BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT, NOIDA.

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TYPE OF DOC.	**TECHNICAL SPECIFICATION**	NAME	**AA**	**PNK**	**PLK**
TITLE	**SPECIFICATION FOR CIVIL WORK OF 400/220KV SWITCHYARD WORKS FOR ADDITONAL BAY ICT#2**	SIGN			12/5/22
		DATE	**11-05-2022**	**11-05-2022**	**11-05-2022**
		GROUP	**TBEM**	**TBEM**	**TBEM**
CUSTOMER	**NTPC LTD.**				
PROJECT	**400/220 KV SWITCHYARD AT NORTH KARANPURA- ICT2 ADDITIONAL SCOPE**				

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SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENT & QUANTITIES

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1.0 SCOPE

1.1.1 The scope of work under this specification is Civil Works for Additional Bay in 400/220kV Switchyard at North Karanpura NKSTPP end being executed by BHEL on turnkey basis. The Customer is NTPC.

The Civil Works shall generally include, *but not limited to* , following:

(i) 400kV & 220kV Tower and Equipment foundations
(ii) Transformer foundations including Rail cum Road
(iii) Cable trenches including precast covers & cable trench crossing
(iv) Road work
(v) Gravel Spreading & Antiweed Treatment
(vi) Civil works associated with deluge valve housing & pedestals to support HVW spray system
(vii) Drainage work
(viii) Any other work required for the project

1.1.2 The works to be performed in the above construction includes preparation of bar bending schedules, based on the drawings released for construction and getting the same approved by the Engineer-in-charge plus the execution of the work including providing of all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, all incidental items necessary for successful completion of the work including contractor's supervision and in strict accordance with the drawings and specifications and with inspection and testing standards. The nature of work shall generally involve excavation in all type of soil including dewatering, shoring, strutting, and filling under and around structures, backfilling with available excavated earth around completed structures, cable trenches with covers, disposal of surplus soil, steel formwork, providing necessary steel embedment's and other inserts, drainage work, concreting, brickwork, flooring and finishing etc. and all other works in building all complete as per detailed specification, drawings and directions of Engineer-in-charge

1.2.0 SPECIFIC TECHNICAL REQUIREMENT

1.2.1 The specific technical requirements for the execution of civil works shall be as per Customer's specification (Section-3) /I.S Specification. In case of any conflict between these Customer's specification shall prevail.

1.3.0 BILL OF QUANTITIES

1.3.1 The Bill of Quantity cum price schedule shall be as per page 1.3 to page 1.6

1.3.2 The quantities indicated in the 'Bill of Quantity cum price schedule' are indicative and can vary to any extent. Contractor shall not be entitled for any claim for any such variation in the quantities.

1.3.3 The provision of Bill of Quantity cum price schedule, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, the clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding.

1.3.4 Method of measurement for payment purpose:

1.3.4.1 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 slope cutting, etc. Backfilling & disposal quantities 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.

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.

BILL OF QUANTITY

Name of Project **400/220 KV Switchyard at North Karanpura- ICT2 ADDITIONAL SCOPE**
Name of Work **Civil Work of 400/220kV Switchyard works for Additonal Bay ICT#2**

S.No.	Description of Item	Quantity	Unit	Unit Rate(Rs)	Amount(Rs)
A1	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 3.5m, disposed earth to be levelled and neatly dressed. All kinds of soil.	5900	cum	125.95	743105.00
A2	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 3.5m, disposed earth to be levelled and neatly dressed. Ordinary rock	500	cum	221.05	110525.00
A3	Extra for every additional lift of 1.5 m or part thereof in excavation and banking excavated or stacked materials. All kinds of soil	2350	cum	51.75	121612.50
A4	Extra for every additional lift of 1.5 m or part thereof in excavation and banking excavated or stacked materials. Ordinary rock	270	cum	92.80	25056.00
A5	Earthwork in excavation by mechanical means (Hydraulic excavator)/manual means in foundation trenches or drains (not exceeding 1.5m in width as well as 10sqm on plan) including dewatering as necessary of rain water/subsoil seepage water and dressing of sides and ramming of bottoms, lift upto 3.5m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 100m. All kinds of soil.	950	cum	166.40	158080.00
A6	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.	4250	cum	125.75	534437.50
A7	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 -. Lead upto 1 km.	1820	cum	98.34	178978.80
A8	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 -. Lead upto 3 km.	520	cum	124.51	64745.20
A9	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 -. Lead upto 5 km.	260	cum	149.17	38784.20
A10	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work upto plinth level M15	5	cum	4943.80	24719.00
A11	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work upto plinth level M10	5	cum	4415.45	22077.25
A12	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work upto plinth level M7.5	210	cum	4148.54	871193.40
A13	Extra for providing and mixing water proofing material 'Impermo' or equivalent in cement concrete work in the proportion recommended by the manufacturer.	10	kg	41.73	417.30
A14	Supplying and filling in plinth with Jamuna/local sand under floors,cable trenches, interlocking paver blocks, including watering, ramming, consolidating and dressing complete.	20	cum	810.82	16216.40
A15	Providing, laying and compacting boulder soiling of required thickness in foundations of equipment and under the floors as per direction of Engineer-in-Charge.	10	cum	797.16	7971.60
A16	Supplying chemical emulsion in sealed containers including delivery as specified. Chloropyriphos emulsifiable concentrate of 20%	30	litre	157.45	4723.50
A17	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/cum. Excess/less cement used as per design mix is payable/recoverable separately). All works	1900	cum	5887.43	11186117.00

BILL OF QUANTITY

Name of Project **400/220 KV Switchyard at North Karanpura- ICT2 ADDITIONAL SCOPE**
Name of Work **Civil Work of 400/220kV Switchyard works for Additonal Bay ICT#2**

S.No.	Description of Item	Quantity	Unit	Unit Rate(Rs)	Amount(Rs)
A18	Add for using extra cement in the items of design mix over and above the specified cement content therein.	950	quintal	533.82	507129.00
A19	Centering and shuttering including strutting, propping, etc., and removal of form for: Foundations, footings, bases of columns, etc., for mass concrete.	750	sqm	184.42	138315.00
A20	Centering and shuttering including strutting, propping, etc., and removal of form for: RCC walls at all levels (any thickness).	3450	sqm	369.24	1273878.00
A21	Centering and shuttering including strutting, propping, etc., and removal of form for: Columns, Pillars, Piers, Posts and Struts .	2000	sqm	454.41	908820.00
A22	Steel reinforcement -Cold twisted bars /TMT- Fe 500 (To be procured from SAIL,TISCO,IISCO, JINDAL STEEL and RINL only) Including supply, straightening, cutting and bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	160000	kg	56.60	9056000.00
A23	Brickwork with F.P.S.bricks of class designation 75 in foundation and plinth in: Cement mortar 1:6 (1 cement : 6 coarse sand)	10	cum	4524.10	45241.00
A24	18mm cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement :5 coarse sand) finished with a top layer of 6mm thick 1:6 (1cement:6 fine sand)	10	sqm	245.49	2454.90
A25	2mm thick plaster of paris punning over the plastered surfaces on wall surfaces as directed by engineer-in-charge.	10	sqm	117.08	1170.80
A26	12mm cement plaster on even side of the walls in the mix: 1:6 (1cement :6 coarse sand)	10	sqm	162.22	1622.20
A27	Distempering with 1st quality acrylic distemper of approved manufacturer, of required shade and colour complete, as per manufacturer's specification .	10	sqm	51.95	519.50
A28	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade. Two or more coats on new work.	10	sqm	80.15	801.50
A29	Structural steelwork welded in built up sections like edge protection angles, pipes, insert plates with lugs & framed work including providing, cutting, hoisting, fixing in position/ embedding in concrete and applying a priming coat of approved steel primer all complete.	12000	kg	51.36	616320.00
A30	Steelwork welded in built up sections/framed work including providing, cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc., as required: In frames, rails, ISMB, ISMC, gratings and similar works.	10000	kg	78.07	780700.00
A31	Providing & placing in position precast cement concrete trench covers or perforated covers wherever necessary at various elevations in all kinds of work including moulding, formwork, mixing, laying out, compacting and curing, storing, transportation, erection without damage etc all as per specs, drawings and directions of Engr-in-Charge but excluding the cost of reinforcement, inserts, edge angles, etc. Grade of concrete shall be M30	70	cum	6256.17	437931.90
A32	Providing and fixing (all dia & length) 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)	5900	kg	87.19	514421.00
A33	Extra over Item above for providing galvanised bolts (Mass of zinc coating = 800gms/sqm), nuts & washer .	5900	kg	7.71	45489.00
A34	Fixing (all dia & length) foundation bolts in position with help of proper templates(template to be supplied by contractor) all complete as per specs, drawings & directions of Engr-in-Charge.Bolts to be provided by BHEL free of cost. (Notes: 1) For payment purpose the weight of Template will not be considered 2) Rates are also includes Unloading, storage, watch and ward etc for BHEL Supplied Foundation Bolts)	100	kg	9.20	920.00
A35	Providing and laying non-pressure NP2 class (light duty) 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. 250mm dia. RCC pipe	5	RM	429.98	2149.90
A36	Providing and laying non-pressure NP2 class (light duty) 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. 300mm dia. RCC pipe	5	RM	459.59	2297.95
A37	Providing and laying non-pressure NP2 class (light duty) 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. 450mm dia. RCC pipe	5	RM	639.06	3195.30

