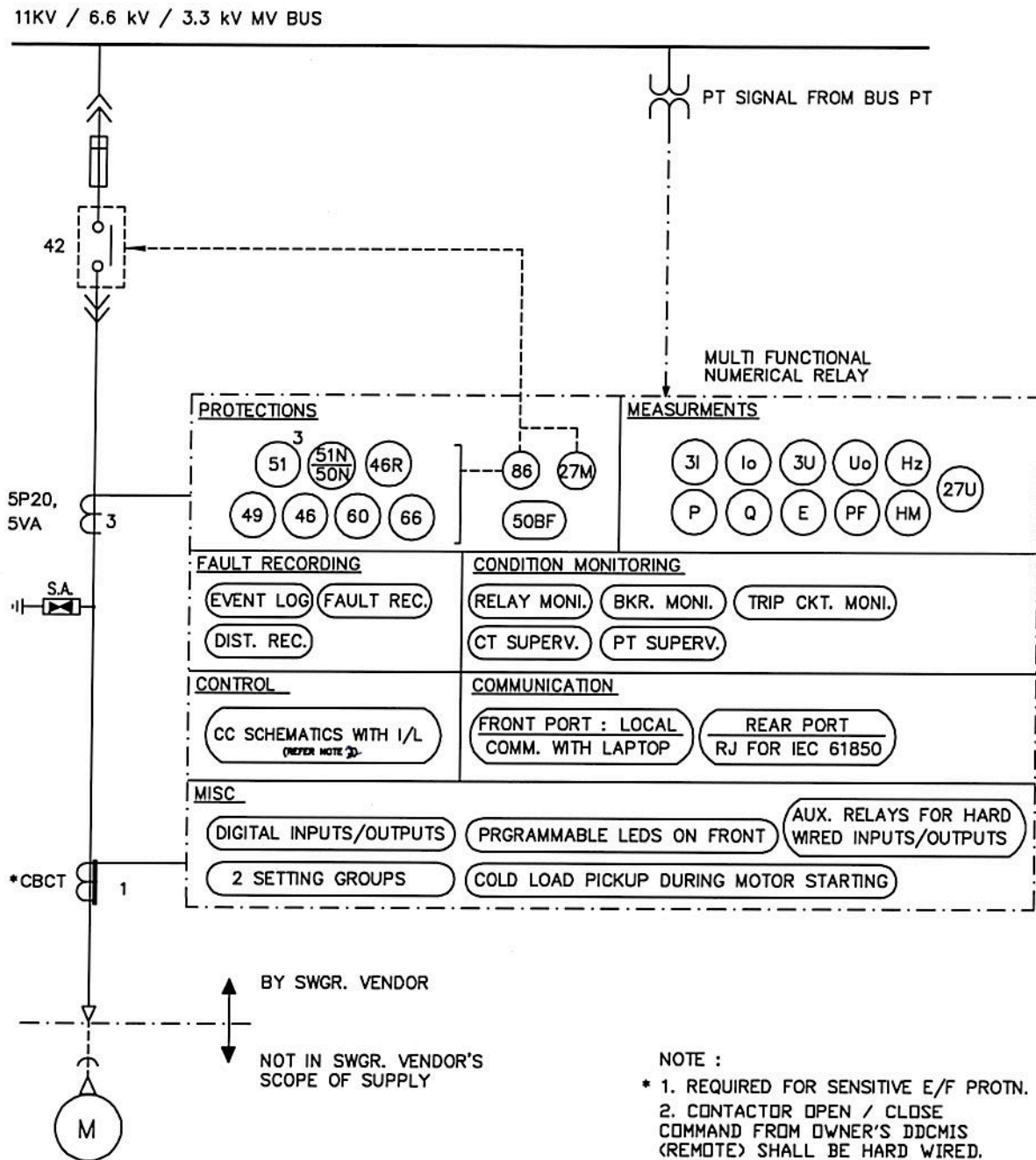
33KV / 11KV / 6.6 kV / 3.3 kV MV BUS



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					SCHEME FOR MV SWGR FEEDER TYPE-DBF (TRANSFORMER WITH DIFF. PROTECTION)				
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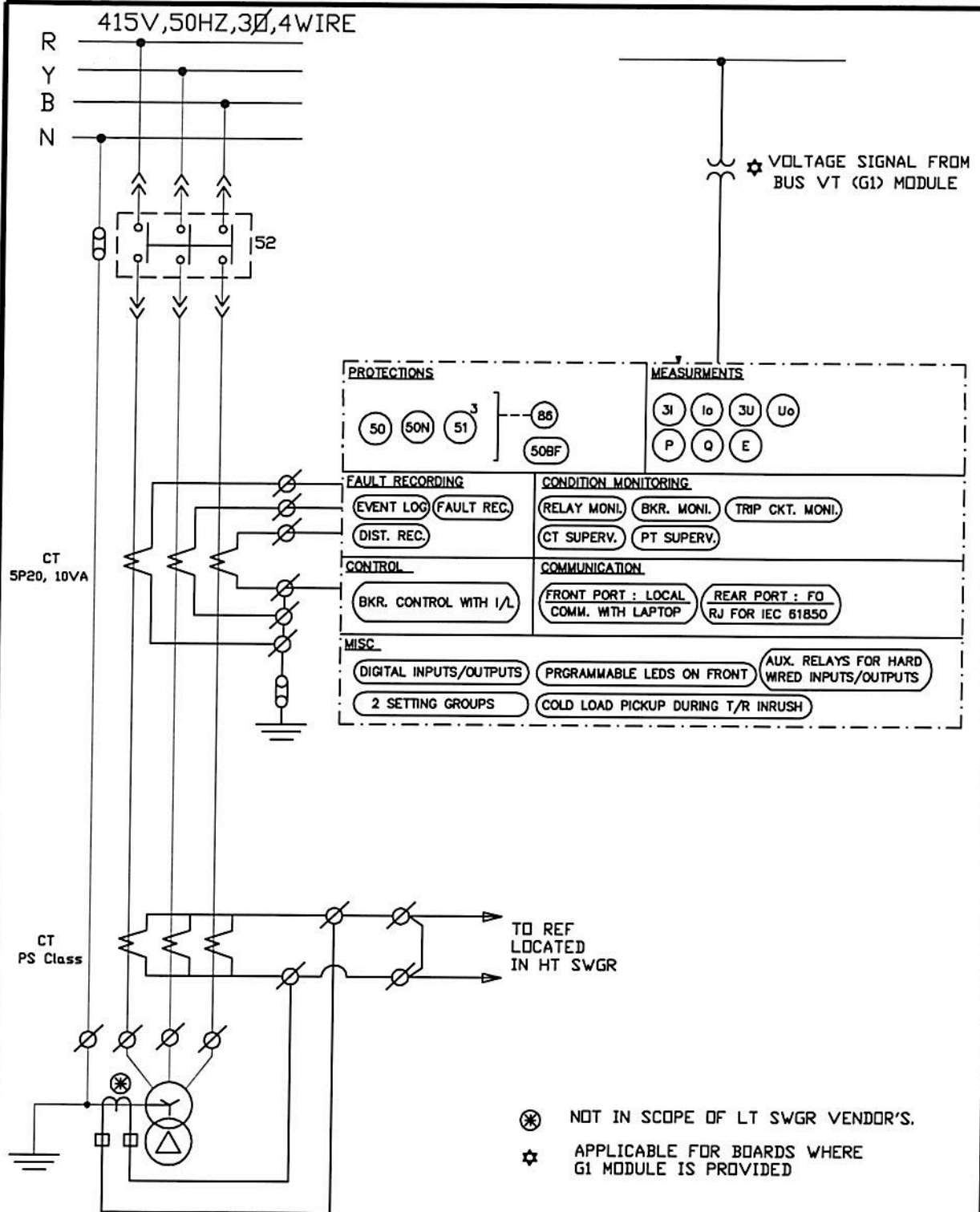
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<p>TITLE</p>					<p>SCHEME FOR FEEDER TYPE - CC (CONTACTOR CONTROLLED MOTOR)</p>				
DRN	DGN	CHKD	APPD	DATE	SCALE	DRAWING No.			REV.
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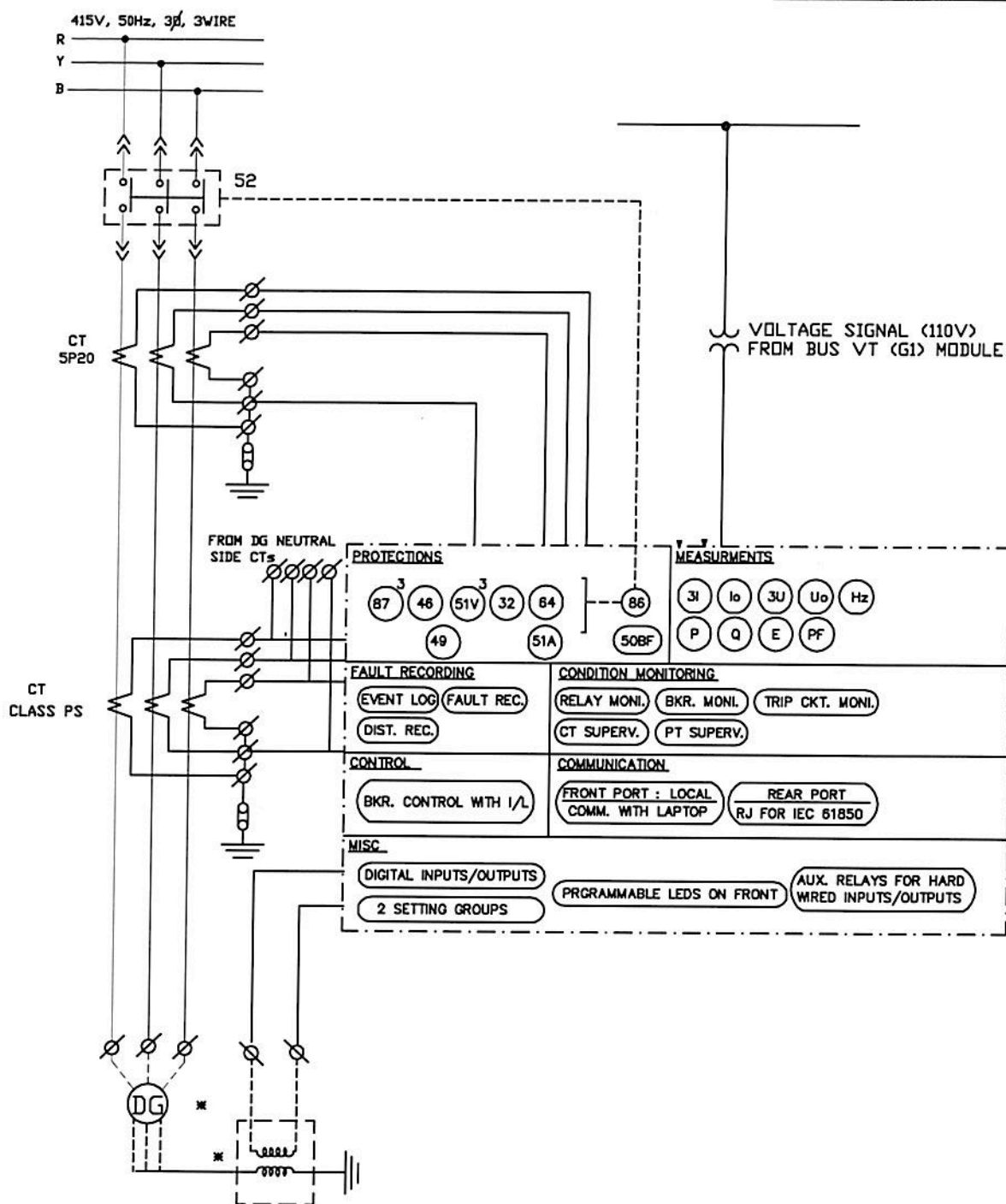
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<p>TITLE</p>					<p>SCHEME FOR FEEDER TYPE-DAET (INCOMER FROM TRANSFORMER)</p>				
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PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)


ANNEXURE – 2D1


TECHNICAL SPECIFICATION FOR SWITCHYARD


SUB-SECTION – B-14


SWITCHYARD


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	CHAPTER: SWITCHYARD ELECTRICAL			
1.00.00	SCOPE AND GENERAL INFORMATION			
1.01.00	The Voltage level for the Switchyard shall be as per Single Line Diagram. In addition to the detailed scope and other requirements specified in Part-A, the intent of the specifications for various electrical equipments shall also cover the following scope:			
1.01.01	Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for Employer’s approval.			
1.01.02	The basic design shall include, but not limited to, the following:			
	<div>a) Development of general arrangement.</div> <div>b) Development of detailed layout (plan & section/elevation) drawings.</div> <div>c) Development of single line diagram with parameters of equipment and details of protection.</div> <div>d) Protection and control philosophy and selection of protection, control and annunciation schemes.</div> <div>e) Development of interlocking schemes.</div> <div>f) Development of switchyard structure loading details.</div> <div>g) Development of earthing system.</div> <div>h) Development of direct stroke lightning protection system.</div> <div>i) Insulation coordination of the EHV equipment.</div> <div>j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading.</div> <div>k) Development of clearance diagrams.</div> <div>l) Lighting design, Lux level calculation and conduit wiring diagram.</div> <div>m) Development of power & control cable laying and termination schedules.</div> <div>n) Relay setting calculations.</div> <div>o) Development of erection key diagram with bill of material.</div> <div>p) Foundation design and construction drawings.</div> <div>q) Development of cable trench layout and sections and construction drawings.</div>			
1.01.03	Contractor shall furnish detailed drawings for the various equipments covered in their scope for Employer’s approval.			
1.01.04	Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by the Owner.			
1.01.05	All equipment shall be supplied with suitable terminal connectors. The terminal connector shall be well coordinated with the rating/type/size of conductor and equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for tube or horizontal or vertical take off suitable for quad/ Twin conductor. The spacing for quadruple and twin conductor shall be 450 mm for 765kV, 400kV & 220kV and spacing for twin conductor shall be 250 mm for 132kV. The type of terminal clamps would be finalised by the Contractor in			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 1 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>consultation with Employer based on layout requirement. The terminal pads shall preferably be capable of taking the required conductor span under normal, short circuit and meteorological conditions, without effecting the performance of the equipment.</p>			
1.01.06	<p>The rigid busbars for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular Al. connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.</p>			
1.01.07	<p>The line take off arrangement from GIS building up to line take off gantry shall be through GIS ducts as indicated in Single line diagram. The line side insulators and hardwares shall be provided by the line contractor, however the clamps and connectors for droppers to equipments are in the bidders scope. Location of line take off gantry and intermediate gantry (as required) for termination of Transmission line dead end tower to switchyard shall be finalized during detailed engineering based on the technical requirements. . All the terminations shall be done as indicated in the Single line diagram. High speed earth switches shall be provided wherever required.</p>			
1.01.08	<p>The minimum sizing criteria of the control room and GIS building shall be as given below:</p> <p>The GIS building shall be adequately designed so as have a passage of minimum 2.0 m on either side and adequate overhead clearance for the movement of equipments without any obstruction, from the top of the GIS equipment to EOT Crane. The GIS switchyard shall have a suitable Double storied Control Room Building with provision of Switchgear room, Battery room, charger room, office, cable vault, SAS room, Lab room, CRP Panel room, conference room, toilet etc.. The GIS & control room building is to be designed keeping future provision for extension if any as shown in the Single line diagram. The GIS building shall have adequate provision for maintenance bay.</p>			
1.01.09	<p>The EOT crane to be provided inside the GIS buildings and shall be suitable to move heaviest part for maintenance. The minimum capacity of EOT crane shall be 12.5T for 765kV, 6T for 400kV, 5T for 220kV & 132kV GIS buildings.</p>			
1.01.10	<p>The Contractor shall cooperate in all respects and exchange the necessary technical data/ drawings with other agencies and Employer's other Contractors under intimation to Employer to ensure proper coordination and completion of work in time.</p>			
1.01.11	<p>The sag tension, conductor spacing, short circuit forces, spacers location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances.</p>			
1.01.12	<p>All overhead stringing shall be carried out by minimum double tension string insulator assembly.</p>			
1.01.13	<p>Post insulators shall be provided at line entry and near transformers and other jumpers so as to avoid mechanical forces on the LA's and Bushings etc.</p>			
1.01.14	<p>Necessary fire wall shall be provided between single phases of reactors and transformers. The fire wall height shall be 600mm above reactor/ transformer bushing.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 2 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS																		
1.01. 15	The pit size of reactors and transformers shall be designed for minimum 1000mm beyond the physical dimension of the reactor.																		
1.01. 16	<p>The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin/ single conductors and 1.5T/conductor in case of quad conductor. The foundations and structures etc shall be designed accordingly. The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All gantries and towers (including intermediate/required for turning etc.) as required for GT O/H stringing on A-Row and line take off, are to be provided by the contractor.</p> <p>Various minimum heights of the AIS switchyard shall be as given below from plinth level:</p> <table><tr><th>Voltage level</th><th>Eqpt./1st level</th><th>Line take off gantry height</th></tr><tr><td>765 kV</td><td>14000mm</td><td>39000mm</td></tr><tr><td>400 kV</td><td>8000mm</td><td>23000mm</td></tr><tr><td>220kV</td><td>6000mm</td><td>17000mm</td></tr><tr><td>132kV</td><td>4600mm</td><td>12200mm</td></tr></table> <p>The peak of towers for 765kV & 400kV shall be 8500mm and for 220kV & 132kV shall be 5200mm.</p> <p>The intermediate gantry height for O/H connection for GT shall be min. 29m+8.50m peak & 25m+ 8.5m Peak for 765kV & 400kV respectively. The gantry width for 765kV, 400kV, 220kV & 132kV AIS shall be min. 30m, 27m, 18m & 12m respectively or as required to meet the specified clearances.</p>				Voltage level	Eqpt./1 st level	Line take off gantry height	765 kV	14000mm	39000mm	400 kV	8000mm	23000mm	220kV	6000mm	17000mm	132kV	4600mm	12200mm
Voltage level	Eqpt./1 st level	Line take off gantry height																	
765 kV	14000mm	39000mm																	
400 kV	8000mm	23000mm																	
220kV	6000mm	17000mm																	
132kV	4600mm	12200mm																	
1.01.17	The switchyard shall be provided with peripheral roads and roads for maintenance/approach for major equipments for maintenance purpose.																		
1.01.18	Voltage drop for sizing of power cables shall not be more than 6%.																		
1.01.19	The illumination level for AIS shall be 20 lux in general and minimum 50lux on equipment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on LM/ lighting masts only. Specification of lighting is provided elsewhere in the specification.																		
1.01.20	Contractor shall provide panel mounted automatic start / stop type centrifugal self priming pump for sump pit to drain the water in approximately one (1) hour. The contractor shall also provide suitable pedestal/ foundation for this pump. The pump shall be complete with all necessary fittings such as NRV, inlet & outlet pipes of suitable length and dia.																		
1.01.21	All ‘T’ off connections at ‘A’ row associated with transformers shall be provided with a bye pass utilizing two PG clamps for each T off. As far as possible the conductor shall pass without cut/joint unless otherwise necessary for planned shutdown/maintenance.																		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 3 OF 97															

CLAUSE NO.	TECHNICAL REQUIREMENTS				
1.01.22	Area of switchyard shall be provided with broken stone filling which shall consist of two layers. The first layer shall be 75mm thick base course of 20mm of normal size and second layer shall be 75mm thick surface course of 40mm nominal size.				
1.01.23	Adequate AC & Ventilation of Control room building and Ventilation of GIS Building is to be provided by the contractor. Specification of AC & Ventilation is specified elsewhere.				
1.02.00	CLEARANCES The minimum clearances for 765kV, 400kV, 220kV & 132kV AIS shall be as given below:				
		<u>765kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>
	Phase to earth clearance	4900mm (conductor to structure) 6400mm (rod to structure)	3500mm	2100mm	1300mm
	Phase to phase clearance	7600mm (conductor to conductor) 9400mm (rod to structure)	4000mm	2100mm	1300mm
	Section clearance	10300mm	6500mm	5000mm	4000mm
	The Contractor shall supply the structures suitable to meet the above clearances. For 765kV Switchyard, the average limit of 10kV per meter and 500 micro tesla for electric and magnetic field respectively are to be met at a height of 1.8 meter from ground level. The Contractor shall furnish calculations.				
1.03.00	SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED The 400kV system shall be designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. The 800 kV systems is being designed to limit the power frequency over voltage of 1.4 p.u.(base=462kV) and the switching surge over voltage to 1.9 p.u.(base=653) In 765 kV system the initial value of temporary over voltage could be 1.6 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.				
1.03.01	SITE SUPERVISION OF EQUIPMENTS The contractor shall ensure that, erection, testing and commissioning of, GIS, Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & Protective relays is carried out, under the supervision of manufacturer of respective equipment.				
1.04.00	Insulation Co-Ordination and Selection of Surge Arrestor				
1.04.01	The contractor shall be fully responsible for complete insulation co-ordination of switchyard. Contractor shall ensure that adequate protective margin is available. If surge arrestors at some more locations other than those indicated in the tender				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD	PAGE 4 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS				
	drawings are required to be provided, the same shall be deemed to be included in the offer.				
1.05.00	SYSTEM PARAMETERS				
1.05.01	FOR GIS				
	The system parameters shall be as under:				
		<u>765 kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>
a)	Highest system voltage	: 800kVrms	420kVrms	245kVrms	145kVrms
b)	Lightning Impulse voltage				
	Phase to earth & between phases	: ±2100kVp	±1425kVp	±1050kVp	±650kVp
c)	Switching impulse voltage	: ±1550kVp	±1050kVp	-----	-----
	Phase to earth				
d)	Power frequency withstand				
	(for 1 min. rms.)				
	Phase to earth & between phases	: 960kVrms	650kVrms	460kVrms	275kVrms
e)	Max. fault level (1 sec.)	: 50 kA	50kA	40kA	31.5kA
f)	PD level for GIS	: Less than 5	Less than 5	Less than 5	Less than 5
		Pico Coulomb	Pico Coulomb	Pico Coulomb	Pico Coulomb
g)	Rated frequency	: 50Hz	50 Hz	50 Hz	50Hz
1.06.00	TYPE TEST REQUIREMENTS				
1.06.01	TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS				
a)	All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of techno-commercial bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.				
b)	However if contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.				
c)	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD	PAGE 5 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.06.02	TYPE TEST REQUIREMENTS FOR GIS			
a)	The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of bids. The type test charges shall be paid only for the test(s) actually conducted successfully under the contract and upon certification by the Employer's engineer.			
b)	The type tests shall be carried out in the presence of the Employer's representative, for which minimum 30 days notice shall be given by the Contractor. The Contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set up, instrument to be used, procedure, acceptance norms, recording of various parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.			
c)	In case the Contractor has conducted such specified type test(s) according to the relevant standard and / or specification not earlier than ten years prior to the date of techno-commercial bid opening, he may submit the type test reports to the Employer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the Contractor.			
1.06.03	Common requirements (For GIS)			
a)	The Employer will have the right of getting any test of reasonable nature carried out on any component or completely assembled equipment at Contractor's premises or at site or in any other place in addition to the aforesaid type and routine tests, to satisfy that the materials/equipment comply with the specification.			
b)	Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies, and supplying the equipment that meet the requirement.			
c)	All equipments with their terminal connectors, control cabinets, main protective relays, energy meters etc as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes etc shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. Charges for the same shall be deemed to be included in the equipment price.			
	The offered GIS equipments shall confirm to the type tests as per IEC 62271-203. The list of the type tests shall be as follows:			
i)	Lightning impulse voltage dry tests.			
ii)	Switching impulse voltage dry tests.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 6 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>	
	<div>iii) iv) v) vi) vii) viii) ix) x) xi) xii) xiii) xiv) xv) xvi) xvii) xviii) xix) xx)</div>	<div>Power frequency voltage dry tests. Partial discharge tests. Radio Interference Voltage test Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit. Test to prove the ability of the main circuit and earthing circuit to carry the rated peak and the rated short time withstand current. Test to verify the making and breaking capacity of the included switching devices. Test for satisfactory operation of the included switching devices. Test to prove the strength of enclosures. Gas tightness test Electromagnetic capability test (if applicable) Test on partitions Internal arc tests. Mechanical operation tests. Test to prove the satisfactory operation at limit temperature. Verification of degree of protection of auxiliary and control circuits. Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators Capacitive Current switching test Shunt reactor current switching test The components forming parts of the GIS which are covered by other standards shall comply with and shall be type tested according to those standards.</div>			
	d)	<div>For surge arrestor and Bus VT following type tests are proposed to be conducted as per relevant IEC. <u>Surge Arrestor (As per IEC 60099-4)</u> a) Insulation withstand test on housing b) Residual voltage test c) Long duration current impulse withstand test d) Operating duty test e) Partial Discharge Test f) Leakage Test <u>BUS VT (As per IEC 60044-2)</u> a) Temperature rise test b) Lightning Impulse test c) Switching Impulse d) Determination of errors e) Short circuit withstand capability f) Chopped lighting impulse test</div>			
1.08.00	CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST: The corona and RIV tests shall confirm to the requirements as per Annexure A to this chapter. The seismic withstand test shall conform to requirements as per Annexure B to this section.				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD	
				PAGE 7 OF 97	


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	Annexure – A			
	CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST			
1.0	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 measurement of radio interference voltage (RIV).			
2.0	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.			
3.0	Test Methods for RIV (765kV, 400kV, 220kV & 132kV):			
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 – I. 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 result 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 measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.			
3.4	Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV & 132kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.			
3.5	The metering instruments shall be as per CISPR recommendations 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 the voltage read by the noise meter.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 8 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
4.0	<p>Test Methods for visible Corona (765kV & 400kV AIS only)</p> <p>The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears.</p> <p style="text-align: right;">Annexure – B</p> <p>SEISMIC WITHSTAND TEST (for 765 kV & 400kV AIS only)</p> <p>a.) The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.</p> <p>b.) The bidder shall arrange to transport the structure from his contractor’s premises / owner’s sites for purpose of seismic withstand test only.</p> <p>c.) The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.</p>		
2.00.00	REQUIREMENTS FOR GAS INSULATED SWITCHYARD		
2.01.00	GENERAL		
2.01.01	The GIS shall comply to IEC – 62271-203. The general requirements and special requirements for Gas Insulated Switchgear (GIS) are given in this chapter. GIS shall also meet other requirements specified under switchyard for various equipments as applicable. Materials and components not specifically stated in this specification but are necessary for the satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.		
2.01.02	The GIS shall be modular in structure and shall be housed indoor. The modules shall be single phase encapsulated for 765kV & 400kV & single/ three phase encapsulated for 220kV & 132kV and provided with hooks for handling by EOT cranes to be provided in the building. The modular design shall be capable of extension on either side without any major dismantling.		
2.01.03	The GIS equipments for 765kV, 400kV, 220kV & 132kV shall be housed in separate GIS building of overall height and width determined by the layout arrangement.		
2.01.04	The bus bars shall be rated for the duty specified and current rating shall be derived		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 9 OF 97


CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
<p>2.02.00</p> <p>2.02.01</p> <p>2.02.02</p> <p>2.02.03</p> <p>2.02.04</p> <p>2.02.05</p> <p>2.02.06</p> <p>2.02.07</p> <p>2.02.08</p> <p>2.02.09</p> <p>2.02.10</p> <p>a)</p> <p>2.03.00</p> <p>2.03.01</p>	<p>considering maximum possibilities.</p> <p>TECHNICAL REQUIREMENTS:</p> <p>The requirements for all switchyard equipments are given in subsequent sections.</p> <p>The VT's for GIS shall be installed within the GIS enclosure and shall be SF6 gas insulated or cast resin type. The secondary terminals shall be brought out in a dust proof enclosure suitably.</p> <p>The Surge arrestors for main buses shall be of GIS type only.</p> <p>The earthing of the GIS shall be carried out considering the safety requirements as per relevant standards. All parts to which access is required for maintenance work shall have provision for earthing. In addition after opening of enclosure it shall be possible to have continuity of earth for the duration of work. The continuity of earthing shall be ensured considering electrical and thermal stresses caused by current they may have to carry.</p> <p>Each section & phase of the GIS enclosure shall be monitored for leakage of SF6 gas and suitable indication shall be provided in the control room.</p> <p>All components of the same rating and construction shall be interchangeable.</p> <p>Each breaker module of the GIS shall have a local control cabinet suitably located and shall be ground mounted meeting the requirements specified elsewhere for cabinets. Suitable interlocking arrangements shall be provided for the entire GIS.</p> <p>All the SF6 gas insulated circuit breakers, disconnectors, grounding switches and bus bars shall be of single phase isolated type for 765 kV & 400 kV and three/ single phase isolated type for 220kV & 132kV .</p> <p>Protective Finish -Preferable</p> <p>All the exterior surfaces shall be cleaned and painted before leaving the factory with one coat of approved primer and two coats of water resistant approved paint on the equipment. The under-side of all painted surfaces bearing upon the concrete foundation shall be given two coats of approved primer. Extra paint for retouching at site shall be made available by the Contractor.</p> <p>Fire Retardancy</p> <p>All components shall be fire retardant and shall be tested in accordance with IEC 695.</p> <p>DESIGN AND SAFETY REQUIREMENT</p> <p>The GIS assembly shall be as per switching arrangement indicated under single line diagram and consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled SF6 gas and separated gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2</p>	<p>SUB-SECTION B-14 SWITCHYARD</p>	<p>PAGE 10 OF 97</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions. The compartments of GIS assemblies shall be supplied filled with nitrogen/ air or dry SF6 gas at a positive pressure and hermetically sealed to protect the dielectric system during transportation.</p>			
2.03.02	The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.			
2.03.03	The switchgear, which shall be of modular design. The conductors and the live parts shall be mounted on insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.			
2.03.04	Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.			
2.03.05	Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand 1.5 times full rated pressure on one side while vacuum is exerted on the other side. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on the pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced, it should be ensured by the contractor that adjacent compartment would remain in service with reduced pressure. The gas tight barriers shall be clearly marked on the outside of the enclosures.			
2.03.06	The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition.			
2.03.07	Sufficient inspection windows/access openings shall be provided at the switchgear to ensure that each switchgear component can be inspected / monitored during installation and future maintenance. Each section shall have plug-in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.			
2.03.08	The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 11 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	temperature variation without imposing any mechanical stress on supporting insulators.			
2.03.09	Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC -62271-203 .			
2.03.10	The maximum SF6 gas leakage shall not exceed half percent (0.5%) per year for the whole equipments and for any individual gas compartment separately.			
2.03.11	Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.			
2.03.12	The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated & fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.			
2.03.13	Void.			
2.03.14	The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.			
2.03.15	The Switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments at least for:			
	a)	Bus bars		
	b)	Intermediate compartment		
	c)	Circuit breakers		
	d)	Bus / Line disconnections		
	e)	Gas insulated bus duct sections		
	f)	Voltage Transformers		
	g)	Surge Arrestors		
	The bus enclosure should be sectionalized in a manner that maintenance work can be carried out by isolating and evacuating the small effected section and not the entire bus.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 12 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>The design of the one and half breaker scheme GIS shall be such that in case one circuit breaker module is removed for maintenance, there is no disruption in the power flow in any of the two circuits in a diameter.</p> <p>The design of double bus scheme shall be such that the common point of the two bus bars along with the earth switch shall be designed and housed in a separate compartments so as to avoid complete shutdown of the system in case of maintenance required in any bus disconnector. Further maintenance on one bus disconnector should be possible when the feeder is live through other disconnector.</p>			
2.03.16	The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.			
2.03.17	It is required that the three phases of each switchgear bay be arranged side by side. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.			
2.03.18	The arrangement of gas section or compartments shall be such as to facilitate extension of any make on either end without any drilling, cutting or welding on existing equipments. The GIS shall be designed such that a future requirement as per single line diagram can be extended with-out any necessity to move or dislocate the existing switchgear bays. It shall be kept in view that very little shutdown time is needed for adding future requirement.			
2.03.19	All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure part or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.			
	It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.			
2.03.20	All interlocks that prevent potentially dangerous mal operations shall be constructed such that they can not be operated easily, i.e. the operator must use tools or brute force to over-ride them.			
2.03.21	The actual position of circuit breakers, disconnectors and grounding switches must be positively displayed by mechanical indicators visible from the operating position.			
2.03.22	In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible discharges. There shall be no radio interference from the energized switchgear at rated voltage.			
2.03.24	The fabricated metal enclosures shall be of Aluminum alloy and have high resistance to corrosion, low electrical losses and negligible magnetic losses. All jointed surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.			
2.03.25	The breaker enclosure shall have provision for easy withdrawal of the interrupter			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 13 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	assemblies/complete CB pole.			
2.03.26	The enclosures of the same phase shall be electrically interconnected and at proper points they shall be connected to the other phases thus entailing a return current almost equal to the current circulating in the conductors.			
2.03.27	The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.			
2.03.28	The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.			
2.03.29	The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment. The connection between the grounding pads of switchgear and ground mat risers shall be provided by the contractor. The contractor shall furnish the design details & drawings for ground mat for GIS.			
2.03.30	The ladders and walkways shall be provided wherever necessary for access to the equipment.			
2.03.31	Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as balanced 3-phase, 4-wire load.			
2.03.32	Arrangement shall be provided to visually observe the contact position of disconnecting switches and earth switches.			
2.03.33	The enclosure & support structure shall be designed that a mechanic 1780mm in height and 80 Kg in weight shall be able to climb on the equipment for maintenance.			
2.03.34	The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.			
2.03.35	Alarm circuit shall not respond to faults for momentary conditions. The following indications in addition to those required elsewhere in the specifications shall be provided in the alarm & indication circuits in Bay Module Control Cabinets:			
I)	Gas Insulating System			
a)	Loss of gas density			
b)	Loss of heater power (if required)			
c)	Any other alarm necessary to indicate deterioration of the gas insulating system			
II)	Operating System			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 14 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div><div>a)</div><div>Low operating pressure.</div></div><div><div>b)</div><div>Loss of Heater Power.</div></div><div><div>c)</div><div>Loss of operating power.</div></div><div><div>d)</div><div>Loss of control</div></div><div><div>e)</div><div>Pole-disordance</div></div></div> <div>In addition, all the above alarms shall also be hooked up to the Substation Automation system.</div>			
2.03.36	Each gas compartment barrier shall be easily identifiable from the outside of the switchgear.			
2.03.37	Maximum weight of gas in gas tight section of GIS duct shall not exceed 400 kg (for 765kV & 400kV) and 250 kg (for 220kV & 132kV)			
2.03.38	The equipment shall be suitable for operation under the ambient conditions prevailing at project site. The prevailing conditions shall be taken into account by the Contractor in the design of the equipment.			
2.04.00	MANDATORY MAINTENANCE EQUIPMENTS The maintenance equipment necessary for the operation and maintenance of GIS shall be supplied. The requirement of such equipments is enclosed at Annexure-C of this section.			
2.05.00	MANDATORY MONITORING EQUIPMENTS The monitoring equipment necessary for the operation and maintenance of GIS shall be supplied. A list of such equipments is enclosed at Annexure-D of this section.			
2.06.00	BELLOWS OR COMPENSATING UNITS Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The metallic bellows (preferably of stainless steel) of following types or other suitable arrangement shall be provided wherever necessary: <div><div>i)</div><div>To enable sections of the switchgear to be removed and reinserted without interfering with adjacent parts.</div></div> <div><div>ii)</div><div>To accommodate changes in length of bus bars due to temperature variations.</div></div> <div><div>iii)</div><div>To accommodate large linear expansions and angle tolerances.</div></div> <div><div>iv)</div><div>For taking up manufacturing, site assembly & foundation tolerances.</div></div> <div><div>v)</div><div>for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil / SF6 bushings.</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 15 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
2.07.00	INDICATION AND VERIFICATION OF SWITCH POSITIONS			
	Indicators shall be provided on all circuit breakers, Disconnectors and earth switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkage and shall be mounted in a position where they are clearly visible through glass windows.			
2.08.00	PRESSURE RELIEF			
	Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably) in downward direction).			
	Pressure relief devices shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.			
	If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria design regarding location of pressure relief devices/rupture diaphragms.			
2.09.00	PRESSURE VESSEL REQUIREMENTS			
	The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.)			
	The bursting strength of Aluminium casting has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.			
	Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.			
2.10.00	BUSBARS			
2.10.01	The conductors of the bus bars shall be fabricated from aluminum/copper tubular sections of cross- sectional area suitable to meet the current rating requirements. . The tubular bus section shall be housed in corrosion resistant aluminum enclosures, filled with pressurized SF6 gas. The conductors shall be supported from the enclosures by insulators shaped to ensure uniform electrical field distribution and zero corona at rated voltage. Adequate provisions shall be made for absorption of the thermal expansions between the conductors and the enclosures. The metal bellow type compensators for adjusting tension shall be provided where ever required. The enclosures shall be designed to eliminate as much as possible all external effects of the flux created by normal and fault currents. The power losses in the system shall be kept to a minimum. The induced voltages on the enclosures shall not be allowed to exceed reasonable limits of safety for operating personnel.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 16 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.10.02	The bus end connections shall be made with multi-contact connectors to allow for axial thermal expansion of the bus. The enclosure connections shall be flanged and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections.			
2.10.03	Main bus bars shall be designed to have future extension bay if any as indicated in the single line diagram. The bus conductor end connectors and enclosure flanges shall be designed accordingly.			
2.10.04	All necessary indoor and outdoor galvanised steel supporting structures for the proper erection, leveling and alignment of the bus bars shall be provided by the Contractor.			
2.10.05	The SF6 GIS bus-bars shall have continuous current rating as shown in the single line diagram or as required for the system.			
2.10.06	The system employed shall be of the electrically continuous enclosure type, allowing free circulation of induced currents in the enclosures. The enclosures shall be cylindrical in shape and designed for maximum shielding to minimize electromagnetic forces caused by short circuit currents.			
2.10.07	Wherever necessary, to absorb expansion / contraction, relative movement between the various items of equipment and the earthquake forces, bellows or other means shall be provided. The contractor must submit details of the means deployed along with the offer.			
2.11.00	BAY MODULE CONTROL CABINETS			
2.11.01	Each switchgear bay module shall be suitable for local control and remote control. The contractor shall supply the main control cabinet of the floor standing type along with GIS equipments. The cabinet shall have double, full height, hinged, gasketed, lockable doors. One door shall have a safety glass window through which the various switchgear controls can be viewed without opening the doors.			
2.11.02	The cabinet will be utilized for the switchgear bay local control module and as the terminating center for all power supply, control annunciation and supervisory wiring interfacing with Employer's systems.			
2.11.03	The following equipments shall be mounted on the cabinet door: <ul style="list-style-type: none">- Remote/local control transfer switch for the circuit breakers and disconnector switches.- Normal operation/maintenance control transfer switch for disconnector of remote electrical controls.- Mimic diagram of the switchgear bay complete with semaphore indicators for the switchgear component position indication and local control switches for open / close or close-trip control of the circuit breaker, isolators and grounding switches.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 17 OF 97				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.11.04	The following equipments shall be mounted internally in the cabinet: <ul style="list-style-type: none">- All bay switchgear interlocking wiring and auxiliary relays.- AC and DC power supply circuit breakers.- All necessary incoming and outgoing terminal blocks.- Space heaters- All instruments and devices required for supervision & control of GIS			
2.11.05	The annunciator system shall have sufficient modules and illuminated windows for providing annunciation for low / high gas pressure / density, alarms & trips for circuit breaker operating mechanism and all other abnormal conditions.			
2.11.06	Each annunciator panel shall be complete with an audible warning horn, acknowledge/reset for horn silence and lamp test push buttons. Apart from annunciator system in LCC, alarm contacts for remote alarm indication shall have to be wired separately in LCC terminal block.			
2.11.07	The control cabinets shall be suitable for bottom entry of cables.			
2.12.00	SUPPORTING STRUCTURES			
2.12.01	The Contractor shall design, fabricate and supply the equipment supporting framework including all rails, transverse & longitudinal beams and supporting members with all necessary hardware & embedded parts. General structural designs and structural details shall be subject to the approval of the Employer.			
2.12.02	The floor of the switchgear building will be designed to support all the loads imposed by the equipment supporting framework. The Contractor shall make provision in his designs to minimize transfer of forces resulting from thermal expansion or switchgear operation to the walls & floors of the switchgear building. To facilitate the design of floor of switchgear, the Contractor shall supply the details of static and dynamic loads to be supported by the slab along with the offer.			
2.12.03	Non-corrosive metal or cadmium plated steel shall be used for bolts and nuts throughout the work when either or both are subjected to frequent adjustment or removal.			
2.12.04	All steel structure members shall be hot dip galvanised.			
2.12.05	All supporting structures shall be designed in such a way so as to allow dismantling for the addition of further switchgear components or maintenance of existing equipment without requiring temporary supports.			
2.12.06	The supporting arrangements for the GIS duct outside the building shall have adequate provision for thermal expansion/seismic forces etc.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 18 OF 97				