BILL OF QUANTITY

Name of Project **400/220 KV Switchyard at North Karanpura- ICT2 ADDITIONAL SCOPE**
Name of Work **Civil Work of 400/220kV Switchyard works for Additonal Bay ICT#2**

S.No.	Description of Item	Quantity	Unit	Unit Rate(Rs)	Amount(Rs)
A38	Providing and laying non-pressure NP3 class (medium duty) 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. 250mm dia. RCC pipe	5	RM	994.28	4971.42
A39	Providing and laying non-pressure NP3 class (medium duty) 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. 300mm dia. RCC pipe	5	RM	1193.14	5965.70
A40	Providing and laying non-pressure NP3 class (medium duty) 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. 450mm dia. RCC pipe	5	RM	1660.11	8300.54
A41	Providing and placing in position suitable PVC water stops conforming to IS 12200 or equivalent for construction/expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. complete. Serrated with central bulb(230mm wide,8-11mm thick)	100	meter	216.54	21654.00
A42	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.	3	cum	7320.65	21961.95
A43	Providing and supplying grating of 40mm thickness and opening size 30mmx100mm, with minimum thickness of main bearing bar 5mm including shot blasting, priming, finish painting and galvanising of minimum weight 610gms/Sqm etc.all complete .	200	kg	78.07	15614.00
A44	Antiweed Treatment in switchyard area including micro levelling, dressing etc as per Technical Specification	3000	sqm	12.51	37530.00
A45	Filling of approved materials i/c cost of materials, labour and equipment for handling, transportation, placing and compacting as required to the required density and to the required elevations as per specification, drawings and directions of Engineer-in-Charge. Broken/crushed/non crushed stone of size 40 to 60mm for placing over transformer grating.	20	cum	1389.23	27784.60
A46	Providing and laying stone aggregate in switch yard areas in 75mm thick layer using 20 mm aggregates size in first layer and 75mm thick layer using 40mm size aggregate in second layer making overall thickness of stone aggregate as 150mm. Before laying the stone aggregates , the yard surface shall be treated with antiweed treatment all complete as per Customer specification (Clause no. 1.01.22 & 5.05.07) and direction of Engineer in Charge.(Aggregate shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall meet the requirements of IS: 383.) (The rate shall be inclusive of all materials ,labour, levelling, dressing, compaction, etc. required for aggregate laying and antiweed treatment with performance guarantee of three years.)	1100	sqm	237.71	261475.50
A47	Same as above Item no A46 excluding supply of stone aggregate & Antiweed treatment, but including Removing,cleaning and washing of existing laid gravel, stacking and respreading of stones in switchyard.	3000	sqm	79.17	237510.00
A48	Preparation and consolidation of sub grade with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth,dressing to camber and consolidating with road roller including making good the undulations etc and re-rolling the sub grade and disposal of surplus earth lead upto 50 metres.	300	sqm	90.10	27030.00
A49	Suppling and stacking at site 90 mm to 45 mm size stone aggregate	50	cum	1278.69	63934.50
A50	Suppling and stacking at site 63 mm to 45 mm size stone aggregate	50	cum	1386.53	69326.50
A51	Suppling and stacking at site 53mm to 22.4 mm	75	cum	1475.02	110626.50
A52	Suppling and stacking at site Stone screening 13.2 mm nominal size (type A)	10	cum	1439.66	14396.60
A53	Suppling and stacking at site 11.2 mm nominal size (Type B)	10	cum	1398.19	13981.90
A54	Suppling and stacking at site moorum	10	cum	563.01	5630.10
A55	Laying WBM with specified size of stone aggregates, screening and moorum/ blinding materials including screening, sorting, spreading to template and consolidation with power road roller of 8 to 10 tonne capacity etc., complete. (Payment will be made for compacted layers only). Subbase with stone aggregate 90mm to 45mm including stone screening 13.2mm size and moorum/blinding material.	50	cum	449.09	22454.50

BILL OF QUANTITY

Name of Project **400/220 KV Switchyard at North Karanpura- ICT2 ADDITIONAL SCOPE**
Name of Work **Civil Work of 400/220kV Switchyard works for Additonal Bay ICT#2**

S.No.	Description of Item	Quantity	Unit	Unit Rate(Rs)	Amount(Rs)
A56	Laying WBM with specified size of stone aggregates, screening and moorum/ blinding materials including screening, sorting, spreading to template and consolidation with power road roller of 8 to 10 tonne capacity etc., complete. (Payment will be made for compacted layers only). Base course with stone aggregate 63mm to 45mm including stone screening 13.2mm sizeand moorum/blinding material.	50	cum	449.09	22454.50
A57	Laying WBM with specified size of stone aggregates, screening and moorum/ blinding materials including screening, sorting, spreading to template and consolidation with power road roller of 8 to 10 tonne capacity etc., complete. (Payment will be made for compacted layers only). Base course with stone aggregate 53mm to 22.4 mm including stone screening 11.2mm size and moorum/binding material.	50	cum	449.09	22454.50
A58	Providing and fixing at or near ground level factory made kerb stone of M-25 grade cement concrete in position to the required line, level and curvature, jointed with cement mortar 1 : 3 (1 Cement : 3 coarse sand) including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete tec. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for calculation of qty. for payment).	50	cum	4335.95	216797.50
A59	Providing and laying 75mm thick factory made cement concrete interlocking paver block of M-35 grade of approved size, design & shape, laid in required colour and pattern all complete as per the specification, recommendation of manufacturer and Engineer In charge.	200	sqm	549.38	109876.00
A60	Providing and fixing in position 12mm thick bitumen impregnated fibre board conforming to IS: 1838, including the cost of primer, sealing compound in expansion joints.	50	per cm depth per 100 m	397.12	19856.00
A61	Providing and laying polythene sheet of 125 microns between the PCC and RCC slab all complete as per direction of Engineer-in-Charge)	250	sqm	12.70	3175.00
A62	Providing and fixing in position pre moulded joint filler in expansion joints	50	per cm depth per cm width per m length	1.89	94.50
A63	Providing and laying in position bitumen hot sealing compound for expansion joints etc. Using grade A ceiling compound	50	per cm depth per cm width per m length	2.16	108.00
A64	Providing and laying cement concrete of grade M35 using 20mm nominal size stone aggregate with approved admixture(if required), in road pavement using fully mechanized paver fitted with electronic sensors, providing dowel bars with sleeve/ tie bars wherever required,laying at site, provision of necessary joints including compaction, finishing to lines and grades, curing and providing and fixing framework etc. all complete. (Excluding the cost of Reinforcement)	40	cum	6048.00	241920.00
A65	Providing and laying Dry lean cement concrete (DLC) of grade M10 (In pavements/shoulders) with 20mm nominal size graded stone aggregate with mechanical paver over granular sub-base including compaction by vibratory roller, finishing, curing etc all complete as per the direction of Engineer In Charge.(excluding cost of cement)	42	cum	4415.45	185448.90
A66	Demolishing brick work manually/by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in- charge. In cement mortar	5	cum	842.73	4213.65
A67	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.	8	cum	1454.54	11636.32
A68	Dismantling manually/ by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-charge : Water bound macadam road	160	sqm	90.50	14480.00
A69	Disposal of building rubbish / malba / similar unserviceable, dismantled or waste materials by mechanical means, including loading, transporting, unloading to approved municipal dumping ground or as approved by Engineer-in-charge, beyond 50 m initial lead, for all leads including all lifts involved.	10	cum	120.53	1205.30
A70	Providing and fixing approved quality pre polished vitrified tiles minimum thickness 9.5 mm of approved make and colours in skirting,risers of steps and dados over 12 mm thick bed of Cement mortar 1:3 (1 Cement:3 coarse sand) and jointing with grey cement slurry @3.3 kg/sqm including pointing in white cement mixed with pigment of matching shade complete.	10	sqm	1010.07	10100.70
				Total	30282106

SECTION - 2

STANDARD TECHNICAL SPECIFICATION
(N.A.)

SECTION - 3

ENCLOSURES TO THE SPECIFICATION

(a) Customer’s specification.

NTPC Limited

(A Government of India Enterprise)

NORTH KARANPURA SUPER THERMAL POWER PROJECT (3x660MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 5)

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BIDDING DOCUMENT NO.: CS-4410-001-2

NTPC Limited

(A Government of India Enterprise)

NORTH KARANPURA SUPER THERMAL POWER PROJECT (3x660MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (CIVIL)

(BOOK 4 OF 5)

SECTION - VI

BIDDING DOCUMENT NO.: CS-4410-001-2

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CIVIL

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1.00.00 **GENERAL**

1.01.00 This specification is to cover, survey works , site leveling works, design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour & materials and construction of all civil, structural and architectural works by the Bidder.

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as civil works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope is given in Part-A and herein.

The work to be performed under this specification consists of design, engineering, construction, erection and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.

All construction materials including cement, reinforcement steel, coarse & fine aggregate, structural steel and construction water etc., shall be arranged by the Bidder.

The scope shall also include setting up by the Bidder a complete testing laboratory in the field to carry out all relevant tests for structural steel, reinforcement steel & constituents of reinforced cement concrete (RCC) etc.

Preliminary geotechnical investigation in the proposed area has been carried out by the Owner and the borelog data is furnished in Annexure 'C'. Detailed Geotechnical Investigation shall be carried out by the bidder. The foundation system shall be evaluated by the bidder based on the above mentioned detailed geotechnical investigation.

The work shall be carried out according to the design/drawings to be developed by the Bidder and approved by the Employer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Bidder keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance. The Bidder's work shall cover the complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Employer.

The Bidder shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. deptt. as per the directions of the Engineer. The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil works.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.

The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

Wherever there is an anomaly in the design concept between the data furnished in the General Design Criteria & Design Concept of Buildings, the data furnished in the design concept of buildings shall be treated as final.

1.02.00 ABBREVIATIONS USED

RCC : Reinforced Cement Concrete
PCC : Plain Cement Concrete
GSI : Geological Survey of India
MS : Mild Steel
IS : Indian Standard
BTG : Boiler Turbine Generator
MPH : Main Power House

2.00.00 SCOPE OF WORK

2.01.01 The scope of work for the EPC contractor shall include the analysis, design, construction, erection of all civil, structural & architectural works and all other items mentioned in Part-A of this Specification.

2.02 Construction Facilities

For details of construction facilities refer to Part-A of this specification.

2.03 Exclusions:

The details of exclusions and terminal points, refer to Part-A of this specification.

3.00.00 SUBMISSIONS

3.00.01 The documents and drawings as listed below are to be submitted for the approval of the Employer unless specified otherwise. The list given below is not exhaustive but indicative only.

a) Project design intent document giving the basis of design, which shall cover all the aspects, parameters, assumptions, references, structural idealization / mathematical model, loading cases, load combinations, basis of analysis and design of all buildings, facilities, systems and structures etc. shall be furnished and got approved before commencement of detailed engineering.

b) Structural analysis, design calculations and drawings of substructure and super structures for all buildings, structures, facilities, and systems including cooling water ducts/pipes unless noted otherwise in the following paras.

c) Analysis, design calculations and drawings for all services like roads, culverts, bridges, road/rail crossings, drainage pump houses (if required), drains, sewers, sewage pump house, water supply, water tank, coal conveyor galleries, trestles, transfer points, trenches, ducts, etc.

d) Survey drawings indicating spot levels for the area under the scope of work and L-section along pipe corridors outside plant boundary.

e) Plant 'General Layout Plan' drawing with coordinates of roads, boundary wall, buildings and facilities, piping/cable corridors, green belt, etc.

f) Drawings showing underground facilities with co-ordinates and invert levels of the facilities like buried pipes, buried cables, trenches, ducts, sewers, drains, sumps, pits, culverts, manholes, etc.

h) All architectural drawings required for execution of construction work such as detail floor plans, detail elevations, detail sections and other miscellaneous architectural details such as finish schedule(internal & external), colour schemes (both internal and external), doors and windows, flooring details & pattern, north/sky light in the roof, false flooring, false ceiling, etc., architectural facia and projections, miscellaneous stair details & architectural details like, coping, flashing, khurras, water proofing, fillet, roof decking, wall cladding, surface drains, rain water down comers, sanitary, plumbing, etc.

i) Design criteria and design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundation for TG, BFP, Mills, Fans (PA, FD, ID & Seal Air), Crusher etc.

j) Write-up on various statutory requirements and their compliance for various buildings, facilities, structures and systems, etc.

k) As Built- Final Shop drawings/fabrication drawings of all structural steel works (only for reference) on CDs and design calculations for important joints/connections

l) Construction and erection procedure for all major structures such as Main Plant building including Control tower, Mill and Bunker building including coal bunkers, Transfer Points, Conveyor Galleries, Boiler/ ESP structures, Chimney, Cooling Towers, Switchyard Structures, Ash Water PH, TG foundation and other machine foundations, Clarifiers, etc. covered under the Bidder's scope.

m) In case of piling, the design of piles in terms of type, rated capacity, length, diameter and termination criteria to locate the founding level and scheme for initial pile load tests in vertical, lateral and uplift modes along with supporting design calculations, scheme of routine load test of piles, High Strain Dynamic Load Test, Pile Integrity Tests and methodology for installation of working piles.

n) Marking scheme identifying the equipment lay-down areas, with distinctive colour scheme.

o) Material test certificates.

p) Design criteria (for approval) and drawings (for information only) for Boiler/ESP supporting structures.

q) As built drawings (including all architectural, interior & landscape drawings in soft copy on a C.D) with quantities of various items of work system wise, building wise, structure wise, etc. duly certified by Site after execution of work for information/record.

r) Details of corrosion protection measures for all structures.

s) One complete set of applicable standards, references, specifications, code of practice along with soft copy (wherever required with minimum 2 years license fee) to the Engineer for use at site.

t) Wherever applicable, scheme for dewatering, shoring, strutting/sheet piling.

u) All other design details/drawings or any other submission as indicated elsewhere in this specification and as required by the Employer.

v) Design and drawings of embankment for approach road to make up water pump house including analysis of slope stability, seepage analysis, with supporting calculation &

methodology of construction & laying of slope protection.

w) Design and drawing of ash dyke, stability analysis / seepage analysis, water escape structure, general arrangement and scheme for internal drainage arrangement, ash storage capacity calculation, technique for decantation.

Commencement of fabrication and erection and construction shall be done after approval of the relevant documents and drawings. All drawings shall be of standard sizes (Metric System) and shall be made on AutoCAD. All documents shall be made using MS office. Bidder shall submit all documents and drawings as per the followings:

Drawings:	-	Soft copy via C-folder for all drawings.
	-	After approval of drawings Hard copies of each construction drawing as specified in General Technical Requirement shall be submitted to Owners site office
As Built Drawings:	-	In CD.
Design/Document:	-	Soft copy via e-mail/ C-folder and two set of hardcopies.

In general 3D modeling and structural frame analysis and design for the plant structures shall be submitted by the bidder for Employer's review and approval. Soft copy of 3D modeling (including input and output files shall be submitted

All construction drawings shall include total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise).

4.00.00 GENERAL LAYOUT PLAN

4.01.00 The preliminary layout plan proposed for the project is shown in the drawing no. 4410-999-POC-F-001 titled "General layout plan". It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

Bidder shall prepare the detailed layout of the plant facilities which are in the scope of this package and shall submit the same for Owner's approval.

While preparing the detailed layout, planning the facilities and deciding upon the transportation and erection strategy bidder shall ensure the following aspects.

a) All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

b) Face of the buildings and facilities are located in such a way so as to have an offset of minimum 20m with respect to centre line of double lane road and 15 metre with respect to centre line of single lane road.

c) The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.

d) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working parallel with the Bidder within the plant premises.

e) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores have been earmarked on the General Layout Plan.

f) No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks, Hydrogen plant complex, etc., except those permitted by Owner.

g) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed. However the same may be adopted subject to approval of the Employer.

h) All the buildings and facilities shall be approachable by fire tenders.

4.02.00 **Technical Specifications for Pre-cast Boundary Wall and Watch Tower**

A pre-cast boundary wall all around the land acquisition line as shown in the General layout Plan for plant area shall be provided. The total height of boundary wall shall be 3600mm above formation level (natural ground level in case formation level is less than natural ground level). Upto height of 3000mm it shall be constructed with precast reinforced cement concrete panels / cast in situ RCC panels and over that for 600mm concertina coil with maximum loop spacing of 125mm shall be provided with Y-shaped MS angle. The RCC precast/cast in situ reinforced concrete columns shall be provided at spacing not more than 2500mm c/c.

The RCC precast/cast in situ reinforced concrete columns and footing shall be minimum 1500mm below finished formation level with suitable foundation designed for horizontal and vertical loads. The precast reinforced concrete panels/ cast in situ RCC panels shall be at least 600m below formation level. The RCC precast concrete columns/ cast in situ RCC panels of minimum size 300mmX350mm shall be provided with two grooves of minimum size 115mmX50mm, so as to receive Precast Concrete RCC panels spanning from column to column with minimum width of 600mm and minimum thickness of 100mm as filler wall. The grade of concrete for all precast/cast in situ work shall be of M30 grade conforming to IS 456.

The boundary wall shall be designed as per relevant IS codes and as per standard practices. The same shall be submitted to Owner for approval at the time of detailed engineering, The architecture of boundary wall shall be finalized in consultation with owner. The precast/ cast in situ reinforced cement concrete coping with minimum projections of 150mm on each side shall be provided at the top of the precast reinforced cement concrete panels / cast in situ RCC panels with suitable provision for MS angle Post for concertina throughout the boundary wall. Opening for gates/drains and for other crossing shall be suitably provided as per the requirement.

All exposed concrete surfaces of all precast members/ cast in situ RCC members have high quality shuttering finish with tolerance of +/- 5mm. Plinth protection of 150mm thickness PCC (M20) shall be provided on both side of boundary wall extending upto 300mm from centre line of boundary wall. High quality shuttering to be approved by Owner.

Watch Towers shall be RCC construction with all weather enclosure at 6M height. Watch Towers shall be provided at 600 m interval along the Boundary as well as at corner turning points of the plant boundary. Watch Towers shall be provided with caged MS ladders.

4.03.00 **Site Levelling and Slope Protection Work**

4.03.01 Complete levelling of entire plant area including the area earmarked for administration building, ash based units, ash silos, and make up water pump house and associated facilities shall be done by the Bidder.

Bidder shall carry out the topographical survey before commencing detailed design and site leveling. This survey shall cover the entire plant area including the areas earmarked for administration building, ash based units, ash silos, make up water pump house & associated facilities, and the diversion drains in Bidder's scope of work. Based on field observations the bidder shall prepare and submit for Owners review the survey maps of the surveyed sited on suitable scale, indicating grid lines, contour lines and demarcating all permanent features like roads, railways, water-ways, buildings, power lines, natural streams, trees etc. For each area two sets of survey maps shall be prepared and submitted, one showing the spot levels and contours with grid lines and the other showing the grid lines, contours and permanent features.