CLAUSE NO.	<div data-bbox="592 145 1011 179" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1299 109 1458 188" data-label="Image"> </div>
<div data-bbox="188 219 293 248" data-label="Section-Header"> 2.13.00 </div> <div data-bbox="188 309 293 338" data-label="Section-Header"> 2.13.01 </div> <div data-bbox="263 723 293 752" data-label="Text"> i) </div> <div data-bbox="263 795 293 824" data-label="Text"> ii) </div> <div data-bbox="188 904 293 934" data-label="Section-Header"> 2.13.02 </div> <div data-bbox="188 1014 293 1043" data-label="Section-Header"> 2.13.03 </div> <div data-bbox="188 1084 293 1113" data-label="Section-Header"> 2.13.04 </div> <div data-bbox="188 1193 293 1223" data-label="Section-Header"> 2.13.05 </div> <div data-bbox="263 1294 293 1323" data-label="Text"> i) </div> <div data-bbox="263 1720 293 1749" data-label="Text"> ii) </div>	<div data-bbox="344 219 539 248" data-label="Section-Header"> MONITORING </div> <p data-bbox="344 309 1458 678">The gas density in each gas compartment shall be monitored by electrically isolated & independently adjustable temperature compensated density switches. The factory set density switches shall also be acceptable. The relative merits, however for such switches in place of adjustable density switches shall be indicated in the offer. Two level density switches shall be provided for each GIS bus compartment to initiate remote devices of level-I alarm and level-II tripping. The setting of level-I alarm and level – II tripping shall be such that the dielectric strengths of SF6 gas are maintained. The necessary indication shall be provided at the circuit breaker control cabinet identifying the gas compartment from which a level-I alarm is initiated. Two level density switches shall be provided for each circuit breaker compartment to initiate the following:</p> <div data-bbox="360 723 1458 860"> <p data-bbox="360 723 1390 752">Level-I- Remote alarm and prevent closing of the breaker in case it is open.</p> <p data-bbox="360 795 1458 860">Level-II- Initiation of Zone trip, Contact shall be in accordance with the requirement.</p> </div> <p data-bbox="344 904 1458 969">Gas pressure monitoring devices shall be fitted with test valves such that field testing of the monitoring device can be performed without draining the main gas system.</p> <p data-bbox="344 1014 1358 1043">Each gas section shall be fitted with a suitable valve for routine gas sampling.</p> <p data-bbox="344 1084 1458 1149">The Contractor shall satisfy the Employer regarding accuracy limits of gas monitoring devices.</p> <p data-bbox="344 1193 1458 1258">The equipment shall have provision to monitor the following parameters periodically to check anomalies and/or wear & tear of equipment.</p> <div data-bbox="344 1294 1289 1966"> <p data-bbox="344 1294 842 1323">Operation of mechanical components:</p> <p data-bbox="344 1366 826 1395">The parameters to be monitored are:</p> <ul data-bbox="379 1438 1289 1682" style="list-style-type: none"> <li data-bbox="379 1438 1289 1467">- Fluid pressure(oil) or hydraulic mechanism power reserve <li data-bbox="379 1509 1023 1538">- The displacement speed of the moving parts <li data-bbox="379 1581 783 1610">- The travel of moving parts <li data-bbox="379 1653 751 1682">- Friction of moving parts <p data-bbox="344 1720 943 1749">Wear of circuit breakers interrupting chamber:</p> <p data-bbox="344 1792 826 1821">The parameters to be monitored are:</p> <ul data-bbox="379 1863 991 1966" style="list-style-type: none"> <li data-bbox="379 1863 975 1892">- Determination of contact closing position <li data-bbox="379 1935 991 1966">- Accumulated effect of interrupted currents </div>


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
iii)	<div>- Decomposition products content in SF6 Gas</div>			
	Insulation failure:			
	The parameters to be monitored are:			
	<div><div>- SF6 gas density monitoring of all the compartments</div><div>- High frequency current detection for partial discharge detection</div><div>- Sonic detection</div></div>			
iv)	Safety bursting disc for each SF6 gas compartment.			
2.14.00	HIGH VOLTAGE TRANSIENTS			
High voltage transients from switching operations and internal faults are coupled to the external enclosure of the GIS. Since the effects of these transients on people are not known, the operating personnel are required to avoid contact with the enclosure during switching operations. The contractor is therefore required to establish that the reduced transient levels are within acceptable level.				
2.15.00	BURN THROUGH PREVENTION			
The Contractor shall furnish the details regarding the design features of their equipment which are intended to prevent burn through when an internal arc occurs.				
2.16.00	HEATERS			
All the heaters shall be suitable for connection to a 240V AC, single phase, 50 Hz supply. The heater in the mechanism housing shall be connected inside the housing to this supply and shall be thermostatically controlled. The leads to the tank heaters shall be enclosed in a conduit.				
All the thermostats and the temperature indicating devices shall be calibrated in metric units.				
2.17.00(A)	SERVICE LIFE			
SF6 circuit breakers, disconnecting switches and grounding switches will be subjected to frequent and occasionally repetitive, no load / full load operations and switching off short circuit currents , capacitive and inductive currents within their ratings. The Contractor shall propose the recommended period for scheduled maintenance.				
2.17.00 (B)	SEISMIC DESIGN CRITERIA:			
a)	The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipment along			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 20 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier, Test Report/Analysis Report should be furnished.</p>			
b)	<p>To prevent the movement of GIS sub-assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the employer's approval.</p>			
2.18.00	INSPECTION AND TESTING			
2.18.01	<p>All the equipment, apparatus, materials and supplies provided by the contractor under the contract shall be subjected to tests in the shop and at the field in the presence of employer for conformity with the requirements of the specifications. be as specified for the particular item or shall be in conformity with the applicable recognized standards for making such test. The details of the test procedures and test equipment to be used should be intimated to the Employer well in advance i.e. no less than 30 days before these tests are conducted. Unless otherwise specified, the contractor shall perform all shop and field tests.</p>			
2.18.02	<p>The Contractor shall submit a detailed quality assurance plan with 30 days after the commencement date intimating the testing program to the Employer for testing may proceed with minimum delay. The performances tests shall start, proceed, stop and be resumed in accordance with the approved schedule.</p>			
2.18.03	<p>The Contractor shall, at its own expense, promptly make good all defects evident by testing or made apparent in any other ways. After defects in the equipment have been rectified, the equipment is proved to be in satisfactory operation.</p>			
2.18.04	<p>Within 30 days of completion of each and every specified test, including commissioning tests, the Contractor shall submit six signed copies of the test reports to the Employer.</p>			
2.18.05	<p>The test reports shall indicate the tests performed, the result obtained, instruments used, names of personnel carrying out the tests and provisions for signature of witnesses. They shall also show the number and date. The format of these reports shall be submitted along with testing procedure for the employer's approval well in advance.</p>			
2.18.06	<p>The test report shall include, but not necessarily be limited to the following:</p> <ul style="list-style-type: none">- A description of the test equipment with diagram showing arrangement of the test instruments and devices.- Sample computations, wherever necessary or desirable to show the test			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 21 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>values employed in the equations.</p> <ul style="list-style-type: none">- Curves showing relation of tested quantities- Data in tabulated form <p>The comparison of the test results with the guaranteed requirements of the specification and explanation of deviations, if any.</p>			
2.19.00	Shop test			
2.19.01	All major part of equipment, is essentially those necessitating subdivision of parts are transport and subsequent and reassembly at site, shall be matched, assembled in the factory and carefully marked before dismantling. The dowel holes shall be provided with dowels to assist reassembly. The accuracy of fitting has to be assured at site at all stages of assembly.			
2.19.02	Each transport section of switchgear shall be shop tested.			
2.19.03	<p>Switchgear components forming part of GIS namely circuit breakers, disconnectors, grounding switches, current transformers, Voltage transformers, surge arrestors & SF6 interface bushing, the routine tests of which have been covered under other relevant IEC standards and which do not form the part of tests specified below shall have these tests performed before being assembled into the switchgear. However, for electronic modules, equipment and individual components burn-in tests, temperature & voltage stress tests shall also be performed. Routine tests shall be conducted by automatic processes, wherever practicable particularly during testing of wiring. An example of the other tests referred to above would be as follows:</p> <ul style="list-style-type: none">a) Verification of terminal markings and accuracy & composite error tests for current and potential transformers.b) Routine and standard acceptance tests for surge arrestors specified in IEC60099-4 relevant to metal oxide type arrestors without gaps.c) Routine tests (on transport section):<ul style="list-style-type: none">i) Dry Power frequency voltage withstand tests on the main circuit.ii) Dielectric tests on auxiliary and control circuit.iii) Tests to verify the resistance of the main circuitiv) Partial discharge testsv) Pressure test on enclosuresvi) Gas tightness test.vii) Mechanical operation tests.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 22 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div><div>viii) Tests of auxiliary, electrical and hydraulic devices.</div><div>ix) Check of wiring.</div><div>x) Power frequency voltage dry tests</div><div>xi) Voltage tests on auxiliary and control circuits</div><div>xii) Fluid leakage tests (where applicable)</div></div><div>The applicable standards for the above tests shall be IEC 62271-203, IEC 62271-100 and IEC 62271-1.</div><div>In addition, corrosion protection tests at random on all equipment shall be performed.</div></div>			
2.20.00	Type Tests <div>For Type Test requirement, Please refer clause No.1.06.02 & 1.06.03.</div>			
2.21.00	Performance Tests <div>Performance tests will be required to prove that equipment meets the requirements of the specifications and the guarantees. All the tests shall be conducted by the contractor subject to Employer's approval. The contractor shall supply all labour, consumables, materials, equipment, meters, gauges etc. necessary for the performance of all the tests and recording the results of the tests. The contractor shall assume full responsibility for the operation and safety of the equipment during all tests. The reports of all the tests shall be prepared by the contractor and incorporated in the final test report. The performance tests shall comprise of:</div> <div><div>a) Field stage tests, to be carried out during erection, to demonstrate that the equipment or any component or subassembly has been properly erected and functions correctly.</div><div>b) Commissioning tests, precedent to the acceptance of work, in respect of the equipment or any section of the equipment, to demonstrate proper operation.</div></div>			
2.22.00	Field Stage Tests: <div>From time to time at various stages of erection, tests of sub-assemblies of the equipment shall be carried out as instructed by the Employer. The contractor shall make records of all measurements and shall make corrections or adjustments as required. A record of all stage tests shall be embodied in a report. These tests shall include, but not be limited to the following:</div> <div><div>(a) Continuous testing of the properties of SF6 gas through the entire filling period.</div><div>(b) Test to check the continuity of wiring and correct operation of electrical</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 23 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
2.23.00	<p>systems.</p> <p>(c) Testing of all current carrying & ground connections to all conductors and terminal pads, to determine that the surfaces & all the bolted connections are tightly secured with lock washers; testing of all the flexible connections to ensure that sufficient slack is available for expansion.</p> <p>(d) Individual inspection of pressure relief devices, pressure gauges, moisture detectors and all other auxiliary devices to examine their condition.</p> <p>(e) Checking of cabling between apparatus by the contractor, prior to acceptance tests. Written evidence shall be produced on these tests. Random checks shall be made in the presence of the Engineer.</p> <p>(f) Measurement of the insulation resistance of the various measuring and control circuits, including cables, instruments and apparatus wherever practical and feasible.</p> <p>(g) Operation checks of operating mechanism, all control, signaling, measuring, metering, recording and interlocking equipment to confirm complete conformity with designed data.</p> <p>Prior to commencement of these tests, the contractor shall submit a detailed programme to Employer's for approval. Detailed records, including all the details of tests performed and the results obtained shall be prepared by the contractor and furnished to the Employer.</p>			
	<p>Commissioning Tests</p> <p>On completion of the erection and installation, following commissioning tests shall be performed as per IEC 62271-203, CIGRE working Group 23.03, 1975-Electra No.42, 7-29:</p> <p>(a) One minute power frequency withstand tests for the main circuits. As per IEC 62271-203 high voltage tests at site with lightning impulse and switching impulse voltages are also acceptable as alternative. The Contractor may carry out either of the above tests but relative merits of particular type of test over the other tests to be carried out by the contractor should be indicated in the offer.</p> <p>(b) Partial discharge measurement tests.</p> <p>(c) Voltage tests for the main circuits</p> <p>(d) Voltage tests for the auxiliary and control circuits.</p> <p>(e) Tests to verify the resistance of the main circuits.</p> <p>(f) Operation tests for various components.</p> <p>(g) Gas leakage tests.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 24 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS						
2.24.00	(h) Calibration/checking of SF6 gas pressure/density switches.						
	Measurement of moisture.						
	After erection, a test shall be made to prove the absence of the dangerous voltages in the enclosure and other metal parts such as pipes and framework. If the tests prove the existence of any fault or faults in the equipment, or any failure to meet the requirements of the specifications the Employer may direct Contractor to rectify the defects or repair, reconstruct or replace faulty work and Contractor shall without delay, carry out the instructions of the Employer in this respect.						
	Except as otherwise provided hereunder, responsibility for apparatus & test equipment and the control thereof shall be exercised by contractor subject to the over riding control of the Employer.						
	Commissioning tests shall be as per the IEC standard and shall not be restricted to the tests stated above. The Contractor shall also recommend any additional commissioning tests.						
2.25.00	Final Acceptance Tests						
	After commissioning tests have been satisfactorily completed, the contractor shall carry out tests as per relevant standards.						
2.26.00	Test Reports						
	The contractor shall record all the relevant facts and the quantities on the basis of which a final test report shall be prepared. Such reports will be prepared in a form approved by the Employer and reproduced at the expense of the contractor in six copies for submission to the Employer.						
2.26.00	TRAINING: GIS manufacturer Shall Provide Training to the Employer's Personnel as per the Details Given Below:						
	SI No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging	
	1	GIS					
	a)	GIS equipments including system description, Basic Design and engineering, Quality Assurance concepts, Erection and operational aspects for the offered equipments.	5 days	Manufacturers works	8	To be provided by Bidder	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD		PAGE 25 OF 97	

CLAUSE NO.	TECHNICAL REQUIREMENTS						<div>एनटीपीसी NTPC</div>
1.0	SI No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging	
	b)	Operation, Maintenance, Site Testing and Trouble shooting for GIS.	5 days	Site	6	-	
	Annexure-C						
	SPECIFICATION OF MANDATORY MAINTENANCE EQUIPMENT						
	SF6 Gas Handling Plants:-						
	a) SF6 gas filling and evacuating equipment (Portable)						
	The capacity of this plant shall be such that it shall not take appreciable time for filling or evacuating of largest compartment. The required vacuum for complete evacuation shall be attained with the help of this plant.						
	b) SF6 gas filtering, drying, storage and recycling plant-						
	- The plant shall be complete with accessories and fittings so that SF6 gas from the breaker can be directly filled in the plant storage reservoir.						
	- In case purging of the equipment before filling with SF6 gas is desirable, then the required equipment for dry gases etc. shall be furnished as a part of the plant.						
- For heavy items within the plant, the lifting hooks shall be provided for lifting and moving with the overhead cranes.							
- The capacity of the plant shall be such as to handle and store the maximum quantity of gas that could be removed from atleast one phase of complete one bay.							
Note:							
i) These SF6 gas handling plants shall be complete with all the necessary pipes, couplings flexible tubes and valves for coupling to the equipment.							
ii) The design and construction of the plant, valves, couplings, and connections shall be such that leakage of SF6 gas shall be minimum. Similarly valves, couplings and pipe work shall be so arranged that accidental loss of gas to							
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)			TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD		PAGE 26 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
2.0	the atmosphere shall be minimum.			
	SF6 gas analyzer The SF6 gas analyser should be portable type and instrument should have following features: <ul style="list-style-type: none">a. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.b. Equipment should be equipped with pumped back facilities so that no SF6 gas is wasted.c. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.d. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376<ul style="list-style-type: none">i) SF6 purity – Range: 0-100 %ii) Dew point - Range: -60 to +20 deg Ciii) SO2 - Range: 0-150 ppmiv) CF4 – Range: 0-60% volv) HF - Range: 0-25 µl/le. Instrument should work on AC source as well as on rechargeable batteryf. Input pressure: upto 10 barg. It should be housed in a robust IP67 case with wheels			
3.0	SF6 Gas leak detector - The SF6 gas leak detector shall meet the following requirements: <ul style="list-style-type: none">a) The detector shall be free from induced voltage effects.b) The sensing probe shall be such that it can reach all the points on the GIS where leakage is to be sensed.c) The accuracy of the equipment shall be at least 10 ppm.			
4.0	Operational analyser with DCRM kit- The operational analyser shall meet the following requirements: <ul style="list-style-type: none">a) Operational analyser shall be one complete system, which once installed should record all the parameters, as laid down in subsequent clauses.b) It shall have facility to record the breaker contact movement during opening, closing, auto reclosing and make-break operation, the speed of contacts at various stages of operation, travel of contacts, opening time, closing time and make break time ,etc.c) The analyser shall have provisions for recording atleast 12 different functions of the circuit breaker. All necessary transducers (i.e. three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 27 OF 97				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
5.0	required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient enough for recordings at site on a completely assembled and erected breaker.			
	d) The analyser shall be suitable for operation outdoor and shall be suitably shielded against induced charges.			
	e) The output of the analyser shall be on a plain paper or any paper having infinite shelf life and the output thus obtained shall have a long life and shall not require any special storage facility. Photographic paper is not acceptable.			
	f) All the necessary catalogues, write up for operation and maintenance of the analyser shall be furnished alongwith each analyser and peripheral system.			
	g) Demonstration at manufacturer's premises for functional/operational check and compatibility with breaker.			
	h) The necessary equipments for monitoring various parameters of circuit breaker termed as signature analysing shall be supplied along with all softwares, laptop computer, devices etc. with the breaker. The same shall be demonstrated at site on a fully assembled breaker.			
	All above maintenance equipments shall be demonstrated at site during handover.			
	Annexure-D			
	MANDATORY MONITORING EQUIPMENTS			
	1.0	Dew Point Meter		
	i)	The meter shall be capable of measuring the dew point of SF6 Gas of the Circuit Breaker/GIS equipment It should be portable and adequately protected for outdoor use. The meter shall be provided with dew point hygrometer with digital indication to display the dew point temperature in degree C. or PPM. It should be capable of measuring the corresponding pressure at which dew point is being measured.		
	The measurement and use of the instrument must be simple, direct without the use of any other material/chemical like dry ice/acetone etc. It should be battery operated with rechargeable batteries.			
	ii)	The equipments should have the following parameters		
	a.	Measuring range: Up to -100 degree C Dew Point		
	b.	Accuracy: + 2 degree C.		
	c.	Display: 4 digit LCD, inch. High		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 28 OF 97				


CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1299 114 1455 188" data-label="Image"> </div>		
2.0	<div data-bbox="344 219 1417 253" data-label="Section-Header"> PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR </div> <div data-bbox="264 288 1455 1910" data-label="List-Group"> <ul style="list-style-type: none"> i) The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs. ii) It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and VTs etc., with the hot sticks. iii) Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. iv) The equipments should have the following parameters: <ul style="list-style-type: none"> a) Measurement shall be possible in noisy environment. b) Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD. c) Environment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency. d) The equipment shall be battery operated with built-in battery charger. It shall also be suitable for 230V AVC/50 Hz input. e) Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer. f) Instrument shall be supplied with standard accessories i.e. connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50 Hz supply connecting cables (duly screened) to view in storage. Contractor shall provide adequate number of sensors in the offered GIS for detection of Partial discharge, the number and location of these sensor shall be subject to approval of the employer. g) The function of software shall cover the following : <ul style="list-style-type: none"> - Data recording, storage and retrival in computer </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 29 OF 97


CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
	<ul style="list-style-type: none"> - Data base analysis - Template analysis for easy location of fault inside the GIS - Evaluation of PD measurement i.e., Amplitude, Phase Synchronisation etc. - Evaluation of bouncing/loose particles with flight time and estimation on size of particle. - Report generation <p>h) To prove the suitability of working in charged switchyard condition, practical demonstration shall be conducted before acceptance.</p> <p>i) Supplier shall have “Adequate after sales service” facility in India.</p> <p>j) Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS.</p> <p>k) Instrument shall be robust and conform to relevant standard.</p> <p>l) Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of the employer. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.</p>		
3.00.00	CIRCUIT BREAKER		
3.01.00	GENERAL		
	<p>Circuit Breakers shall be metal enclosed SF6 gas insulated, single phase encapsulated for GIS and outdoor type S_f6 gas insulated for AIS, both comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to relevant standard.</p> <p>The controlled switching device for circuit breakers (as indicated in single line diagram) shall meet the requirements as specified in annexure-I.</p>		
3.02.00	DUTY REQUIREMENTS		
3.02.01	<p>Circuit breaker shall be restrike free under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 765/ 400/ 220/ 132kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily. The circuit breaker shall meet the requirements of C2/M2 type of duty as per IEC for 765kV & C2/ M1 type of duty as per IEC for 400kV, 220kV</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD <div data-bbox="1334 2029 1426 2085" data-label="Page-Footer"> PAGE 30 OF 97 </div>

CLAUSE NO.	<div data-bbox="595 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1455 188" data-label="Image"> </div>		
<div data-bbox="177 286 277 315" data-label="Text">3.02.02</div> <div data-bbox="177 555 277 584" data-label="Text">3.03.00</div> <div data-bbox="177 622 277 651" data-label="Text">3.03.01</div> <div data-bbox="177 723 277 752" data-label="Text">3.03.02</div> <div data-bbox="177 891 277 920" data-label="Text">3.04.00</div> <div data-bbox="177 958 277 987" data-label="Text">3.04.01</div> <div data-bbox="177 1025 277 1055" data-label="Text">3.04.02</div> <div data-bbox="177 1193 277 1223" data-label="Text">3.04.03</div> <div data-bbox="177 1294 277 1323" data-label="Text">3.05.00</div> <div data-bbox="177 1361 277 1391" data-label="Text">3.05.01</div> <div data-bbox="177 1496 277 1525" data-label="Text">3.05.02</div> <div data-bbox="177 1630 277 1659" data-label="Text">3.05.03</div>	<div data-bbox="341 219 464 248" data-label="Text">& 132kV.</div> <div data-bbox="341 286 1455 488" data-label="Text"> <p>The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.</p> </div> <div data-bbox="341 555 778 584" data-label="Section-Header"> CONSTRUCTIONAL FEATURES </div> <div data-bbox="341 622 1455 689" data-label="Text"> <p>All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically.</p> </div> <div data-bbox="341 723 1455 857" data-label="Text"> <p>Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.</p> </div> <div data-bbox="341 891 1153 920" data-label="Section-Header"> SULPHUR HEXAFLUORIDE (SF6) GAS CIRCUIT BREAKER </div> <div data-bbox="341 958 927 987" data-label="Text"> <p>Circuit breakers shall be single pressure type.</p> </div> <div data-bbox="341 1025 1455 1160" data-label="Text"> <p>Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes.</p> </div> <div data-bbox="341 1193 1455 1261" data-label="Text"> <p>Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.</p> </div> <div data-bbox="341 1294 702 1323" data-label="Section-Header"> OPERATING MECHANISM </div> <div data-bbox="341 1361 1455 1462" data-label="Text"> <p>Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.</p> </div> <div data-bbox="341 1496 1455 1597" data-label="Text"> <p>The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.</p> </div> <div data-bbox="341 1630 1455 1899" data-label="Text"> <p>The Spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.</p> </div>		
<div data-bbox="145 2018 603 2096" data-label="Page-Footer"> EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW) </div>	<div data-bbox="655 2018 967 2096" data-label="Page-Footer"> TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2 </div>	<div data-bbox="1066 2029 1270 2085" data-label="Page-Footer"> SUB-SECTION B-14 SWITCHYARD </div>	<div data-bbox="1337 2029 1430 2085" data-label="Page-Footer"> PAGE 31 OF 97 </div>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
3.05.04	The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.			
3.06.00	FITTINGS AND ACCESSORIES			
3.06.01	The insulators and terminal connectors shall conform to requirements stipulated elsewhere. All routine tests shall be conducted on the insulators as per relevant IEC.			
3.06.02	UNIT COMPRESSED AIR SYSTEM			
a)	The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves(if any), isolating valves, drain ports, etc. The air compressor shall be driven by automatically controlled motor. It shall be of air cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. Each compressor shall be equipped with a time totaliser.			
b)	The compressor size shall be such that it is capable of performing following operations satisfactorily :			
	i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations.			
	ii) Air charging time not exceeding 20 minutes after one CO operation of the breaker.			
c)	Air Receivers:			
	i) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker.			
	ii) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized.			
d)	Controls and Control Equipment:			
	i) The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided.			
	ii) All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.			
	iii) Facility to annunciate failure of power supply to the compressor control shall also be provided.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 32 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
e)	Compressed Air Piping, Valves and Fittings:			
	i) The flow capacity of all valves shall be at least 20% greater than the compressor capacity.			
	ii) The high pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes.			
	iii) All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless steel pipe (C-106 of BS: 2871).			
3.07.00	TESTS			
3.07.01	Type test			
	a) GIS circuit breaker shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.			
3.07.02	Routine Tests			
	Routine tests as per IEC on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers.			
3.07.03	SITE TESTS			
	All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.			
3.08.00	PARAMETERS			
3.08.01	General			
a)	Type of circuit breaker	SF6 insulated		
b)	Number of poles	Three (3)		
c)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO		
d)	Reclosing	Single and three phase high speed auto reclosing (as required)		
e)	Total closing time	Not more than 150 ms.		
f)	Maximum difference in the instants of closing/opening of contacts	As per IEC		
g)	Trip and closing coil voltage	220V DC		
h)	Auxiliary contacts	As required plus 10 NO and 10 NC contacts per breaker as spare. The contacts shall have continuous		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 33 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		
		rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V DC.	
	i) Noise level	Maximum 140dB at 50m distance from base of circuit breaker	
	j) Rated terminal load	Adequate to withstand 100kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.	
	k) Type of operating mechanism	Pneumatic/spring/hydraulic/or a combination of these	
3.08.02	765kV Class Circuit Breakers (GIS)		
	a) Rated voltage	800 kV rms	
	b) Rated continuous current	As per SLD	
	c) Rated short circuit breaking current at rated voltage	50kA with percentage of DC component as per IEC corresponding to minimum opening time under operating conditions specified.	
	d) Symmetrical interrupting Capability	50 kA rms	
	e) Short time current carrying Capability	50 kA rms for One (1) second	
	f) Short circuit making current Capability	125 kAp	
	g) Rated out-of-phase breaking	12.5 kA rms	
	h) Rated line charging breaking Current (voltage factor of 1.4)	900A at 90° C leading power factor with maximum permissible switching overvoltage of 2.0 pu.	
	i) Rated small inductive current Breaking capacity	Corresponding to interrupting steady and transient magnetising current of 1000 MVA transformers and 330MVar shunt reactor with overvoltage less than 2.0 pu	
	j) First pole to clear factor	1.3	
	k) Rated break time		
		i) 40 ms under test duties 2, 3 & 4 at rated values	
		ii) 45 ms under test duties 1 to 5 and short line fault test duties and combined variation of trip coil voltage, operating pressure and quenching media pressure, etc.	
	l) Rated one minute power	i) 960 kV rms between live terminals and earth.	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 34 OF 97


CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>		
	<p>frequency withstand voltage ii) 1270 kV rms across isolating distance.</p> <p>m) Rated lightning impulse withstand voltage i) ± 2100 kVp between live terminals and earth. ii) ± 2100 kVp impulse on one terminal and 455 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).</p> <p>n) Rated switching impulse withstand voltage i) ± 1550 kVp between live terminals and earth ii) ± 1175 kVp impulse on one terminal and 653 kVp power freq. voltage of opposite polarity on other terminal (across isolating distance).</p> <p>o) Max. radio interference voltage for 2500 Frequency between 0.5 MHz and 2MHz at 508kV rms (Micro volts) both in open and closed position</p> <p>p) Partial discharge level 5 Pico coulombs max.</p> <p>q) Pre Insertion Resistor Rating 450 ohms minimum with pre- insertion time of 9 (+1,-0) millisec. (if required)</p> <p>3.08.03 400kV Class Circuit Breakers (GIS)</p> <p>a) Rated voltage 420 kV rms</p> <p>b) Rated continuous current current capacity As per SLD</p> <p>c) Rated short circuit breaking current at rated voltage 50kA with percentage of DC component as per IEC corresponding to minimum opening time under operating conditions specified.</p> <p>d) Symmetrical interrupting Capability 50 kA rms</p> <p>e) Short time current carrying Capability 50 kA rms for One (1) second</p> <p>f) Short circuit making current Capability 125 kAp</p> <p>g) Rated out-of-phase breaking 12.5 kA rms</p> <p>h) Rated line charging breaking Current (voltage factor of 1.4) 600A at 90° C leading power factor with maximum permissible switching overvoltage of 2.3 pu.</p> <p>i) Rated small inductive current As per IEC</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 35 OF 97


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CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
	f)	Rated small inductive current Switching capability with over-voltage less than 2.3 p.u.	0.5 to 10 A
	g)	Interrupting capability of Transformer steady and transient magnetising current	upto 500 MVA
	h)	First pole to clear factor	1.3
	i)	Rated break time	60 ms
		Total break time	65 ms
	j)	Rated Insulation levels:	
	i)	Full wave impulse withstand voltage (1.2/50 micro sec.)	
		between line terminals and ground	± 1050 kV peak
		between terminals with circuit breaker open	± 1200 kV impulse on one terminal and other terminal earthed
	ii)	One minute power frequency dry and wet withstand voltage	
		between line terminals and ground	460 kV rms
		between terminals with circuit breaker open	530 kV rms
	k)	Max. radio interference voltage for Frequency between 0.5 MHz and 2 MHz at 156 kV rms (Micro volts) both in open and closed position	1000
	m)	Partial discharge level	5 Pico coulombs max.
3.08.05	132 kV Class Circuit Breakers (GIS):		
	a)	Rated voltage	145 kV, rms.
	b)	Rated continuous current at an ambient temperature of 50 ⁰ C	As per SLD
	c)	Symmetrical interrupting Capability	31.5 kA, rms.
	d)	Rated short circuit making current	80 kAp
	e)	Short time current carrying Capability for one second	31.5 kA, rms.
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 37 OF 97


CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
	<div data-bbox="277 248 1457 1771" data-label="List-Group"> <p>f) Out of phase breaking current Capacity 7.8 kA, rms.</p> <p>g) Rated line charging breaking current At 90° leading power factor angle (A, rms.) As per IEC (The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4 as per IEC-60271-100).</p> <p>h) Rated small inductive current Switching capability with over-voltage less than 2.3 p.u. 0.5 to 10 A</p> <p>i) Interrupting capability of Transformer steady and transient magnetising current up to 500 MVA</p> <p>j) First pole to clear factor 1.5</p> <p>k) Rated breaktime 60 ms</p> <p>l) Total breaktime 65 ms</p> <p>m) Rated Insulation levels : I) Full wave impulse withstand voltage (1.2/50 micro sec.) between line terminals and ground ± 650 kV peak between terminals with circuit breaker open ± 750 kV impulse on one terminal and other terminal earthed II) One minute power frequency dry and wet withstand voltage between line terminals and ground 275 kV rms between terminals with circuit breaker open 315 kV rms</p> <p>n) Max. radio interference voltage for Frequency between 0.5 MHz and 2MHz at 92kV rms (Micro volts) both in open and closed position 1000</p> <p>o) Partial discharge level 5 Pico coulombs max.</p> </div> <div data-bbox="1251 1839 1457 1872" data-label="Section-Header"> ANNEXURE-I </div> <div data-bbox="344 1924 1278 1957" data-label="Section-Header"> Requirement of Controlled Switching Device for Circuit Breaker </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 38 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>The circuit breaker with controlled switching as indicated in single line diagram shall meet the following requirement:</p> <ol style="list-style-type: none">1. The Switching controlled Device shall be used to reduce increased over voltages, re ignition between circuit breaker contacts that may be caused by normal switching of high voltage circuit breakers and hence optimize the stresses on circuit breaker while switching the circuit. The switching controlled device will be called device henceforth.2. The device shall be such that only switching commands (for operating purpose) are processed in the device. Open command triggered by protection on fault shall be forwarded directly to the breaker. In these cases switching instance is not controlled.3. Circuit breaker should be able to be switched while switching controlled device is not in operation e.g. during maintenance work or power supply is not connected, a bypass shall be provided to the device. In these cases the switching commands will then be forwarded directly to the circuit breaker via this Bypass. The switching time will not be controlled with these switching operations.4. The device shall have functions for switching ON & OFF the circuit breakers.5. The controller shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.6. The device shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command and optimize the switching behavior as necessary. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker.7. The device should have display facility at the front for the settings and measured values, alternatively a laptop shall be supplied with each CSD to facilitate display at the front for the setting and measured values.8. The device shall have self monitoring facility.9. The device shall be suitable for operation considering transient and dynamic state values of the current and voltage from the secondary of the CTs and CVTs10. During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. The control			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 39 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>switching device provided shall be networked to an Engineering work station (EWS) located in the switchyard control room. It shall be possible to extract the switching oscillographic records and also to do CSD parameterization from this EWS. All necessary software & hardware shall be in bidder's scope.</p>			
11.	<p>It shall have self monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm.</p>			
12.	<p>The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification.</p>			
13.	<p>The device shall have time setting resolution of 0.1 ms or better.</p>			
14.	<p>The device shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.</p>			
15.	<p>Supply of all the necessary accessories required for the successful operation of controlled switching device shall be in the scope of supplier of the device.</p>			
16.	<p>Test reports for the following type tests shall be submitted:</p> <ul style="list-style-type: none">a. Dielectric withstand test as per IEC 60255-27.b. High voltage Impulse test as per IEC 60255-27.c. Slow damped oscillatory wave test as per IEC60255-26d. Fast transient test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-4)e. Electrostatic Discharge test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-2)f. Surge Immunity test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-5)g. Power frequency magnetic field test as per IEC 60255-26 (class 5 installation as per base standard IEC 61000-4-8)h. Radiated radio frequency electromagnetic field test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-3)i. Conducted disturbance induced by radio frequency field as as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-6)j. Power frequency immunity test on binary input as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-16)			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 40 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.00.00	DISCONNECTOR			
4.01.00	GENERAL			
4.01.01	The isolators and accessories shall conform in general to relevant IEC 62271-102 (or equivalent Indian Standard) except to the extent explicitly modified in specification.			
4.01.02	Earth switches shall be provided on isolators as marked on SLD.			
4.01.03	The isolators and earth switches shall be A. C. motor operated.			
4.01.04	Complete disconnecter with all the necessary items for successful operation shall be supplied.			
4.02.00	DUTY REQUIREMENTS			
4.02.01	and thermal effects of the maximum possible short circuit current of the Isolators and earth switches shall be capable of withstanding the dynamic system in their closed position. They shall be constructed such that they do not open under influence of short circuit current, wind pressure and other mechanical loads together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.			
4.02.02	In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for 'DC' control scheme of the isolator as well as for AC/DC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised.			
4.02.03	The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.			
4.03.00	CONSTRUCTIONAL FEATURES (For GIS)			
a)	The three pole/ Single pole group operated disconnectors shall be operated by electric motor suitable for use on 220 V DC ungrounded system/415V AC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current & short circuit.			
b)	Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the capacitive charging currents during their opening and closing. They shall also be able to make & break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent restrikes			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 41 OF 97				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>and high local stresses caused by the transient recovery voltages when these currents are interrupted.</p> <p>c) The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.</p> <p>d) It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.</p> <p>e) The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.</p> <p>f) The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.</p> <p>g) Remote control of the disconnectors from the BCU in Relay room & power house control room shall be made through remote / local transfer switch.</p> <p>h) The disconnector operations shall be interlocked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.</p> <p>i) Each disconnector shall be supplied with auxiliary switch having eight normally open and eight normally closed contacts for use by others over and above those required for disconnector operation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts. Additionally MBB contact as required shall also be provided.</p> <p>j) The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.</p> <p>k) The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.</p> <p>l) All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.</p> <p>m) The auxiliary switches shall be capable of breaking at least 2 A in a 220-V DC circuit with a time constant of not less than 20 milliseconds.</p> <p>n) The disconnectors and safety grounding switches shall have a mechanical key (padlocking key) and electrical interlocks to prevent closing of the grounding</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 42 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS												
	<p>switches when disconnecter switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.</p> <p>o) The local control of the disconnecter and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.</p> <p>p) All electrical sequence interlocks will apply in both remote and local control modes.</p> <p>q) Each disconnecter shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the power house control room. The details of the inscriptions & colouring for the indicator are given as under:</p> <table><tr><td>Sign</td><td>Back ground</td><td>Colour</td></tr><tr><td>Open position</td><td>Open</td><td>Green</td></tr><tr><td>Closed position</td><td>Closed</td><td>Red</td></tr></table> <p>r) All the disconnecter and earth switches shall be provided with inspection window so that the travel of the switch contacts in both open and close positions can be verified by visual inspection.</p> <p>s) The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.</p> <p>t) The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.</p>				Sign	Back ground	Colour	Open position	Open	Green	Closed position	Closed	Red
Sign	Back ground	Colour											
Open position	Open	Green											
Closed position	Closed	Red											
4.04.00	SAFETY GROUNDING SWITCHES												
	<p>a) Three-pole/ Single pole, group operated, safety grounding switches shall be operated by electric motor for use on 220V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.</p> <p>b) In order to provide test facilities for CTs, transformers, cables etc., certain ground switches may require to be electrically insulated from the enclosures and have easily removable ground connections.</p> <p>c) Each safety grounding switch shall be electrically interlocked with its associated disconnecter and circuit breaker such that it can only be closed if both the circuit breaker and disconnecter are in open position. Safety grounding switch shall however be mechanically key interlocked with its associated disconnecter.</p> <p>d) Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Power House Control Room.</p>												
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 43 OF 97									

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
e)	The details of the inscription and colouring for the indicator are given as under:			
	Sign	Background	Colour	
	Open position	Open	Green	
	Closed position	Closed	Red	
f)	Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.			
g)	Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.			
h)	Provision shall be made for padlocking the ground switches in either the open or closed position.			
i)	All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 50 mm2.			
j)	The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 1 s and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.			
k)	The safety grounding switches shall conform to the requirements of IEC 62271-102			
l)	Mechanical position indication shall be provided locally at each switch along with remote indication at each bay module control cabinet & in the power house control room.			
4.05.00	HIGH SPEED GROUNDING SWITCHES			
a)	Grounding switches located at the beginning of the Feeder bay modules shall be of the high-speed and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall also be capable of interrupting the inductive currents and to withstand the associated TRV.			
b)	Single phase switches shall be provided with individual/group operated mechanism operating mechanism for each phase suitable for operation from a 220V DC ungrounded supply.			
c)	The switches shall be fitted with a stored energy closing system to provide fault making capability.			
d)	The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125KA. The switches shall have inductive / capacitive current switching capability as per IEC-62271-102.			
e)	Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 44 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>									
	<p>module control cabinet and provision for taking the signal to Power House Control Room.</p>												
f)	<p>The details of the inscription & coloring for the indicator shall be as under:</p> <table><tr><td>Sign</td><td>Background</td><td>Colour</td></tr><tr><td>Open position</td><td>Open</td><td>Green</td></tr><tr><td>Closed position</td><td>Closed</td><td>Red</td></tr></table>				Sign	Background	Colour	Open position	Open	Green	Closed position	Closed	Red
Sign	Background	Colour											
Open position	Open	Green											
Closed position	Closed	Red											
g)	<p>High-speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the relay room & power house control room in conjunction with opening of the associated disconnecter.</p>												
h)	<p>These high-speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches can not be closed if the circuit breakers and disconnectors are closed.</p>												
i)	<p>Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.</p>												
j)	<p>Each high speed ground switch shall be fitted with auxiliary switches having six normally open(NO) and six normally closed (NC) auxiliary contacts for use by others, over and above those required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the grounding switches in either the open or closed position.</p>												
k)	<p>All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing flexible copper conductor having minimum cross-sectional area of 50 sq mm.</p>												
l)	<p>The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.</p>												
m)	<p>The high speed grounding switches shall conform to the requirements of IEC-62271-102.</p>												
4.06.00	CONSTRUCTIONAL FEATURES (For AIS)												
a)	<p>The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surfaces shall be silver plated. The thickness of silver plating wherever provided should not be less than 25 microns.</p>												
b)	<p>The isolator shall be provided with a galvanised steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level.</p>												
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD									
				PAGE 45 OF 97									


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
c)	All metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities, if provided on current carrying parts, shall be made of copper silicon alloy or equivalent. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces.			
d)	The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals.			
e)	The insulator of the isolator shall conform to the requirements stipulated elsewhere and shall have a min. cantilever strength of 800 kg for 400 kV isolator.			
4.07.00	EARTHING SWITCHES (For AIS) Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructional interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa.			
4.08.00	OPERATING MECHANISM AND CONTROL (For AIS)			
4.08.01	The Contractor shall offer, motor operated switches having padlock arrangement for both 'ON' and 'OFF' positions.			
4.08.02	Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches.			
4.08.03	It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.			
4.08.04	Control cabinet/operating mech. box shall conform to requirements stipulated under auxiliary part and IS:5039/IS 8623/IEC 60439 as applicable.			
4.09.00	OPERATION (For AIS)			
4.09.01	Isolator shall be electrically/mechanically gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.			
4.09.02	The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 46 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.09.03	The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch.		
4.10.00	TESTS		
4.10.01	The GIS disconnecter shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.		
4.10.02	In continuation to the requirements stipulated under clause no.1.06.01 the isolator along with operating mechanism (AIS) shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC 62271-102. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator of each type assembled completely with all accessories as acceptance test. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close.		
4.10.03	The insulator (AIS) shall conform to all the type tests as per IEC 60168. In addition to all type, routine and acceptance tests, as per IEC-60168, the following additional routine/ acceptance tests shall also be carried out:		
	a)	Bending load test in four directions at 50% min. bending load guaranteed in all insulators.	
	b)	Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot.	
	c)	Torsional test on sample insulator of a lot.	
4.11.00	PARAMETERS		
4.11.01	General		
	a)	Type of isolator	Metal enclosed, SF6 Gas Insulated (For GIS) Outdoor type (For AIS)
	b)	Number of poles	Three (3)
	d)	Operating time	Not more than 12 sec.
	e)	Control voltage	220V DC
	f)	Auxiliary contacts on Isolator	Minimum 8NO and 8NC contacts per pole/isolator shall be provided. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V dc. Additionally MBB contacts as required shall also be provided.
	g)	Auxiliary contacts on earth switch/ safety grounding switch/high speed	Total 6NO and 6NC
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 47 OF 97

CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>		
	<p>fault making switch</p> <p>h) Rated mechanical terminal load As per table III of IEC 62271-102 (For AIS)</p> <p>i) Temperature rise over ambient As per IEC:62271-102</p> <p>j) Operating mechanism of isolator and earth switch AC/DC/Universal motor operated</p> <p>4.11.02 765kV Class Isolators (GIS)</p> <p>a) Rated voltage 800 kV rms</p> <p>b) Rated continuous current As per SLD</p> <p>c) Rated short time withstand current of isolator and earthswitch 50 kA rms for One (1) second</p> <p>d) Rated dynamic short circuit withstand current of isolator and earthswitch 125 kAp</p> <p>e) Rated Insulation levels</p> <p>i. Rated one minute power Frequency withstand voltage i) 960 kV rms between live terminals and earth. ii) 1270 kV rms across isolating distance.</p> <p>ii. Rated lightning impulse Withstand voltage i) ± 2100 kVp between live terminals and earth. ii) ± 2100 kVp impulse on one terminal and 455 kVp power freq. Voltage of opposite polarity on other terminal (across isolating distance).</p> <p>iii. Rated switching impulse Withstand voltage i) ± 1550 kVp between live terminals and earth. ii) ± 1175 kVp impulse on one terminal and 650 kVp power freq.voltage of opposite polarity on other terminal (across isolating distance).</p> <p>f) Max. Radio interference voltage 2500 micro volts for freq. between 0.5 MHz and 2.0 MHz at voltage 508kV rms.</p> <p>g) Partial discharge level at $1.1 U_n/\sqrt{3}$ 5 pico coulombs</p> <p>4.11.03 400kV Class Isolators (GIS)</p> <p>a) Rated voltage 420 kV rms</p> <p>b) Rated continuous current As per SLD</p> <p>c) Rated short time withstand current of isolator and earth switch 50 kA rms for One (1) second</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 48 OF 97

CLAUSE NO.	<div> <div>एनटीपीसी</div> <div>NTPC</div> </div> TECHNICAL REQUIREMENTS		
	<div> <div>d) Rated dynamic short circuit withstand 125 kAp current of isolator and earth switch</div> <div>e) Rated Insulation levels</div> <div> <div>i. Rated one minute power Frequency withstand voltage</div> <div>i) 650 kV rms between phase to earth & between phases.</div> <div>ii) 815 kV rms across isolating distance and/or open switching device</div> </div> <div> <div>ii. Rated lightning impulse Withstand voltage</div> <div>i) ±1425 kVp between live terminals and earth.</div> <div>ii) ± 1425 kVp impulse on one terminal and 240 kVp power freq. Voltage of opposite polarity on other terminal (across isolating distance).</div> </div> <div> <div>iii. Rated switching impulse Withstand voltage</div> <div>i) ± 1050 kVp between live terminals and earth.</div> <div>ii) ± 900 kVp impulse on one terminal and 345 kVp power freq.voltage of opposite polarity on other terminal (across isolating distance).</div> </div> <div>f) Partial discharge level at 1.1 Un/√3 5 pico coulombs</div> </div> <div> <div>4.11.04 220 kV ISOLATORS (GIS) :</div> <div> <div>a) Normal system voltage 220 kV</div> <div>b) Highest system voltage 245 kV</div> <div>c) Rated current at 50° C ambient Temperature As per SLD</div> <div>d) Rated short time withstand Current of isolator and earth switch 40kArms for 1 sec.</div> <div>e) Rated dynamic short circuit withstand Current of isolator and earth switch 100 kA (Peak)</div> <div>f) Rated insulation levels:</div> <div> <div>1.2/50 micro sec. lightning impulse withstand voltage (+ ve or – ve polarity) impulse on one terminal and other terminal earthed</div> <div>One minute power frequency withstand voltage (Between live terminal and earth)</div> </div> <div> <div>To earth ± 1050 kV (Peak)</div> <div>460 kV (rms)</div> </div> </div> </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 49 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी</div> <div>NTPC</div>
	Across isolating distance	± 1200 kV peak	530 kV (rms)	
	g) Max. Radio interference voltage	1000 micro volts for frequency between 0.5 MHz to 2.0 MHz at 156 kV (rms)		
	h) Partial discharge level at 1.1 Un/√3	5 pico coulombs		
4.11.05	132 kV Class Isolators (GIS):			
	a) Normal system voltage	132 kV		
	b) Highest system voltage	145 kV		
	c) Rated current at 50° C ambient Temperature	As per SLD		
	d) Rated short time withstand Current of disconnector/isolator and earth switch	31.5 kA for 1 sec.		
	e) Rated dynamic short circuit withstand Current of disconnector/isolator and earth switch	80 kA (Peak)		
	f) Rated insulation levels :			
		1.2/50 micro sec lightning impulse withstand voltage	One minute over frequency withstand voltage (Between live terminal and earth)	
		(÷ve or ÷ve polarity) (impulse on one terminal and Other terminal earthed)		
	To earth	± 650 kV (Peak)	275 kV (rms)	
	Across isolating distance	± 750 kV (Peak)	315 kV (rms)	
	g) Radio interference level for 0.5 MHz to 2.0 MHz	1000 microvolts (Max.) at 92 kV (rms) between phase and ground		
	h) Partial discharge level at 1.1 Un/√3	5 pico coulombs		
4.11.06	33 kV Class Isolators (AIS):			
	a) Rated voltage	36kV rms		
	b) Rated continuous current	AS per SLD		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 50 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	c)	Rated short time withstand current of isolator and earthswitch	25 kA rms for One (1) second
	d)	Rated dynamic short circuit withstand current of isolator and earthswitch	62.5 kAp
	e)	Rated Insulation levels	
	i.	Rated one minute power Frequency withstand Voltage (dry & wet)	70 kV rms
	ii.	Rated lightning impulse Withstand voltage	± 170 kVp
	f)	Minimum total creepage distance (mm)	1260
5.00.00	INSTRUMENT TRANSFORMER		
5.01.00	CODES AND STANDARDS		
	Current transformers	IEC 61869-2, BS: 3938, IS: 2705	
	Voltage transformers	IEC 60044-2&5, IEC 60358, IS: 3156	
	Insulating oil	IS: 335	
5.02.00	GENERAL REQUIREMENTS (FOR GIS)		
	a)	The current transformers and accessories shall conform to IEC-61869-2 and other relevant standards except to the extent explicitly mentioned in the specification.	
	b)	The instrument transformers i.e. current and voltage transformers shall be single phase transformer units.	
	c)	Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.	
	d)	The particulars of the various cores are given here for tender purpose and may change within reasonable limits as per the requirements of protection relays. The contractor is required to submit the VA burden calculations and obtain approval from the Employer before proceeding with design of the cores. The other characteristics of CTs shall be as given below:	
5.03.00	PARAMETERS AND CONSTRUCTION DETAILS (GIS)		
5.03.01	GENERAL FOR CURRENT TRANSFORMER (GIS)		
	(a)	One minute power frequency Withstand voltage between Secondary terminal and earth	5 kV
	(b)	Partial discharge level	10 pico Coulombs max.
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 51 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
	(c)	Temperature rise	As per IEC
	(d)	Type of insulation	Class A
	(e)	Number of cores	Details are given in table below
	(f)	Rated frequency	50 Hz
	(g)	System neutral earthing	Effectively earthed
	(h)	Number of terminals in box	All terminals of control circuits wired marshalling up to marshalling box plus 20 terminals spare.
	(i)	Rated extended primary current	120% of rated primary current
5.03.02(a)	765 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	125 kA (peak)
	(b)	Rated short time thermal current	50 kA for 1 sec.
	(c)	Rated system voltage (Um)	800 kV (rms)
5.03.02 (b)	400 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	125 kA (peak)
	(b)	Rated short time thermal current	50 kA for 1 sec.
	(c)	Rated system voltage (Um)	420 kV (rms)
5.03.02 (c)	220 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	100 kA (peak)
	(b)	Rated short time thermal current	40 kA for 1 sec.
	(c)	Rated system voltage (Um)	245 kV (rms)
5.03.02(d)	132 kV Current Transformers (GIS)		
	(a)	Rated dynamic current	80 kA (peak)
	(b)	Rated short time thermal current	31.5 kA for 1 sec.
	(c)	Rated system voltage (Um)	145 kV (rms)
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 52 OF 97

CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1299 114 1457 188" data-label="Image"> </div>		
5.03.03	<div data-bbox="344 219 636 253" data-label="Section-Header"> Construction Details </div> <div data-bbox="264 282 1457 1346" data-label="List-Group"> <ul style="list-style-type: none"> a) The current transformers incorporated into the GIS will be used for protective relaying and metering. The secondary windings shall be air/gas insulated. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star / delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle. c) Rating and Diagram Plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate. The diagram plate shall show the terminal markings and relative physical arrangement of the current transformer cores with respect to the primary terminals(P1 & P2) d) The position of each primary terminal in the current transformer SF₆ gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer. e) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. f) The current transformers shall be suitable for high speed auto reclosing. g) Electro magnetic shields to be provided against high frequency transients typically 1-30 MHz. h) The wiring between each CT and bay module control cabinet shall be included in the scope of supply. i) Provision shall be made for primary current injection testing of current transformers. </div>		
5.04.00	<div data-bbox="344 1375 896 1411" data-label="Section-Header"> BUS VOLTAGE TRANSFORMERS (GIS) </div>		
5.04.01	<div data-bbox="344 1442 458 1476" data-label="Section-Header"> General </div> <div data-bbox="264 1507 1457 1973" data-label="List-Group"> <ul style="list-style-type: none"> a) The voltage transformers and accessories shall conform to IEC and other relevant standards except to the extent explicitly mentioned in the specification. b) Voltage transformers shall be of the electro magnetic type with SF₆ gas insulation. The earth end of high voltage winding and the ends of secondary winding shall be brought out in the terminal box. c) The rating and diagram plate shall be provided complying with the requirement of IEC specification incorporating the year of manufacture and including turn's ratio, voltage ratio, burden, connection diagram etc. d) The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of SF₆ switchgear. </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE -I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 53 OF 97

CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
e) f) g)	<p>All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.</p> <p>The transformer shall be able to sustain full line voltage without saturation of transformer.</p> <p>Core details are given in table.</p>		
5.04.03	Constructional Details <p>a) The voltage transformers shall be located in a separate bay module on the bus and will be connected phase-to ground and shall be used for protection, metering and synchronizing</p> <p>b) The voltage transformers shall be of induction type, nonresistant and shall be contained in their own- SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have three secondary windings.</p> <p>The voltage transformer secondaries shall be wired by Contractor to their associated bay control cabinets</p>		
5.05.00 5.05.01 5.05.02 5.05.03 5.05.04 5.05.05 5.05.06 5.06.00 5.06.01 5.06.02 5.06.03	GENERAL REQUIREMENTS (For AIS) <p>The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units.</p> <p>All exposed mild steel shall be hot dip galvanised or painted with Grey color of shade RAL 9002.</p> <p>The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.</p> <p>Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.</p> <p>The insulators shall have a cantilever strength of more than 500 kg.</p> <p>No oil shall come into direct contact with Zinc galvanized surface.</p> CURRENT TRANSFORMERS (For AIS) <p>The CTs shall have single primary of either ring type or hair pin type or bar type.</p> <p>The CT shall be provided with oil level indicator which should be clearly visible to maintenance personnel standing on ground.</p> <p>The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 54 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
	transient conditions at all ratios with specified parameters. The CTs shall be suitable for high speed auto-reclosing.		
5.06.04	Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.		
5.06.05	The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.		
5.06.06	The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.		
5.06.07	The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below.		
5.06.08	The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT.		
5.06.09	The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.		
5.06.10	The CT shall have provision for measurement of capacitance and tan delta as erected at site.		
5.07.00	VOLTAGE TRANSFORMERS (CVTs) (AIS)		
5.07.01	Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.		
5.07.02	The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens.		
5.07.03	The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.		
5.07.04	The secondaries shall be protected by HRC cartridge type fuses for all windings In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.		
5.07.05	The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 55 OF 97


CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
5.08.00	MARSHALLING BOX		
5.08.01	Marshaling box shall conform to all requirements as given in part auxiliary. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.		
5.09.00	PARAMETERS FOR CURRENT TRANSFORMERS (For AIS)		
5.09.01	General Parameters		
	<div data-bbox="272 656 1366 1227" data-label="List-Group"> <ul style="list-style-type: none"> a) One minute power frequency withstand voltage between secondary terminal and earth 5 kV b) Partial discharge level 10 pico Coulombs max. c) Temperature rise As per IEC d) Type of insulation Class A e) Number of cores Details are given in table below. f) Installation Outdoor (up right) g) Number of terminals in marshalling box All terminals of control circuits wired upto marshalling box plus 20 terminals spare. </div>		
5.09.02	33 kV Current Transformers (Oil filled type) (For AIS)		
	a) Highest System Voltage 36 kV		
	b) Rated short time thermal current 25 kA for 1 sec.		
	c) Rated dynamic current 62.5kA (Peak)		
	d) Rated insulation level :		
	<div data-bbox="312 1559 994 1619" data-label="Text"> i) 1.2/50 micro seconds (impulse voltage) 170 kV (Peak) </div>		
	<div data-bbox="312 1619 970 1709" data-label="Text"> ii) 1 minute (dry and wet) power frequency withstand voltage 70 kV (rms) </div>		
	e) Rated extended primary current 120% of rated primary current as per SLD		
	f) Minimum total creepage distance (mm) 1260		
5.10.00	PARAMETERS FOR VOLTAGE TRANSFORMERS (FOR AIS)		
5.10.01	General Parameters		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	<div data-bbox="1062 2029 1270 2085" data-label="Page-Footer"> SUB-SECTION B-14 SWITCHYARD </div> <div data-bbox="1334 2029 1430 2085" data-label="Page-Footer"> PAGE 56 OF 97 </div>


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	a) Installation	Outdoor	
	b) Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement.	
	c) High frequency capacitance for frequency range	Within 80% to 150% of rated entire carrier capacitance	
	d) Equivalent resistance over entire carrier frequency range	Less than 40 ohms	
	e) Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:60358	
	f) One minute power frequency withstand voltage		
	a) between LV (HF) terminal	10kV rms(for 400kV) and earth for exposed terminals or 4 kV rms (for 400kV) for terminals enclosed in a weather proof box.	
	b) For secondary winding	2 kV rms	
	g) Temp. rise over an ambient temp. of 50 deg. C	As per IEC	
	h) Number of terminals in control Cabinet	All terminals of control circuits wired upto marshalling box plus 10 terminals spare.	
	i) Rated total thermal burden	750 VA	
	j) Partial discharge level	10 pico Coulombs max.	
	k) Number of cores	As per details given in Tables below.	
	l) Rated Voltage factor	1.2 continuous, 1.5 – 30sec	
	m) Minimum total creepage distance (mm)	28000/ 14700/ 8575 for 765kV/ 400kV/ 220kV respectively.	
5.10.02	765 kV CVT (AIS)		
	a) Rated system voltage	800 kV (rms)	
	b) Rated insulation levels		
	i) One minute power frequency withstand voltage	975kV rms	
	ii) 1.2/ 50 micro sec. impulse	2100kV (peak)	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 57 OF 97


CLAUSE NO.	<div data-bbox="1305 114 1455 190">एनटीपीसी NTPC</div> TECHNICAL REQUIREMENTS		
	<div data-bbox="325 219 1465 1962"> <div> <div>ii) 250/2500 micro sec. switching surge withstand voltage (dry & wet)</div> <div>1550 kV (peak)</div> </div> <div> <div>c) Radio Interference voltage at 508 kV at frequency range 0.5 to 2 MHz(rms)</div> <div>2500 micro volts (max.)</div> </div> <div> <div>d) Corona extinction voltage (min.)</div> <div>508 kV (rms)</div> </div> <div> <div>e) HF Capacitance</div> <div>4400 pf / 8800pf (nominal)</div> </div> <div> <div>5.10.03 400kV CVT (AIS)</div> <div> <div>a) Rated system voltage</div> <div>420 kV (rms)</div> </div> <div> <div>b) Rated insulation levels</div> <div> <div>i) One minute power frequency withstand voltage</div> <div>630kV rms</div> <div>ii) 1.2/ 50 micro sec. impulse</div> <div>1425kV (peak)</div> <div>ii) 250/2500 micro sec. switching surge withstand voltage (dry & wet)</div> <div>1050 kV (peak)</div> </div> <div> <div>c) Radio Interference voltage at 266 kV at frequency range 0.5 to 2 MHz(rms)</div> <div>1000 micro volts (max.)</div> </div> <div> <div>d) Corona extinction voltage (min.)</div> <div>320 kV (rms)</div> </div> <div> <div>e) HF Capacitance</div> <div>4400 pf / 8800pf (nominal)</div> </div> </div> <div> <div>5.10.04 220 kV CVT (AIS)</div> <div> <div>a) Rated system voltage</div> <div>245 kV (rms)</div> </div> <div> <div>b) Rated insulation levels</div> <div> <div>i) One minute power frequency withstand voltage</div> <div>460kV rms</div> <div>ii) 1.2/ 50 micro sec. impulse</div> <div>1050kV (peak)</div> </div> <div> <div>c) Radio Interference voltage at 156 kV at frequency range 0.5 to 2 MHz(rms)</div> <div>1000 micro volts (max.)</div> </div> <div> <div>d) HF Capacitance</div> <div>4400 pf / 8800pf (nominal)</div> </div> </div> </div> </div></div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 58 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
5.10.04	TESTS <p>a) GIS Instrument transformer shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.</p> <p>b) The current and voltage transformers (For AIS) shall confirm to type tests and subjected to routine tests in accordance with the relevant IEC/IS and shall also conform to the following additional type tests as applicable:</p> <div><div>i)</div>Radio Interference voltage test</div> <div><div>ii)</div>Corona test (for 765kV & 400kV)</div> <div><div>iii)</div>Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit. (for CT only)</div> <div><div>iv)</div>Seismic withstand test along with structure (for 765kV & 400kV only)</div> <div><div>v)</div>Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only)</div> <div><div>vi)</div>Multiple chopped impulse test on Primary winding.</div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 59 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS							
	CORE DETAILS							
	CORE DETAILS OF 765kV CTs – 3000A (Set - 1)						TABLE – IA	
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Bus Differential	3000/ 2000/ 1000/500/1	-----	PS	3000/2000/1000/500V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120
	2	Bus Differential	3000/ 2000/ 1000/500/1	-----	PS	3000/2000/1000/500V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120
	CORE DETAILS OF 765kV CTs – 3000A (Set - 2)						TABLE – IB	
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Metering & Synchronising.	3000/ 2000/ 1000/ 500/1	20 / 20 / 20 / 20	0.2S	-----	-----	-----
	2	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	4500/3000/1500/ 750V	15/ 8/ 4/ 2 Ohm	20/ 30/ 60/ 120
	3	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	4500/3000/1500/ 750V	15/ 8/ 4/ 2 Ohm	20/ 30/ 60/ 120
ISF for metering core should be less than 10. The rated extended primary current of the CTs shall be 120% continuous of 3000A.Physical arrangement of CTs shall be as per Protection SLD.								
CORE DETAILS OF 765kV VTs (GIS)						TABLE – II		
Secondary Winding		Application	Rated Voltage (V)	Secondary Accuracy		Rated Burden (min)	Secondary VA*	
I		Protection	110/v3		3P	50 VA		
II		Protection	110/v3		3P	50 VA		
III		Metering	110/v3		0.2	50 VA		
The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 75 VA on all the three windings without any adjustments during operation.								
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)			TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2			SUB-SECTION B-14 SWITCHYARD		PAGE 60 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS								
	<p>* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.</p>								
	CORE DETAILS OF 7650kV CVTs (AIS)						TABLE – III		
	Secondary Core	Application	Rated Voltage (V)		Secondary Accuracy	Output Minimum	Burden –		
	I	Protection	110/v3		3P	50 VA			
	II	Protection	110/v3		3P	50 VA			
	III	Metering	110/v3		0.2	50 VA			
	The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 75 VA on all the three windings without any adjustments during operation.								
	CORE DETAILS OF 400kV CTs – 3000A (Set - 1)						TABLE – IVA		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	
	1	Bus Differential	3000/ 2000/ 1000/1	-----	PS	3000/2000/1000V	15/ 10/ 5 Ohm	20/ 30/ 60	
	2	Bus Differential	3000/ 2000/ 1000/1	-----	PS	3000/2000/1000V	15/ 10/ 5 Ohm	20/ 30/ 60	
	CORE DETAILS OF 400kV CTs – 3000A (Set - 2)						TABLE – IVB		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	
	1	Metering & Synchronising.	3000/ 2000/ 1000/ 500/1	20 / 20 / 20 / 20	0.2S	-----	-----	-----	
	2	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	6000/4000/2000/ 1000V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120	
	3	Transf. backup/ Line Protection	3000/ 2000/ 1000/ 500/1	-----	PS	6000/4000/2000/ 1000V	15/ 10/ 5/ 2.5 Ohm	20/ 30/ 60/ 120	
	ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 3000A.Physical arrangement of CTs shall be as per Protection SLD.								
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)			TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2			SUB-SECTION B-14 SWITCHYARD		PAGE 61 OF 97	

CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>							
	CORE DETAILS OF 400kV VTs (GIS)					TABLE -V		
	Secondary Winding	Application	Rated Voltage (V)	Secondary Accuracy		Rated Burden (min) VA*	Secondary	
	I	Protection	110/v3		3P	75 VA		
	II	Protection	110/v3		3P	75 VA		
	III	Metering	110/v3		0.2	75 VA		
	The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.							
	* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.							
	CORE DETAILS OF 400kV CVTs (AIS)					TABLE - VI		
	Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy		Output Burden – Minimum		
	I	Protection	110/v3		3P	75 VA		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	CORE DETAILS OF 220kV CTs – 1600A (Set - 1)					TABLE – VIIA		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Bus Differential	1600/ 800/1	-----	PS	1600/800 V	8/ 4 Ohm	30/ 60
	2	Bus Differential	1600/ 800/1	-----	PS	1600/800 V	8/ 4 Ohm	30/ 60
	CORE DETAILS OF 220kV CTs – 1600A (Set - 2)					TABLE – VIIB		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Metering & Synchronising.	1600/ 800/ 400/200/1	20 / 20 / 20/ 20	0.2S	-----	-----	-----
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2			SUB-SECTION B-14 SWITCHYARD		PAGE 62 OF 97	

CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>							
	2	Transf. backup/ Line Protection	1600/ 800/ 400/ 200/1	-----	PS	3200/ 1600/800 /400V	8/ 4/ 2/ 1 Ohm	30/ 60/ 120/ 240
	3	Transf. backup/ Line Protection	1600/ 800/ 400/ 200/1	-----	PS	3200/ 1600/800 /400V	8/ 4/ 2/ 1 Ohm	30/ 60/ 120/ 240
	ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 1600A.Physical arrangement of CTs shall be as per Protection SLD.							
	CORE DETAILS OF 220kV CTs - 2500A (Set - 1) For Bus Section/Bus Coupler Bays						TABLE - VIIIA	
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Bus Differential	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
	2	Bus Differential	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
	CORE DETAILS OF 220kV CTs - 2500A (Set - 2) For Bus Section/Bus Coupler Bays							
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
	1	Metering & Synchronising.	2500/ 1250/1	20/ 20	0.2S	-----	-----	-----
	2	Transf. backup/ Line Protection	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
	3	Transf. backup/ Line Protection	2500/ 1250/1	-----	PS	2500/125 0V	12.5/ 6.25 Ohm	30/ 60
	ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 2500A.Physical arrangement of CTs shall be as per Protection SLD.							
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)				TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD		PAGE 63 OF 97

CORE DETAILS OF 132kV CTs – 1200A (Set - 2)						TABLE – XIB	
CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	Metering & Synchronising.	1200/ 600/ 300/1	20 / 20 / 20	0.2S	-----	-----	-----

CLAUSE NO.	TECHNICAL REQUIREMENTS								
	2	Transf. backup/ Line Protection	1200/ 600/ 300/1	-----	PS	1200/ 600/300V	6/ 3/ 1.5 Ohm	30/ 60/ 120	
	3	Transf. backup/ Line Protection	1200/ 600/ 300/1	-----	PS	1200/ 600/300V	6/ 3/ 1.5 Ohm	30/ 60/ 120	
	ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 1200A.Physical arrangement of CTs shall be as per Protection SLD.								
	CORE DETAILS OF 132kV CTs – 2000A (Set - 1) For Bus Section/ Bus Coupler Bays						TABLE – XIIA		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	
	1	Bus Differential	2000/ 1000/1	-----	PS	2000/100 0V	10/ 5 Ohm	30/ 60	
	2	Bus Differential	2000/ 1000/1	-----	PS	2000/100 0V	10/ 5 Ohm	30/ 60	
	CORE DETAILS OF 132kV CTs – 2000A (Set - 2) For Bus Section/ Bus Coupler Bays						TABLE – XIIB		
	CT No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	
	1	Metering & Synchronising.	2000/ 1000/ 500/1	20 / 20 / 20	0.2S	-----	-----	-----	
2	Transf. backup/ Line Protection	2000/ 1000/ 500/1	-----	PS	2000/ 1000/ 500/V	10/ 5/ 2.5 Ohm	30/ 60/ 120		
3	Transf. backup/ Line Protection	2000/ 1000/ 500/1	-----	PS	2000/ 1000/ 500/V	10/ 5/ 2.5 Ohm	30/ 60/ 120		
ISF for metering core should be less than 5. The rated extended primary current of the CTs shall be 120% continuous of 2000A.Physical arrangement of CTs shall be as per Protection SLD.									
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)			TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2			SUB-SECTION B-14 SWITCHYARD		PAGE 65 OF 97	

CLAUSE NO.	TECHNICAL REQUIREMENTS										<div>एनटीपीसी NTPC</div>
6.00.00	CORE DETAILS OF 132kV VTs (GIS)							TABLE –XIII			
	Secondary Winding		Application	Rated Voltage (V)		Secondary	Accuracy	Rated Burden (min)		Secondary VA*	
	I		Protection	110/v3			3P	75 VA			
	II		Protection	110/v3			3P	75 VA			
	III		Metering	110/v3			0.2	75 VA			
	The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.										
	* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.										
	CORE DETAILS OF 132kV CVTs (AIS)							TABLE – XIV			
	Secondary Core		Application	Rated Voltage (V)		Secondary	Accuracy	Output Burden – Minimum			
	I		Protection	110/v3			3P	75 VA			
	II		Protection	110/v3			3P	75 VA			
	III		Metering	110/v3			0.2	75 VA			
	The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.										
	CORE DETAILS OF 33kV CT										TABLE – XV
	CT No.	Core No.	Application	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk		
1	1	Tie HV REF	1000/ 1	-----	PS	1000V	5	30			
2	1	Tie LV REF	2000/ 1	-----	PS	2000V	10	30			
	2	Tie BACKUP E/F	2000/ 1	15	5P20	-----	-----	-----			
Note: The rated extended primary current of the CTs shall be 120% continuous of rated current.											
6.00.00	SURGE ARRESTOR										
6.01.00	GENERAL										
6.01.01	The surge arrestors shall conform in general to IEC-60099-4 and IS: 3070 except to the extent modified in the specification.										
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)			TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2			SUB-SECTION B-14 SWITCHYARD		PAGE 66 OF 97			

CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
6.01.02	Arrestors shall be hermetically sealed units, self supporting construction, suitable for mounting on lattice/tubular type support structures.		
6.02.00	DUTY REQUIREMENTS		
6.02.01	The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines.		
6.02.02	The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.		
6.02.03	The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.		
6.03.00	CONSTRUCTIONAL FEATURES (FOR AIS)		
6.03.01	Each Surge Arrester (SA) shall be hermetically sealed single phase unit.		
6.03.02	The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties.		
6.03.03	SAs shall have pressure relief devices and arc diverting ports suitable for preventing shattering of porcelain housing and to provide path for flow of rated fault currents in the event of SA failure.		
6.03.04	The SA shall not fail due to porcelain contamination.		
6.03.05	Seals shall be effectively maintained even when SA discharges rated lightning current.		
6.03.06	Porcelain shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto maximum design value for SA. The cantilever strength of the insulator shall be minimum 500kg.		
6.03.07	The end fittings shall be non-magnetic and of corrosion proof material. The metal flanges shall be fixed with the porcelain by cement or other materials so as to withstand the forces experienced in normal operation and provide continuous sealing for entry of moisture for a period of minimum 20 years.		
6.04.00	CONSTRUCTIONAL FEATURES FOR GAS INSULATED SURGE ARRESTOR		
	a) It will be SF6 gas insulated, metal enclosed surge arrester of the gapless non linear zinc oxide, heavy duty, station type.		
	b) The arrester enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear and shall be fitted with a discharge counter located in an easily accessible position.		
	c) The main grounding connection from the surge arrester to the earth shall be provided by the Contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 67 OF 97