Established methods of surveying like triangulation, traversing, fly leveling etc. shall be adopted for the survey work. Spot levels shall be taken at 25 metres interval and at closer intervals where pits, undulations etc. are met with. these levels shall be taken in two orthogonal directions. Contours shall be plotted at 0.5m interval.

It is proposed that for the purposes of site leveling the entire plant and associated areas will be divided into various blocks as defined in the drawing no. 4410-001-POC-A-001 titled, "Site Levelling Works ". Each block shall be finished to the formation level as specified in drawing. Bidder shall deploy adequate number of experienced site leveling contracting agency(s) with requisite earth moving and compacting equipment to complete the work as per schedule.

Since the construction of roads and drains for the entire plant is included in the scope of Bidder, it shall be the responsibility of the Bidder to ensure that these facilities are also constructed along with site leveling works. Bidder shall ensure that road access and drainage facilities for each block is available when site leveling in that block is completed. Unless otherwise instructed by the Engineers, all roads and drains within a block shall be constructed by the bidder within a month from the date of completion of site leveling of that block.

The specified formation level(s) shall be achieved either by excavation where the existing ground levels are higher than the specified formation level or by raising by controlled filling with borrowed earth where the existing ground levels are lower than the specified level.

The excavation shall be in all types of soils or rock or a mixture of these. Bidder should assess and satisfy himself about the actual nature of soil present at site, before submitting his bid.

All materials arising out of site clearance and excavation shall be the property of owner. They shall be dealt with in the manner specified by the Engineer. Earth / boulders / rock etc. excavated and useful portion (serviceable materials) of trees cut shall be stacked at suitable places within Owner's acquired land for the plant and the ash disposal area in a manner as directed by the engineer. Woods, branches, trunks of trees shall be termed as serviceable material. Other materials like twigs, leaves, roots, vegetable and organic matters etc. shall be termed as unserviceable material and shall be sorted out from the serviceable materials before disposal. They shall be cleared from the area and disposed off at places within Owner's acquired land for the plant and the ash disposal area in a manner as directed by the engineer.

If the excavated material is suitable and accepted by the Engineer as fill material, the same can be used for filling in other areas where raising by filling is required. Otherwise the same shall be taken and stacked at places(s) within the plant boundary as directed by the Engineer.

Filling with rock shall be done only after the written permission of the Engineer in the following manner:

- Filling with rock shall be done only in areas identified for laydown and preassembly and ash based units.

- Original ground after removal of all organic and vegetable matters shall be consolidated by rolling as directed by the engineer subject to a minimum of six passes of 8-10 tonnes roller.

- Excavated rock shall be laid (on original ground or after filling 300 mm thick layers of soil as specified), in layers not exceeding 1000 mm and rolled with vibratory roller (10-15 tonnes static weight) with minimum six passes.

- Over the compacted layer of rock, soil shall be filled in horizontal layers not exceeding 300mm in compacted thickness. The soil shall be compacted as specified elsewhere.

- It shall be ensured that the top soil layer is in minimum 3 layers of 300 mm each. To achieve this the thickness and number of rock fill layers below can be suitably adjusted.

Contour map and spot levels of the area based on the preliminary survey carried out by Owner is enclosed for the purpose of guidance of Bidder. Refer tender drawing no. 4410-001-PVC-A-001. However, Owner does not take any responsibility about the accuracy of the survey details furnished and any variation of the said data shall not constitute a valid reason for changing the terms and conditions of the contract. Bidder is requested to carry out his independent assessment of the existing ground levels before furnishing his Bid. Detailed survey shall be carried out by Bidder after award of work and all findings as stated earlier shall be submitted for Owner's review.

4.03.02 All existing drains/channels in the plant and other areas associated with the plant except those proposed to be constructed by the Owner shall be suitably diverted by the Bidder before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding within the limits of overall land acquisition line and in adjoining areas.

4.03.03 Before commencement of cutting/filling, all organic and vegetable matters like grass. plants shrubs bushes, weeds, trees etc. in the areas to be filled, shall be completely removed along with their roots and disposed off. It shall also be ensured that the area to be filled is clear of any water, slush etc. Original ground shall be compacted by rolling as directed by the Engineer subject to a minimum of six passes of 8 to 10 tonne roller. The earth shall then be spread in horizontal layers not exceeding 300 mm in compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction of 95% or more of Standard Proctor's maximum dry density. The moisture content of the fill material shall be controlled to obtain near optimum moisture content during compaction. The fill material shall be tested for determining optimum moisture content and maximum dry density by Standard Proctor Test as per IS : 2720 (Part-VII). The fill material shall also be tested for determining moisture content before compaction as per IS: 2720 (Part-II). For

each of the above tests, one sample for every 10,000 cubic meter of fill material shall be tested. Additional samples shall be tested, whenever there is a change in the source or type of fill material. The compacted soil shall be tested for its dry density as per IS 2720 (Part-XXIX) or Part-XXVIII). Samples shall be taken at the rate of one sample for every 10,000 sq.m. area for each compacted layer. In addition random checks shall be carried out in compacted soils by means of Proctor needle penetration. Bidder shall submit to the Engineer, the test results immediately after completion of the tests. A sample shall be deemed to have passed the test when the in-situ dry density is equal to or more than the specified percentage of maximum dry density. If a sample taken from a layer fails to pass the test, the layer shall be further compacted till two samples taken and tested from this layer pass without any negative deviation. Only after this, spreading of further layers shall be taken up.

4.03.04 Before start of filling, the Bidder shall submit to the Owner his proposal for the methodology to be adopted for compaction for each type of fill material. The Bidder shall also carry out compaction trials to establish the proposed methodology. The Bidder shall start the compaction work only after approval of the methodology by the Owner.

4.03.05 The surface of the cut/filled up areas after reaching final level shall be dressed to the required levels and slopes. The difference in levels shall not be more than +/- 10cm locally.

4.03.06 The borrow areas outside the overall plant boundary limits for obtaining suitable fill material which is required over and above the earth available after cutting high grounds within the plant area, for site levelling shall be arranged by the Bidder himself and all expenses in respect of royalties, taxes, duties, etc. for borrow areas/fill material shall be borne by him. He shall also obtain and submit to the Owner the necessary clearances/permission from the concerned authorities for the borrow areas/fill material.

4.03.07 Material suitable for filling shall be loaded and transported to the filling site by the Bidder. Any coarse grained or fine grained low plastic soil, free from shingle, salts, organic matter, sod or any other foreign substances, may be used for filling. The Bidder shall test the fill material to establish its suitability and submit its results to the Owner. Fill material shall be approved by the Owner. The following types of materials shall not be used for filling:

a) Material from swamps, marshes and bogs.

b) Expansive clays

c) Peat, logs, stumps, sod and perishable materials.

d) Materials susceptible to combustion

e) Any material or industrial and domestic produce which will adversely affect other materials in the work.

f) Materials from prohibited areas

4.03.08 Bidder shall include in his offer any extra filling that may be required on account of subsidence of the original ground due to overburden of filling above and/or compaction works for site levelling.

4.03.09 After levelling, the bidder shall establish concrete pillars at the intersection points of the grid lines for future reference. These pillars shall project at least 450 mm above the formation level and shall be labeled permanently with their respective coordinates and reduced levels.

4.03.10 Filling upto the specified formation level shall extend at least 2.0 m beyond the outside face of boundary wall/fence. Thereafter, it shall be finished at a suitable slope (not steeper than 1 Vertical: 2 Horizontal) and provided with good quality dry stone pitching minimum 300mm thick.

5.00.00 **SALIENT FEATURES & DESIGN CONCEPT OF MAIN PLANT BUILDINGS, CHIMNEY, COOLING TOWERS, ACW SYSTEM, DM PLANT, PT PLANT & CW TREATMENT CIVIL WORKS, BALANCE OF PLANT BUILDINGS, INTERNAL COAL HANDLING & ASH HANLING SYSTEMS, SWITCHYARD STRUCTURES, FUEL OIL HANDLING SYSTEM, OFFICE BUILDINGS, ROADS and DRAINAGE**

5.00.01 **Architectural concepts & design**

a) Architectural Design and Detailing aspect of all the Building shall be rendered through professional services of a registered Architect. The Architect consultant shall be of National/ International repute, having experience in similar kind of works. The consultant shall evolve the design based on employer's guidelines and shall present it in the form of Presentation Drawings, Detail Drawings, Perspective View& 3D Model/ Walk through. All drawing and document shall be duly stamped by the Registered Architect

b) Power Plant Buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehendible scale, blending colour scheme with the surroundings.

c) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology.

d) Overall colour scheme of the Main plant building and other buildings shall be designed judiciously and in a comprehensive manner taking into a account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements.

e) For adequate light and ventilation, National Building Code recommendations shall be followed. Main Power House Building shall have skylights in polycarbonate sheet in each bay on T.G Hall Roof, so as to provide adequate natural light inside. All buildings having height more than 4.0 m shall have glazed ventilators.

f) Architectural design of Main Power House Building, Administration Building, Service Building, & Canteen Building shall be suitable for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose.

g) All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations.

h) During design stage, Technical specification as prepared shall govern the finishes.

i) Service building, Administration building, Auditorium building and Canteen building shall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building, with a minimum four (4) star rating. Bidder shall perform all services related to GRIHA certification including preliminary assessment, GRIHA facilitation, simulation & analysis leading to obtaining the final certification by GRIHA. For information about GRIHA, bidder is requested to visit the web site www.grihaindia.org

j) All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.