CLAUSE NO.	<div data-bbox="592 147 1011 181" data-label="Section-Header"> TECHNICAL REQUIREMENTS </div> <div data-bbox="1302 114 1457 188" data-label="Image"> </div>		
6.05.00	FITTINGS AND ACCESSORIES FOR AIS		
6.05.01	Each SA shall be complete with insulating base for mounting on structure.		
6.05.02	SAs shall be provided with grading and/or corona rings as required.		
6.05.03	Self contained discharge counters, suitably enclosed for outdoor use (IP:55 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA alongwith necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milliammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up.		
6.06.00	PARAMETERS		
6.06.01	General		
a)	System neutral earthing	Effectively earthed	
b)	Installation	Outdoor	
c)	i) Nominal discharge current	20kA of 8/20 microsec. Wave (800kV & 400kV) 10 kA of 8/20 microsec. Wave (220 & 132kV)	
	ii) Discharge current at which insulation coord. is done	20 kA of 8/20 microsec. wave	
d)	Rated frequency	50 Hz	
e)	Current for pressure relief test	50 kArms (765kV & 400kV), 40kArms (220kV), 31.5kArms (132kV),	
f)	Prospective symmetrical fault current	50 kArms for 1 second (765kV & 400kV) 40 kArms for 1 second (220kV), 31.5 kArms for 1 second (132kV)	
g)	Low current long duration test value (2000 micro sec.)	As per IEC	
h)	Pressure relief class	Class A of Table VII of IS: 3070 or equivalent IEC	
i)	Partial discharge at 1.05 MCOV (Continuous operating voltage)	Not more than 50 p.C.	
j)	Siesmic acceleration	0.3 g horizontal	
k)	Reference ambient temp.	50 deg. C	
l)	Minimum total creepage distance (mm)	28000/ 14700/ 8575/ 5075 for 765kV/ 400kV/ 220kV/ 132kV respectively.	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 68 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
6.06.02	765 kV class Surge Arrestor		
a)	Rated system voltage	800 kV	
b)	Rated arrestor voltage	624 kV	
c)	Minimum discharge capability	13kJ/kV or corresponding to minimum discharge characteristics given in clause m) below whichever is higher.	
d)	Continuous operating voltage (COV) at 50 deg. C	490 kV rms	
e)	Min. Switching surge residual voltage at 1 kA	1180 kVp	
f)	Maximum residual voltage at		
) 20kA nominal discharge current	1480 kVp	
g)	Steep fronted wave residual voltage at 10kA	1480 kVp	
h)	High current short duration test value (4/10 microsec. wave)	100 kAp	
j)	Switching Impulse withstand voltage of arrestor housing	As per IEC	
k)	Impulse withstand voltage of arrestor Housing with 1.2/50 micro sec. wave.	As per IEC	
l)	RIV at 508 kV (rms)	Less than 2500 micro volts	
m)	Long duration discharge class	3	
n)	The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the table I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 69 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	TABLE – I			
	S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL	
			LIGHTNING IMPULSE (kVp) FOR 765 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 765 kV SYSTEM
	1.	Power Transformer	± 1950	± 1550
	2.	Instrument Transformer	± 2100	± 1550
	3.	Reactor	± 1950	± 1550
		CB/Isolator		
	-	Phase to ground	± 2100	± 1550
	-	Across open contacts	±2100 (±455)	±1175 (± 650)
	o)	Surge arrestors shall be capable of discharge on severe re-energisation switching surges on 800KV, 350KM long line with Surge impedance of 270 ohms and capacitance of 13nf/Km and over voltage factor of 1.9p.u. Surge arrestor shall be capable of discharging energy equipment to class 5 of IEC for a 800 kV system on two successive operations followed immediately by 50 Hz energisation with a sequential voltage profile as specified below: 1000 kVp for 3 peaks 910 kVp for 0.1 second 885 kVp for 1 second 866 kVp for 10 seconds		
	6.06.03	400 kV class Surge Arrestor		
	a)	Rated system voltage	420 kV	
	b)	Rated arrestor voltage	336 kV	
c)	Minimum discharge capability	12kJ/kV or corresponding to minimum discharge characteristics given in clause m) below whichever is higher.		
d)	Continuous operating voltage (COV) at 50 deg. C	267 kV rms		
e)	Min. Switching surge residual voltage at 2 kA	670 kVp		
f)	Max. Switching Surge	650 kVp		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 70 OF 97


CLAUSE NO.	<div> <div>एनटीपीसी</div> <div>NTPC</div> </div> TECHNICAL REQUIREMENTS																																		
	<p>voltage at 500A</p> <p>g) Maximum residual voltage at</p> <p>i) 10kA nominal discharge current 800 kVp</p> <p>ii) 20kA nominal discharge current 850 kVp</p> <p>h) Steep fronted wave residual voltage at 10kA 925 kVp</p> <p>i) High current short duration test value (4/10 microsec. wave) 100 kAp</p> <p>j) One minute dry/wet power frequency withstand voltage of arrestor housing 630 kV (rms)</p> <p>k) Impulse withstand voltage of arrestor Housing with 1.2/50 micro sec. wave. 1425 kVp</p> <p>l) RIV at 266 kV (rms) Less than 1000 micro volts</p> <p>m) Long duration discharge class 4</p> <p>n) The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the table I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.</p> <p style="text-align: center;">TABLE – I</p> <table> <tr> <th data-bbox="325 1263 405 1294">S.NO.</th><th data-bbox="443 1263 715 1326">EQUIPMENT TO BE PROTECTED</th><th colspan="2" data-bbox="927 1263 1203 1294">INSULATION LEVEL</th></tr> <tr> <th></th><th></th><th data-bbox="791 1397 999 1532">LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM</th><th data-bbox="1102 1397 1422 1532">SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM</th></tr> <tr> <td>1.</td><td>Power Transformer</td><td>± 1425</td><td>± 1175</td></tr> <tr> <td>2.</td><td>Instrument Transformer</td><td>± 1425</td><td>± 1050</td></tr> <tr> <td>3.</td><td>Reactor</td><td>± 1300</td><td>± 1050</td></tr> <tr> <td></td><td>CB/Isolator</td><td></td><td></td></tr> <tr> <td>-</td><td>Phase to ground</td><td>± 1425</td><td>± 1050</td></tr> <tr> <td>-</td><td>Across open contacts</td><td>± 1425 (± 240)</td><td>± 900 (± 340)</td></tr> </table>			S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL				LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM	1.	Power Transformer	± 1425	± 1175	2.	Instrument Transformer	± 1425	± 1050	3.	Reactor	± 1300	± 1050		CB/Isolator			-	Phase to ground	± 1425	± 1050	-	Across open contacts	± 1425 (± 240)	± 900 (± 340)
S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL																																	
		LIGHTNING IMPULSE (kVp) FOR 400 KV SYSTEM	SWITCHING SURGE 250/2500 (kVp) FOR 400 kV SYSTEM																																
1.	Power Transformer	± 1425	± 1175																																
2.	Instrument Transformer	± 1425	± 1050																																
3.	Reactor	± 1300	± 1050																																
	CB/Isolator																																		
-	Phase to ground	± 1425	± 1050																																
-	Across open contacts	± 1425 (± 240)	± 900 (± 340)																																
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 71 OF 97																																

CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
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CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>																					
	<div><div><div>l) One minute power frequency withstand voltage of arrestor housing (dry and wet)</div><div>m) Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave</div><div>n) Radio interference voltage at 92kV</div><div>o) Partial discharge at 1.05 MCOV (continuous operating voltage)</div><div>p) Arrestor shall be capable of discharging energy equivalent to class-3 of IEC on two successive operations.</div></div><div>The surge arrestors are being provided to protect the following equipment whose insulation levels are indicated in the Table – I given below:</div><div>TABLE – I</div><table><tr><th>SL.NO.</th><th>EQUIPMENT TO BE PROTECTED</th><th>INSULATION LEVEL</th></tr><tr><td></td><td></td><th>LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM</th></tr><tr><td>1.</td><td>Power Transformer</td><td>± 950</td></tr><tr><td>2.</td><td>Instrument Trf.</td><td>± 1050</td></tr><tr><td>3.</td><td>CB/Isolator</td><td></td></tr><tr><td>-</td><td>Phase to ground</td><td>± 1050</td></tr><tr><td>-</td><td>Across open contacts</td><td>± 1200</td></tr></table></div>	SL.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL			LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM	1.	Power Transformer	± 950	2.	Instrument Trf.	± 1050	3.	CB/Isolator		-	Phase to ground	± 1050	-	Across open contacts	± 1200	<div><div>460 kV (rms)</div><div>1050 kV (Peak)</div><div>Not more than 1000 micro volt</div><div>Not more than 50 p.c.</div></div>	
SL.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL																						
		LIGHTNING IMPULSE (kVp) FOR 220 kV SYSTEM																						
1.	Power Transformer	± 950																						
2.	Instrument Trf.	± 1050																						
3.	CB/Isolator																							
-	Phase to ground	± 1050																						
-	Across open contacts	± 1200																						
6.06.05	<div><div>132 kV class Surge Arrestor</div><div><div>a) Rated system voltage</div><div>b) Rated arrestor voltage</div><div>c) Nominal discharge current</div><div>d) Minimum discharge capability</div></div></div>	<div><div>145 kV</div><div>120 kV (Not less than)</div><div>10 kA of 8/20 micro sec.</div><div>5 kilo joule/kV (referred to rated arrestor voltage corresponding to minimum discharge characteristics)</div></div>																						
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 73 OF 97																					

CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
	<div><div>e) Continuous operating voltage at 50⁰ C.</div><div>f) Max. Switching surge residual voltage (1 kA)</div><div>g) Max. residual voltage at<div><div>i) 5 kA</div><div>ii) 10 kA</div></div></div><div>h) Max. steep current residual voltage at 10 kA</div><div>i) Long duration discharge class (2 successive shots)</div><div>j) Current for Pressure relief test</div><div>k) High current short duration test value (4/10 micro sec.)</div><div>l) One minute power frequency withstand voltage of arrestor housing (dry and wet)</div><div>m) Impulse withstand voltage of arrestor housing with 1.2/50 micro sec. Wave</div><div>n) Radio interference voltage at 92kV</div><div>o) Partial discharge at 1.05 MCOV (continuous operating voltage)</div></div>	<div>102 kV (rms)</div> <div>280 kVp(max)</div> <div></div> <div>310 kVp</div> <div>330 kVp</div> <div>370 kVp</div> <div>3</div> <div>40kArms</div> <div>100 kAp</div> <div>275 kV (rms)</div> <div>650 kV (Peak)</div> <div>Not more than 1000 micro volt</div> <div>Not more than 50 p.c.</div>	
TABLE – I			
S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL	
		LIGHTNING IMPULSE(kVp) FOR 132kV SYSTEM	
1.	Power Transformer	± 650	
2.	Instrument Transformer	± 650	
3.	CB/Isolator - Phase to ground	± 650	
-	Across open contacts	± 750	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 74 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
6.07.00	TESTS			
6.07.01	Surge arrestor (GIS) shall be type tested in accordance with clause no. 1.06.02 & 1.06.03.			
6.07.02	Surge arrestors (AIS) shall confirm to all type tests (as applicable) as per IEC 60099-4 and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4. The resistive current drawn by the arrestor for at rated voltage shall be indicated in the routine test report.			
7.00.00	POST INSULATOR			
7.01.00	GENERAL			
	The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168.			
7.02.00	CONSTRUCTIONAL FEATURES			
7.02.01	Post type 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 shall be accepted. Height of post insulator shall be preferably as given under parameters of this part.			
7.02.02	The other requirements of insulator as given under auxiliary requirements shall also be applicable.			
7.03.00	TESTS			
7.03.01	In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out.			
7.03.02	In addition to acceptance/sample/routine tests as per IS: 2544, IEC-60168, the following tests shall also be carried out.			
	a) Ultrasonic tests on all cut shells as routine check.			
	b) Visual examination and magna flux test on all flanges prior to fixing.			
	c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing.			
	d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 75 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	e)	Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used.	
	f)	Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.	
7.03.03	The post insulator shall conform to following type tests as applicable according to voltage class:		
	a)	Switching Impulse withstand test (dry & wet)	
	b)	Lightning Impulse withstand test (dry)	
	c)	Power frequency withstand test (dry & wet)	
	d)	Measurement of RIV	
	e)	Corona extinction voltage test	
	f)	Test for deflection under load.	
	g)	Test for mechanical strength,	
7.04.00	PARAMETERS		
7.04.01	765 kV class Bus Post Insulator		
	a)	Type	Solid core type
	b)	Voltage class (kV)	800
	c)	Dry and wet one minute power frequency withstand voltage (kV)	830
	d)	Dry impulse withstand positive and negative (kVp)	+/- 2100
	e)	Wet switching surge withstand voltage (kVp)	+/- 1550
	f)	Max. radio interference voltage (in micro Volts) for any frequency between 0.5 MHz to 2 MHz at voltage of 508 kV (rms) between phase to ground.	2500
	g)	Corona extinction voltage (kV rms)	508
	h)	Total min. cantilever strength (Kg)	800
	i)	Min. torsional moment (Kg m)	As per IEC 60273
	j)	Minimum total creepage distance (mm)	28000
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 76 OF 97

CLAUSE NO.	<div data-bbox="1305 107 1460 190">एनटीपीसी NTPC</div> <div data-bbox="592 147 1011 179">TECHNICAL REQUIREMENTS</div>		
	<div data-bbox="272 219 1059 521"> <p>k) i) Top p.c.d. (mm) 225 ii) Bottom p.c.d. (mm) 325</p> <p>l) No. of bolts : Top 4 : Bottom 8</p> <p>m) Diameter of bolt holes (mm) : Top M16 : Bottom M18</p> <p>Note: 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 bidder without any price implication.</p> <p>n) pollution level as per IEC-815 Class III, Heavy</p> </div>		
	<div data-bbox="183 790 807 822">7.04.02. 400 kV class Bus Post Insulators</div> <div data-bbox="272 857 1161 1865"> <p>a) Type Solid core type</p> <p>b) Voltage class (kV) 400</p> <p>c) Dry and wet one minute power frequency withstand voltage (kV) 680</p> <p>d) Dry impulse withstand positive and negative (kVp) 1550</p> <p>e) Wet switching surge withstand voltage (kVp) 1175 (As per IEC)</p> <p>f) Total min. cantilever strength (Kg) 800</p> <p>g) Min. torsional moment (Kg m) 600</p> <p>h) Total height of insulator (mm) 3650 i) Top p.c.d. (mm) 127 ii) Bottom p.c.d. (mm) 300</p> <p>i) No. of bolts : Top 4 : Bottom 8</p> <p>j) Diameter of bolt holes (mm) : Top M16 : Bottom dia 18</p> <p>h) Minimum total creepage distance (mm) 14700</p> <p>i) pollution level as per IEC-815 Class III, Heavy</p> </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD	PAGE 77 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	Note: 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 bidder without any price implication.		
7.04.03.	220 kV BUS POST INSULATOR		
a)	Type	Solid core	
b)	Voltage class (kV)	245	
c)	Dry and wet one minute power frequency withstand voltage (kV)	460	
d)	Dry impulse withstand positive and negative (kVp)	1050	
e)	Max. radio interference voltage (Microvolts) for any frequency between 0.5 MHz to 2 MHz at voltage of 92 kV (rms) between phase to ground	1000	
f)	Total min. cantilever strength (Kg)	800	
g)	Min. torsional moment (Kg m)	As per IEC	
h)	Total height of insulator (mm)	2300	
i)	i) Top p.c.d. (mm)	127	
	ii) Bottom p.c.d. (mm)	254	
j)	No. of bolts : Top :	4	
	Bottom :	8	
k)	Diameter of bolt holes (mm)		
	Top :	M16	
	Bottom :	dia 18	
l)	pollution level as per IEC-815	Class III, Heavy	
m)	Minimum total creepage distance (mm))	8575	
7.04.04	132 kV class Bus Post Insulators		
a)	Type	Solid core	
b)	Voltage class (kV)	145	
c)	Dry and wet one minute power frequency withstand voltage (kV)	275	
d)	Dry impulse withstand positive and negative (kVp)	650	
e)	Max. radio interference voltage	1000	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 78 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>
	(Microvolts) for any frequency between 0.5 MHz to 2 MHz at voltage of 92 kV (rms) between phase to ground		
f)	Total min. cantilever strength (Kg)	600	
g)	Min. torsional moment (Kg m)	500	
h)	Total height of insulator (mm)	1500	
i)	i) Top p.c.d. (mm)	127	
	ii) Bottom p.c.d. (mm)	225	
j)	Diameter and no. of bolt holes (mm)		
	Top :	M16 x 4	
	Bottom :	dia 18 x 4	
k)	Pollution level as per IEC-815	Class III, Heavy	
l)	Minimum total creepage distance (mm)	5075	
7.04.05. 33kV BUS POST INSULATOR			
a)	Type	: Solid core	
b)	Voltage class (kV)	: 36	
c)	Rated Insulation levels		
	i. Rated one minute power frequency withstand voltage	: 70kV (rms)	
	ii. Rated lightning impulse withstand voltage	: 170kV (Peak)	
d)	Total min. cantilever strength (kg)	: As per IEC 60273	
e)	Min. torsional moment (Nm)	: As per IEC 60273	
f)	Minimum total creepage distance (mm)	:1260	
g)	i) Top p.c.d. (mm)	: 76	
	ii) Bottom p.c.d. (mm)	: 76	
h)	No. of bolts : Top	: 4	
	Bottom	: 4	
i)	Diameter of bolt holes (mm)		
	Top	: M12	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 79 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		
I)	Bottom Pollution level as per IEC-815	: M12 : Class-III- Heavy	
8.00.00	WAVE TRAP		
8.01.00	GENERAL		
	The Wave Trap covered under the package shall conform to IEC 353 or IS: 8792, IS: 8793 and relevant IEC/IS Specifications except to the extent modified by the specification.		
8.02.00	LOCATION OF EQUIPMENT		
8.02.01	Wave Traps as specified under this section shall be installed at the respective transmission line bays as indicated in single line diagram. The foundation shall be provided for all the three phases. The wave traps shall be installed in two phases in such a way that it should match with the location of wave traps on the phases of other side of the transmission line.		
8.03.00	TECHNICAL REQUIREMENTS		
8.03.01	Wave Trap shall be inserted into high voltage transmission line to prevent undue loss of carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.		
8.03.02	Wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device.		
8.03.03	Wave trap shall be Broad Band tuned for its entire carrier frequency range. Resistive component of impedance of the Wave trap within its carrier frequency blocking range shall not be less than 570 ohms.		
8.03.04	Wave trap shall be provided with a protective device in the form of lightning arrestor which shall be designed and arranged such that neither significant alternation in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage developed across the line trap by the rated short time current. The protective device shall be shunt connected to the main coil and tuning device.		
	The lightning arrestor provided shall have a rated discharge current of 10 kA. Coordination, however, shall be done by taking 20 kA discharge current into account.		
8.03.05	The lightning arrestor provided with the Wave trap of each rating shall fully comply with the requirements of IS-3070-Part-I (1974)/IEC-60099.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 80 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
8.03.06	The lightning arrester provided with the Wave trap shall be subject to routine and acceptance tests as per IEC – 60099.			
8.03.07	The Wave trap on 765kV & 400 kV lines shall show no visual corona at extinction voltage of 508kVrms & 320 kV rms respectively. Suitable corona rings shall be incorporated in the line trap for 765kV & 400 kV.			
8.03.08	Wave trap shall be equipped with bird barriers.			
8.03.09	Wave trap shall preferably be spray painted with light admiralty Grey paint (shade 697 of IS-5) or may have its natural epoxy colour.			
8.03.10	Wave trap shall conform to IEC - 60353 fulfilling the following technical particulars.			
		765 KV	400kV	
	a) Rated Power frequency	50 Hz	50 Hz	
	b) Rated system voltage	765 KV	400kV	
	c) Highest system voltage	800kV	420kV	
	d) Rated continuous current at 50degree C ambient	As per SLD	As per SLD	
	g) Rated short time current for 1 sec.	50kA	50kA	
	f) Nominal discharge current of protective device	20kA	10 kA	
	g) Type of tuning	Broad Band	Broad Band	
	h) Rated Blocking band-width	50 - 500 KHZ for 1 mH 90 - 500 KHZ for 0.5 mH	50 - 500 KHZ for 1 mH 90 - 500 KHZ for 0.5 mH	
	i) Inductance	1.0 mH / 0.5 mH	1.0 mH / 0.5 mH	
	j) Radio Interference voltage level	not more than 2500 micro volts at 508 kV	not more than 500 micro volts at 266kV	
		220kV		
	a) Rated power frequency	50 Hz		
	b) Rated system voltage	220kV		
	c) Highest system voltage	245kV		
	d) Rated continuous current at 50degreeC ambient	1600Amps		
	e) Rated short time current for 1sec.	40kA		
	f) Nominal discharge current of protective device	10kA		
	g) Type of tuning	Broad Band		
	h) Rated Blocking band-width	50-500 KHZ for 1.0 mH 90-500 KHZ for 0.5 mH		
	i) Inductance	1.0mH / 0.5 mH		
	j) Radio Inteference voltage level for 0.5 MHz to 2.0 MHz	not more than 500 micro volts at 156 kV		
8.03.11	In accordance with the requirements stipulated elsewhere, the Wave Trap shall confirm to following type tests and shall be subjected to routine and acceptance tests as per IEC-60353.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 81 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>	
	a)	Measurement of inductance of the main coil		
	b)	Measurement of temperature rise		
	c)	Insulation tests		
	d)	Short time current tests		
	e)	Corona Extinction Voltage Measurement		
	f)	Radio Interference Voltage measurement		
8.04.00	WAVE TRAP MOUNTING			
8.04.01	The Wave Traps shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind pressure of 195 kg/square metre.			
8.04.02	For pedestal mounting, each Wave trap shall be mounted on a lattice structure formed by three solid core type insulators.			
9.00.00	REQUIREMENT OF AUXILIARY ITEMS			
9.01.00	ALUMINIUM TUBULAR CONDUCTOR			
9.01.01	The aluminium tube shall be grade 63401 WP (range2) as per IS 5082.			
9.01.02	There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.			
9.01.03	Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also the wall thickness and ovality shall be measured by ultrasonic method. In addition 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.			
	For 765kV			
	a)	Size	4.5" IPS (EH type),	
	b)	Outer diameter	120.00 mm with no negative tolerance	
	c)	Thickness of tube	12.00 mm with no negative tolerance	
	d)	Cross-sectional area	4071.5 sq. mm.	
	e)	Weight	11.034 kg/m	
	f)	Aluminum grade	63401 WP (range 2) conforming to IS: 5082	
	For 400/ 220kV			
	a)	Size	4" IPS (EH type),	
	b)	Outer diameter	114.20 mm with no negative tolerance	
	c)	Thickness of tube	8.51 mm with no negative tolerance	
	d)	Cross-sectional area	2825.61 sq. mm.	
	e)	Weight	7.7 kg/m	
	f)	Aluminum grade	63401 WP (range 2) conforming to IS: 5082.	
	For 132kV			
	a)	Size	3" IPS (EH type),	
	b)	Outer diameter	88.9 mm with no negative tolerance	
	c)	Thickness of tube	7.62 mm with no negative tolerance	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 82 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS		
d)	Cross-sectional area	1947 sq. mm.	
e)	Aluminum grade	63401 WP (range 2) conforming to IS: 5082.	
9.02.00	AAC Bull CONDUCTOR for 765kV		
a)	Code and standard	IS 398	
b)	Name	AAC Bull	
c)	Overall diameter	38.25 mm	
d)	Weight	2.4 kg/m	
e)	Ultimate tensile strength	139.0 kN minimum	
f)	Strands and wire diameter of		
	- Aluminium	61/4.25 mm	
	ACSR CONDUCTOR for 400kV/ 220kV/ 132kV		
a)	Code and standard	IS 398	
b)	Name	MOOSE ACSR	
c)	Overall diameter	31.77 mm	
d)	Weight	2.004 kg/m	
e)	Ultimate tensile strength	161.2 kN minimum	
f)	Strands and wire diameter of		
	- Aluminium	54 / 3.53 mm	
	- Steel	7 / 3.53 mm	
9.03.00	CLAMPS AND CONNECTORS		
9.03.01	The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.		
9.03.02	The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S.shield wire.		
9.03.03	Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.		
9.03.04	All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.		
9.03.05	They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.		
9.03.06	Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.		
9.03.07	Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 83 OF 97


CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>
9.04.00	INSULATOR STRING HARDWARE
9.04.01	The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above.
9.04.02	In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.
9.04.03	<p>Disc Insulator for porcelain type insulator The disc insulator shall meet the following parameters:</p> <p>a. Type : Antifog type insulator b. Size of insulator : 255x145 c. Electro mechanical strength : 120kN d. Leakage distance (mm) : 430mm minimum or as required to meet the total creepage. e. Power frequency withstand voltage : 85 kV (dry), 50kV (wet)</p>
9.04.04	<p>Insulator string</p> <p>The insulator string shall meet the following parameters</p> <p style="text-align: center;">765kV</p> <p>a) Type Porcelain type/ composite type b) Creepage distance 28000mm c) PF withstand voltage 830 KV 1 min(rms) (dry and wet) d) L / I withstand voltage +/- 2100 KV e) S / I Withstand voltage +/- 1550 KV f) Pollution level(as per IEC 71) Class-III, Heavy g) No. of disc insulator (for porcelain) min 66 nos. h) Electro mechanical strength 210 kN/ String</p> <p style="text-align: center;">400 KV</p> <p>Type Porcelain type/composite type a) Creepage distance 14700 mm b) PF withstand voltage 680 KV 1 min(rms) (dry and wet) c) L / I withstand voltage +/- 1550 KV d) S / I Withstand voltage +/- 1050 KV e) No. of disc insulator (for porcelain) 35 nos. f) Electro mechanical strength 120 KN / string</p> <p style="text-align: center;">220 KV</p> <p>a) Type Porcelain type b) Creepage distance 8575 mm c) PF withstand voltage 460 KV (rms) 1 min (dry and wet) d) L / I withstand voltage +/- 1050 KV e) S / I Withstand voltage ----- f) No. of disc insulator (for porcelain) 20 nos.</p>
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	
TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	
SUB-SECTION B-14 SWITCHYARD	
PAGE 84 OF 97	

CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>																																											
	<p>g) Electro mechanical strength 120 KN/ String</p> <p style="text-align: center;">132kV</p> <p>a) Type Porcelain type/ composite type</p> <p>i) Creepage distance 5075 mm</p> <p>j) PF withstand voltage 275kV 1 min(rms) (dry and wet)</p> <p>k) L / I withstand voltage +/- 650 KV</p> <p>l) S / I Withstand voltage</p> <p>m) Pollution level(as per IEC 71) Class-III, Heavy</p> <p>n) No. of disc insulator (for porcelain) 12 nos.</p> <p>o) Electro mechanical strength 120kN/string</p> <p>TECHNICAL PARAMETERS FOR SF6/ AIR BUSHING</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th><th style="text-align: center;"><u>765kV</u></th><th style="text-align: center;"><u>400kV</u></th><th style="text-align: center;"><u>220kV</u></th><th style="text-align: center;"><u>132kV</u></th></tr> </thead> <tbody> <tr> <td>a) Rated Voltage (kVrms)</td><td style="text-align: center;">800kVrms</td><td style="text-align: center;">420kVrms</td><td style="text-align: center;">245kVrms</td><td style="text-align: center;">145kVrms</td></tr> <tr> <td>b) Rated Current (Amp)</td><td colspan="4" style="text-align: center;">.....As per SLD.....</td></tr> <tr> <td>c) 1.2/ 50 micro second Impulse voltage (L/I Withstand voltage)</td><td style="text-align: center;">± 2100kVp</td><td style="text-align: center;">± 1425kVp</td><td style="text-align: center;">± 1050kVp</td><td style="text-align: center;">± 630kVp</td></tr> <tr> <td>d) 250/2500 micro second switching Impulse voltage</td><td style="text-align: center;">± 1550kVp</td><td style="text-align: center;">± 1050kVp</td><td style="text-align: center;">-----</td><td style="text-align: center;">-----</td></tr> <tr> <td>e) One minute power Frequency withstand voltage</td><td style="text-align: center;">960kVrms</td><td style="text-align: center;">650kVrms</td><td style="text-align: center;">460kVrms</td><td style="text-align: center;">275kVrms</td></tr> <tr> <td>f) Minimum total Creepage Distance (mm)</td><td style="text-align: center;">28000</td><td style="text-align: center;">14700</td><td style="text-align: center;">8575</td><td style="text-align: center;">5075</td></tr> <tr> <td>g) Minimum Cantilever Strength (kN)</td><td style="text-align: center;">10</td><td style="text-align: center;">10</td><td style="text-align: center;">8</td><td style="text-align: center;">5</td></tr> </tbody> </table> <p>9.05.00 SPACERS</p> <p>9.05.01 Spacers shall conform to IS: 10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.</p> <p>9.05.02 Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.</p> <p>9.05.03 In addition to the type tests as per IS: 10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.</p>					<u>765kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>	a) Rated Voltage (kVrms)	800kVrms	420kVrms	245kVrms	145kVrms	b) Rated Current (Amp)As per SLD.....				c) 1.2/ 50 micro second Impulse voltage (L/I Withstand voltage)	± 2100kVp	± 1425kVp	± 1050kVp	± 630kVp	d) 250/2500 micro second switching Impulse voltage	± 1550kVp	± 1050kVp	-----	-----	e) One minute power Frequency withstand voltage	960kVrms	650kVrms	460kVrms	275kVrms	f) Minimum total Creepage Distance (mm)	28000	14700	8575	5075	g) Minimum Cantilever Strength (kN)	10	10	8	5
	<u>765kV</u>	<u>400kV</u>	<u>220kV</u>	<u>132kV</u>																																								
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EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD	PAGE 85 OF 97																																								

CLAUSE NO.	TECHNICAL REQUIREMENTS		
9.06.00	EARTHING CONDUCTOR		
	a)	The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.	
	b)	All earthing conductors above the ground level shall be galvanised steel only.	
9.07.00	Earthwire for Lightning Protection		
	a)	Number of strands	7 of steel
	b)	Strand diameter	3.66 mm
	c)	Overall diameter	10.98 mm
	d)	Weight	583 kg/km approx.
	e)	Ultimate tensile strength	68.4 kN minimum
	f)	Total cross-sectional area	73.65 sq.mm.
	g)	Calculated d.c. resistance	2.5 ohms/km at 20 deg.C.
	h)	Direction of lay of outer layer	Right hand
	i)	Protective coating for storage	Boiled linseed oil to avoid wet storage stains (white rust)
	The earth wire shall be preformed and post formed quality.		
9.08.00	BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS		
9.08.01	Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds. Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.		
9.08.02	Porcelain used shall be homogenous, 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.		
9.08.03	Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.		
9.08.04	The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 86 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS		
9.08.05	Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.		
9.08.06	Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.		
9.08.07	All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.		
9.08.08	In accordance with the requirements stipulated elsewhere, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.		
9.09.00	CABINETS, BOXES, KIOSKS, PANELS, ETC.		
9.09.01	All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable.		
9.09.02	They shall be of Stainless steel or Aluminium. The thickness of Stainless steel shall be minimum 1 mm. The thickness of aluminium shall be minimum 3 mm and shall provide rigidity. Top of the boxes shall be sloped towards the rear of the box.		
9.10.00	BAY MARSHALLING BOX		
9.10.01	Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.		
9.10.02	It shall have three separate distinct compartments for following purposes: - To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch. - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs. - 150 nos. terminal blocks in vertical formation for interlocking facility.		
9.11.00	AUXILIARY SWITCH The auxiliary switch shall conform of following type tests:		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 87 OF 97


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a)	Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.		
	b)	Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination		
	c)	Heat run test on contacts		
	d)	IR/HV test, etc.		
9.12.00	Type tests All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.			
10.00.00	INSTALLATION			
10.01.00	EARTHING The earthing shall be done in accordance with requirements given in Annexure-II of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.			
10.02.00	CIVIL WORKS The civil works shall be done in accordance with requirements stipulated elsewhere in the specification.			
10.03.00	STRUCTURAL STEEL WORKS The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.			
10.04.00	BAY EQUIPMENT			
10.04.01	The disposition of equipment to be supplied are shown in enclosed tender drawings.			
10.04.02	The Contractor shall prepare layout drawings and submit the same for approval of the Employer. The approval of drg. shall not absolve Contractor from his responsibility regarding designing & engineering of switchyard and Contractor shall be fully responsible for all works covered in the scope of this specification.			
10.05.00	LIGHTNING PROTECTION			
10.05.01	Direct stroke lightning protection (DSLPP) shall be provided in the switchyard by lightning masts (at least 50 m high) and shield wires.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 88 OF 97				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
10.05.02	Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode.			
10.05.03	Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system.			
10.05.04	The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.			
10.06.00	EQUIPMENT ERECTION NOTES			
a)	All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity.			
b)	Where, assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment.			
c)	The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.			
d)	Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.			
e)	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.			
f)	For cleaning the inside and outside of hollow insulators only Muslin or leather cloth shall be used.			
10.07.00	CABLING			
10.07.01	Cabling shall be on cable racks, in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification.			
10.07.02	Cables inside the switchyard shall be laid on bolted GI angle supports at 600mm spacing with separate tiers for control and power cables. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 89 OF 97				

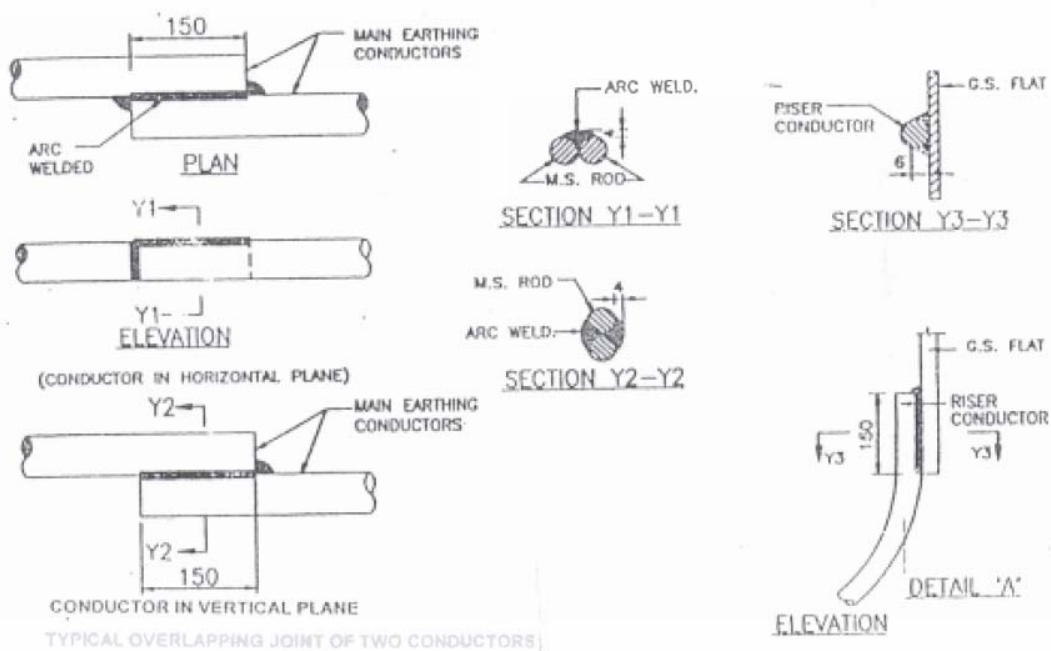
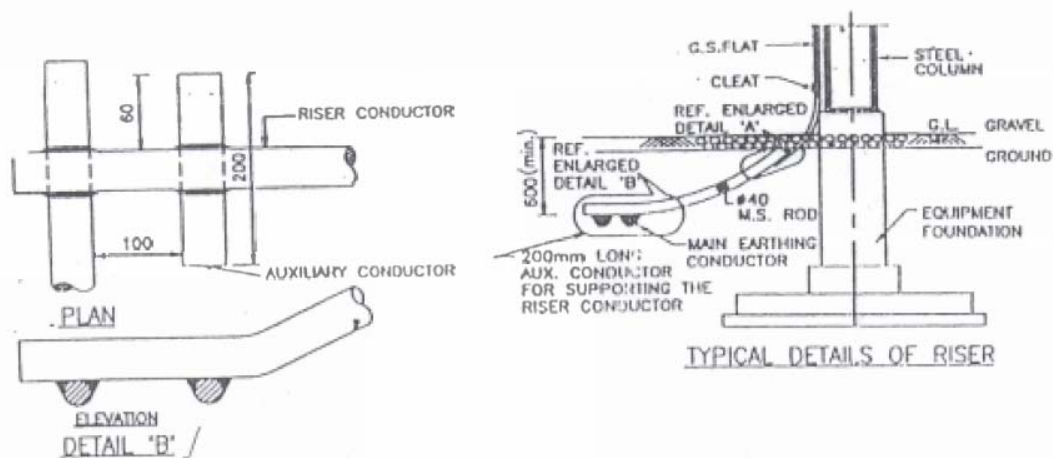
CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
10.07.03	Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the ground. In the case of equipment located away from cable trench either pipe inserts shall be embedded in the ground connecting the cable trench and the equipment or in case the distance is small, notch/opening shall be provided. In all these cases necessary bending radii as recommended by the cable supplier shall be maintained.		
10.07.04	Cabling in the control room shall be done on ladder type cable trays with supports at an interval of 2000mm.		
10.07.05	All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.		
a)	<div>ANNEXURE-II</div> <div>EARTHING NOTES FOR SWITCHYARD</div> <div>GENERAL</div> <div>i) Earthing of operating boxes, cubicles shall be done by 50 X 6 mm GS flat while cable trenches and structure by 75 X 12 mm GS flat.</div> <div>ii. 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.</div> <div>iii. Earthing 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.</div>		
b)	<div>EARTHING OF GIS</div> <div>i) The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-mechanical interferences.</div> <div>ii.) The GIS contractor shall define clearly what constitutes the main grounding bus of the GIS. The GIS contractor must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc.</div> <div>iii.) The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with links or straps to bridge the flanges. Subassembly-to-subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.</div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 90 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
iv)	The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise is kept to an acceptable level. Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.			
	u) The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contracts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-liner resistor/counter discontinued SF6/Transformer and SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.			
c)	DETAILS OF EARTHING SYSTEM			
	Item	Size	Material	
	Main Earthing conductor	40mm dia rod	Mild steel	
	Conductor above ground & earthing leads (for equipment)	75 x 12/ G.S. Flat 50 x 6	Galvanized steel	
	Rod Electrode	40mm dia, 3000mm	Mild steel	
	G.I. Earthwire	7/8 SWG	GI	
	Copper Flat (if required)	as per requirement		
d)	For Step and Touch Potential the following parameters shall be considered			
	i) Current distribution factor – 1 (one)			
	ii) Duration of fault current – 0.5 sec			
	iii) Human body weight – 50kg			
e)	Grid resistance shall be less than 1(one) ohm.			
f)	EARTHING CONDUCTOR LAYOUT			
	i.	Earthing conductors in outdoor areas shall be burried atleast 600mm below finished grade level unless stated otherwise.		
	ii.	Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earthmat design calculations.		
	iii.	Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid atleast 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 91 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
iv.	Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid. Otherwise, “earth insert” with temporary wooden cover or “earth riser” shall be provided near the equipment foundation/pedestal for future connections to the equipment earthing terminals.		
v.	Earthing conductor along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.		
vi.	Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.		
vii.	In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future, in case equipment is not available at the time of grid installations.		
viii.	Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.		
ix.	Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.		
g)	EQUIPMENT AND STRUCTURE EARTHING		
i.	The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads 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 engineer.		
ii.	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.		
iii.	Metallic conduits shall not be used as earth continuity conductor.		
iv.	A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.		
v.	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.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD
			PAGE 92 OF 97

CLAUSE NO.	TECHNICAL REQUIREMENTS			
h)	vi.	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 minimum two points, whether specifically shown or not.		
	vii.	Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations.		
	viii.	Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead.		
	ix.	Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.		
	x.	Equipment earthing (Riser & welding of two conductors) shall be done as per standard drawing enclosed in this part.		
	JOINTING			
	i.	Earthing connections with equipment earthing pads shall be of bolted type. Contact surfaces shall be free from scales, 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.		
	ii.	Connection between equipment earthing lead and between main earthing conductors shall be welded/brazed type. For rust protections, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.		
	iii.	Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.		
	iv.	Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.		
	v.	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.		
	vi.	Bending of large diameter rod/thick conductor shall be done preferably by gas heating.		
	vii.	All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.		
	i)	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.				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 93 OF 97				


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
j)	SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS			
i.	Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.			
ii.	Auxilliary earthing mat of 1500mm X 1500mm size comprising of closely spaced conductors at (300mm x 300mm) spacing and at 300mm below ground shall be provided below the operating handles of the isolators. Operating handle shall be directly connected to earthing mat.			
k)	SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM			
i.	Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.			
ii.	Down conductors shall be cleated on the structures at 2000mm interval.			
iii.	Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.			
iv.	Lightning conductors shall not pass through or run inside G.I. conduits.			
v.	Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
				PAGE 94 OF 97



NOTE : WELDING OF EARTHING CONDUCTOR SHALL BE CONDUCTED IN VERTICAL PLANE
WHEREVER POSSIBLE

EQUIPMENT EARTHING DETAILS


STANDARD DRAWING


CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.00.00	SITE TESTING AND COMMISSIONING			
11.01.00	INTRODUCTION			
	An indicative list of tests for AIS and GIS as applicable is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ 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 get the list of instruments approved from the Employer.			
11.02.00	GENERAL CHECKS			
	<div>a) Check for physical damage.</div> <div>b) Visual examination of zinc coating/ plating</div> <div>c) Check from name plate that all items are as per order/ specification.</div> <div>d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.</div> <div>e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up.</div> <div>f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.</div> <div>g) Check cleanliness of insulator and bushings.</div> <div>h) All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection.</div> <div>i) Check for surface finish of grading rings (corona control ring.)</div> <div>j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.</div>			
11.03.00	CIRCUIT BREAKERS			
	<div>a) Insulation resistance of each pole.</div> <div>b) Check adjustments, if any, suggested by manufacturer.</div> <div>c) Breaker closing and tripping time.</div> <div>d) Slow and power closing operation and opening</div> <div>e) Trip free and anti pumping operation.</div> <div>f) Minimum pick up volts of coils</div> <div>g) Contact resistance</div> <div>h) Functional checking of compressed air plant and all accessories</div> <div>i) Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation.</div> <div>j) Insulation resistance of control circuits, motor etc.</div> <div>k) Resistance of closing and tripping coils.</div>			
11.04.00	ISOLATORS			
	<div>a) Insulation resistance of each pole</div> <div>b) Manual and electrical operation on interlocks</div> <div>c) Insulation resistance of control circuits and motors.</div> <div>d) Ground connections</div> <div>e) Contact resistance</div> <div>f) Proper alignment to minimise the vibration to the extreme possible during operation.</div> <div>g) Measurement of operating torque for isolator and Earth switch</div> <div>h) Resistance of operating and interlocking coils.</div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2		SUB-SECTION B-14 SWITCHYARD
PAGE 96 OF 97				


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
11.05.00	CURRENT TRANSFORMERS a) Insulation Resistance Test 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) Capacitance and tan delta measurement at minimum 10kV.		
11.06.00	VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFOREMER a) Insulation resistance test. b) Polarity test. c) Ratio test. d) Dielectric test of oil (if applicable). e) Capacitance and tan delta measurement at minimum 10kV.		
11.07.00	SURGE ARRESTER a) Grading leakage current. b) Resistance of ground connection. c) Resistive current drawn at rated voltage after energisation.		
11.08.00	PHASING OUT The phasing out of all supplies in the station system shall be carried out.		
11.09.00	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 surface. e) Dip test on earth conductor prior to use.		
11.10.00	CONDUCTOR STRINGING AND POWER CONNECTORS a) Physical check for finish b) Electrical clearance check c) Testing of torque by torque by torque wrenches on all bus power connectors and other accessories. d) Sag and tension check on conductors.		
11.11.00	INSULATORS Visual examination for finish damage, creepage distance, etc.		
11.12.00	WAVE TRAP a) Insulation resistance Test b) Visual check		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE –I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION-VI, PART-B BID DOC.NO.:CS:9585-001-2	SUB-SECTION B-14 SWITCHYARD PAGE 97 OF 97


SUB-SECTION – B-09


CABLING, EARTHING AND LIGHTNING PROTECTION


CLAUSE NO.	TECHNICAL REQUIREMENTS 		
1.00.00 1.01.00	CODES AND STANDARDS All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable . <div> <div>IS:513</div> <div>Cold rolled low carbon steel sheets and strips.</div> </div> <div> <div>IS:802</div> <div>Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</div> </div> <div> <div>IS:1079</div> <div>Hot Rolled carbon steel sheet & strips</div> </div> <div> <div>IS:1239</div> <div>Mild steel tubes, tubulars and other wrought steel fittings</div> </div> <div> <div>IS:1255</div> <div>Code of practice for installation and maintenance of power cables upto and including 33 KV rating</div> </div> <div> <div>IS:1367 Part-13</div> <div>Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).</div> </div> <div> <div>IS:2147</div> <div>Degree of protection provided by enclosures for low voltage switchgear and control gear</div> </div> <div> <div>IS:2309</div> <div>Code of Practice for the protection of building and allied structures against lightning.</div> </div> <div> <div>IS:2629</div> <div>Recommended practice for hot dip galvanising of iron & steel</div> </div> <div> <div>IS:2633</div> <div>Method for testing uniformity of coating on zinc coated articles.</div> </div> <div> <div>IS:3043</div> <div>Code of practice for Earthing</div> </div> <div> <div>IS:3063</div> <div>Fasteners single coil rectangular section spring washers.</div> </div> <div> <div>IS:6745</div> <div>Methods for determination of mass of zinc coating on zinc coated iron & steel articles.</div> </div> <div> <div>IS:8308</div> <div>Compression type tubular in- line connectors for aluminium conductors of insulated cables</div> </div> <div> <div>IS:8309</div> <div>Compression type tubular terminal ends for aluminium conductors of insulated cables.</div> </div> <div> <div>IS:9537</div> <div>Conduits for electrical installation.</div> </div> <div> <div>IS:9595</div> <div>Metal - arc welding of carbon and carbon manganese steels - recommendations.</div> </div> <div> <div>IS:13573</div> <div>Joints and terminations for polymeric cables.</div> </div> <div> <div>BS:476</div> <div>Fire tests on building materials and structures</div> </div> <div> <div>IEEE:80</div> <div>IEEE guide for safety in AC substation grounding</div> </div> <div> <div>IEEE:142</div> <div>Grounding of Industrial & commercial power systems</div> </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 1 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.	
	DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors	
	BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.	
		Indian Electricity Act.	
		Indian Electricity Rules.	
1.02.00	Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.		
2.00.00	DESIGN AND CONSTRUCTIONAL FEATURE		
2.01.00	Inter Plant Cabling		
2.01.01	Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly buried cables, if essential ,shall not have concentration of more than 4 cables in one route. All buried cables, Cables for switchyard and CHP shall be armoured		
2.01.02	Transformer yard		
	In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.		
2.01.03	Trenches		
	PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.		
2.01.04	No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.		
2.01.05	Cable Vault		
	Clear access passage of at least 750mm wide & 2.1 mt clear heights shall be provided at entrances and along the cable trays in cable vault. Wherever the passage is through cable routes & across the cable tray the clear height shall not be less than 1.5 mts.		
	Cable vaults shall be provided with adequate drainage facilities for drainage of fire water.		
	Each cable vault should have at least two doors.		
	Exit signs shall be provided near doors for personnel escape in case of emergency		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 2 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS	
2.01.06	<p>Boiler Area</p> <p>Two separate cable routes one on each side shall be provided for each boiler unit. Cables for on set of auxiliaries such as ID, FD, PA fan & half of the coal mills shall be routed in one route & for other set of auxiliaries through other route.</p> <p>Cable trays in boiler & ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor.</p> <p>Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.</p>	
2.01.07	<p>Turbine Hall Area</p> <p>a)Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.</p>	
2.01.08	<p>OffSite Area</p> <p>In offsite pumphouses, overhead cable tray arrangement shall be followed. However cable trenches may be considered below switchgear/mcc.</p> <p>Trestle In fuel oil pump house, overhead cable tray arrangement shall be provided. RCC trenches provided in MCC room shall be separated from fuel oil area to avoid oil accumulation.</p>	
2.01.09	<p>The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.</p>	
2.01.10	<p>Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.</p>	
2.01.11	<p>Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:</p> <ul style="list-style-type: none">• Meet all safety requirements• Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc	
3.00.00	<p>EQUIPMENT DESCRIPTION</p>	
3.01.00	<p>Cable trays, Fittings & Accessories</p>	
3.01.01	<p>Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.</p>	
3.01.02	<p>Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.</p>	
3.01.03	<p>Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.</p>	
3.01.04	<p>Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip</p>	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2
		SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
		Page 3 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS	
	galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm	
3.02.00	Support System for Cable Trays	
3.02.01	Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.	
3.02.02	<p>Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder</p> <ol style="list-style-type: none"> a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc. b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanised. c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation. e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below: The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079. f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position. g. Support system shall be able to withstand <ul style="list-style-type: none"> weight of the cable trays weight of the cables (75 Kg/Metre run of each cable tray) Concentrated load of 75 Kg between every support span. Factor of safety of minimum 1.5 shall be considered. 	
3.02.03	The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		Page 4 of 20
TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2		SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.			
3.03.04	FOR COAL HANDLING PLANT THE FOLLOWING SHALL ALSO BE APPLICABLE:			
	<div>a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route.</div> <div>b) Cable trenches shall be provided only in Switchgear/MCC rooms.</div> <div>c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.</div> <div>d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.</div>			
3.04.00	Pipes, Fittings & Accessories			
3.03.01	Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria			
3.03.02	GI Pipes shall be of medium duty as per IS: 1239			
3.03.03	Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.			
3.03.04	Hume pipes shall be NP3 type as per IS 458.			
3.04.00	Junction Boxes			
3.04.01	<p>Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-</p> <div><div>(a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102</div><div>(b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.</div><div>(c) Class of protection shall be IP 55.</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2		SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
Page 5 of 20				


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	(d) HV test.		
3.04.02	Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.		
3.05.00	Terminations & Straight Through Joints		
3.05.01	Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless crimping type cable lugs & ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables. (Tender drg. no 0000-211-POE –A-51-RA of cable lug attached at the end of this chapter)..		
3.05.02	Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system & of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV & 3.3 KV system. Straight through joints shall have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design		
3.05.03	1.1 KV grade Straight Through Joint shall be of proven design.		
3.06.00	Cable glands		
3.06.01	Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.		
3.07.00	Cable lugs/ferrules		
3.07.01	Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 6 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN standards.			
3.08.00	Trefoil clamps			
3.08.01	Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.			
3.09.00	Cable Clamps & Ties			
3.09.01	The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyester coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.			
3.10.00	Receptacles			
3.10.01	Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polyimide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable adjustable mA sensitivity ranging from 30-300 mA			
3.12.00	Cable Drum Lifting Jack			
	The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.			
3.13.00	Galvanising			
3.13.01	Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.			
3.13.02	The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 7 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
3.14.00	Welding		
3.14.01	The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595		
4.00.00	INSTALLATION		
4.01.00	Cable tray and Support System Installation		
4.01.01	Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.		
4.01.02	Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.		
4.01.03	The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.		
4.01.04	The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.		
4.01.05	All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.		
4.01.06	In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.		
4.02.00	Conduits/Pipes/Ducts Installation		
4.02.01	The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.		
4.02.02	GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.		
4.02.03	Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. 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 with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 8 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS												
4.02.04	<p>Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise</p> <table><tr><th>Conduit /pipe size (dia).</th><th>Spacing</th></tr><tr><td>Upto 40 mm</td><td>1 M</td></tr><tr><td>50 mm</td><td>2.0 M</td></tr><tr><td>65-85 mm</td><td>2.5 M</td></tr><tr><td>100 mm and above</td><td>3.0 M</td></tr></table>			Conduit /pipe size (dia).	Spacing	Upto 40 mm	1 M	50 mm	2.0 M	65-85 mm	2.5 M	100 mm and above	3.0 M
Conduit /pipe size (dia).	Spacing												
Upto 40 mm	1 M												
50 mm	2.0 M												
65-85 mm	2.5 M												
100 mm and above	3.0 M												
4.02.05	<p>For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.</p>												
4.03.00	Junction Boxes Installation												
4.03.01	<p>Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.</p>												
4.04.00	Cable Installation												
4.04.01	<p>Cable installation shall be carried out as per IS:1255 and other applicable standards.</p>												
4.04.02	<p>For Cable unloading, pulling etc following guidelines shall be followed in general:</p> <div><div>a)</div><div>Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. 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. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.</div></div> <div><div>b)</div><div>While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.</div></div>												
4.04.03	<p>Cables shall be laid on cable trays strictly in line with cable schedule . Where specific cable layouts are not shown on drawings, Contractor shall route these as directed by the Project Manager</p>												
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION										
			Page 9 of 20										

CLAUSE NO.	TECHNICAL REQUIREMENTS			
4.04.04	Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend. Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.			
4.04.05	Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.			
4.04.06	Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.			
4.04.07	No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.			
4.04.08	In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.			
4.04.09	Wherever few cables are branching out from main trunk route troughs shall be used.			
4.04.10	Wind loading shall be considered for designing support as well Cable trays wherever required.			
4.04.11	Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.			
4.04.12	The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.			
4.04.13	Separation At least 300mm clearance shall be provided between: - HT power & LT power cables, - LT power & LT control/instrumentation cables,			
4.04.14	Segregation 1) Segregation means physical isolation to prevent fire jumping. 2) All cables associated with the unit shall be segregated from cables of other units. 3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 10 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.04.15	DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.		
	4) In switchyard, control cables of each bay shall be laid on separate racks/trays.		
	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:		
	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:		
	No. of cores in cable	No. of spare cores	
	2C,3C	NIL	
	5C	1	
	7C-10C	2	
	14C and above	3	
4.04.16	Directly Buried Cables		
	a)	Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.	
	b)	RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The 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 crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.	
4.04.17	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 every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.		
4.04.18	While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.		
4.05.00	Cable Terminations & Connections		
4.05.01	The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 11 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
	shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.		
4.05.02	Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.		
4.05.03	The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.		
4.05.04	Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.		
4.05.05	All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.		
4.05.06	All cable terminations shall be appropriately tightened to ensure secure and reliable connections.		
5.00.00	EARTHING SYSTEM		
5.01.00	Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts. Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.		
5.02.00	The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects		
5.03.00	The material of the earthing conductors shall be as follows : 1) Conductors above ground level and in built up trenches. - Galvanized steel 2) Conductors buried in earth - Mild steel 3) Earth electrodes - Mild steel rod		
5.04.00	The sizes of earthing conductors for various electrical equipments shall be as below: EquipmentEarth conductor buried in earthEarth conductor above ground level & in built-up trenches		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 12 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a)	Main earth grid	40 mm dia. MS rod	65 x 8mm GS flat
	b)	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	---	65 x 8mm GS flat
	c)	415 V MCC/ Distribution boards / Transformers	---	50 x 6mm GS flat
	d)	LT Motors above 125 KW	---	50 x 6mm GS flat
		25 KW to 125 KW	---	25 x 6mm GS flat
		1KW to 25 KW	---	25 x 3mm GS flat
		Fractional House power motor	---	8 SWG GS wire
	e)	Control panel & control desk	---	25 x 3 mm GS flat
	f)	Push button station / Junction Box	---	8 SWG GI wire
	g)	Columns, structures, cable trays and bus ducts enclosures	---	50 x 6mm GS flat
	h)	Crane, rails, rail tracks & other non-current carrying metal parts		25 x 6mm GS flat
5.05.00	Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.			
5.06.00	Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground			
5.07.00	Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.			
5.08.00	Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.			
5.09.00	Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2		SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION Page 13 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एनटीपीसी NTPC</div>												
5.10.00	Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.														
5.11.00	Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.														
5.12.00	Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.														
5.13.00	Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.														
5.14.00	Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.														
5.15.00	A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.														
5.16.00	Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.														
5.17.00	Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be provided with bolted arrangement alongwith each earth pit, in order to facilitate measurement of earth resistance as & when required.														
5.18.00	On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.														
5.19.00	Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.														
5.20.00	<div>Other Requirements of Earthing System:</div> <table><tr><td>Standard/Code</td><td>IEEE 80, IS 3043</td></tr><tr><td>Earthing System</td><td></td></tr><tr><td>Life expectancy</td><td>40 Years</td></tr><tr><td>System Fault Level</td><td>As per system requirement (B0)</td></tr><tr><td>Soil resistivity</td><td>Actual as per site conditions.</td></tr><tr><td>Min. Steel corrosion</td><td>0.12mm/year</td></tr></table>			Standard/Code	IEEE 80, IS 3043	Earthing System		Life expectancy	40 Years	System Fault Level	As per system requirement (B0)	Soil resistivity	Actual as per site conditions.	Min. Steel corrosion	0.12mm/year
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EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION												
			Page 14 of 20												


CLAUSE NO.	<div> <div>TECHNICAL REQUIREMENTS</div> <div>एनटीपीसी NTPC</div> </div>		
	<div> <div>Depth of burial of main earth conductor</div> <div>600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.</div> </div> <div> <div>Conductor joints</div> <div>By electric arc welding, with resistance of joint not more than that of the conductor.</div> </div> <div> <div>Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.</div> </div> <div> <div>Surface resistivity</div> <div> <div>- Gravel</div> <div>3000 ohm-meter</div> <div>- Concrete</div> <div>500 ohm-meter</div> </div> </div>		
<div>6.00.00</div> <div>6.01.01</div> <div>6.01.02</div> <div>6.01.03</div> <div>6.02.00</div> <div>7.00.00</div> <div>7.01.01</div>	<div> <div>6.00.00</div> <div>LIGHTNING PROTECTION SYSTEM</div> </div> <div> <div>6.01.01</div> <div>Lightning protection system shall be in strict accordance with IS:2309 .</div> </div> <div> <div>6.01.02</div> <div>Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system</div> </div> <div> <div>6.01.03</div> <div>Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.</div> </div> <div> <div>6.02.00</div> <div>Down Conductors</div> <div> <div>1.</div> <div>Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.</div> </div> <div> <div>2.</div> <div>Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.</div> </div> <div> <div>3.</div> <div>All joints in the down conductors shall be welded type.</div> </div> <div> <div>4.</div> <div>Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.</div> </div> <div> <div>5.</div> <div>Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.</div> </div> <div> <div>6.</div> <div>All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.</div> </div> <div> <div>7.</div> <div>Lightning conductors shall not pass through or run inside GI Conduits.</div> </div> <div> <div>8.</div> <div>Testing link shall be made of galvanized steel of size 25x 6mm.</div> </div> <div> <div>9.</div> <div>Pulser system for lightning shall not be accepted.</div> </div> <div> <div>10.</div> <div>Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.</div> </div> </div> <div> <div>7.00.00</div> <div>TESTS</div> </div> <div> <div>7.01.01</div> <div>All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this</div> </div>		
<div>EPC PACKAGE FOR</div> <div>PATRATU SUPER THERMAL POWER</div> <div>STATION EXPANSION PHASE-I (3X 800MW)</div>	<div>TECHNICAL SPECIFICATIONS</div> <div>SECTION VI, PART-B</div> <div>BID DOC. NO.:CS- 9585-001-2</div>	<div>SUB SECTION- B-09</div> <div>CABLING, EARTHING &</div> <div>LIGHTNING PROTECTION</div>	<div>Page</div> <div>15 of 20</div>

CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एनटीपीसी NTPC</div>	
7.01.02	<p>specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.</p> <p>However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.</p>		
7.01.03	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.		
7.01.04	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.		
7.02.00	Type Test reports shall be furnished for the following		
7.02.01	<p>Type tests on Cable Trays support system</p> <p>a) Test 1A:</p> <p>On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals:</p> <div><div>i)</div><div>Working load</div></div> <div><div>ii)</div><div>Working load + point load</div></div> <div><div>iii)</div><div>Off load</div></div> <div><div>iv)</div><div>Proof load + point load</div></div> <div><div>v)</div><div>Off load</div></div> <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.</p> <p>B) Test 1B:</p> <p>Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
			Page 16 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides</p> <p>a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.</p> <div><div>i)</div><div>Working load</div></div> <div><div>ii)</div><div>Working load + Point load</div></div> <div><div>iii)</div><div>Off load</div></div> <div><div>iv)</div><div>Proof load + Point load</div></div> <div><div>v)</div><div>Off load</div></div> <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied</p> <p>b) Test 2 B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.</p> <p>Test 3 : Tests on Channel Fixed on Beam/Floor</p> <p>A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below</p> <p>a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.</p> <p>b) Test 3B: With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.</p> <p>c) Test 3C: With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.</p> <p>The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.</p> <p>Test 4 : Channel Insert Test</p> <p>A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 17 of 20

CLAUSE NO.	<div style="text-align: center;"> TECHNICAL REQUIREMENTS  </div>			
	<p>100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.</p> <ul style="list-style-type: none"> i) Working Load ii) Working Load + Point Load iii) Off Load iv) Proof Load + Point Load v) Off load <p>The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied</p> <p>Test 5 : Channel nut slip characteristics (what ever applicable)</p> <p>Tests 5A1,5A2,5A3 : A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting.</p> <p>A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.</p> <p>Tests 5B1,5B2,5B3: The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.</p> <p>A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM.</p> <p>Test 6 Weld Integrity Test</p> <p>After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.</p> <p>7.02.02 Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.</p> <p>7.03.00 Routine/ Acceptance Tests</p> <p>7.03.01 Routine Tests</p> <ul style="list-style-type: none"> a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification. 			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2		SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION
				Page 18 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS 			
7.03.02	<p>b) Physical & dimensional check on all equipments as per approved drawings/standards</p> <p>c) HV/IR as applicable.</p> <p>d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.</p> <p>Acceptance Test</p> <p>a) Galvanising Tests as per applicable standards</p> <p>b) Welding checks</p> <p>c) Deflection tests on cable trays:</p> <p>d) One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm.</p> <p>d) Proof load tests on cable tray support system</p> <p>i) Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test.</p> <p>ii) Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done.</p> <p>iii) Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test. The procedure for carrying out tests at "d" above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity.</p> <p>e) The above acceptance tests shall be done only on one sample from each offered lot.</p>			
8.00.00	COMMISSIONING			
8.01.01	The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance..			
8.01.02	<p>Cables</p> <p>a) Check for physical damage</p> <p>b) Check for insulation resistance before and after termination/jointing.</p> <p>c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.</p> <p>d) Check of continuity of all cores of the cables.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 19 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS 		
8.02.00	e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor. f) Check for correct polarity and phasing of cable connections. g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc. h) Check for provision of correct cable tags, core ferrules, tightness of connections. Cable trays / supports and accessories 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories. 2) Check for continuity of cable trays over the entire route. 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports. 4) Check for earth continuity and earth connection of cable trays.		
	8.03.00 Earthing and Lightning protection system 1) Earth continuity checks. 2) Earth resistance of the complete system as well as sub-system.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION Page 20 of 20

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2D2


TECHNICAL SPECIFICATION FOR SWITCHYARD CIVIL WORKS


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एन टी पी सी NTPC</div>		
10.00.00	MATERIAL SPECIFICATION			
10.01.00	Cement <p>Fly ash based portland pozzolana cement conforming to IS:1489 (Part-1) shall be used for all areas other than for the critical structures identified below. Other properties shall be as per IS code.</p> <p>Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.</p> <div><div>a)</div><div>TG foundation top deck</div></div> <div><div>b)</div><div>Spring supported decks of all machine foundations such as TDBFP/MDBFP</div></div> <div><div>c)</div><div>RCC for Chimney shell.</div></div> <div><div>d)</div><div>NDCT shell and racker columns of NDCT.</div></div> <p>The grade of cement shall be Grade 43 for OPC conforming to IS:8112.</p> <p>In place of fly ash based portland pozzolana cement, OPC mixed with Fly Ash can be used. Batching plant shall have facility for mixing fly ash. Fly ash shall conform to IS:3812(Part I & Part II). Percentage of fly ash to be mixed in concrete shall be based on trial mix. Mix design shall be done with varying percentage of fly ash mix with cement</p>			
10.02.00	Aggregates <div><div>a)</div><div>Coarse aggregate<p>Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.</p></div></div> <div><div>b)</div><div>Fine aggregate<p>Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS : 383. For plaster, it shall conform to IS : 1542 and for masonry work to IS : 2116.</p></div></div> <div><div>c)</div><div><p>Petrographic examination of aggregate shall be carried out by the contractor at National Council for Cement and Building Materials (NCB), Ballabgarh, or any other approved laboratory to ascertain the structure and rock type including presence of strained quartz and other reactive minerals for machine foundations, etc. In case, the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining the rock type, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. The procedure laid down in IS 2430 for sampling of aggregates may be followed.</p><p>The laboratory shall determine potential reactivity of the aggregate, which may lead to reaction of silica in aggregate with the alkalis of cement and / or potential of some aggregates like limestone to cause residual expansion due to repeated temperature cycle. If the same is established, the contractor shall further carry out alkali</p></div></div> <td></td> <td></td>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 177 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>aggregates reactivity test as per IS 2386 (Pt.VII) and / or repeated temperature cycle test to establish the suitability of the aggregates for the concrete work. The test results, with the final recommendations of the laboratory, as to a suitability of the aggregate, for use in the concrete work for various structures and suggested measures, in case of results are not satisfactory, shall be submitted to the Engineer for his review, in a report form.</p> <p>In case in the report, it is established, that the aggregates contain reactive silica, which would react with alkalis of the cement, the contractor shall change the source of supply of the aggregate or use low alkali cement as per recommendation or take measures as recommended in the report as instructed by Engineer. In case aggregates indicate residual expansion, under repeated temperature cycle test (from 10o Celsius to 65o Celsius and for 60 temperature cycles) the material shall not be used for concreting of TGs', BFPs', Mills', Fans' and other equipment foundations which are likely to be subjected to repeated temperature cycle. The contractor shall use aggregates free from residual expansion under repeated temperatures cycle test.</p>			
10.03.00	Reinforcement Steel			
	<p>Reinforcement steel shall be of high strength deformed TMT steel bars of grade Fe-500 and shall conform to IS:1786. However, minimum elongation shall be 14.5%.</p> <p>Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade-1 of IS:432 (Part-1) or grade A of IS:2062. Welded wire fabric shall conform to IS:1566.</p>			
10.04.00	Structural Steel			
	<p>Structural Steel (including embedded Steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall comprise of mild steel, medium strength steel and high tensile steel as specified below.</p>			
10.04.01	Mild Steel			
	<p>a) Rolled Sections and plates shall be of grade designation E350, Quality B0 (killed), conforming to IS 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.</p> <p>b) Pipes shall conform to IS: 1161.</p> <p>c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240.</p> <p>d) Chequered plate shall conform to IS 3502 and shall be minimum 6 mm thick excluding projection. Steel for chequered plate shall conform to grade E250A semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.</p>			
10.04.02	Medium and High Tensile Steel			
	<p>Rolled Sections and plates shall be of grade designation E350 or higher, Quality B0 (Fully killed), conforming to IS 2062. Plates beyond 12mm thickness and up to 40mm thickness shall be normalized rolled. Plates beyond 40mm thickness shall be vacuum degassed & furnace normalised and shall also be 100% ultrasonically tested as per ASTM –A578 level B-S2.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 178 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS	<div>एन टी पी सी NTPC</div>		
10.05.00	<p>Bricks</p> <p>Bricks shall be table mounted/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 50kg/cm². Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS:13757 and IS:12894 respectively. Minimum fly ash content in fly ash based bricks shall be minimum 25%. Common burnt clay bricks shall conform to IS:1077.</p>			
10.06.00	<p>Foundation Bolts</p> <p>Material and details of foundation bolts shall conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade 1 of IS432 and/ or grade A of IS:2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 upto M36 diameter and IS 5624 for M42 to M150 diameter.</p>			
10.07.00	<p>Stainless steel</p> <p>The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.</p>			
10.08.00	<p>Water</p> <p>Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS:456.</p> <p>All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.</p>			
10.08.00	<p>Statutory Requirements</p> <p>Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.</p> <p>Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.</p> <p>Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.</p> <p>Statutory clearances and norms of State Pollution Control Board shall be followed.</p> <p>Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 179 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एन टी पी सी NTPC</div>
11.00.00	Inspection, Testing And Quality Control			
11.01.00	<p>Sampling and testing of major items of civil works viz. earthwork, concreting, structural steel work (including welding), piling, sheeting, etc. shall be carried out in accordance with the requirements of this specification. Wherever nothing is specified relevant Indian Standards shall be followed. In absence of Indian Standard equivalent International Standards may be used.</p> <p>The Bidder shall submit and finalise a detailed field Quality Assurance Programme before starting of the construction work according to the requirement of this specification. This shall include frequency of sampling and testing, nature/type of test, method of test, setting of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. Tests shall be done in the field and/or at a laboratory approved by the Engineer. The Bidder shall furnish the test certificate from the manufacturer's of various materials to be used in the construction.</p>			
11.02.00	Workmanship and dimensional shall be checked as stipulated below.			
12.00.00	<p>ANNEXURES</p> <p>(a) List Of Codes And Standards</p> <p>All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder. List of some of the applicable Standards, in original Codes and references is as given in Annexure-a of this specification.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 180 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Annexure-(a)			
	<u>LIST OF CODES AND STANDARDS</u>			
	Excavation and Filling			
	IS :2720	Methods of test for soils(relevant parts)		
	IS:4701	Code of practice for earth work on canals.		
	IS:9759	Guide lines for dewatering during construction.		
	IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.		
	Properties, Storage and Handling of Common Building Materials			
	IS:269	33 grade for ordinary Portland cement.		
	IS:383	Coarse and fine aggregates from natural sources for concrete.		
	IS:432	Specification for mild steel and medium tensile steel bars and		
	(Part 1&2)	hard drawn steel wires for concrete reinforcement.		
	IS:455	Portland slag cement.		
	IS:702	Industrial bitumen.		
	IS:712	Specification for building limes.		
	IS:1077	Common burnt clay buidling bricks.		
	IS:1161	Steel tubes for structural purposes.		
	IS:1239	Mild steel tubes, tubulars and other wrought steel fillting - MS tubes.		
	IS:1363	Hexagon head bolts, screws and nuts of productions		
	(Part 1-3)	grade - C.		
	IS:1364	Hexagon head bolts, screws and nuts of productions		
	(Part 1-5)	grade-A & B.		
	IS:1367 (Part 1-18)	Technical supply condition for threaded fasteners.		
	IS:1489 (Part-I)	Portland-pozzolana cement. Fly ash based		
	IS:1542	Sand for Plaster.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2		SUB-SECTION-D-01 CIVIL WORKS
PAGE 181 OF 340				


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div>IS:1566</div><div>Hard drawn steel wire fabric for concrete reinforcement.</div></div> <div><div>IS:1786</div><div>High strength deformed steel bars & wires for concrete reinforcement.</div></div> <div><div>IS:2062</div><div>Hot Rolled Low, Medium and High Tensile Structural Steel</div></div> <div><div>IS:2116</div><div>Sand for masonry mortars.</div></div> <div><div>IS : 2185 (Part 1) (Part 2)</div><div>Hollow & solid concrete blocks. Hollow & solid light weight concrete blocks.</div></div> <div><div>IS:2386 (Part I-VIII)</div><div>Testing of aggregates for concrete.</div></div> <div><div>IS:3812</div><div>Specification for fly ash for use as pozzolona and admixture.</div></div> <div><div>IS:4082</div><div>Recommendation on stacking and storage of construction materiel and components at site</div></div> <div><div>IS:8112</div><div>43 grade ordinary portland cement.</div></div> <div><div>IS:8500</div><div>Structural steel-Microalloyed (Medium and high strength qualities).</div></div> <div><div>IS:12269</div><div>53 grade ordinary portland cement.</div></div> <div><div>IS:12894</div><div>Specification for fly ash lime bricks.</div></div> <div><div>IS:13757</div><div>Burnt clay fly ash building bricks.</div></div> <div><div>Cast in-situ Concrete and Allied Works</div></div> <div><div>IS:280</div><div>Mild steel wire for general engineering purpose.</div></div> <div><div>IS:456</div><div>Code of practice for plain and reinforcement concrete.</div></div> <div><div>IS:457</div><div>Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.</div></div> <div><div>IS:516 IS:1199</div><div>Method of test for strength of concrete. Methods of sampling and analysis of concrete.</div></div> <div><div>IS:1791</div><div>General requirement for batch type concrete mixers.</div></div> <div><div>IS:1834</div><div>Hot applied sealing compound for joints in concrete.</div></div> <div><div>IS:1838</div><div>Preformed fillers for expansion joints in concrete pavement and structures.</div></div> <div><div>IS:2438</div><div>Specification for roller pan mixers.</div></div> <div><div>IS:2502</div><div>Code of practice for bending and fixing of bars for concrete reinforcement.</div></div> <div><div>IS:2505</div><div>Concrete vibrators - immersion type.</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 182 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	IS:2506	General requirements for screed board concrete vibrators.	
	IS:2722	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).	
	IS:2750	Steel scaffoldings	
	IS:2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.	
	IS:3150	Hexagonal wire netting for general purposes.	
	IS:3366	Specification for pan vibrators.	
	IS:3370 (Part 1-4)	Code of practice for concrete structures for the storage of liquids.	
	IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.	
	IS:4014 (Part-1&2)	Code of practice for steel tubular scaffolding.	
	IS:4326	Code of practice for earth quake resistant design and construction of buildings.	
	IS:4656	Form vibrators for concrete.	
	IS:4925	Concrete batching and mixing plant.	
	IS:4990	Plywood for concrete shuttering work.	
	IS:5256	Code of practice for sealing expansion joints in concrete lining on canals.	
	IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.	
	IS:6461	Glossary of terms relating to cement concrete.	
	IS:6494	Code of practice for water proofing of underground reservoir and swimming pools.	
	IS:6509	Code of practice for installation of joints in concrete pavements.	
	IS:7861 (Part -1&2)	Code of practice for extreme weather concreting.	
	IS:9012	Recommended practice for shotcreting.	
	IS:9103	Admixtures for concrete.	
	IS:9417	Recommendations for welding cold worked bars for reinforced concrete construction.	
	IS:10262	Recommended guidelines for concrete mix design.	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS
			PAGE 183 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div>IS:11384Code of practice for composite construction in structural steel and concrete.</div> <div>IS:12118Two parts polysulphide based sealants.</div> <div>IS:12200Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.</div> <div>IS:13311Non destructive testing of concrete - methods of test.</div> <div>(Part 1)Ultrasonic pulse velocity.</div> <div>(Part 2)Rebound hammer.</div> <div>SP-16Design codes for reinforced concrete to IS:456-1978.</div> <div>SP-23Hand book of concrete mixes.</div> <div>SP-24Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)</div> <div>SP-34Hand book on concrete reinforcement and detailing.</div> <div>ACI-318American Concrete Institute code for structural concrete.</div> <div>Precast Concrete Works</div> <div>SP:7National Building Code - Structural Design</div> <div>(Part 6/Sec.7)Prefabrication and system building and mixed / composite construction.</div> <div>IS:10297Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.</div> <div>IS:10505Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.</div> <div>IS:15658Pre-cast concrete block for paving.</div> <div>Masonry & Allied Works</div> <div>IS:1905Code of practice for structural use of unreinforced masonry.</div> <div>IS: 2185Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks</div> <div>Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks</div> <div>IS:2212Code of practice for brick work.</div> <div>IS:2250Code of practice for preparation and use of masonry mortars.</div> <div>IS:2572Code of practice for construction of hollow concrete block masonry.</div> <div>SP:20Hand book on masonry design and construction.</div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 184 OF 340