k) All the buildings and site development including landscaping shall be designed to take care of Rain water harvesting & Ground water recharging.

l) For Control Rooms of MPH/ ESP Control Buildings, Dry Wall Construction Technology shall be incorporated.

m) Due consideration shall be given to preserve and protect the existing Landscape during the construction, reduce air pollution during construction and provide for minimum level of sanitation and safety for construction workers.

n) Overall emphasis shall be on developing eco-friendly architecture, merging with the nature with its own sustainable energy management systems

o) Landscape Development

There shall be comprehensive landscape development in entire Plant area to create a pleasant and healthy environment. The scope of work for landscape and horticulture work shall include supply and planting of trees, shrubs, hedges/edges/borders, grass lawn around different areas, buffer and peripheral plantation etc. The scope shall also include supply and installation of all landscape furniture i.e. Park-Benches, & Gazebos, Landscape fountain & water bodies, Landscape Pavers/ Tiles etc & all associated electrical works/ items, Mechanical works/items and civil works and all other work required for completion of Landscape development. The landscape design and drawing shall be developed by competent Landscape Architect. The landscape shall use the

suitable plants and trees preferably local trees, plants, and shrubs. There shall be provision of pathways in and around the landscaped area. Around the pathways and roads, trees shall be planted. There shall be provision of drip/sprinkler irrigation system for irrigation of landscaped area. There shall be intense landscape with four water body development one near to Main gate complex, one near Administration building, one near Service building and one near Canteen building. The landscape (including water body) around Administration Building, Service Building, Auditorium Building, and Canteen building shall meet the GRIHA requirement for 4 STAR rating.

5.01.00 **Main plant Buildings/ Structures shall comprise of:**

a) Main Power House

b) Mill Bunker Building

c) Machine Foundations in Main Plant

d) Boiler Structure

e) Compressor House

f) ESP Structure

g) ESP Control Building

h) Miscellaneous Equipment Foundations & Pipe Cable Trenches/ and Pedestals below finished ground level.

i) Pipe & Cable Gallery

j) Service Building

k) Transfer Points , Conveyor Galleries & Trestles

The Main Power house, Bunker building, transfer points, conveyor galleries and trestles, boiler supporting structure, ESP supporting structures including inlet and exhaust duct support structures, Pipe cable Galleries & trestles shall have structural steel framed super structure.

All other buildings may have either RCC or structural steel framework.

Brief description of the above mentioned Main Plant Buildings is furnished herein:-

a) Main Power House

- **Salient Features:**

Main Power House shall consist of the Turbine bay, adjacent Deaerator/ heaters Bay, electrical bay & Control room Building (as stipulated elsewhere in the specification). The Turbo – Generator (TG) foundation, MDBFP & TDBFP foundations shall be located inside the power house. The RCC floors shall comprise RCC slab over profiled metal deck sheets (to be used as permanent shuttering over structural steel beams and not to be considered for deign of RCC slab as composite slab). Shear anchor studs shall be provided with stud welding

(b) Forced vibration analysis

Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition : -

1. For unbalance load corresponding to G16 as per ISO 1940-1: 2003

2. For unbalance load corresponding to one blade failure condition.

The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent.

Mid Bearing Supporting Structure

The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns.

Fan Stack

The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS : 11504 for Natural Draught Cooling Towers. The fanstack shall have two layers of reinforcement on either surfaces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 150mm c/c.

Steel Structure

All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanised as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent.

For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as per Cl. 6.04.03. However, for painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting of steel structures as specified elsewhere in the technical specification shall be referred.

The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers.

Test for water tightness

The water tightness of C.W. basin, outlet channel, hot water channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS : 3370.

iii. Unless specified, the wall cladding for buildings shall be with minimum one brick thick on exterior face. However, brick wall for buildings adjacent to transformers shall be minimum 345mm thick.

5.04.01.01 Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.

5.04.01.02 The load and load combinations and design criteria shall be as specified elsewhere in the specification.

5.04.01.03 All liquid retaining structures shall be designed for following load conditions.

Underground structures:

a. Water filled inside up to design level and no earth outside.

b. Earth pressure with surcharge of 2.0 T/m2 and ground water table up to FGL outside and no water inside.

c. Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure.

d. The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table.

For design of over - ground liquid retaining structures appropriate load cases shall be considered.

5.04.01.04 All liquid retaining and conveying structures shall be designed by working stress method as given in clause 4.5 of IS 3370(Part2):2009.

5.04.01.05 In the wall of liquid retaining structures with cylindrical shape such as clarifiers, vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.

5.04.01.06 Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate / disc compactors in such a manner that the bottom slab is not structurally damaged.

5.04.01.07 Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.

5.04.01.08 Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.

5.04.01.09 The minimum grade of concrete for all RCC structures associated with DM plant, PT plant, ETP, CW chemical treatment and CPU shall be of grade M30.The minimum concrete clear cover to reinforcement bars in all RCC structures shall be as per IS:456(2000) and IS:3370(Part II) for water retaining structures. Durability of concrete shall conform to moderate exposure conditions as per Table-3 of IS 456 except noted specifically otherwise.

5.04.01.10 Factor of safety against overturning and sliding

The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and 1.4 against sliding conditions as per IS: 456.

5.04.01.11 For detailing of Reinforcement IS: 5525, IS: 13920, IS: 4326 and SP: 34 shall be followed.

5.04.01.12 Two layers of reinforcement (on both faces) shall be provided for RCC sections having thickness of 150 mm and above.

5.04.01.13 Minimum diameter of main and distribution Reinforcement bars in different structural elements shall be as follows::

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement / Stirrups/ ties/ Anchor Bars
a)	Foundation	12 mm	12 mm
b)	Beams	12 mm	8 mm
c)	Columns	12 mm	8mm

5.04.01.14 Spacing of reinforcement bars in walls and slabs of liquid retaining / conveying structures shall not be more than 200 mm.

5.04.01.15 Suitable shrinkage reinforcement shall be provided at top face of foundations. Minimum shrinkage reinforcement shall be 10 mm dia. @ 200mm c / c.

5.04.01.16 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be 0.24 % of cross sectional area.

5.04.01.17 Minimum tensile Reinforcement in each direction for all foundation slabs / rafts shall be 0.2% of cross sectional area.

5.04.01.18 Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks / pits shall not be less than 250 mm.

5.04.01.19 Minimum thickness of all elements of RCC liquid retaining / conveying structures (except effluent drains, launders and aerator waste slab) shall be 200mm. Effluent drains (depth more than 500mm), aerator waste slab and launders shall have minimum element thickness of 150mm.

5.04.01.20 All Insert plates (except edge protection angles) provided in liquid retaining structures shall be 12 mm thick GI with lugs not less than 12 mm diameter. Edge protection angles shall be provided as specified elsewhere.

5.04.01.21 All water retaining structures shall be tested for water tightness as per provisions of IS: 3370 and IS: 6494.

5.04.01.22 **Architectural Concepts and Finishing Schedule**

Architectural concepts and finishing schedule shall be as specified elsewhere in architectural specification.

5.04.02 **Acid / Alkali Resistant Treatment:**

Acid / alkali resistant lining treatment shall be provided in different areas as follows:

Neutralization Pit: The walls shall be provided with one coat of bitumen primer, followed by 18 mm thick bitumastic layer, 115 mm thick A.R. bricks, 6 mm thick under bed of potassium silicate mortar, pointing the joints of bricks with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing. Suitable pilasters shall be provided with A.R. bricks at regular intervals depending upon the height of lining, as per the specification.

The floor of neutralization pit shall be provided with acid / alkali resistant lining treatment as given in the above para, except that the 115 mm thick A.R.bricks layer shall be replaced by 75 mm thick A.R. tile layer and pilasters shall be omitted.

The ceiling of neutralization pit shall be provided with one coat of epoxy primer followed by 2 coats of epoxy paint (150 micron).

Acid / Alkali storage area / projections above the floor, pedestals projecting from the floor / saddles : The floor shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick under - bed by potassium silicate mortar, 6mm thick pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar up to a depth of 20 mm and bitumastic end sealing. Dado of 1.0M high with above treatment shall also be provided if applicable in case of walls nearby.

Alum/Lime Storage area and first floor of Chemical House : One coat of bitumen primer followed by 12mm thick bitumastic layer, 20 mm thick A.R. tiles, 6 mm thick underbed of potassium silicate mortar, 6mm thick pointing of joints of tiles with acid /alkali resistant epoxy /furane mortar up to a depth of 20 mm and bitumastic end sealing.

Alum solution preparation tank: The wall shall be provided with one coat of bitumen primer followed by 12 mm thick bitumastic layer, 75 mm thick A.R. tiles, 6 mm thick underbed by potassium silicate mortar, pointing of joints of tiles with acid / alkali resistant epoxy / furane mortar upto a depth of 20 mm and bitumastic end sealing.

The floor shall be provided with acid / alkali resistant lining treatment as given in the above para except that the 75 mm thick A.R. tile layer shall be replaced by 12 mm thick A.R. tile layer.

Basket of Alum Solution Preparation tank: 5mm thick epoxy lining over a coat of epoxy primer.

Curved surfaces of saddles shall have minimum 12 MM thick bitumastic layer to support the vessel / tanks.

Effluent Drains: Acid Resistant lining treatment indicated for the storage area shall be provided on the bed as well as walls of the drains with 38 MM AR tiles. The underside of the pre-cast slab cover shall be applied with one coat of epoxy primer and two coats of epoxy coating, total DFT 150 microns.

Lime tank: Two coats of bitumen paint conforming to IS : 9862, with total DFT 150 microns.