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Sheeting Works			
	IS:277	Galvanised steel sheets (Plan & corrugated).		
	IS:513	Cold-rolled low carbon steel sheets & strips.		
	IS:730	Hook bolts for corrugated sheet roofing.		
	IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.		
	IS:2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.		
	IS:7178	Technical supply condition for tapping screw.		
	IS:8183	Bonded mineral wool.		
	IS:8869	Washers for corrugated sheet roofing.		
	IS:12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.		
	IS:12436	Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.		
	IS:12866	Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).		
	IS:14246	Continuously pre-painted galvanised steel sheets and coils.		
	BS:5950	Code of practice for design of light gauge profiled		
	(Part-6)	steel sheeting		
	Fabrication and Erection of Structural Steel Works			
	IS:800	Code of practice for General Construction of steel.		
	IS:813	Scheme for symbols for welding.		
	IS:814	Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.		
	IS:816	Code of practice for use of metal arc welding for general construction in mild steel.		
	IS:817	Code of practice for training and testing of metal arc welders.		
	IS:1024	Welding in bridges and substructured subject to dynamic.		
	IS:1181	Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 185 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:1182	Recommended practice for Radiographic examination of fusion welded butt joints in steel plates		
	IS:1608	Mechanical testing of metals - tensile testing		
	IS:1852	Rolling and Cutting Tolerances for Hot rolled steel products.		
	IS:2016	Specification for Plain washers.		
	IS:2595	Code of practice for Radiographic testing		
	IS:2629	Hot dip galvanising of iron and steel		
	IS:3502	Steel chequered plate.		
	IS:3613	Acceptance tests for wire flux combination for submerged arc welding.		
	IS:3658	Code of practice for liquid penetrant flaw detection.		
	IS:3664	Code of practice for ultra sonic pulse echo testing contact and immersion method		
	IS:3757	High strength structural bolts.		
	IS:4000	High strength bolts in steel structure - code of practice.		
	IS:4353	Sub merged arc welding of mild steel and low alloy steel Recommendation		
	IS:4759	Hot dip zinc coating on structural steel and other allied products.		
	IS:5334	Code of practice for magnetic particle flaw detection of welds.		
	IS:5369	General requirements for plain washers and lock washer		
	IS : 6623	High strength structural nuts.		
	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.		
	IS:6911	Stainless steel plate, sheet and strip.		
	IS:7205	Safety code for erection of structural steel.		
	IS:7215	Tolerances for fabrication of structural steel.		
	IS:7307	Approved test for welding procedures		
	(Part - I)	Fusion welding of steel.		
	IS:7310 (Part-I)	Approval test for welders working to approval welding procedure. Fusion welding of steel		
	IS:9178 (Part-1to 3)	Criteria for design of steel bins for storage of bulk material.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 186 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div>IS:9595</div><div>Recommendations for metal arc welding of carbon & carbon manganese steel.</div></div> <div><div>IS:12843</div><div>Tolerances for erection of steel structures.</div></div> <div><div>SP:6 (Part 1 to 7)</div><div>ISI Hand book for structural Engineers.</div></div> <div><div>Plastering and Allied Works</div><div><div>IS:1661</div><div>Code of practice for application of cement and cement lime plaster finishes.</div></div><div><div>IS:2402</div><div>Code of practice for external rendered finishes.</div></div><div><div>IS:2547 (Parts 1&2)</div><div>Gypsum building plaster.</div></div></div> <div><div>Acid and Alkali Resistant Lining</div><div><div>IS:158</div><div>Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.</div></div><div><div>IS:412</div><div>Expanded metal steel sheets for general purpose.</div></div><div><div>IS:4441</div><div>Code of practice for use of silica type chemical resistant mortars.</div></div><div><div>IS:4443</div><div>Code of practice for use of resin type chemical resistant mortars.</div></div><div><div>IS:4456 (Part I & II)</div><div>Method of Test for chemical resistant tiles.</div></div><div><div>IS:4457</div><div>Ceramic unglazed vitreous acid resisting tiles.</div></div><div><div>IS:4832</div><div>Specification for chemical resistant mortars.</div></div><div><div>(Part - 1)</div><div>Silicate type</div></div><div><div>(Part - 2)</div><div>Resin type</div></div><div><div>(Part - 3)</div><div>Sulfur type</div></div><div><div>IS:4860</div><div>Acid resistant bricks.</div></div><div><div>IS:9510</div><div>Bitumastic acid resisting grade.</div></div></div> <div><div>Water Supply, Drainage and Sanitation</div><div><div>IS:458</div><div>Precast concrete pipes (with & without reinforcement).</div></div><div><div>IS:554</div><div>Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.</div></div><div><div>IS:651</div><div>Salt glazed stoneware pipes and fittings.</div></div><div><div>IS:774</div><div>Flushing cisterns for water closets and urinals.</div></div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 187 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	IS:775	Cast iron brackets and supports for wash basins and sinks.		
	IS:778	Copper alloy gate, globe and check valves for water works purposes.		
	IS:781	Cast copper alloy screw down bib taps & stop valves for water services.		
	IS:782	Caulking lead.		
	IS:783	Code of practice for laying of concrete pipes.		
	IS:1172	Code of basic requirements of water supply, drainage and sanitation.		
	IS:1230	Cast iron rain water pipes and fittings.		
	IS:1239 (Part 1&2)	Mild Steel tubes, tubulars and other wrought steel fittings		
	IS:1536	Centrifugally cast (Spun) iron pressure pipes for water.		
	IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.		
	IS:1538	Cast iron fittings for pressure pipe for water, gas and sewage.		
	IS:1703	Copper alloy float valve for water supply fitting.		
	IS:1726	Cast iron manhole covers and frames.		
	IS:1729	Cast iron / Ductile iron drainage pipes and pipe/fittings for over ground non pressure pipeline socket and spigot series.		
	IS:1742	Code of practice for building drainage.		
	IS:2064	Selection, installation and maintenance of sanitary appliances.		
	IS:2065	Code of practice for water supply in buildings.		
	IS:2326	Automatic flushing cisterns for urinals.		
	IS:2548	Plastic seats and covers for water closets.		
	IS:2556	Vitreous sanitary appliances (vitreous china).		
	IS:3114	Code of practice for laying of cast iron pipes.		
	IS:3311	Waste plug and its accessories for sinks and wash basins.		
	IS:3438	Silvered glass mirrors for general purposes.		
	IS:3486	Cast iron spigot and socket drain pipes.		
	IS:3589	steel pipe for water and sewage (168.3 to 2540mm outside diameter)		
	IS:3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 188 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div>IS:4111 (Part 1 to 5)</div><div>Code of practice for ancillary structure in sewerage system.</div></div> <div><div>IS:4127</div><div>Code of practice for laying of glazed stone ware pipes.</div></div> <div><div>IS : 4733</div><div>Methods of sampling and testing sewage effluents.</div></div> <div><div>IS:4764</div><div>Tolerance limits for sewage effluents discharged into inland surface waters.</div></div> <div><div>IS:1068</div><div>Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.</div></div> <div><div>IS:5329</div><div>Code of practice for sanitary pipe work above ground for buildings.</div></div> <div><div>IS:5382</div><div>Rubber sealing rings for gas mains, water mains and sewers.</div></div> <div><div>IS:5822</div><div>Code of practice for laying of electrically welded steel pipes for water supply.</div></div> <div><div>IS:5961</div><div>Specification for cast iron grating for drainage purpose.</div></div> <div><div>IS:7740</div><div>Code of practice for construction and maintenance of road gullies.</div></div> <div><div>IS:8931</div><div>Copper alloy fancy single taps combination tap assembly and stop valves for water services.</div></div> <div><div>IS:9762</div><div>Polyethylene floats for float valves.</div></div> <div><div>IS:10592</div><div>Industrial emergency showers, eye and face fountains and combination units.</div></div> <div><div>IS:12592</div><div>Specification for precast concrete manhole covers and frames.</div></div> <div><div>IS:12701</div><div>Rotational moulded polyethylene water storage tanks.</div></div> <div><div>IS:13983</div><div>Stainless steel sinks for domestic purposes.</div></div> <div><div>SP:35</div><div>Hand book on water supply and drainage with special emphasis on plumbing.</div></div> <div><div>CPH&EEO</div><div>Manual on sewage and sewage treatment</div></div> <div><div>Publication</div><div>- as updated.</div></div> <div><div>Doors Windows and Allied Works</div></div> <div><div>IS:204</div><div>Tower Bolts.</div></div> <div><div>(Part 1)</div><div>Ferrous metals</div></div> <div><div>(Part 2)</div><div>Non - ferrous metals</div></div> <div><div>IS:208</div><div>Door Handles.</div></div> <div><div>IS:281</div><div>Mild steel sliding door bolts for use with padlocks.</div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 189 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS		<div>एन टी पी सी NTPC</div>	
		<div><div>IS:362</div><div>Parliament Hinges.</div></div> <div><div>IS:419</div><div>Putty, for use on window frames.</div></div> <div><div>IS:451</div><div>Technical supply conditions for wood screws</div></div> <div><div>IS:733</div><div>Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.</div></div> <div><div>IS:1003 (Part I)</div><div>Timber panelled and glazed shutters (doors shutters).</div></div> <div><div>IS:1003 (Part-1)</div><div>Timber panelled and glazed shutters door shutters.</div></div> <div><div>IS:1038</div><div>Steel doors, windows and ventilators.</div></div> <div><div>IS:1081</div><div>Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.</div></div> <div><div>IS:1285</div><div>Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).</div></div> <div><div>IS:1341</div><div>Steel butt hinges.</div></div> <div><div>IS:1361</div><div>Steel windows for Industrial buildings.</div></div> <div><div>IS:1823</div><div>Floor door stoppers.</div></div> <div><div>IS:1868</div><div>Anodic coatings on Aluminium and its alloys.</div></div> <div><div>IS:2202 (Part-2)</div><div>Wooden flush door shutters (solid core type) particle board face panels and hard board face panels.</div></div> <div><div>IS:2209</div><div>Mortice locks (vertical type)</div></div> <div><div>IS:2553 (Part-1)</div><div>Safety glass. General purposes</div></div> <div><div>IS:2835</div><div>Flat transparent sheet glass.</div></div> <div><div>IS:3548</div><div>Code of practice for glazing in buildings.</div></div> <div><div>IS:3564</div><div>Door closers (Hydraulically regulated)</div></div> <div><div>IS:3614 (Part-1)</div><div>Specification for fire check doors : plate, metal covered and rolling type.</div></div> <div><div>(Part-2)</div><div>Resistance test and performance criteria.</div></div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 190 OF 340


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div><div>IS:4351</div><div>Specification for steel door frames.</div></div><div><div>IS:5187</div><div>Flush bolts.</div></div><div><div>IS:5437</div><div>Figured, rolled and wired glass.</div></div><div><div>IS:6248</div><div>Specification for metal rolling shutters and rolling grills.</div></div><div><div>IS:6315</div><div>Specification for floor springs (Hydraulically regulated) for heavy doors.</div></div><div><div>IS:7196</div><div>Hold fast.</div></div><div><div>IS:7452</div><div>Hot rolled steel sections for doors, windows and ventilators.</div></div><div><div>IS:10019</div><div>Mild steel stays and fasteners.</div></div><div><div>IS:10451</div><div>Steel sliding shutters (top hung type)</div></div><div><div>IS:12823</div><div>Prelaminated particle boards.</div></div></div> <div>Roof Water Proofing and Allied Works</div> <div><div><div>IS:3067</div><div>code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.</div></div><div><div>ASTM</div><div>Standard specification for high solid content cold</div></div><div><div>C836-89a</div><div>liquid applied elastomeric water proofing membrane for use with separate wearing course.</div></div><div><div>ASTM</div><div>Standard guide for high solid content cold</div></div><div><div>C898-89</div><div>liquid applied elastomeric water proofing membrane for use with separate wearing course.</div></div></div> <div>Floor Finishes and Allied Works</div> <div><div><div>IS:5318</div><div>Code of practice for laying of flexible PVC sheet and tile flooring.</div></div><div><div>IS:8042</div><div>White portland cement.</div></div><div><div>IS:13755</div><div>Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).</div></div><div><div>IS:13801</div><div>Chequered cement concrete tiles.</div></div></div> <div>Painting and Allied Works</div> <div><div><div>IS:162</div><div>Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.</div></div><div><div>IS:428</div><div>Distemper, oil, emulsion, colour as required.</div></div><div><div>IS:1477</div><div>Code of practice for painting of terrous metals in buildings.</div></div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 191 OF 340

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	(Part -1)	Pretreatment.		
	(Part -2)	Painting.		
	IS:1650	Specification for colours for building and decorative materials.		
	IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.		
	IS:2338	Code of practice for finishing of wood and wood based materials.		
	(Part -1)	Operations and Workmanship.		
	(Part -2)	Schedule.		
	IS:2395	Code of pratice for painting concrete, masonry and plaster surfaces.		
	(Part-1)	Operations and Workmanship.		
	(Part -2)	Schedule.		
	IS:2524	Code of practice for painting of nonferrous metals in buildings.		
	(Part -1)	Pretreatment		
	(Part -2)	Painting.		
	IS:2932	Enamel, synthetic, exterior, (a) under coating and (b) finishing.		
	IS:2933	Enamel exterior, (a) under coating, (b) finishing.		
	IS:4759	Hot dip zinc coatings on structural steel and other allied products.		
	IS:5410	Specification for cement paint.		
	IS:15489	Plastic emulsion paint.		
	IS:6278	Code of practice for white washing and Colour washing.		
	IS:10403	Glossary of term related to building finish.		
	IS:12027	Silicone based water repellent		
	IS:13238	Epoxy based zinc phosphate primer (2 pack)		
	IS:13239	Epoxy surfacer (2 pack)		
	IS:13467	Chlorinated rubber for paints		
	IS:14209	Epoxy enamel, two component glossy.		
	BS:5493	Code of practice for protective coating of iron and steel structures against corrosion.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 192 OF 340

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	Piling and Foundation			
	IS:1080	Code of practice for design and construction of shallow foundations on soils.		
	IS:1904	Code of practice for design and construction of foundation in Soils : General Requirements.		
	IS:2314	Steel sheet piling sections.		
	IS:2911	Code of practice for design and construction of pile foundations. (Relevant Parts)		
	IS:2950	Code of practice for designs and construction of Raft foundation.		
	(Part-1)	Design		
	IS:2974 (Part-1 to 5)	Code of practice for design and construction of machine foundation.		
	IS:4091	Code of practice for design and construction foundations for transmission line towers and poles.		
	IS:6403	Code of practice for determination of Bearing capacity of Shallow foundations.		
	IS:8009	Code of practice for calculation of settlement of foundation.		
	(Part -1)	Shallow foundations.		
	(Part -2)	Deep foundations.		
	IS:12070	Code of practice for design and construction of shallow foundations on rocks.		
	ISO 10816	Criteria for assessing mechanical vibrations of machines.		
	ISO 1940	Criteria for assessing the st of balance of rotating rigid bodies.		
	DIN : EN 13906-1	Helical compression spring made of round wire and rod : calculation and design of compression .		
	DIN:2096	Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.		
	DIN:4024	Flexible supporting structures for machine with rotating machines.		
	Roads			
	IRC:5 (Section-1)	Standard specifications and Code of practice for road bridges, General Features of Design.		
	IRC:14	Recommended practice for 2cm thick bitumen and tar carpets.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 193 OF 340

CLAUSE NO.	<div data-bbox="624 232 1005 262" style="text-align: center;">TECHNICAL REQUIREMENTS</div> <div data-bbox="1262 203 1402 275" style="text-align: right;">  </div>		
	<div data-bbox="381 315 1398 1854"> <div> <div>IRC:15</div> <div>Standard specifications and code of practice for construction of concrete roads.</div> </div> <div> <div>IRC:16</div> <div>Specification for priming of base course with bituminous primers.</div> </div> <div> <div>IRC:19</div> <div>Standard specifications and Code of practice for water bound macadam.</div> </div> <div> <div>IRC:21 (Section-III)</div> <div>Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).</div> </div> <div> <div>IRC:34</div> <div>Recommendations for road construction in water logged areas.</div> </div> <div> <div>IRC:36</div> <div>Recommended practice for the construction of earth embankments for road works.</div> </div> <div> <div>IRC:37</div> <div>Guidelines for the Design of flexible pavements.</div> </div> <div> <div>IRC:56</div> <div>Recommended practice for treatment of embankment slopes for erosion control.</div> </div> <div> <div>IRC:58</div> <div>Guidelines for the design of rigid pavements for highways.</div> </div> <div> <div>IRC:73</div> <div>Geometric Design standards for rural (non-urban) highways.</div> </div> <div> <div>IRC : 86</div> <div>Geometric Design standards for urban roads in plains.</div> </div> <div> <div>IRC:SP:13</div> <div>Guidelines for the design of small bridges & culverts.</div> </div> <div> <div>IRC - Publication</div> <div>Ministry of Surface Transport (Road wing), specifications for road and bridge works.</div> </div> <div> <div>IS:73</div> <div>Paving bitumen.</div> </div> <div> <div>Loading</div> </div> <div> <div>IS:875</div> <div>Code of practice for design loads (other than earthquake) for (Relevant parts) buildings and structures.</div> </div> <div> <div>IS:1893</div> <div>Criteria for earthquake resistant design of structures.</div> </div> <div> <div>IS:4091</div> <div>Code of practice for design and construction of foundation for transmission line towers and poles.</div> </div> <div> <div>IRC:6 (Section-II)</div> <div>Standard specifications & Code of practice for road bridges. loads and stresses</div> </div> <div> <div>Safety</div> </div> <div> <div>IS:1641</div> <div>Code of practice for fire safety of buildings - General principles of fire grading and classification.</div> </div> <div> <div>IS:1642</div> <div>Code of practice for fire safety of buildings - Details of construction.</div> </div> <div> <div>IS:3696</div> <div>Safety code for scaffolds and ladders.</div> </div> </div>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 194 OF 340

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>(Part-1&2)</p> <p>IS:3764 Excavation work - code of safety.</p> <p>IS:4081 Safety code for blasting and related drilling operations.</p> <p>IS:4130 Demolition of buildings - code of safety.</p> <p>IS:5121 Safety code for piling and other deep foundations.</p> <p>IS:5916 Safety code for construction involving use of hot bituminous materials.</p> <p>IS:7205 Safety code for erection of structural steel work.</p> <p>IS:7293 Safety code for working with construction machinery.</p> <p>IS:7969 Safety code for handling and storage of building materials. Indian Explosives (As updated) Act 1940)</p> <p>Architectural Design of Buildings</p> <p>SP:7 National Building Code of India</p> <p>SP:41 Hand book on functional requirements of buildings (other than industrial buildings)</p> <p>ECBC Energy Conservation Building Code</p> <p>GRIHA Green Rating For Integrated Habitat Assessment.</p> <p>Chimney</p> <p>IS:4998 Criteria for design of reinforced chimneys IS:6533 Code of practice for design and construction of steel chimneys</p> <p>ICAO International Civil Aviation Organisation (ICAO)</p> <p>DGCA Instruction of Director General of Civil Aviation , India</p> <p>ACI:307 Specification for the design and construction of reinforced concrete chimneys</p> <p>BS:4076 Specification for steel chimneys</p> <p>CICIND Model Code for concrete chimneys Model code for steel chimneys</p> <p>ASCE Code Design and construction of steel chimney liners prepared by Task committee on steel chimney liners. Fossil power committee, Power division published by ASCE - 1975.</p> <p>IS:1554 PVC insulated (heavy duty) electric cables</p> <p>IS:2606 Alloy lead anodes for chromium plating</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 195 OF 340

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<div><div><div>IS:3043</div><div>Code of Practice for Earthing</div></div><div><div>IS:9537</div><div>Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act</div></div><div><div>IS:2309</div><div>Practice for protection of buildings and allied structures against lightning</div></div><div><div>Miscellaneous</div></div><div><div><div>IS:802 (Relevant parts)</div><div>Code of practice for use of structural steel in overhead trans- mission line towers.</div></div><div><div>IS:803</div><div>Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.</div></div><div><div>IS:10430</div><div>Criteria for design of lined canals and guidance for selection of type of lining.</div></div><div><div>IS:11592</div><div>Code of practice for selection and design of belt conveyors.</div></div><div><div>IS:12867</div><div>PVC handrails covers.</div></div><div><div>IS 11504</div><div>Criteria for structural design of reinforced concrete natural draught cooling towers</div></div><div><div>BS:4485 (IV)</div><div>British Standard : Code of design for water cooling towers</div></div><div><div>CIRIA Publication IS 4671</div><div>Design and construction of buried thin-wall pipes. Expanded polystyrene for thermal insulation purposes.</div></div></div></div>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)		TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 196 OF 340

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2D3

TECHNICAL SPECIFICATION FOR TRANSMISSION LINE WORKS

**NOTE: IN THIS DOCUMENT “NORTH KARANPURA STPP (3X660 MW)” TO BE READ AS
“PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3x800 MW)”**

SUB SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Structures.

(In case any variance in Section-2 , NTPC specification shall prevail.)

2.1 STEEL MATERIAL

Mild Steel (MS) materials shall be tested quality and shall conform to IS:2062 and High Tensile (HT) Steel shall be tested quality and shall conform to IS: 8500. Steel material (Both HT and MS) should be procured from NTPC approved source.

Steel shall not be pitted and should be free from scales and rust. If the rolled section and plates are bent or distorted, bend or distortion shall normally be removed by the cold treatment. Straightening under hot stage shall be resorted to only under specific permission from BHEL. If any rolling defects viz., laminations, cracks etc. are discovered in the steel during the processing, it is to be rejected.

TOLERANCE:

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS:1852-1985.

No rolled or fabricated member shall deviate from straightness by more than 1/1000 of the axial length or 10mm whichever is smaller.

2.2 FABRICATION

GENERAL:

All the workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burrs. Shearing and cropping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Material at the shops shall be kept clean and protected from weather.

The fabrication of galvanized steel structures shall be carried out generally in accordance with IS:802 part. II, IS:800-1984. All materials shall be completely shop fabricated. Normally, butt splices shall be used. The components constituting the joint shall have a total strength greater than the heavier of the members connected. Lap splices may be used for connecting members of unequal sizes. The inside angle of lap splice shall be grounded at the heel to fit the fillet of the outside angle. The splices shall develop full strength of the members connected through bolts. Butt as well as lap splices shall be made as close to the main panel points as possible.

Joints shall be so designed and detailed as to avoid eccentricity as far as possible. However, where joints are such that the elimination of gusset plates

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

would result into eccentric joints, gusset plates and spacer plates may be used in conformity with modern practices.

The use of filler in the connections shall be avoided as far as possible. The diagonal members in tension may be connected entirely to the gusset plate where necessary to avoid the use of fillers. Each diagonal shall be in one piece without splices or center gussets, and it shall be connected at the point of intersection by one or more bolts.

The gap between the ends of two connected members in butt joints shall not be more than 6 mm and less than 4mm.

The tower structure members shall be accurately fabricated to bolt together easily at site without any undue strain on them or the bolts.

Drain holes shall be provided at all points where pockets or depressions are likely to hold water.

For designing of towers , preferably rationalized steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to owner and the same shall be borne by the bidder. However design approval for such substitution shall be obtained from owner before substation.

STRAIGHTENING:

For rolled steel material, if straightening or flattening is necessary, it shall be done by methods that will not injure the materials.

CUTTING:

Cutting may be effected by chopping, cropping, sawing or machine flame cutting. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

PUNCHING AND DRILLING:

Holes in members may be punched full size through material not over 12mm thick. Holes must be cleaned of burrs and ragged edges. Drilled holes shall be preferred. Holes made by drilling shall also be cleaned of burrs and ragged edges. Where several parts are to be drilled, they shall be first assembled, tightly clamped together and drilled through.

Punched holes must be square with plates and the walls of the holes shall be parallel. The following maximum allowance in accuracy of punched holes is permissible:

- i) Holes must be perfectly circular and no tolerance in this respect is permissible.
- ii) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm, i.e. the allowable taper in punched holes should not exceed 0.8 mm in diameter.

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

- iii) Holes must be square with the plates. Holes at angle or slant shall not be permitted.

The minimum spacing of bolts and edge distances shall be as given below:

Bolt Diameter (mm)	Minimum Bolt Spacing (mm)	Maximum edge distance	
		Hole center To rolled Edge (mm)	Hole center to cut/ flame edge (mm)
16	40	20	23

WELDING:

The work shall be done as per approved fabrication drawings, qualified welding procedure specifications (WPS) and by qualified welders. Procedure qualification records (PQR) shall be maintained. Electrodes for shielded arc manual welds shall comply with the requirements of IS:814 - 1991. All welds shall be free from defects like blow holes, slag inclusions, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of all slag or flux before galvanizing.

MARKING OF MEMBERS FOR IDENTIFICATION.

All members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on. The erection mark shall be stamped with a metal dye with figures at least 16 mm high and to such optimum depth as to be clearly visible, even after a member is galvanized. All erection marks shall be on outer surface of all sections and near one end, but clear of bolt holes. Marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 3.0 M or more shall have the erection mark at both ends.

PROTOTYPE ASSEMBLY:

Towers shall be trial assembled at shop before galvanizing i.e. prototype assembly keeping in view the actual site condition prior to dispatch to testing station/erection sites. The prototype assembly of each structure shall be got approved from BHEL/Customer as directed. Necessary match marks shall be made on each components before dismantling the prototype assembly and galvanizing. Any error shall be rectified at the expense of the contractor.

No extra charge on account of erecting the assemblies or getting them inspected will be permissible. It is however to be mentioned that the responsibility for proper fitting of various members for the erection of the structure in the field will rest with the supplier and any discrepancy found at the time of erection will have to be rectified by the contractor at his cost.

2.3 GALVANISING:

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES

All structural steel works shall be hot dip galvanized after fabrication. Galvanizing of each members shall be carried out in one complete immersion and double dipping shall not be permitted.

Zinc required for galvanizing will have to be arranged for by the Contractor. Purity of zinc to be used for galvanizing shall be 99.5% as per IS:209-1992.

All burrs and irregular edges shall be ground smooth before galvanizing.

After all shop work is complete, all structural materials shall be punched with the Erection Mark and be hot dip galvanized. Before galvanizing the steel section shall thoroughly be cleaned of any paint, grease, rust, scale, acid/alkali or such other foreign matters as are likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Pickling shall be carefully done and shall be proper.

Minimum weight of zinc coating shall be 610gms/sqm. However, higher coating may be provided as per requirement.

The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky deposits, blistered surface 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.

There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633 - 1986.

When the steel section is removed from the galvanizing kettle excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specification, or lack of quality control in any manner in the galvanizing plant shall render the entire production in the relevant shift liable to rejection.

All the galvanized structural steel members and accessories shall be treated with sodium dichromate or an approved equivalent solution after galvanizing, so as to prevent white storage stains.

If the galvanizing of any member is damaged, BHEL shall be shown of the extent of damage and if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost.

Contractor shall also furnish sufficient quantity of appropriate paint, free of cost, for repairing galvanized surfaces damaged in transit, and minor modifications done at site during erection.

Galvanizing tests shall be made from time to time on as many samples as may be considered necessary. The supplier shall supply all samples and equipment and carry out the tests without any extra cost.

2.4 INSPECTION OF MATERIALS

GENERAL:

Contractor shall give notice to BHEL/ Customer in advance for inspection of materials. All rejected material shall be promptly removed from the shop and replaced with new material for BHEL/ Customer approval/ inspection. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by BHEL/ Customer if it fails to be in proper condition or has fabrication inaccuracies which prevent proper assembly. No materials shall be painted, galvanized or dispatched to site without the inspection and approval by BHEL/ Customer unless such inspection is waived off in writing by BHEL/ Customer.

Shop inspection by BHEL/ Customer, for submission of test certificates and acceptance thereof by BHEL/ Customer shall not relieve contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which BHEL/ Customer may make because of defective or unsatisfactory material and workmanship.

Contractor shall provide all the testing and inspection services and facilities for shop work. For fabrication work carried out in the field the standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to BHEL/ Customer.

The supplier shall submit QP (Quality Plan) detailing each stage of manufacturing i.e. raw-material, in process and final inspection for approval by BHEL/Customer in the prescribed format of NTPC. The final Quality plan shall be approved by BHEL/ Customer.

MATERIAL TESTING

If mill test reports are not available for any steel materials the same shall be got tested by the contractor and demonstrate conformity with the relevant specification to the full satisfaction of BHEL/ Customer. The cost of such tests shall be borne by the contractor.

DIMENSIONS AND WORKMANSHIP:

The Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish, are in accordance with the requirements shown in Contractor's approved shop drawings.

INSPECTION OF TEST FAILURE:

In the event of any failure of structural steel members to meet an inspection or test requirement, contractor shall inform BHEL/ Customer and must obtain permission from the BHEL/ Customer before repair is undertaken. The quality control procedures to be allowed to ensure satisfactory repair shall be subject to approval by BHE/ Customer L.

2.5 PACKING TRANSPORTATION AND DELIVERY

After completion of final inspection and marking, the fabricated galvanized structural items shall be packed and loaded for transportation.

Packing must be adequate to protect items against bending and any mechanical injuries and damage to galvanized film during loading and unloading. As far as possible, like member should be bundled together and tied.

Proper lifting devices shall be used for loading at shop and unloading at site in order to protect items against bending, mechanical injuries and damage to galvanized film.

Loading, transporting and unloading shall be done in compliance with transportation rules.

Slender and projected parts shall be braced properly with additional spacer steel bars, spacer wood etc, before loading for transportation, to protect against bending or any other damages during transportation.

If certain parts cannot be transported in the lengths stipulated in the design drawing, the position and type of additional splice joints shall be got approved from BHEL/ Customer.

Items must be carefully loaded and tied up properly to prevent bending, falling etc. during transportation.

The small parts such as plates, gussets, cleats etc. shall be securely tied with the wire, and packed in wooden boxes and properly identified.

As far as possible the delivery of fabricated galvanized structural steel shall be as per the order stipulated by BHEL/ Customer and to suit the erection sequence.

Contractor shall make good/ replace at his own cost any damage occurred during loading, transporting, unloading and stacking of fabricated galvanized steel structures as directed by BHEL/ Customer. No extra payment on this account shall be entertained under any circumstances.

2.6 APPLICABLE STANDARDS

Unless otherwise specified, materials, and workmanship shall conform to the following standards of their latest editions:

1. IS : 209 - Zinc Ingot.

SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES


- | | | |
|-----|---|---|
| 2. | IS : 228 | - Method of chemical analysis of pig iron, cast iron, plain carbon and low alloy steel. |
| 3. | IS : 406 | - Methods of analysis of zinc (Spelter). |
| 4. | IS : 800 | - Code of practice for general construction. |
| 5. | IS : 802 - Part1 -
Part1/Sec.2
- Part 2
- Part 3 | - - Code of Practice for use of structural in over head Transmission line towers. |
| 6. | IS : 806 | - Code of practice for use of steel tubes in general building construction. |
| 7. | IS : 808 | - Dimensions for hot rolled steel beam, column, channel and angle sections. |
| 8. | IS : 814 | - Covered electrodes for manual metal arc welding of carbon and carbon manganese steel. |
| 9. | IS : 816 | - Code of Practice for use of metal arc welding for general construction in mild steel. |
| 10. | IS : 817 | - Code of practice for training & testing of Metal Arc welders. |
| 11. | IS : 1161 | - Steel tubes for structural purposes. |
| 12. | IS : 1599 | - Method of bend test |
| 13. | IS : 1608 | - Method of tensile testing of steel products. |
| 14. | IS : 1852 | - Rolling and cutting tolerances for hot rolled steel products. |
| 15. | IS : 1978 | - Line pipe |
| 16. | IS : 2062 | - Steel for general structural purposes. |
| 17. | IS : 2074 | - Ready Mixed Paint, air drying red oxide zinc, chrome, priming. |
| 18. | IS : 2629 | - Recommended practice for hot dipped galvanising on Iron & Steel. |


SPECIFICATION FOR SUPPLY OF GI LATTICE STRUCTURES


- | | | |
|-----|-----------|---|
| 19 | IS : 2633 | - Methods for testing uniformity of coating on zinc coated articles. |
| 20. | IS : 3502 | - Steel chequered plates. |
| 21. | IS : 4759 | - Hot dip zinc coating on structural steel and other allied products. |
| 22. | IS : 6745 | - Method for determination of mass of zinc coating on zinc coated iron and steel articles |
| 23. | IS : 8500 | - Specification for micro-alloyed structural steel |

NTPC SPECIFICATION FOR TRANSMISSION LINE TOWER MATERIAL.

(In case of any variance in Sub Section -2 , NTPC specification shall prevail.)