5.04.03 **Roof**

a) Roof of all RCC buildings shall have cast - in - situ RCC slabs.

b) The troughed permanently colour coated metal sheeting provided for sheds as roof shall be as specified elsewhere in the specification.

5.04.04 **DM Tank Foundation**

5.04.04.01 **General Requirements**

The tank foundation shall be as per IS:803 and as specified in Cl. No.7.01.04.

5.04.04.02 **Anti Corrosive Layer**

Anti-corrosive layer shall consist of screened coarse sand, mixed with 80/100 bitumen or equivalent 8% to 10% by volume.

Bitumen shall be heated to a temperature 175^0 C to 190^0 C, with 3% kerosene, if required. Sand shall be thoroughly mixed with it in a mixing drum to obtain uniform mixture and shall be laid over the compacted surface, laid in line, grade and levels and as directed by the Engineer. Bitumen shall not be heated beyond the temperature limits given above.

The premix carpet shall be laid in two layers of 3 cm and 2 cm respectively. After compacting and laying the first layer of 3cm, a tack coat of hot bitumen at the rate of 1 Kg. per Sq.m. shall be uniformly applied to the surface, by means of Sprayer and the Second layer of 2cm thick shall be laid, tamped and compacted to the satisfaction of the Engineer.

Sand shall be spread on the final surface at the rate of 0.5 Cu. m per 100Sq.m.

5.04.04.03 **Premix**

Materials

Sand

Sand shall be clean, dry, coarse, hard angular, free from coatings of clay, dust and mix of vegetable and organic matters and shall conform to IS :383 (Grade -III).

Stone Chippings

Stone chippings shall be hard black trap or granite or approved locally available stone and shall conform to IS:383. The grading shall be of normally 12mm down size and 6mm down size, in the ratio of 3:2 respectively.

Bitumen

Bitumen required for the work shall be 80/100 grade or its equivalent quality.

Laying

Areas on which the premix is to be laid shall be thoroughly cleaned of all dust and loose materials. On the cleaned surface, a tack coat at the rate of 1.0 Kg. per Sq.M. of hot Bitumen shall be uniformly applied by Sprayers. The applied Binder shall be evenly brushed.

The Binder bitumen 80/100 shall be heated to the temperature of about 190^0 C with 3% kerosene, if required and mixed with stone chippings of size, as mentioned above, at the rate of 400 KG, with Six (6) Cu. M. of stone chips, for 100 Sq.M. of surface. The total mixed quantity, as mentioned above, is the quantity required for the total 50mm thick for 100 Sq. m. of area. Mixing shall continue until the aggregate is well coated.

5.05 Switchyard Civil Works

5.05.01 Civil works for switchyard includes:

a. Towers, girders, lightning masts and equipment supporting structures including proto type assembly etc.,

b. Foundations and supporting pedestals for towers, lightning masts, equipment supporting structures etc.,

c. Switchyard Control room building, foundation for AC Kiosks etc.

d. Foundations for transformers and reactors including oil pit, stone filling, laying and fixing of rails for movement of Transformers / reactors, rail track, jacking pad and fire walls as required, arrangement for cabling etc. all complete

e. Earthing mat, single lane rigid pavement roads and R.C.C. drains in switchyard area including road/drain/trench crossings etc.,

f. All necessary embedments, inserts, supporting structures & supporting members as required etc.

g. Cable trenches in switchyard and inside control room building including civil works for panel fixing etc.

5.05.02 Design Criteria

5.05.02.01 Gantry structure, which consists of open web towers connected by girders, shall be made of structural steel conforming to Grade IS:2062 or IS:8500 and duly galvanized conforming to IS: 2629 and IS: 4759. All joints shall be bolted connections. All bolts for connections shall be of 16mm dia conforming to IS: 12427 and of property class 5.6 as per IS:1367 (Part 3). Nuts shall conform to IS:1363 (Part 3) of property class 5. Foundation bolts shall conform to IS: 5624 and property class shall be 4.6 as per IS:1367 (Part-3). Butt splice shall be used for splicing the main members and splice shall be located away from the node point. IS: 802 “Code of practice for use of structural steel in overhead transmission line towers” shall be followed for design of structures. Height & type of towers shall be established based on electrical requirements. A provision of ± 30 degree angle of deviation of line in horizontal plane and ± 20 degree deviation in vertical plane is considered and the resulting worst combination of forces shall be considered for design. For all outgoing and incoming feeders, the conductor span shall be taken as 200m for design purpose.

5.05.02.02 Switchyard structures shall be designed for the worst combination following loads:

1) Dead loads (load of wires/conductors, insulator, electrical equipment and structural members),

2) Live loads,

3) Wind loads

a. Switchyard gantries, towers, equipment supporting structures and lightning mast shall be designed as per IS:802. The wind load calculations shall be made as per IS: 802 except the parameters basic wind speed (Vb) and terrain category as stipulated in "Criteria for wind resistant design of structures and equipment".

b. All other structures shall be designed as per IS:456 / IS:800. The wind load calculations to be made as per IS: 875 shall be with the parameters as stipulated in "Criteria for wind resistant design of structures and equipment" .

4) Seismic loads,

5) Temperature load,

6) Loads due to deviation of conductor (gantries shall be checked for ± 30 deg. deviation in horizontal plane and ± 20 degree deviation in vertical plane),

7) Loads due to unbalanced tension in conductor/wire,

8) Torsional load due to unbalanced vertical and horizontal forces,

9) Erection loads,

10) Short circuit forces including snap in case of bundled conductors, etc.

Note:

i. The occurrence of earthquake and maximum wind pressure is unlikely to take place at the same time. The structure shall be designed for either of the two. However, temperature stresses can be ignored, as these towers are freestanding structure in open space.

ii. Short Circuit forces and Wind pressure shall be considered to act together for design of switchyard structures

iii. Direction of wind shall be assumed such as to produce maximum stresses in any member for the combination of wind load with conductor tensions. The wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.

iv. The conductor tension shall be assumed as acting on only one side of the gantry for the analysis and design of switchyard gantries.

v. The distance between terminal and dead end gantry shall be taken as 200 meters.

5.05.02.03 **Factor of safety:**

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition. Foundation shall be designed for a factor of safety of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire condition.

5.05.02.04 **Design consideration for switchyard equipment support:**

The supporting structure for B.P.I., LA, CVT & Isolator equipment's shall be comprised of GI (ERW) pipe of grade YST:210 or of higher grade conforming to IS: 1161 & shall be designed as per IS:806 "Code of Practice for use of steel tubes in general building construction".

Minimum diameter of the pipe type support for 765kV structure shall be 300NB, 400kV structure shall be 250NB, for 220kV & 132kV structures shall be 200NB and that for 66kV & 33kV shall be 150 NB.

The supporting structure for CT, CSE & Wave Trap equipment shall be comprised of lattice structural steel conforming to IS 2026 and shall be designed as per IS: 802.

Common raft foundation shall be provided for each pole of isolator.

5.05.02.05 **Special design consideration for lightning Mast:**

Diagonal wind condition shall be considered for lightning masts. Diagonal wind shall be taken as 1.2 times the wind calculated on Longitudinal/Transverse side. Lightning mass shall be provided with minimum two nos. of platforms as per requirement and an ladder for climbing purpose shall be provided up to platform at top level. Top of platform shall have grating, railing and toe guard plates. The minimum width of platform shall be 900mm. Live load of 300kg/m2 above platforms shall be considered for design of Lighting Mast.

5.05.02.06 **Design Criteria for structures not covered under Cl. 5.06.02.01 to Cl. 5.06.02.05**

The Switchyard Control Room building shall have RCC framed super structure with one brick thick wall cladding on exterior face. The Control room building shall consist of rooms/facilities/ equipments/ monorail as per system requirement. An open space of one meter width (minimum) shall be provided on the periphery of the panel rows and equipment to allow easy operator movement and access for maintenance purposes.

The design of RCC structures shall generally be carried out using limit state method of design as per IS: 456. The minimum grade of concrete shall be of RCC M25 as per IS: 456.

5.05.03 The architectural features including roof water proofing, rain water down comers and RCC parapet walls etc. shall be as specified elsewhere in the specifications.

5.05.04 The fabrication and erection of the switchyard works shall be carried out generally in accordance with IS: 802 and IS: 800. All materials shall be completely shop fabricated and galvanised.

5.05.05 All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication Minimum section thickness should not be less than 4 mm. Weight of zinc coating shall be at least 0.610 kg/m2 and foundation bolts shall have heavier zinc coating at least 0.80 kg/m2.

5.05.06 **Cable Trenches**

Cable trenches shall be provided for routing of cables as required and shall be of adequate size. The trenches located within switchyard shall project at least 300 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected to sump pits. The precast covers shall not be more than 300mm in width and shall not be more than 65 kg. Lifting hooks shall be provided in the precast covers. Trenches shall be given a slope of 1:250 in the direction perpendicular to the run of the trenches. Angle

of size 50x50x6 mm (minimum) with lugs shall be provided in the edges of RCC cable trenches and any other place where breakage of corners of concrete is expected. All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays. All internal cable trenches shall have minimum 6mm thick (o / p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer. Cable trenches inside switchyard, having depth more than 500mm, shall have wall thickness of minimum 150mm with two layer reinforcement.

5.05.07 **Gravel Filling:**

Gravel filling shall be provided as specified elsewhere in the specifications.. Each layer shall be compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling. Before laying the gravel fill, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed/soil sterlization chemical shall be procured from reputed manufacturer. The Bidder shall submit necessary details pertaining to the types of weeds found in the vicinity, anti-weed/soil sterlization such as manufacturer's name, their specification, test certificate, etc., for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the Bidder at no extra cost to the Employer. The Bidder shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.