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.00.00	220kV TRANSMISSION LINES - GENERAL			
11.01.00	SCOPE AND GENERAL INFORMATION			
	In addition to the project information and scope of work given in this specification, the following is the scope of work for overhead Transmission line work:			
11.01.01	This specification covers detailed survey, tower spotting, optimization of tower location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all types of transmission line towers including tower which are already designed and tested for equal or higher loads as specified in this specification, bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device, etc.; foundation design, selecting type of foundation for different towers and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion, supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors, OPGW/earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines.			
11.01.02	Further for type tested towers bidder shall furnish design calculation for transmission line tower structures along with foundation design and drawing meeting the requirements of this technical specification.			
11.01.03	This specification includes the design and supply of insulator and their hardware conductor and earthwire, earthwire suspension and tension clamps and all the other line accessories to be incorporated in the towers during erection and stringing.			
11.01.04	All the raw materials such as steel, zinc for galvanising, reinforcement steel and cement for foundation, coke and salt for earthing, bird guards, anti climbing devices, bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate etc. required for tower manufacture and erection shall be included in the scope of supply.			
11.01.05	The entire stringing work of conductor and earthwire shall be carried out as per standard stringing practice.			
11.01.06	The Contractor shall carry out the detailed survey and shall submit report/results within one (1) month of date of mobilization at site. No other details except those included in tender documents shall be furnished by the Owner. Also no topographical maps shall be furnished by Owner. However, Owner's assistance may be given in obtaining these maps from Survey of India.			
11.01.07	The tree-cutting shall be responsibility of the Contractor. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut. Contractor may note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.			
11.02.00	ROUTE AND TERRAIN			
11.02.01	The 220kv Double Circuit Transmission Line shall be connecting 220KV North Karanpura Switchyard and 220 KV Chatti Bariatu & Kerandari-A Coal Mine substation. The latitude and Longitude of the Chatti Bariatu & Kerandari-A Coal Mine substation are indicated in clause 1.15.00 of subsection IIB Section – VI Part-A. The Bidder may carryout preliminary / detailed survey of the corridor so as to acquaint himself to the transmission line route, crossings, ground profile and levels.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 59 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
11.02.02	Right of way and way leave clearance shall be arranged by the Owner.			
11.02.03	To evaluate and tabulate the trees and bushes coming within 13.5 meters on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of one meter from ground level. The trees list should contain the following: a) Girth (circumference) measured at a height of 1 meter from ground level. b) Approximate height of the tree with an accuracy of + 2 meters. c) Name of the type of the species/tree. d) The bushy and under growth encountered in the 1.5 meters belt should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.			
11.02.04	Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.			
11.03.00	DETAILED SURVEY			
11.03.01	The detailed survey shall be carried out along the Transmission Line alignment by successful bidder/contractor.			
11.3.2	Route Marking At the starting point of the commencement of route survey, an angle iron spike of 65 x 65 x 6 mm section and 1000 mm long shall be driven firmly into the ground to project only 150 mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50 x 50 x 650 mm size shall be driven at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed upto the next angle point. Nails of 100 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. At angle position stone/concrete pillar with "NTPC" marked on them shall be put firmly on the ground for easy identification.			
11.03.03	Profile Plotting & Tower Spotting From the field book entries the route plan with route details and level profile shall be plotted and prepared as per approved procedure. Reference levels at every 20 meters along the profile are also to be indicated on the profile besides R/Ls at undulations. Areas along the profile, which in the view of the Contractor are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels is too high, the chart may be broken up according to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be in accordance with the IS Standard. For `as built' profile these shall be A1 size			
11.03.04	Sag Template Necessary data in respect of conductor, earthwire and insulator have been given in the specifications. On the basis of these, the Contractor shall prepare the sag template drawing and tower spotting data and submit the same alongwith sag tension calculations for the approval of the Owner. Sag template prepared based on the approved sag-template curve drawing shall only be used for tower spotting on the profiles. Two numbers of the approved template, prepared on rigid transparent plastic sheets, shall be provided by the Contractor to			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 60 of 102				

CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL REQUIREMENTS		
11.03.05	<p>the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.</p> <p>Tower Spotting</p> <p>With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:</p> <p>a) Span</p> <p>The number of consecutive spans between the section points shall not exceed 15 spans. Section point shall comprise of tension point with B type, C type or D Type towers as applicable. For all crossing spans such as major road crossings, railway crossings, power line crossings etc. the span shall not exceed 80% of design span.</p> <p>b) Extension</p> <p>An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification.</p> <p>c) Road Crossing</p> <p>At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall be in line with IE rules. At all national highway crossings, tension towers shall be used.</p> <p>d) Railways Crossings</p> <p>At the time of detail survey all the railway crossings coming enroute the transmission line shall be finalised as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987):</p> <p>i) The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings.</p> <p>ii) The crossing shall normally be at right angle to the railway track.</p> <p>iii) The crossing span shall be limited to 80% of design span.</p> <p>iv) The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track..</p> <p>v) No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.</p> <p>vi) Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as per IE rules.</p> <p>The approval for crossing railway track shall be obtained by the Owner from the Railway Authority. However, six copies of profile and plan, tower and foundation design and</p>		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 61 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी</div> <div>NTPC</div>
	<p>drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.</p> <p>e) River Crossings</p> <p>In case of major river crossing, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be C type tower. Clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL).</p> <p>f) Power Line Crossing</p> <p>Where this line is to cross over another line of the same voltage or lower voltage, towers with suitable extension shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956. The Contractor may be required to under-cross higher voltage lines by erecting gantries/suitable Rail Pole structures.</p> <p>g) Telecommunication Line Crossing</p> <p>The angle of crossing shall be as near 90 degree as possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. When the angle of crossing has to be below 60 degree, the matter will be referred to the authority incharge of the telecommunication system. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner. Also, in the crossing span power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.</p> <p>h) Details Enroute</p> <p>All topographical details, permanent features, such as trees, building etc. 13.5m on either side of the alignment shall be detailed on the profile plan.</p> <p>Ash Pipe Line (If applicable)</p> <p>Adequate clearances shall be maintained from ash pipe line and adjacent road.</p> <p>i) Clearance from Ground, Building, Trees, etc.</p> <p>Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.</p>			
11.04.00	PRELIMINARY LINE SCHEDULE			
	<p>The profile sheets, duly spotted, alongwith preliminary schedules indicating type of towers, wind span, weight span, angle of deviation, river, power line, railway or road crossing and other details shall be submitted for the approval of the Owner. After approval, the Contractor shall submit six more sets of the approved reports along with two sets in soft copy of final profile drawings to the Owner for record purpose.</p>			
11.05.00	CHECK SURVEY OF TOWER LOCATIONS			
11.05.01	<p>The detailed survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the process, it is necessary to have the pit centers marked according to the excavation marking charts. The levels, up or</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 62 of 102

CLAUSE NO.

TECHNICAL REQUIREMENTS

11.05.02

down of each pit center with respect to the center of the tower locations shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters.

Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.

11.06.00

ELECTRICAL SYSTEM DATA


- | | |
|--|--------------|
| a) Nominal voltage | 220 kV |
| b) Maximum system voltage | 245 kV |
| c) BIL (Impulse) | 1050kVp |
| d) Power frequency withstand voltage (wet) | 460 kV (rms) |


11.07.00

LIST OF STANDARDS (LATEST EDITION OF STANDARDS SHALL BE FOLLOWED)

Unless specified otherwise analysis & design of various components and systems of transmission line shall be in accordance with latest editions, latest amendments, of the relevant Indian & other international standards.(except for those references where the year of publication is specifically mentioned)

	<u>Indian Standards</u>	<u>Title</u>	<u>International & Internationally recognised standards</u>
1.	IS:209	Specification for Zinc	ISO/R/752-1968 AST, B6
2.	IS:2062	Structural Steel (Standard Quality)	ISO/R/6F30-1967 CAN/CSA G40.21 BS 4360
3.	IS:269	Ordinary rapid hardening & low heat Portland Cement.	ISO/R/597-1967
4.	IS:278	Specification for barbed wire	ASTM A 121
5.	IS:383	Coarse and fine aggregates from natural sources for concrete.	CSA A 23.1/A 23.2
6.	IS:398	Alum. Condr. galvanised steel reinforced	
7.	IS:406	Methods of Chemical Analysis of Slab Zinc	
8.	IS:432 (Part 1 & 2)	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement	CSA-G-30
9.	IS:456-1978	Code of practice for plan and reinforced concrete	

CLAUSE NO.	<div style="text-align: right;">  </div> TECHNICAL REQUIREMENTS		
10.	IS:731-1971	Porcelain Insulators for Overhead lines with a Nominal Voltage greater than 1000 volts	BS:137-1973 (I & II) Power IEC:274-1968 IEC:383-1976
11.	IS:800-1984	Code of practice for use of structural in general Building construction	CSA STEAM 16.1 steel
12.	IS:802	Code of practice for use of structural steel in overhead transmission Line. (Load, Permissible stresses. Fabrication, Galvanising, Inspection, and Packing and Testing)	IEC 826 ASCE 52 BS 8100
13.	IS:1139-1966	Hot rolled mild steel medium tensile steel and high yield strength deformed Bars for concrete reinforcement	CAN / CSA G 30 18
14.	IS:1367-1967	Technical supply conditions for threaded fasteners	
15.	IS:1489-1991	Portland Pozzolana Cement	ISO/863-1968
16.	IS:1521-1972	Method of Tensile Testing of Steel wire	
17.	IS:1573-1976	Electroplated Coating of Zinc on Iron & Steel	
18.	IS:1778-1980	Reels and Drums of Barewire	
19.	IS:1786-1985	High strength deformed steel bars and wires for concrete reinforcement	
20.	IS:1893-1984	Criteria of Earthquake resistant design of structures.	IEEE 693
21.	IS:2016-1967	Plain Washers	ISO/R/887-1968 ANSI B 18.22.1
22.	IS:2070- 1962	Method of impulse voltage testing	
23.	IS:2071	Method of high voltage testing	
24.	IS:2121-1981	Specification for conductors and earthwire Accessories for Overhead Power Lines	ASTM D 1883
	Part-I Part-II	Armour Rods Mid-span joints & repair sleeves for conductors	
25.	IS:2131-1967	Method of Standard penetration test for soils.	
26.	IS:2551-1982	Danger Notice Plates	
27.	IS:2486	Specification for Insulator Fittings for	
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD Page 64 of 102

CLAUSE NO.		TECHNICAL REQUIREMENTS		
		overhead Power Lines with a nominal voltage greater than 1000 volts Part- I General Requirements and Tests Part-II Dimensional Requirements Part-III Locking Devices	BS:3288-1972 IEC:120-1960 IEC:372-1976	
28.	IS:2629-1985	Recommended practice for hot dip galvanising of iron & steel.	ASTM A 123 CAN/CSA G 164	
29.	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles.	ASTM A 123 CAN/CSA G 164	
30.	IS:3043-1987	Code of Practice for earthing (with amendment No. 1 & 2).		
31.	IS:3063-1994	Single Coil Rectangular Section spring washers for bolts, nuts, screws.	DIN - 127-1970	
32.	IS:3138-1966	Hexagonal bolts and nuts	ISO/R 947 and ISO/R 272	
33.	IS:3188-1980	Characteristics of string insulator units	IEC:305-1906	
34.	IS:4091-1979	Code of practice for design and construction of foundation for transmission line tower and poles.	ASCE / IEEE 691	
35.	IS:4218-1976	Metric Screw Threads.	ISO:68-1969 R-26-1963, R-262-1969 R-965-1965	
36.	IS:4826-1979	Galvanised coatings on round steel wire	BS:443-1969	
37.	IS:5300-1980	Porcelain Guy strain insulators		
38.	IS:5358-1969	Hot dip galvanised coatings on fasteners	ASTM A 153 CAN/CSA G 164	
39.	IS:5613 (Part-II) 1985	Code of practice for Design, installation & maintenance of overhead power lines		
40.	IS:6610-1972	Specification for heavy washers for steel structures.		
41.	IS:6639 -1972	Hexagonal bolts for structure	ASTM A 394 CSA B 33.4	
42.	IS:6745-1972	Methods for determination of weight of Zinc coated iron and steel articles	ASTM A 90	
43	Pub. No. 19 (N)/ 700-1963	Regulation for Electrical Crossing of Railway Tracks.		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 65 of 102

44.	IS:7814-1985	Phosphor bronze sheet, strip and foil	BS:2870-1968
45.	IS:8263-1976	Method of Radio Interference tests on high voltage insulators	NEEMA:107 – 1964 CISPR/IEC:437-1973
46.	IS:8269-1976	Method of switching impulse test on high voltage insulators	IEC:506-1975
47.	IS:8500-1991	Specification for weld-able structural steel (Medium and High strength qualities).	BS : 4360
48.	IS:9708-1993	Specifications for Stockbridge Vibration Dampers for overhead power lines	
49.		Thermal mechanical performance test and mechanical performance test on String insulator units	IEC: 575-1974


12.00.00 GENERAL DESCRIPTION OF TOWERS
12.01.00 Types of Towers

- 12.01.01 The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires/ OPGW and all fittings under all loading conditions.
- 12.01.02 The tower shall be of a fully galvanised structure, using structural mild steel sections for members. Bolts and nuts with spring washers shall be used for connections.
- 12.01.03 Bidders can also use high tensile steel and cold formed steel for fabrication of towers provided they furnish the justification for use of such steel with reference to national or international standards. However, the factors of safety, limitation on member length, requirement of fasteners and galvanisation shall be as specified in this specification.

The towers shall be classified as given in Table -1

Table -1

Type of Tower	Deviation limit	Typical use
A	0 to 2	To be used as tangent/suspension tower
B	0 to 15	a) Angle towers with tension insulator string b) Tension tower for uplift forces resulting from an uplift span up to half of ruling span under broken wire condition c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.
B	0	d) to be used as section tower

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	C	5 to 30 degree.	a) Angle tower with tension insulator string b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.	
	D	30 deg. To 60 deg.	a) Angle tower with tension insulator string. b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition. c) Also to be designed for the unbalanced tension resulting from unequal ruling span as specified in Table T1-2. d) Dead end with 0 deg. to 15 deg deviation both on line and sub- station side (slack span).	
	D	0deg.	e) Complete dead end.	
	D	90deg.	f) To be used near switchyard with Reduced design and span	
	NOTE: 1) For double circuit tower types, A, B, C and D shall be prefixed by 'D'. 2) Special type of tower/ higher voltage class towers, wherever required shall also be provided by the bidder under the contract at no extra cost.			
12.01.04	Extension a) The single and double circuit tower shall be designed so as to be suitable for adding 3M, 6M and 9M body extension for maintaining adequate ground clearance without reducing the specified factor of safety in any manner. b) For power line crossing 25 metre extensions with D type towers are required. The 25 metre extension should be designed in such a manner the same can also be used as 18 metre extension to normal tower after removal of bottom panels. c) For under line crossing of EHV transmission lines the bidder shall have to design minus-three metres and minus six metre extensions to D type tower.			
12.01.05	Stub Setting templates. Stub templates shall be designed and arranged by the contractor at his own cost for all types of tower with or without extension and also for leg extension. Stub templates for standard towers and tower with extension shall be of adjustable type. The stub templates shall be painted. One set of each type of stub setting template for single and double circuit tower shall be supplied to the Owner, on completion of the project, at no extra cost.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 67 of 102

12.02.00 SPANS AND CLEARANCES
12.02.01 Ruling Span

The normal ruling span of the line shall be 320 meters for 220 KV towers.

12.02.02 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

12.02.03 Weight Span

The weight span is the horizontal distance between lowest point of the conductors on the two spans adjacent to the tower. For design of structures, the span limits given below shall prevail.

Tower type	Normal Condition		Broken Wire Condition	
	Max. (m)	Min. (m)	Max. (m)	Min. (m)
A, B, C & D (220 KV)	390	-100	270	-100

12.02.04 Electrical Clearance
A) Ground clearance

The minimum ground clearance from the bottom conductor shall be as per IE rules at the maximum sag conditions i.e. at maximum temperature and still air. However, to achieve the above clearance the height of tower shall be increased in the following manner:

- Allowance of 150 mm shall be provided to account for errors in stringing.
- Conductor creep shall be compensated by over tensioning the conductor at a temperature lower than the ambient temperature. The creep correction temperature along with calculations shall be furnished by the Contractor.
- Minimum spacing
The minimum electrical clearance between conductors shall be as per relevant standards.

B) Rail Crossing


In case of rail crossing the min. height above rail level of the lowest portion of any conductor under condition of max. sag, in accordance with the regulations for Electrical Crossing of Railway tracks as prevailing at the time of construction of line shall be applicable.

C) Power Line Crossing


Minimum clearance between power line to power line crossing shall be as per IE rules.

D) Live Metal Clearance

The minimum live metal clearance to be provided between the live parts and steel work of super-structure shall be as per relevant standards.

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>NOTE:</p> <p>i) Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for `D' type tower to be used as dead end and angle tower.</p> <p>ii) The design of the tower shall be such that it will satisfy all the conditions when clearances are measured from any live point of the strings.</p>			
E)	Angle of Shielding	<p>The angle of shielding is defined as the angle formed by the line joining the center lines of the earthwire and outer power conductor, in still air, at tower supports, to the vertical line through the center line of the earthwire. Bidders shall design the tower in such a way that the angle of shielding does not exceed as specified in relevant standard for 220KV towers. The drop of the earthwire clamp, which is in the scope of contractor supplied items, should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp alongwith shackle shall be taken as 150mm.</p>		
F)	Mid Span Clearance	<p>The minimum vertical mid span clearance between the earthwire and the nearest power conductor as per IE rules, which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwires and power conductors, shall be so co-ordinated that the sag of earthwires shall be at least 10% less than that of power conductors under all temperature loading conditions.</p>		
12.03.00	LOADING CONDITIONS			
12.03.01	Loads at Conductor And Earthwire Points			
	<p>Contractor shall consider the ultimate external loadings at conductor and earthwire points base on IS 802-1, 1995. The Contractor shall develop the tower designs considering these loadings. The towers are to be designed to cater for the following loads:</p>			
	<p>a) Reliability Loads (Normal condition)</p> <p>b) Security Loads (Broken wire condition)</p> <p>c) Safety Loads (Construction & Maintenance loads)</p>			
12.03.02	Suspension towers shall be designed for full wind load under security condition			
	Wind Loads on Tower Body			
	<p>The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 1995.</p>			
12.03.03	Maximum Tension			
	<p>Maximum tension shall be based on either of the following (whichever is more stringent):</p>			
	<p>a) at 0 deg C with 36% full wind pressure., or</p> <p>b) at 32 deg C with full wind pressure</p>			
	<p>The value of drag co-efficient (Cd) shall be 1.2 for conductor/earthwire if the diameter of the conductor/earth is 15mm or less.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 69 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>																
12.03.04	Sag tension calculation for design purpose shall be calculated considering normal span of 320 meter.																			
12.03.05	The initial conductor and earthwire tension at 32 degree C and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the Earthwire.																			
12.03.06	Limiting Tensions of conductor & Earthwire The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.																			
12.03.07	Broken Wire Condition The loads for broken wire conditions shall be considered as per clause 16 of IS 802 (Part I/ Sec 1): 1995. The tower type B & C shall be considered as small and medium angle towers whereas tower type D shall be considered as large angle tension tower/ dead end tower.																			
12.03.08	Design Loads Owner's requirement for most stringent design longitudinal and transverse loads is summarized in Table -2.																			
12.04.00	DESIGN OF TOWERS																			
12.04.01	Design Criteria Towers shall be designed based on spans and clearances, and loading conditions as detailed above.																			
12.04.02	Design Temperatures The following temperature range for the conductors and ground wires shall be adopted for line design: <table><tr><td>a)</td><td>Minimum temperature</td><td>:</td><td>0 deg.C</td></tr><tr><td>b)</td><td>Everyday temperature of conductor</td><td>:</td><td>32 deg.C</td></tr><tr><td>c)</td><td>Max. temperature of Conductor</td><td>:</td><td>75 deg.C</td></tr><tr><td>d)</td><td>Max. temperature of Earthwire exposed to sun:</td><td></td><td>53 deg.C</td></tr></table>				a)	Minimum temperature	:	0 deg.C	b)	Everyday temperature of conductor	:	32 deg.C	c)	Max. temperature of Conductor	:	75 deg.C	d)	Max. temperature of Earthwire exposed to sun:		53 deg.C
a)	Minimum temperature	:	0 deg.C																	
b)	Everyday temperature of conductor	:	32 deg.C																	
c)	Max. temperature of Conductor	:	75 deg.C																	
d)	Max. temperature of Earthwire exposed to sun:		53 deg.C																	
12.04.03	Redundant Design All redundants in the towers are to be triangulated. Redundants, having an angle of 15 deg or less with horizontal are to be designed for a concentric vertical ultimate load of 1.5 KN acting at center of the unsupported length. The Contractor has to furnish the calculation for the same. The redundants shall also be designed for 2.5% of max. axial load of connecting members (i.e. leg members, bracing members etc.).																			
12.04.04	Steel Sections For designing of towers, preferably rationalised steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to Owner and the same shall be borne by the Contractor.																			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD																
Page 70 of 102																				


CLAUSE NO.	TECHNICAL REQUIREMENTS													
12.04.05	<p>However, design approval for such substitution shall be obtained from the Owner before any substitution.</p> <p>Thickness of Members</p> <p>The minimum thickness of angle sections used in the design of tower, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:</p> <p>a) Main corner leg members including the groundwire peak and main cross arm : 5 mm b) For all other members : 4 mm</p>													
12.04.06	<p>Bolts & Nuts</p> <p>A) The minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of the bolt holes to be maintained are given below:</p> <table><tr><td>a) Diameter of bolts</td><td>16 mm</td></tr><tr><td>b) Hole diameter</td><td>17.5 mm</td></tr><tr><td>c) Min. bolt spacing</td><td>40 mm</td></tr><tr><td>d) Min. rolled distance</td><td>20 mm</td></tr><tr><td>e) Min. sheared edge distance</td><td>23 mm</td></tr></table> <p>B) Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.</p> <p>C) For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1993 may be referred.</p>				a) Diameter of bolts	16 mm	b) Hole diameter	17.5 mm	c) Min. bolt spacing	40 mm	d) Min. rolled distance	20 mm	e) Min. sheared edge distance	23 mm
a) Diameter of bolts	16 mm													
b) Hole diameter	17.5 mm													
c) Min. bolt spacing	40 mm													
d) Min. rolled distance	20 mm													
e) Min. sheared edge distance	23 mm													
12.04.07	<p>Slenderness Ratio</p> <p>A) Slenderness ratio for members shall be computed in accordance with IS:802, Part-II, 1993. Slenderness ratio for compression and tension members shall not exceed the values specified therein.</p> <p>B) The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:</p> <table><tr><td>a) For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms</td><td>120</td></tr><tr><td>b) For other members having calculated stresses</td><td>200</td></tr><tr><td>c) For redundant members</td><td>250</td></tr><tr><td>d) For members having tensile stress only</td><td>400</td></tr></table>				a) For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms	120	b) For other members having calculated stresses	200	c) For redundant members	250	d) For members having tensile stress only	400		
a) For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms	120													
b) For other members having calculated stresses	200													
c) For redundant members	250													
d) For members having tensile stress only	400													
12.04.08	<p>The bracing pattern, including that of secondary bracings (redundants) shall be identical on transverse and longitudinal faces of the tower, i.e. staggering of primary and secondary bracings are not permitted. Primary bracings and redundants shall be properly triangulated, i.e. the overall pattern of bracing on tower body and cross arms shall be triangular only.</p>													
12.04.09	<p>Erection Stress</p> <p>Where erection stress combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified limit.</p>													
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD										
				Page 71 of 102										


12.05.00 TOWER MATERIALS
12.05.01 Tower Steel Sections


IS steel sections of tested quality in conformity with IS: 2062 or IS: 8500 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. The Bidder can also use most efficient grades of structural steel angle sections and plates conforming to latest international standards. However, the Bidders are permitted to opt for not more than two (2) grades of steel for any particular package.


12.05.02 Fasteners: Bolts, Nuts and Washers


- a) All bolts and nuts shall conform to IS: 6639. All bolts and nuts shall be galvanised and shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.
- b) The bolt shall be of 16 mm dia and of property class 5.6 as specified in IS:1367 (Part-III) 1979 and matching nut of property class as specified in IS:1367 (Part-VI).
- c) Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MP a minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 Part-I to ensure proper bearing.
- d) To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing.
- e) Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.
- f) Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.
- g) All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8mm when fully tightened. All nuts shall fit and tight to the point where the shank of the bolt connects to the head.
- h) Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm dia.
- i) The Bidder shall furnish bolt schedules giving thickness of members connected, the nut and the washer and the length of shank and the threaded portion bolts and sizes of holes and any other special details of this nature.
- j) To obviate bending stress in bolts or to reduce to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.
- k) The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2).


CLAUSE NO.	TECHNICAL REQUIREMENTS			
l)	Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.			
12.06.00	Tower Accessories			
12.06.01	Step Bolts & ladders			
	Each tower shall be provided with step bolts of not less than 16mm diameter and 175 mm long, spaced not more than 450mm apart and extending from about 3.5 meters above the ground level to the top of the tower. Step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special structures, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 3.5 m to 30 m height of super structure step bolts shall be provided. Suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the groundwire support shall be fixed on tower by using countersunk bolts.			
12.06.02	Insulator Strings and Earthwire Clamps Attachments			
	a) For the attachment of suspension insulator string a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free from swinging of the string. The hanger shall be designed to withstand an UTS equivalent to that of insulators. The supply of design & supply of hanger is in the scope of the Contractor.			
	b) At tension towers strain plates of suitable dimensions on the underside of each cross-arm tip and at the top of earthwire peak, suitable plate should be provided for taking the hooks or D-Shackle of the tension insulator strings or earthwire tension clamps, as the case may be. Full details of the attachments shall be submitted by the bidder for Owner's approval before starting the mass fabrication.			
12.06.03	Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.			
12.06.04	Anti-climbing Device			
	Barbed wire type anti-climbing device shall be provided and installed by the Contractor for all towers. The height of the anti-climbing device should be provided approximately 3m above ground level. The barbed wire shall conform to IS-278-1978. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340-1959.			
12.06.05	Danger plate, Number plates, Circuit Plate, Phase plate & Bird Guards.			
	Danger, Number Plates, Phase Plates & Bird Guards shall be provided and installed by the Contractor:			
	a) Each tower shall be fitted with a number plate, and danger plate. Each tension tower shall be provided with a set of phase plates also. The arrangement for fixing these accessories shall not be more than 4.5m above the ground level.			
	b) The letters, figures and the conventional skull and bones of data plates shall conform to IS:2551-1963 and shall be in a single red on the front of the plate.			
	c) The corners of the number and danger plate shall be rounded off to remove sharp edges.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 73 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
d)	To prevent birds from perching immediately above the suspension insulator strings and thus fouling it with droppings suitable birdguards shall be provided at cross arm tips of all suspension towers. The arrangement shall conform to IS:5613 part-2/Sec.I.			
12.07.00	TOWER FABRICATION			
12.07.01	Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.			
12.07.02	Butt splices shall be used and the inside Angle and outside plate shall be designed to transmit the load and inside cleat angle, shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal size and the inside angle of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main panel point as possible.			
12.07.03	Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plates required to transmit stress shall not be less than that of members connected.			
12.07.04	The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.			
12.07.05	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.			
12.07.06	No angle member shall have the two leg flanges brought together by closing angle.			
12.07.07	The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.			
12.07.08	The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets depression are likely to hold water.			
12.07.09	All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact through out. No rough edges shall be permitted in the entire structure.			
12.07.10	Drilling and Punching			
A)	Before any cutting work is started all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.			
B)	Holes for bolts shall be drilled on punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 74 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	a)	Holes must be perfectly circular and no tolerance in this respect permissible.		
	b)	The max. allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.		
	c)	Holes must be square with the plates or angles and have their walls parallel.		
C)	All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.			
12.07.11	Erection mark			
A)	Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be marked with marking dies of 16mm size before galvanising and shall be legible after galvanising.			
B)	Erection Mark shall be “A - BB- CC – DDD”, where			
	A =	Owner's code assigned to the Contractor Alphabet.		
	BB =	Contractor's Mark-Numerical		
	CC =	Tower Type-Alphabet		
	DDD =	Number mark to be assigned by Contractor.		
12.07.12	Quantities and Weights			
	The unit weight of each type of tower, stubs and extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un-galvanised) weight of steel members of the size indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights, holes, notches and bevel cuts etc, but taking into consideration the weight of the fasteners, anti-climbing devices etc.			
12.07.13	Galvanising			
	Fully galvanised towers and stub shall be used for the line. Galvanisation of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanisation shall be 610 gms/sqm. The galvanisation shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanising. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanised as per Grade 4 of IS:1573.			
12.08.00	TOWER EARTHING			
	The footing resistance of all towers shall be measured by the Contractor in dry weather after tower erection but before the stringing of earthwire. All the tower are to be earthed. In no case tower footing resistance shall exceed 10 ohms. Pipe type earthing and counterpoise type earthing wherever required shall be provided in accordance with the stipulations made in IS:3043-1987 and IS:5613 (part-II/Section-2) 1985. The details for pipe and counterpoise type earthing are given in drawing enclosed with the specification.			
12.09.00	INSPECTION AND TESTS			
12.09.01	All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 75 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
12.09.02	Inspection <p>In addition to the provisions as specified elsewhere in this specification, the following shall also apply:</p> <p>A) The Contractor shall keep the Owner informed in advance about the time of starting and the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.</p> <p>B) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.</p> <p>C) The Owner or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Owner's material for satisfying himself that the fabrication is being done in accordance with the provisions of the specifications.</p> <p>D) Unless specified otherwise inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.</p> <p>E) Should any member of the structure be found not to comply with the approved design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Owner or his authorised representative considers that the defects can be rectified.</p> <p>F) Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the Owner.</p> <p>G) All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.</p> <p>H) The correct grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used the inspector may at his discretion get the material tested at an approved laboratory.</p>			
12.09.03	Tower Load Tests <p>A) The Contractor shall submit one set of shop drawings alongwith the bill of materials. Further, Contractor shall submit one copy of test reports and final tracings of shop drawings and Bill of materials for Owner's reference and record.</p> <p>B) The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective towers free of cost to the Owner. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.</p>			
12.09.04	Tower Testing Procedure <p>The testing of towers shall be as per the procedure described below:</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 76 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
A)	Bolt Slip Test <p>In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually.</p> <p>The initial and final readings on the scales (for measurement of defection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip.</p>			
B)	Normal/Broken Wire Load Tests <p>All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:</p> <p>50 percent 75 percent 90 percent 95 percent 100 percent</p>			
C)	Observation Periods <p>a) Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading upto and including 95 per cent of full design loads.</p> <p>b) For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.</p> <p>c) While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.</p> <p>d) The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts.</p> <p>e) Ovalization of holes and permanent deformation of bolts shall not be considered as failure.</p>			
D)	Recording <p>The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy.</p>			
E)	Destruction Test <p>a) The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 77 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>b) The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) percent after the full design loads have been reached.</p>			
12.10.00	PACKING			
12.10.01	The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.			
12.11.00	DESIGN CALCULATION AND DRAWINGS			
12.11.01	The following design calculation and drawings are required to be furnished during detailed engineering.			
	<p>a) Computation of wind load b) Sag-tension calculation c) Tower loading d) Single line diagram of towers showing electrical clearances and steel sections.</p>			
12.11.02	The Contractor shall also furnish following to the owner:			
	<p>a) Detailed design calculation and drawing for towers and foundations. b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc. c) Bill of materials, indicating cutting and bending details against each member. d) Shop drawings showing all details relevant to fabrication. e) All the drawings for the tower accessories.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 78 of 102				

TECHNICAL REQUIREMENTS



**TABLE-2
DESIGN LOADS**

S.No	Tower Type	Longitudinal Loads		Transverse Loads	
		Reliability Condition	Security Condition	Reliability Condition	Security Condition
1	2	3	4	5	6
a.	A	0.0	0.5 x MT For Conductor). 1.0 x MT (For Earth Wire)	WC + WI + DY	0.6 WC + WI +0.25 DY (For Conductor) 0.6 WC + 0.5 DY (For Earth Wire)
b.	B (Section Tower-0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
c.	B (15° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
d.	C (Section Tower-0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
e.	C (30° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
f.	D (60° Deviation)	MT1	1.0 x MT x Cos $\frac{\alpha}{2}$	WC + WI + DY	0.6 WC + WI +0.5 DY
g.	D (Dead End with slack span of 100 Mtrs. Max.)	0.7 MT	1.0 x MT	WC + WI + (0.3 MT x Sin 15°)	0.6 WC + WI
h.	D Complete Dead End	MT	1.0 x MT	WC + WI	0.1 WC + WI

DESCRIPTION	SYMBOL	REMARKS
Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent	MT	
Wind On Conductor	WC	Wind Span shall be the normal ruling span.
Wind On Insulator	WI	In case of Double String Insulators, both their strings shall be considered
Angle Of Deviation (Degrees)	\square	
Load Due To Deviation Of Tower	$DY = 2 \times MT \times \sin \square / 2$	
Difference In Tension For unequal adjacent spans considering full ruling span on one side and 50% of ruling span on other side	MT1	

Note:

1. Vertical loads shall conform to IS 802 – Part I, 1995. Weight spans as furnished under Clause 2.03.00 shall be considered for computation of vertical loads.


2. Safety loads and Anti-cascade loads as specified in IS 802- Part I, 1995 shall also be considered for design of Towers.


3. Wind loads on the towers shall be considered in transverse loads as per clause 11, 12 and 13 of IS: 802 (Part-I/ Sec. I)- 1995.


4. Any additional loads apart from the loads mentioned above, as required as per IS: 802- 1995 shall be considered for design purpose.

13.00.00 TOWER FOUNDATIONS**13.01.00 TYPES OF FOUNDATION****13.01.01 General**


- A) Reinforced concrete footing shall be used for all type of tower in conformity with the IS Codes and the specifications. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift.
- B) Foundation includes supply of materials such as cement, sand, coarse aggregates, reinforcement steel etc., and all work related to construction of foundations including excavation and backfilling, form work, stub setting, placing of reinforcement, concreting etc.
- C) Design criteria for Foundations

CLAUSE NO.		TECHNICAL REQUIREMENTS			
		<p>The foundation shall be designed for the actual soil parameters based on the soil investigation carried out by the bidder and approved by the owner. For design purposes:</p> <p>(a) The angle of repose shall be considered as two-third (2/3) of the value as obtained from the soil investigation</p> <p>(b) Water table shall be considered up to the ground level.</p> <p>(c) The weight of soil shall be considered as 1440 Kg/m³ under dry condition and 940 Kg/m³ under wet condition.</p> <p>Well foundation or pile foundation shall be provided by the bidder wherever necessitated.</p>			
13.02.00		SOIL INVESTIGATION			
13.02.01		<p>The Contractor is required to carry out detailed soil investigation at various tower locations along the corridor, one borehole at centre of the tower, angle points, crossings, etc. and also where soil strata is different from the other locations investigated. In addition the soil investigation may be required to be carried at other locations at the discretion of the Engineer.</p>			
13.02.02		<p>The investigation comprises of field and laboratory testing. Field investigation includes boreholes, Standard Penetration Test (SPT), Static Cone Penetration Test (SCPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), collection of water samples, etc. Laboratory tests shall include, Physical, chemical and engineering properties of soil/rock.</p>			
13.02.03		<p>This specification covers technical requirements for geotechnical investigation and preparation of a detailed geotechnical report. It shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, carrying out field investigation and tests, laboratory tests, analysis and interpretation of data and results, collecting data regarding change of course of rivers from local sources, velocity, scour, etc., giving flood details of the area (past history), safe bearing capacity for different sizes of foundations, different founding strata for the various locations along the transmission lines and preparation of geotechnical report.</p>			
13.02.04		<p>The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. Depth of bore holes at river/bridge crossings shall be 40m, at angle points depth shall be 15.0m and at the centre of tower along the corridor depth of BH shall be 10.0m. Boring shall be terminated at the above specified depth or 3.0m continuous in rock with RQD>25% for river crossings and for balance areas 3.0m in refusal whichever is earlier. Refusal means SPT 'N' value greater than 100.</p> <p>SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. At refusal penetration shall be measured and the same shall be reported in Borelog. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. The diameter of UDS sampler shall be 100 mm minimum.</p>			
13.02.05		<p>Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD	
				Page 81 of 102	


CLAUSE NO.	TECHNICAL REQUIREMENTS			
	<p>a) Laboratory Tests on Soil Samples</p> <p>Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.</p> <p>b) Laboratory Tests on Rock Samples</p> <p>Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.</p>			
13.02.06	The laboratory tests shall be carried out progressively during the field work after sufficient numbers of samples have reached the laboratory in order that the test results of the initial boreholes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel and the tests shall be carried out as per the procedures laid out in the latest editions of the relevant IS codes. Soil shall be classified as per the provisions of Indian standards.			
13.02.07	On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.			
13.02.08	<p>The Geotechnical report shall include, but not limited to the following:</p> <p>a) Borelogs: A true cross section of all individual boreholes with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, details of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.</p> <p>b) Results of all laboratory tests summarized for each Borehole along with a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores shall be furnished.</p> <p>c) Recommendations : The report should contain specific recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total/ differential settlement permissible for structures and equipments, minimum depth and width of foundation. The observation/recommendations shall include but not limited to the following:</p> <p>i) Geological information of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 82 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS																																						
	<div><div><div>ii) Net safe allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlements characteristics of soil with supporting calculations for the recommendations.</div><div>iii) Based on the chemical nature of soil and ground water and exposure condition, recommendations for protective measures on concrete and steel shall be mentioned.</div><div>iv) If expansive soil is met with, recommendation and removal or retainment of the same under structures/ roads etc. shall be given. In the later case detailed specification of any special treatment required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.</div><div>iv) Additional investigation other then specified above, if any, the same shall be carried out by the bidder at no extra cost to owner.</div></div></div>																																						
13.02.09	Indian Standard References																																						
	<div><div>IS:1498</div><div>Classification and Identification of Soils for general Engineering Purposes.</div></div> <div><div>IS:1892</div><div>Code of practice for Subsurface Investigation for Foundation.</div></div> <div><div>IS:1904</div><div>Code of practice for design and construction of foundations in Soils: General Requirements.</div></div> <div><div>IS:2131</div><div>Method of Standard Penetration Test for Soils.</div></div> <div><div>IS:2132</div><div>Code of practice for Thin walled Tube Sampling of Soils.</div></div> <div><div>IS:2470</div><div>Code of practice for design and construction of Septic</div></div> <tr><td></td><td>(Part-I)</td><td colspan="3">Tanks.</td></tr> <tr><td></td><td>IS:2720</td><td colspan="3">Method of Test for Soils (Relevant Parts).</td></tr> <tr><td></td><td>IS:5313</td><td colspan="3">Guide for Core Drilling Observations.</td></tr> <tr><td></td><td>IS:4968</td><td colspan="3">Method for subsurface Sounding for Soils - Dynamic</td></tr> <tr><td></td><td>(Part-II)</td><td colspan="3">method using Cone and Bentonite slurry.</td></tr> <tr><td></td><td>IS:4968</td><td colspan="3">Method for subsurface Sounding for Soils- Static Cone</td></tr> <tr><td></td><td>(Part-III)</td><td colspan="3">Penetration Test.</td></tr>					(Part-I)	Tanks.				IS:2720	Method of Test for Soils (Relevant Parts).				IS:5313	Guide for Core Drilling Observations.				IS:4968	Method for subsurface Sounding for Soils - Dynamic				(Part-II)	method using Cone and Bentonite slurry.				IS:4968	Method for subsurface Sounding for Soils- Static Cone				(Part-III)	Penetration Test.		
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13.03.00	LOADS ON FOUNDATIONS																																						
13.03.01	The foundations shall be designed to withstand the specific loads of the superstructure and for the full footings reactions obtained from the structural stress analysis in conformity with the relevant over load factors. The over load factor for foundation design shall be 1.10 for all loads except dead loads.																																						
13.03.02	The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:																																						
	a)	Max. tension or uplift along the leg slope.																																					
	b)	Max. compression or down-thrust along the leg slope.																																					
	c)	Max. horizontal shear or side thrust.																																					
13.03.03	The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.																																						
13.03.04	The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.																																						
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD																																			
				Page 83 of 102																																			