5.05.08 **Transformer/reactor foundations**

Foundations of transformers/reactors shall be designed for seismic and wind loads. Block foundations shall be provided for the main transformer block.

The oil soak pit, if provided, shall be filled with gravel of size 40mm. The volume of the soak pit shall be sufficient to store complete oil of the transformer/reactor along with 10 minutes of fire water considering only 40% of the volume as available voids between gravel filling. However, in case a separate oil collection tank is provided for the transformer/reactor, oil soak pit of volume equivalent to one-third (1/3) the oil volume of transformer/reactor shall be provided around transformer/reactor. The oil collection tank, in such cases, shall be designed for an effective capacity of complete oil of the transformer along with 10 minutes of fire water. The oil soak pit shall also be provided with a sump at the corner to allow drainage of water/oil from the soak pit.

Arrangement for moving the transformer into place using rail cum road, jacking pads and pulling blocks including inserts, as required, shall be provided along with the transformer/reactor foundations.

RCC Firewall shall also be provided between the transformers wherever required.

300 mm thick PCC M20 encasement all around the Pylon supports inside soak pit for fire fighting system shall be provided up to top of gravel filling. Coarse aggregate filling inside the transformer oil soak pit shall be carried out only after construction/erection of Pylon supports and PCC encasement.

5.05.09 The switchyard roads, drains, fencing and gate shall be as specified elsewhere in the specification.

5.07.10 **Staircases**

All floors of transfer houses/crusher house and roof/floors of all MCC/Control room buildings shall be accessible through staircase. Cage ladders (min. 450mm wide) shall be provided for access to roof of penthouses & mumty.

All stairs of overground portion of transfer houses & crusher house shall be of steel (minimum 1000 mm wide)and maximum rise should not be more than 180 mm and minimum tread width 250 mm. Stringers shall be of rolled steel channel(minimum ISMC 250)and tread shall be of electroforged steel gratings. Stairs shall be provided with 32 mm dia nominal bore medium duty M. S. pipe hand rail.

Handrails (for staircases, around openings, in walkways etc.) shall be of standard weight steel pipe of flush welded constructions, ground smooth using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1.0 metre above platform level and pipe posts spaced not more than 1.5 metre apart. Angle handrail post may be provided when specifically called for in drawings approved by Engineering. Toe guard of size 100mm x 6mm shall be provided along the railing for all steel platforms/landings and RCC staircases.

Smooth uniform curves and bends shall be provided at stair returns and also where so ever required. Posts connected to curb plates shall have a neat closure at the bottom and a 6 mm thick plate neatly welded to posts for attachment to curb plate. All necessary fittings including inner dowels at splices, brackets, belts, bends, flanges and chains, where required shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the handrail.

Treads and landing shall be suitable for the prescribed loading. The maximum width of openings in gratings shall not exceed 40 mm. The minimum size of main bars shall be 25 x 6 mm and cross bar shall be 6mm. The usual span of grating will not generally exceed 1.5 meters. Stair case gratings shall be galvanized to grade 610g/m^2.

Out side stairs to transfer points shall be open type. However sheeting shall be provided at the top.

Stairs of MCC/control room, reclaim hopper and underground TP's shall be of R. C. C. construction. The minimum width of stairs for MCC/Control room shall be 1200mm wide and for reclaim hopper/underground TP's shall be 1000mm. Maximum rise should not be more than 180 mm and minimum tread with 250 mm. Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection for treads of stairs in wagon tippler/ reclaim hopper/underground TP's.

Numbers and arrangement (including enclosures etc.) of stair cases shall be such as to meet the fire safety requirement as per guide lines of statutory regulatory bodies.

5.07.11 **Trenches**

All trenches for cables or any other underground facility as detailed out elsewhere shall be of R. C. C. Cable trenches shall be provided with pre - cast R. C. C. covers / chequered plate cover. Cable trenches as well as pre - cast covers shall be provided with edge protection angles and lifting hooks. All embedments / block outs as required and specified elsewhere in these specifications shall be provided. Trench pre - cast cover weight shall not be more than

65 Kgs. At road crossings & entry locations, trench covers designed for 10 T wheel load at centre shall be provided. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable trenches shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers. For cable trenches outside buildings, top level shall be 200 mm above G. L and sand filling shall be overlaid with 50 thk. PCC.

Minimum 50 x 50 x 6 mm size angles with lugs shall be provided as edge protection all around cut outs / openings in floor slabs, edges of drains supporting grating/precast RCC covers, edges of R. C. C. trenches supporting pre - cast covers, supported edges of pre - cast cover.

5.07.12 **Drainage & Water Supply Works**

5.07.12.01 Drainage System

The drainage arrangements shall be so planned so as to ensure quick disposal of drainage water without stagnation and / or overflow. It is envisaged to clean the conveyor galleries, transfer points, crusher building, penthouse etc. with water periodically.

Minimum 4 nos. down comers shall be provided in each transfer house / crusher house. In case of conveyor galleries, the down comer shall be provided at every trestle location.

Drainage of the complete coal stock pile, area around stacker reclaimer rails etc. shall be discharged into the coal slurry settling pond.

For Conveyors in Main plant area each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally into trunk drain routed alongside the nearby road.

For Conveyors in stock pile area, each down comer shall lead the water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

For Crusher House, Pent Houses & TP's in stock pile area, each down comer shall lead the water / coal slurry into the peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry to water / coal slurry to RCC pit (of 2 Cu.M capacity) to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

For TP's in Main plant area, each down comer shall lead the water / coal slurry into the peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry to RCC drain and finally into trunk drain routed alongside the nearby road.

For reclaim hopper, peripheral drains (Brick drains with steel gratings provided around the building) shall lead the water / coal slurry to a local RCC pit (of 2 Cu. M. capacity) near each facility to allow settling of coal. The water from the pit shall overflow into R.C.C drain, which will lead the discharge finally to the coal settling pond.

In case of Control rooms and M. C. C. buildings, Pump houses, etc, water / coal slurry coming from down comers shall discharge into peripheral drains (Brick drains with steel gratings provided around the building) which will lead the water / coal slurry into R.C.C drain,

which will lead the discharge finally into trunk drain routed alongside the nearby road/ coal settling pond.

Suitable kick plates/Curb beams shall be provided around the floor openings, stair case landings, in the transfer points, crusher house and other buildings.

Contractor's scope shall also include construction of necessary culverts under the rail lines / roads as per railway / I. R. C. standards and approval of Railway culverts from concern Railway authorities.

5.07.12.02 Internal and external water supply, drainage etc.:-

The scope for potable water supply includes all distribution systems, tanks, pipes, fittings etc. as required and as described here or elsewhere in these specifications.

The scope for service water supply and dust control water supply shall be as described elsewhere in these specifications.

For water supply, medium class galvanized mild steel pipes conforming to IS: 1239 shall be used.

The scope for drainage of surface water shall include design, layout and construction of drains for and from buildings and drains required for coal stockyard area, drainage up to main coal slurry settling tank including connection with the tank. Drainage system shall be designed for maximum intensity of rainfall as 75 mm/hr and 60 % runoff coefficient. All buildings (including transfer houses and crusher house) shall be provided with open surface brick drains of minimum size of 300 mm width and 300 mm depth all around the periphery. All drains excepting the peripheral drains around the transfer points, crusher house, control / M. C. C. buildings, pumps house etc., shall be of R. C. C. construction. All open drains shall have removable steel grating designed for loads as specified under loading clause. Minimum size of main bar of grating (Galvanised to 610 gm/m^2) shall be 12 mm x 3mm and cross bars 6mm. At all entry or road/rail crossing point's RCC box/pipe culvert shall be provided. The opening size of grating shall not be more than 90 mm x 35 mm. All drains as well as pre - cast covers shall be provided with edge protection angles and lifting hooks.

However, drains in coal stockyard area shall have pre cast R. C. C. covers. RCC pre - cast cover weight shall not be more than 65 Kgs. RCC pre-cast covers near entry or at road crossings shall be designed for 10 T wheel load at centre. RCC pre - cast covers shall be designed for central point load of 75 Kgs.

The scope for foul water from toilets shall include layout and laying of sewers up to the Employer's main sewer line for sewerage system together with all fittings and fixtures and inclusive of ancillary works such as connections, manholes and inspection chambers within the building and from the building to the Employer's sewer line.

For rain water down comer and those to be used for conveying water / coal slurry generated from cleaning of walkway/floors, Galvanised MS pipes conforming to IS: 1239 (for 150 mm NB Medium grade pipes) with welded joints shall be used for MCC buildings, penthouse, control rooms and Galvanised steel ERW pipes (273mm OD, 4mm thk) of steel grade Fe330 conforming to IS: 3589 with welded joints shall be used for all TP's, Crusher house, and Conveyor galleries.

Galvanising shall be as per IS: 4736. The minimum mass of zinc coating shall not be less than 360 gms/sq.m. as per IS:6745. The zinc coating shall be smooth and shall be subjected

to testing as per IS: 2633, for uniformity of coating. The zinc coating shall be free from all defects as per IS: 2629.

All rain water down comers shall be provided with roof drain heads and complete with shoes bends, junctions, sockets, adapters, brackets and finished with anti corrosive painting over a coat or primer.

For design of building drainage system IS: 1742 shall be followed.