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
13.04.00	STABILITY ANALYSIS			
13.04.01	In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.			
13.04.02	The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:			
13.04.03	Resistance against uplift The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical. However, the angle of repose for uplift resistance shall be considered two-third (2/3) of the value as obtained from the soil investigation report. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the center line of the tower base.			
13.04.04	Resistance against down thrust The down-thrust load combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.			
13.04.05	Resistance against side-thrust The chimney portion of the foundation shall be designed as per limit state method of IS-456, considering the chimney as a column subjected to axial loads (down thrust loads) and biaxial bending moments resulting from side thrust forces. The passive earth pressure (as per Rankine's formula) shall be considered for the design of chimney against side thrust. If uplift and down thrust are computed in vertical direction for the foundation design, full resultant horizontal shear shall be taken at footing tip for design of the footing to resist side thrust.			
13.05.00	PROPERTIES OF CONCRETE			
13.05.01	The cement concrete used for the foundations shall be of grade M20 (nominal mix) with 20mm coarse aggregate.			
13.05.02	All the properties of concrete regarding its strength under compression tension, shear, punching and bending etc. as well as workmanship will conform to IS:456.			
13.05.03	The material properties for cement, aggregate and reinforcement steel shall be as specified in Chapter-C0 "Switchyard Civil Works".			
13.05.04	The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is generally preferred.			
13.06.00	DESIGN OF FOUNDATIONS			
13.06.01	Structural design of the foundations shall be done by limit State method conforming to IS 456.			
13.06.02	The chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 84 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
13.06.03	The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower.			
13.06.04	Minimum thickness of foundation shall be 300 mm.			
13.06.05	The distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 150 mm or more than 200mm.			
13.06.06	The total depth of foundations below the ground level shall not be less than 1.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations.			
13.06.07	The portion of the stub in the chimney and foundation slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.			
13.06.08	Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.			
13.06.09	Over Load Factor The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent.			
13.07.00	CONSTRUCTION OF TOWER FOUNDATION			
13.07.01	Excavation			
13.07.02	Excavation work must not be started until the tower schedule & profile and foundation drawing are approved by the Owner.			
13.07.03	Except specified otherwise, all excavation for footing shall be made to the lines and grades of the foundation. All excavation shall be protected so as to maintain a clean subgrade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.			
13.07.04	Rock excavation requiring Blasting Wherever blasting is required for excavation in rock, the same shall be done after obtaining license from the competent authority. Following shall be adhered to: i) All provisions of explosive acts shall be adhered to. ii) The magazine for the storage of explosive shall be to suit as per the requirements of explosive department. iii) Where blasting is required, same shall be controlled blasting. iv) Contractor shall prepare the detailed blasting scheme and get the same approved from Engineer-in-charge before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 85 of 102				


CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	<p>v) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.</p> <p>vi) The Contractor shall also observe any specific instructions given by the Engineer-in-charge. The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosives and the blasting operations. The Engineer-in-charge or his authorised representative shall frequently check the Contractor's compliance with these precautions and the manner of storing and accounting of explosives. The Contractor shall provide necessary facilities for this the above.</p> <p>vii) Controlled blasting shall be done by a specialised agency duly approved by Engineer-in-charge. All controlled blasting shall be done by using time delay detonators (i.e. excel type).</p> <p>viii) All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081.</p>			
13.08.00	Setting of Stubs			
13.08.01	The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to the Owner by the Contractor.			
13.08.02	Setting of stub at each location shall be approved by the Owner's representative.			
13.08.03	<p>Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without extension and also for leg extension. Stub templates for standard towers and towers with extension upto 6M shall be of adjustable type. The stub templates shall be painted. Generally for each transmission line tower package, following numbers of stub setting templates shall be deployed by the Contractor:</p> <p>For each A type tower : 3 Nos. For each of B, C and D type : 2 Nos.</p> <p>However, if Owner feels that more number of templates are required for timely completion of a particular line the Contractor shall have to deploy the same without any extra cost to Owner.</p>			
13.08.04	One set of each type of stub setting template as applicable, shall be supplied to the Owner, on completion of the project at no extra cost to Owner.			
13.09.00	Mixing, Placing and Compacting of Concrete			
13.09.01	The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain hand mixing may be permitted at the discretion of Owner. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalies. Saltish or blackish water shall not be used.			
13.09.02	Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 86 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.			
13.09.03	Form boxes shall be used for casting all type of foundations. The concrete shall be well compacted such that no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of Owner. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge, to drain off any rain water falling on the coping.			
13.09.04	In wet locations, the site must be kept complete de-watered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.			
13.09.05	After the form-work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of the Owner's representative before the foundation pits are backfilled.			
13.10.00	Back-Filling and Removal of Stub Template			
13.10.01	After opening of form-work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, shall be done by the Contractor at his own cost, irrespective of lead.			
13.10.02	The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits, towards the outer ends. After the pits have been backfilled to full depth, the stub template may be removed.			
13.10.03	The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling 50 mm high earthen embankment (bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilled earth for atleast 24 hours.			
13.11.00	Curing The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.			
13.12.00	Benching When the line passes through hilly/undulated terrain, for a few tower locations it may be required to level the ground for casting of tower footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Owner. Benching shall be resorted to only after getting specific approval from the Owner.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 87 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
13.13.00	Protection of Tower Footing			
13.13.01	The work shall include all necessary stone revetments, concreting and earth filling above ground level in hilly/undulated terrain and special measures like RCC retaining walls for protection of foundation close to or in nallah, river bed etc. The top seal cover of the stone revetments shall be done with M20 concrete (nominal mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.			
13.13.02	The quantity of excavated earth obtained from a particular location shall generally be utilised in back-filling work in protection of tower footing of same locations, unless it is unsuitable for such purpose. In the latter case, the back-filling shall be done with borrowed earth of suitable quality. The consolidation of earth shall however be done after backfilling.			
14.00.00	TOWER LINE ERECTION AND STRINGING			
14.01.00	GENERAL REQUIREMENTS			
14.01.01	The details of the scope of erection work shall include the cost of labour, all tools and plants like tension stringing equipment and all other incidental expenses in connection with erection and stringing work.			
14.01.02	The Contractor shall be responsible for transportation of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the Owner.			
14.02.00	TREATMENT OF MINOR GALVANISING DAMAGE			
	In case any minor damage to galvanising is noticed, the same shall be treated with zinc rich paint (having at least 90% zinc content) before erection.			
14.03.00	ASSEMBLY			
14.03.01	The method followed for the erection of towers, shall ensure the points mentioned below :			
	<div>a) Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than 450 mm long may be used.</div> <div>b) Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided and tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.</div> <div>c) All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.</div> <div>d) The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section 2).</div> <div>e) Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described.</div> <div>f) All bank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of correct size.</div>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 88 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.03.02	Tightening and Punching of Bolts and Nuts			
A)	All nuts shall be tightened properly using correct size spanner/torque wrench. Before tightening, it shall be ensured that filler washers and plates are placed in gaps between members wherever applicable, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nut. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.			
B)	The threads of all the bolts projected outside the nuts shall be welded at two diametrically opposite places. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm level for double circuit towers. After welding, cold galvanised paint having at least 90% Zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.			
C)	In addition to the tack welding of nuts with bolts, as described above, the Contractor can also propose some alternative arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nut permanently with the bolt and thus preventing pilferage of the tower members.			
14.04.00	INSULATOR HOISTING			
	I-Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and fittings, if any, shall not be employed in the assemblies. Before hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for the purpose. Corona control rings/arching horn shall be fitted in an approved manner. The yoke arrangements be horizontal for tensions strings. Torque wrench shall be used for fixing different line materials and their components, like suspension clamp for conductor and earthwire, etc., whenever recommended by the manufacturer of the same of river crossing towers.			
14.05.00	HANDLING OF CONDUCTOR AND EARTHWIRE			
14.05.01	The Contractor shall be entirely responsible for any damage to the towers or conductors during stringing. While running out the conductors, care shall be taken that the conductors do not touch or rub against the ground or objects which could cause scratches or damages to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. Immediately after running out, the conductor shall be raised at the supports to the levels of the clamps and placed into the running blocks. The groove of the running blocks shall be of such a design that the seat is semi-circular and larger than the diameter of the conductor earthwire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.			
14.05.02	The running blocks shall be suspended in a manner to suit the design of the crossarm. All running blocks, especially those at the tension end, will be fitted on the cross-arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. In case suspension, or section towers are used even for temporary terminations, if this be unavoidable, they shall be well guyed			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 89 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी</div> <div>NTPC</div>
	<p>and steps shall be taken by the Contractor to avoid damage. Guying proposal alongwith necessary calculations shall be submitted by the Contractor to Owner by the Contractor for checking the tensions in the guy made available to the Owner by the Contractor for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the manufacturers.</p>			
14.05.03	<p>Repairs to conductors, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and without any projections, sharp points, cuts, abrasions etc.</p>			
14.05.04	<p>Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.</p>			
14.05.05	<p>Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire and accessories in the field.</p>			
14.05.06	<p>The sequence of running out shall be from top to downwards i.e. the earthwire shall be run out first, followed by the conductors in succession. Unbalances of loads on towers shall be avoided as far as possible.</p>			
14.05.07	<p>The proposed 400 kV transmission line may run parallel for certain distance with the existing Transmission lines which may remain energised during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires, which although comparatively small during normal operations can be severe during switching. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.</p>			
14.05.08	<p>B and C type of towers are not designed for one side stringing. Therefore proper guying arrangement shall be made for B and C type of towers during stringing on one section while the other section is not strung. The Contractor has to submit the detailed proposal alongwith the calculation for guying which shall be approved by the Owner. Proper T&P shall be made available to the Owner by the Contractor for checking the tensions in the guy wires. All the expenditure on account of the above work is deemed to be included in the bid price and no extra payment shall be made for the same.</p>			
14.06.00	STRINGING OF CONDUCTOR AND EARTHWIRE			
14.06.01	<p>The stringing of the conductor shall be done by standard stringing method.</p>			
14.06.02	<p>After being pulled the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 90 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			
14.06.03	Conductor creep are to be compensated by over tensioning the conductor at appropriate temperature for which calculations are to be submitted by the contractor for Owner's approval.			
14.06.04	The Bidder shall give complete details of the stringing methods which be proposes to follow. Before the commencement of stringing the Contractor shall submit the stringing charts for the conductor and earthwire for various temperatures and span alongwith equivalent spans for the approval of the Owner.			
14.06.05	Jointing			
A)	All the joints on the conductor and earthwire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Contractor. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti- corrosive compound if required, and as recommended by the contractor before the final compression is done with the compressors.			
B)	All joints or splices shall be made at least 30 meters away from the structures . No joints or splices shall be made in spans crossing over main road, railways, small rivers with tension spans. During compression or splicing operation the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.			
C)	During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protection can be passed over it smoothly.			
14.07.00	Sagging-in-Operation			
14.07.01	The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductor from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.			
14.07.02	The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.			
14.07.03	The running blocks, when suspended from the transmission structure for sagging shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured,			
14.07.04	At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, he conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.			
14.07.05	Tensioning and sagging operations shall be carried out in clam weather when rapid changes in temperatures are not likely to occur.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 91 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
14.07.06	Tensioning and Sagging of Conductors and Earthwire <p>The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The 'Initial' stringing chart shall be used for the conductor and 'final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.</p>			
14.07.07	Clipping In			
A)	Clipping of the conductors in positions shall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.			
B)	The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements and shall match the jumper drops shown in the tower drawings.			
C)	Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.			
14.07.08	Fixing of Conductor and Earthwire Accessories <p>Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.</p>			
14.08.00	REPLACEMENT <p>If any replacements are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys as suspension points.</p>			
14.09.00	FINAL CHECKING TESTING AND COMMISSIONING			
14.09.01	After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected keeping in view of the following main points:			
	a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.			
	b) Concrete chimneys and their copings are in good finally shaped conditions.			
	c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever.			
	d) All bolts are properly tightened and punched/tack welded.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 92 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>								
	<div><div>e) The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available.</div><div>f) All conductor and earthwire accessories are properly installed.</div><div>g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed.</div><div>h) Wherever required it should be ensured that revetment is provided.</div><div>i) The original tracings/ soft copies of profile route alignment and tower, design, structural drawings, bill of material, shop drawings of all towers are submitted to the Owner for reference and record.</div><div>j) The insulation of line as a whole is tested by the Contractor by providing his own equipment, labour etc. to the satisfaction of the Owner.</div><div>k) All towers are properly grounded.</div><div>l) The line is tested satisfactorily for commissioning purpose.</div></div>											
15.00.00	TRANSMISSION LINE MATERIAL											
15.01.00	GENERAL											
15.01.01	All the equipment shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 220 kV AC transmission with twin conductor and will give continued good performance.											
15.01.02	The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and a good finish.											
15.01.03	All ferrous parts shall be hot dip galvanised, after all machining has been completed, nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electrogalvanised. The bolt threads shall be under cut to take care of increase in diameter due to galvanising . Galvanising shall be done in accordance with IS:2629. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall be guaranteed to withstand at least six dips each lasting one minute under the standard preece tests for galvanising.											
15.01.04	The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continues and free from imperfection such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn. 99.95 as per IS:209.											
15.02.00	EARTHWIRE											
15.02.01	The galvanised steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part-II)-1976 except where otherwise specified herein.											
15.02.02	<div>Parameters of the earthwire</div> <table><tr><td>(a) Size (strands & wire diameter)</td><td>7/3.15 mm</td></tr><tr><td>(b) Overall diameter</td><td>9.45 mm</td></tr><tr><td>(c) Stranded weight</td><td>428 Kg/km</td></tr><tr><td>(d) Minimum ultimate tensile strength</td><td>56 kN</td></tr></table>				(a) Size (strands & wire diameter)	7/3.15 mm	(b) Overall diameter	9.45 mm	(c) Stranded weight	428 Kg/km	(d) Minimum ultimate tensile strength	56 kN
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NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 93 of 102								

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एन टी पी सी NTPC</div>
15.02.03	The earthwire shall be pre-formed and post-formed to avoid opening of strands at the time of cutting or joining. The finished material shall have minimum brittleness, as it will be subject to appreciable vibration while in use. It shall withstand 3 and ½ number of one minute dips in the standard preece test.			
15.02.04	There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earthwire. There shall be no strand joints or strand splicer in any length of the completed stranded earthwire.			
15.03.00	CONDUCTOR			
15.03.01	The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.			
15.03.02	Parameters of the conductor			
	(a) Name	Zebra Conductor'		
	(b) Strands and wire diameter			
	(i) Aluminium	54/3.18 mm		
	(ii) Steel	7/3.18 mm		
	(c) Conductor per phase	twin		
	(d) Inter phase spacing	as per IE rules		
	(e) Overall diameter	28.62 mm		
	(f) Weight (Approx.)	1.621 Kg/km		
	(g) Minimum ultimate tensile strength	130.3 kN minimum		
15.03.03	The steel strands shall generally comply with the requirements stipulated for earthwire at clause 2.00.00 above.			
15.03.04	Joints shall be permitted in the individual Aluminium wires in all layers except the outer most layer of the finished conductor. These joints shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.			
15.03.05	The standard length of the conductor shall be 1600 meters for conductor and 2x2000 metres for earth wire. A tolerance of ± 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of random lengths shall not be more than 10% of the total quantity ordered.			
15.04.00	CONDUCTOR ACCESSORIES			
15.04.01	Mid Span Compression Joint for Conductor			
	As per details given in IS: 2121 Part-2.			
15.04.02	Repair Sleeve			
	Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be of rounded that the conductor strands are not damaged during installation.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 94 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
15.04.03	The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve for owner's review. The compression pressure shall also be indicated by the Bidder.			
15.04.04	Vibration Damper for conductor and Earthwire			
A)	Vibration dampers of 4 R-Stock bridge type with four (4) different resonance spread within the specified aeolian frequency bandwidth shall be used at all suspension and tension points on each span to damp out the Aeolean vibrations of the conductors to the specified level as mentioned hereinafter. Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span.			
B)	The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.			
C)	The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 kg/mm ² . It shall be of pre-formed and post-formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826-1979 for heavily coated wires.			
D)	The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.			
E)	The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amps at 50 Hz alternating current.			
F)	The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the systems area follows: Span length i) Ruling design span			

CLAUSE NO.	TECHNICAL REQUIREMENTS					<div>एनटीपीसी NTPC</div>																												
iv)	The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.																																	
15.05.00	EARTHWIRE ACCESSORIES																																	
15.05.01	Mid Span Compression Joint for Earthwire																																	
It shall be used for joining two lengths of earthwire. The joint shall be made of mild steel. The steel sleeve should not crack or fail during compression in it or service period. The Brinell Hardness of steel should not exceed 200. The steel sleeve shall be hot dip galvanised. The joints shall not permit slipping off, damage to , of failure of the complete earthwire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earthwire. The joint shall have resistivity less than 75% of resistivity of equivalent length of earthwire. The dimensions and the dimensional tolerance of the joint shall be as given below:																																		
<table><tr><th rowspan="2">Item</th><th colspan="2">Dimensions before compression</th><th colspan="3">Dimension after compression</th></tr><tr><th>Inner Dia.</th><th>Outer Dia.</th><th>Length</th><th>Corner to Corner width</th><th>Face to face width</th></tr><tr><td></td><td>(mm)</td><td>(mm)</td><td>(mm)</td><td>(mm)</td><td>(mm)</td></tr><tr><td>Al. sleeve</td><td>22±0.5</td><td>30±0.5</td><td>315±5</td><td>29.4±0.5</td><td>25±0.5</td></tr><tr><td>Steel sleeve</td><td>10±0.2</td><td>21±0.5</td><td>230±5</td><td>20.2±0.5</td><td>17.5±0.5</td></tr></table>						Item	Dimensions before compression		Dimension after compression			Inner Dia.	Outer Dia.	Length	Corner to Corner width	Face to face width		(mm)	(mm)	(mm)	(mm)	(mm)	Al. sleeve	22±0.5	30±0.5	315±5	29.4±0.5	25±0.5	Steel sleeve	10±0.2	21±0.5	230±5	20.2±0.5	17.5±0.5
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15.05.02	Vibration Damper For Earthwire																																	
Refer Clause 15.04.04 detailed above.																																		
15.05.03	Flexible Copper Bond: As detailed in is:2121 part3.																																	
15.05.04	Suspension Clamp for Earthwire : As Detailed in IS:2121 Part3																																	
A)	At all suspension towers, suitable suspension clamp shall be used to support the earthwire of 7/3.15 mm size, the clamp shall be of either free-centre type or trunion type and shall provide adequate area of support to the earthwire.																																	
B)	The total drop of the suspension assembly from the center point of the attachment to the centre point of the Earthwire shall not exceed 150 mm. The complete assembly shall be guaranteed for slip strength of not less than 9 kN and not more than 14 kN. The breaking strength of the assembly shall not be less than 25 kN.																																	
C)	The clamping piece and the clamp body shall be clamped by at least two U-bolts of size not less than 10 mm diameter having one nut and 3 mm thick lock nut with washer on each of its limbs. Suspension clamps shall be provided with inverted type U-bolts. One limb of the U-bolt shall be long enough to accommodate the lug of the flexible copper bond.																																	
15.05.05	Tension Clamp for Earthwire																																	
The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold galvanised steel earthwire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates. The strain plates supplied with the																																		
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD		Page 96 of 102																												

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	towers will have a minimum thickness of 8 mm with a hole of 17.5 mm diameter. Suitable lugs for jumper connection shall also be supplied alongwith necessary bolts and nuts.			
15.06.00	HARDWARE FITTINGS			
15.06.01	The hardware fittings shall be as per the specification and IS/IES standards			
15.06.02	Each hardware fittings shall be supplied complete in all respects and include the following hardware parts:			
	a) Ball hook for suspension hardware fittings suitable for attaching to V-hanger of the tower. Anchor shackle shall be supplied, which shall be suitable for attaching the tension hardware fittings to strain plate, of the tower.			
	b) Suitable yoke plates			
	c) Suspension and dead end assembly to suit conductor size.			
	d) Other necessary fittings such as eye links, ball clevis, socket clevis, clevis eye, U-clevis, ball link, arcing horn etc. to make the hardware fittings complete.			
	e) 2.5% extra fasteners shall be supplied along with the hardware fittings.			
	f) Socket fittings shall be provided with only R-shaped security clip in accordance with IS-2486 (part-II).			
15.06.03	Suspension Assembly for Conductor			
A)	The suspension assembly shall include AGS type suspension clamps alongwith standard performed armour rods set suitable for ACSR ‘Moose conductor. The elastomer used for AGS clamp shall be neoprene rubber with insert. This shall be suitable to withstand upto 75deg. Centigrade temperature and atmospheric ozone.			
B)	The suspension clamp assembly alongwith standard armour rods shall have a slip strength between 11 to 16 KN.			
C)	The length and diameter of each rod shall be 1550±16 mm and 6.35±0.10mm respectively. The tolerance in length of the rods in completed set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed or ball ended.			
D)	The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy applications on the line.			
E)	The armour rod shall not loose, their resilience even after five applications.			
F)	The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).			
G)	The armour rods shall be made of aluminium alloy of type 6061 or equivalent. The alloy shall have a minimum tensile strength of 35 kg / mm ² .			
15.06.04	Dead End Assembly			
	The dead end assembly shall be complete with jumper cone etc.			
	The bidder shall clearly specify the before and after compression dimensions of the dead-end clamp. The compression pressure shall also be indicated by the bidder. The dimensions and dimensional tolerances of the cross section of aluminium dead-end for conductor shall be as given below:			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
				Page 97 of 102

CLAUSE NO.

TECHNICAL REQUIREMENTS

Item	Dimensions before compression		Dimension after compression	
	Inner Dia. (mm)	Outer Dia. (mm)	Corner to corner width (mm)	Face to face width (mm)
Alum. Dead-end	31±0.5	48±1	46±0.5	40±0.5
Steel Dead-end	10±0.2	20±0.5	19±0.5	16±0.5

15.06.05 Yoke Plates

The Plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavourable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations, i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS:800-1984.

15.07.00 INSULATOR

15.07.01 The size of disc insulator, the number to be used in different type of strings, their electromechanical strength and minimum creepage distance shall be as follows :


Type of String	Size of disc insulator (mm)	Min. creepage distance of each disc (mm)	No. of standard discs	Electro-mechanical strength of insulator string (kN)
Single Suspension	255/280 x 145	280	1x 14	90
Double Suspension	-do-	-do-	2x 14	2 x 90
Double tension	-do-	-do-	2x 14	2 x 120
Single tension	-do-	-do-	1x 14	120


Note: Single Suspension (Pilot) string will be used for jumpers of tension type towers. It will be similar to single suspension type except the clamp of the conductor.

A) Disc Insulator: The insulator shall be pin and cap; ball and socket type. The disc insulator shall conform to IS: 731.

B) Ball and Socket Designation

The dimensions of the balls and sockets shall be of 20 mm designation, for 90KN/120KN disc insulator in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120.

CLAUSE NO.	TECHNICAL REQUIREMENTS			
15.07.02	Materials			
A)	Porcelain: The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.			
B)	Glaze: The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of he insulator and shall have a good lustre, smooth, surface and good performance under the extreme weather conditions of a tropical climate. It shall not be cracked or chipped by ageing under the normal service conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.			
C)	Toughened Glass: In case of glass insulator, the glass used for the shells shall be sound, free from defects such as flows, bubbles, inclusions etc. and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.			
D)	Cement: Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.			
E)	Pins and Caps: Pins and Caps shall be made of drop forged steel and malleable cast iron/spheriodal graphite iron/drop forged steel respectively, duly hot dip galvanised and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.			
F)	Security Clips: Security clips shall be made of good quality stainless steel or phosphor bronze as per IS: 1385-1968 2.5% extra Security clip shall be provided.			
15.07.03	Hot Line Maintenance			
	The insulators offered shall be suitable for employment of hot line maintenance technique so that the usual hot line operations can be carried out with ease, speed and safety.			
	Bidders shall indicate the methods generally used in the routine hot and dead line maintenance of HV lines for which similar insulator have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.			
15.08.00	TESTS FOR TL. LINE MATERIAL			
15.08.01	GENERAL REQUIREMENTS			
15.08.02	The materials shall conform to all the type tests as per relevant standards. The acceptance, routine tests and tests during manufacture shall be carried out on the line material as per relevant standards.			
16.00.00	OPGW and its accessories			
16.00.01	General			
	This specification covers the provision of one peak of 220kV tower with Optical Fiber (OPGW). This optical fiber cable will be connected to suitable optical line terminal and multiplex equipment to form part of the Plant's overall communications transmission system. Any expected variation shall be clearly identified in the Bidder's Proposal. Bidder to ensure that optical fiber characteristic of the OPGW cable to be supplied shall be compatible with the existing OPGW cable.			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2		SUB SECTION B-14 SWITCHYARD
Page 99 of 102				

CLAUSE NO.	TECHNICAL REQUIREMENTS																																																																															
16.00.02	<p>Construction</p> <p>The OPGW shall be composed of a layer of aluminum-clad steel wires around a seamless aluminum tube or stainless steel tube. The Optical core, in order to protect the fibers from external forces, shall be laid loose inside buffer tubes.</p> <p>The optical core shall be filled with hydrogen absorbent and water blocking filling compound. The optical fiber itself shall be manufactured by using high grade silica to provide the required performance.</p>																																																																															
16.00.03	<p>Optical Fiber Characteristics</p> <p>Optical fiber shall be supplied in accordance with ITU – T Recommendation G.652 with the following requirements.</p> <table><tr><td>Profile of Optical Fiber:</td><td colspan="4">Single mode stepped index</td></tr><tr><td>Average Transmission Loss:</td><td colspan="4"></td></tr><tr><td>At wavelength 1310 nm</td><td colspan="4">0.38 dB per km maximum</td></tr><tr><td>At Wavelength 1550 nm</td><td colspan="4">0.25 dB per km maximum</td></tr><tr><td>Number of Fiber</td><td colspan="4">12</td></tr><tr><td>Average splicing loss:</td><td colspan="4">0.05db per joint</td></tr><tr><td>Maximum splicing loss:</td><td colspan="4">0.10 dB per joint</td></tr><tr><td>Mode field diameter (MFD):</td><td colspan="4">9.0µm ± 1.0µm</td></tr><tr><td>Cladding diameter:</td><td colspan="4">125 ± 2 µm</td></tr><tr><td>Core / Cladding</td><td colspan="4"></td></tr><tr><td>Mode field concentricity error:</td><td colspan="4">1µm</td></tr><tr><td>Chromatic – dispersion coefficient @ 1310 nm</td><td colspan="4">3.5 ps / nm km. Maximum</td></tr><tr><td>Chromatic – dispersion coefficient @ 1550 nm</td><td colspan="4">20 ps / nm km. Maximum</td></tr><tr><td>Fiber Identification:</td><td colspan="4">each fiber shall be uniquely identifiable throughout the Length of the wire.</td></tr><tr><td>Operating Temperature:</td><td colspan="4">0°C to 80 °C continuously</td></tr></table>					Profile of Optical Fiber:	Single mode stepped index				Average Transmission Loss:					At wavelength 1310 nm	0.38 dB per km maximum				At Wavelength 1550 nm	0.25 dB per km maximum				Number of Fiber	12				Average splicing loss:	0.05db per joint				Maximum splicing loss:	0.10 dB per joint				Mode field diameter (MFD):	9.0µm ± 1.0µm				Cladding diameter:	125 ± 2 µm				Core / Cladding					Mode field concentricity error:	1µm				Chromatic – dispersion coefficient @ 1310 nm	3.5 ps / nm km. Maximum				Chromatic – dispersion coefficient @ 1550 nm	20 ps / nm km. Maximum				Fiber Identification:	each fiber shall be uniquely identifiable throughout the Length of the wire.				Operating Temperature:	0°C to 80 °C continuously			
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16.00.04	<p>OPGW Characteristics</p> <table><tr><td>Ultimate tensile strength</td><td>(kg)</td><td>≥</td><td>7,500</td></tr><tr><td>Outside diameter</td><td>(mm)</td><td>≤</td><td>14</td></tr><tr><td>Cross sectional area of Conduct</td><td>(mm²)</td><td>≥</td><td>80</td></tr><tr><td>D.C. Resistance @ 20 °C</td><td>(□/km)</td><td>≤</td><td>0.76</td></tr><tr><td>Length per reel</td><td>(m)</td><td></td><td>3000 Approx.</td></tr><tr><td>Modulus of elasticity</td><td>(kg/mm²)</td><td>≥</td><td>10,000</td></tr><tr><td>Coefficient of linear expansion</td><td>(/°C)</td><td>≤</td><td>15.0 x 10⁻⁶</td></tr><tr><td>Capacity fault current (KA)² sec.</td><td></td><td></td><td>46</td></tr><tr><td>Maximum allowable temp.</td><td></td><td></td><td></td></tr><tr><td>For optical fiber in loose type</td><td>(°C)</td><td></td><td>160</td></tr><tr><td>Maximum Transmission Loss Change – Temperature Range</td><td></td><td></td><td></td></tr><tr><td>0°C to 150 °C</td><td>(dB/km)</td><td></td><td>0.1</td></tr><tr><td>Unit Weight</td><td>(kg./km)</td><td>≤</td><td>600</td></tr></table> <p>The Bidder shall design the OPGW requirements to suit each span in the system, based on the applicable drawings and field surveys. The Bidder's proposal shall stipulate the characteristics of the OPGW required for each span in the system.</p>					Ultimate tensile strength	(kg)	≥	7,500	Outside diameter	(mm)	≤	14	Cross sectional area of Conduct	(mm ²)	≥	80	D.C. Resistance @ 20 °C	(□/km)	≤	0.76	Length per reel	(m)		3000 Approx.	Modulus of elasticity	(kg/mm ²)	≥	10,000	Coefficient of linear expansion	(/°C)	≤	15.0 x 10 ⁻⁶	Capacity fault current (KA) ² sec.			46	Maximum allowable temp.				For optical fiber in loose type	(°C)		160	Maximum Transmission Loss Change – Temperature Range				0°C to 150 °C	(dB/km)		0.1	Unit Weight	(kg./km)	≤	600																							
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CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
16.00.05	<div>Assemblies and Line Accessories</div> <div>a. General</div> <p>The OPGW assemblies and line accessories shall consist of the hardware indicted herein. All hardware and accessories shall be made of aluminum, aluminum alloy, malleable iron, steel (metal mold of drop forging process), stainless steel, or non-ferrous metal, unless otherwise specified. In addition, all hardware and accessories shall have an ultimate tensile strength equal to or exceeding the rated ultimate tensile strength of the overhead ground wire. All metal shall be free from burrs, sharp edges, lumps and dross and shall be smooth so that interconnecting parts will fit properly, and so that the parts maybe assembled and readily.</p> <p>All bolts and other fasteners shall be installed according to manufacturer's recommendations. Materials no specifically covered herein by detailed specifications shall be of standard commercial quality suitable for the intended use. The Contractor shall determine the most suitable type of clamp to be used at each and every transmission tower location.</p> <div>b. Suspension Clamps</div> <p>The suspension clamps for the OPGW shall be of bolt or performed type. The bolt type suspension clamps shall be complete with bolts, keeper pieces, and other required parts. Each clamp shall be capable of holding the OPGW without slipping under an unbalanced tension of 25% of the ultimate tensile strength of the OPGW.</p> <div>c. Tension Clamps</div> <p>The tension clamps shall be of bolt or performed type, and cable of holding the OPGW without slipping or damaging the OPGW under a tension of 75% of the OPGW ultimate tensile strength. A suitable piece shall be of same material as the clamp body. Bolts, nuts and washers shall be hot-dipped galvanized malleable iron or steel.</p> <div>d. Grounding clamps and Parallel Groove Clamp</div> <p>Each clamp shall be capable holding the OPGW using bolts and nuts.</p> <div>e. Vibration dampers</div> <p>Stock bridge type vibration dampers, suitable for use on the OPGW shall be supplied. The dampers shall have an aluminum, clamping bolts, or other suitable device, on the galvanized wire between the weights, and be suitable for attachment to the OPGW. The damper clamp shall be designed to permit installation and removal using hot line tools. Each damper weight, subject to the accumulation of moisture, shall be provided with one drain hold positioned at the bottom of the weight when the damper is installed in the vertical plane. Damper weights shall be made of hot dip galvanized case iron or zinc.</p> <div>f. Armor rods</div> <p>The armor rods for the OPGW shall be of the preformed type. They shall be smooth and fee from corrosion, splitting, cracking, or any other defects. They shall be designed to effectively protect the OPGW from fatigue caused by vibration.</p> <p>Armor rods may or may not be employed, as per OPGW manufacturer recommendations, however the use of armor rods is preferred by the Employer.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 101 of 102

CLAUSE NO.	TECHNICAL REQUIREMENTS			<div>एनटीपीसी NTPC</div>
	<p>g. The joint box shall be air-tight, water-proof. The cover shall be securely fastened to the case by non-loosening fasteners. Both the case and the cover shall be made of non-corrosive aluminum alloy or hot dip galvanized steel or approved materials. The joint box shall be sufficiently rugged and sturdy to withstand outdoor climatic and environmental conditions. The joint box shall accommodate sheath protected arc-fusion splices and up to 1.5 m of additional fiber on each side of the splice; guides shall be provided to keep the extra fiber well above the allowable bending radius of the fiber. The spliced parts of the optical fiber within the joint box shall be reinforced and free from tension after completion of the splicing.</p> <p>The contractor shall provide one set of terminating materials with every joint box for optical fiber connection.</p> <p>1. Way Joint Box for OPGW</p> <p>This type of joint box shall be used to straight joint OPGW to OPGW, or OPGW to approach cable. It shall be used at all locations requiring such a device except those specified otherwise in the text or drawings elsewhere in this specification.</p> <p>2.Way Joint Box for OPGW and approach cable</p> <p>This type of joint box shall be used to spur joint all fibers contained in two OPGW cables to OPGW or one multi-core optical fiber cable at each terminal station, repeater station, or other location, as detailed in the text or drawings elsewhere in this specification.</p>			
NORTH KARANPURA STPP (3 X 660 MW) EPC PACKAGE		TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS-4410-001-2	SUB SECTION B-14 SWITCHYARD	Page 102 of 102

**TECHNICAL PARAMETERS REQUIRED FOR ACSR PANTHER
CONDUCTOR**
(FOR OTHER DETAILS REFER ANNEXURE-2D3)

4.0. PRINCIPAL PARAMETERS:

4.1. The details of conductors are tabulated below:

Sl No.	PARAMETER	Panther
a).	Stranding and Wire Diameter	30/3.00 mm Aluminium 7/3.00mm Steel
b).	Number of Strands Central Steel Wire 1 st Steel Layer 1 st Aluminium Layer 2 nd Aluminium Layer	1 6 12 18
c).	Sectional Area of Aluminium (Sq.mm)	212.10
d).	Total Sectional Area (Sq.mm)	261.50
e).	Overall Diameter (mm)	21.00
f).	Approximate Weight (Kg/ Km)	974
g).	Calculated Maximum D.C Resistance at 20 deg. C (Ohm/ Km)	0.139
h).	Minimum UTS (KN)	89.67
i).	Modulus of Elasticity (GN/ Sq. Meter)	80
j).	Coefficient of Linear Expansion per deg C	17.80×10^{-6}

The details of Aluminium Strand are as follows:

Sl No.	<i>PARAMETER</i>	Panther
a).	Minimum Breaking Load of Strand Before Stranding (KN)	1.17
b).	Minimum Breaking Load of Strand After Stranding (KN)	1.11
c).	Maximum D.C Resistance of Strand at 20 deg. C (Ohm/ KM)	4.079
d).	Diameter mm (Standard/ Max/ Min)	3.00/3.03/2.97
e).	Mass (Kg/ KM) (at Normal Diameter)	19.11

The details of Steel Strand are as follows:

Sl No.	<i>PARAMETER</i>	Panther
a).	Minimum Breaking Load of Strand Before Standing (KN)	9.29
b).	Minimum Breaking Load of Strand After Standing (KN)	8.83
c).	Diameter mm (Standard/ Max/ Min)	3.00/3.06/2.94
d).	Zinc Coating Testing	3 /dips of 1mm each
e).	Maximum Weight of Zinc Coating (Gm/ Sq.mm)	250
f).	Mass of Steel at Normal Diameter (Kg/ KM)	55.13

PROJECT: PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)
CUSTOMER : PATRATU VIDYUT UTPADAN NIGAM LIMITED (PVUNL)

ANNEXURE – 2E

QUALITY ASSURANCE