For sanitary / sewerage pipes above ground, sand cast iron pipes conforming to IS : 1729 with leak proof lead joints.

For underground drain pipes, minimum class NP - 2 pipes conforming to IS: 458. At road crossings, concrete pipes of class NP 3 conforming to IS: 458 and at rail crossing R.C.C. box culvert to be provided.

For sewerage below ground stoneware pipes conforming to IS: 651 with concrete bedding and haunch.

5.07.13 Roof Details

Roof slab shall be minimum 150 mm thick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom.

900 mm high and minimum 100 mm thick R. C. C. parapet wall shall be provided over roofs. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings.

Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet.

Drain level shall be provided with 45 x 45 cm size khurras having minimum thickness of 30 mm of M-15 concrete over PVC sheet of 1 m x 1m x 400 micron and finished with 12 mm 1 : 3 cement : sand plaster.

Roofs of all M. C. C./control rooms, penthouse etc., shall have roof water proofing treatment. Roof water proofing treatment shall be as follows:

1) Application of polymerised mastic over the RCC roof to achieve smooth surface as primer coat.

2) Application of high solid content liquid applied urethane based elastomeric water proofing membrane, over the primer coat, to give uniform joint less dry film thickness of minimum 1.5 mm (as per ASTM C 836 and C 898).

3) For efficient disposal of rain water, the run off gradient for the roof shall not be less than 1: 100. This gradient shall be provided by screed concrete M-15 (using 12.5 mm coarse aggregate) and / or cement mortar (1: 4) over the elastomeric water proofing membrane with 25mm thick cement mortar (1:4) topping.

4) Wearing course at top, shall consist of 25 mm thick P. C. C. (M-15) cast in panels of maximum 1.2 x 1.2 m size and reinforced with 0.56 mm diameter galvanized chicken

wire mesh and sealing of joints using sealing compound / elastomeric water proofing membrane. Pathways for handling of materials and movement of personnel shall be provided with 22 mm thick chequered cement concrete tiles as per IS : 13801 for a width of 1000 mm in place of P. C. C.

Roof of transfer points and crusher house shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water.

5.07.14 Floors and Grade level details

The floor slabs shall be minimum 150 mm thick and shall have minimum 10 dia HYSD reinforcement bars placed at 200 mm center both ways at top and bottom

Floors of transfer points shall have cross slope of not flatter than 1: 80, towards the floor washing drainage outlets, for efficient drainage. For ground conveyor & crusher house slope shall be 1:100.

Chequered plates (used for platforms, walkways etc.) shall be minimum 6 mm thick o/p or as indicated on drawings. The chequered plate pattern shall be approved by Employer / Engineer. Mild steel flats/angles of suitable size shall be welded to the bottom portion of chequered plates at a designed spacing to stiffen chequered plates to restrict deflection within span/200. Chequered plates shall be fixed by staggered welding of suitable size.

Toe guard of size 100 x 6 mm shall be provided at various openings provided in floors e.g. around stair case openings, chute openings and other similar cutouts. For conveyor walkways, angle runner to act as toe guard shall be provided.

All along the periphery of R. C. C. floors (where no brick masonry walls are provided) shall be provided with one brick thick 300 mm high brick wall and 700 mm high steel hand rails all around over this brick work.

The grade slab shall consists of 230 mm thick rubble soling (63 mm downgraded hard stone aggregate as per IRC specification, watering and compaction to minimum of 90% Standard Proctor density, including filling the interstices of stone aggregates with sand), over well compacted earth, overlaid by 75 mm thick P. C. C. M-7.5 and 100 mm thick R. C. C. of grade M-20 with minimum 8 mm dia bars placed at 200 mm C / C in either direction respectively. There will be minimum 50 mm thick metallic hardener finish over the R. C. C. slab.

All buildings (including reclaim hopper, penthouse, MCC rooms, pump houses, transfer houses and crusher house) and ground conveyors shall be provided with 750 mm wide plinth protection all around. It consists of 50 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand.

An area of 5 m width all round the reclaim hopper, around water tanks near pump house, transfer houses and crusher house shall be paved. This paving will be in addition to plinth protection. The paving construction shall be as per specifications for the grade slab at ground level. However, 50 mm thick metallic hardener finish is not required to be provided in paved area.

Plinth level of all buildings shall be kept at least 500 mm above the finished grade / formation level.

5.07.15 Fencing

Fencing with toe wall and steel gates shall be provided around the transformers. Fencing shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2.4 m above the toe wall. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 12G. Fence posts shall be of pre – cast R. C. C. of minimum M20 grade. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R. C. C. foundation for the post and stays shall be provided based on prevailing soil conditions. Gates shall be sturdy with locking provisions.

Toe walls of brick masonry shall be provided between fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the formation level with 50 mm thick P. C. C. coping (1: 1. 5: 3) and shall extend minimum 300 mm below the formation level. Toe wall shall be plastered on both sides and painted with two coats of cement paint of approved colour and shade. Toe wall shall be provided with weep holes at suitable spacing.

5.07.16 Loading

For consideration of loads on structures IS : 875 - ‘Code of practice for structural safety of buildings’ shall be followed. In addition to the dead load, live load, equipment load (including impact / vibration). Temperature loads etc. various loading conditions arising due to operation and maintenance of equipment shall be considered in the design. The structure and equipment shall also be designed for seismic loads as per the “Criteria for Earthquake Resistant Design of Structures and equipment" and the “Criteria for Wind Resistant Design of Structures and equipment". whichever is governing. Wind and seismic forces shall not be considered to act simultaneously. The following minimum live loads shall be adopted for the design of various structures. If actual expected load is more than the specified load, then actual load is to be considered.

Roofs	150 Kgs. / Sq. M. for accessible roofs and 75 Kgs. / Sq. M. for non - accessible roofs. In addition to this coal dust load (Dead load) of 150 Kgs. / sq. m. on flat roofs & 75 Kgs. / sq. m. on inclined roofs shall also be considered.
R. C. C. floors	500 Kgs. / Sq. M.
Stair and balconies	500 Kgs. / Sq. M.
Toilet rooms	200 Kgs. / Sq. M.
Chequered plate floors	400 Kgs. / Sq. M.
Walkways (including walkways in conveyor/cable galleries)	300 Kgs. / Sq. M.

Design of Hopper walls shall be done for both Static & Dynamic flow condition using Walker's theory.

Design of masonry walls shall be made as per IS : 1905.

Civil task drawing indicating various equipment loading and supporting arrangement and floor loads to be submitted along with the design calculation.

For metal roofing and side cladding, the spacing of purlins/runners shall be such that the deflection of metal sheet used is limited to span/250 under adverse loading condition.

Minimum reinforcement shall be provided at the top face of the footing, even if, no reinforcements are required as per design.

5.07.18 CHEMICAL INJECTION GROUTING

Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

5.07.19 POLYMER MODIFIED CEMENTITIOUS COATING

5.07.19.01 Materials

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size.

5.07.19.02 Mixing

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

5.07.19.03 Properties of Coating

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about 5x10-10 Cm / Sec.

Water absorption after continuous soaking shall not be more than 1 %.

The materials shall be permeable under water vapour.

The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14.

The co - efficient of thermal expansion of the material shall be close to that of concrete.

5.07.19.04 Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

(a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m^2 in the 2 coats. A lap of 75 mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

(b) For Brush Topping Mix

This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a push broom or any other similar brush. It

shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any.

The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat.

Rate of application of coating shall be established to achieve the required thickness.

5.07.20 SHOTCRETING

5.07.20.01 General Requirements

Generally, shotcreting shall be done in accordance with IS : 9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

Reinforcement in one direction consisting of 6 mm M. S. bars at 750 mm c / c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.

Wire fabric conforming to IS : 1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm and tied.

Clear cover to reinforcement mesh shall not be less than 15 mm.

Minimum thickness of shotcreting shall be 50 mm. for abrasion resistant work and 25 mm for ordinary surface protection work.

5.07.20.02 Material

Generally, the materials shall be in accordance with aggregates specification given hereunder.

Fine aggregate shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp, chemically inert, clean and free from any coating. It shall be

free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS : 383.

Fine aggregate (Sand) shall be well graded and particles shall range in size within the following limits. The Engineer, may approved the use of any other grading as per requirement or as per IS : 9012.

The fineness modulus shall be preferably between 2.5 and 3.3. Any other value can be used, with prior approval of the Engineer.

5.07.20.03 Application

After the placement of reinforcement and / or welded mesh and not more than six hours prior to the application of shotcrete, the surface shall be thoroughly cleaned of all loose materials and dirt. The Contractor shall properly prepare the surfaces, reinforcement and / or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than hour prior to shotcreting.

The mix as placed on surface shall be one part cement to three parts approved sand by mass. Cement and sand shall be dry mixed; not water shall be added after mixing and before using in the gun. The quantity of water when added shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5 by mass. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 3 Kg/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted, above location of the machine.

The application shall proceed in an upward direction. Beams, stiffeners and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.

As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep too moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap or similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38oC during placing and curing.

5.07.21 VIBRATION ISOLATION SYSTEM

These specifications are meant for the design, supply and erection of vibration isolation system for supporting coal crushers (ring granulators).

5.07.21.01 Supporting Arrangement

The crushers shall be supported on vibration isolation system consisting of steel helical springs and viscous dampers. The supporting arrangement for each crusher shall consist of an R. C. C. deck supported on steel helical spring units and viscous damper units which in

turn shall be supported on girders. The girders shall be an integral part of the crusher house building.

The part of the structure consisting of the R. C. C. deck, springs and viscous dampers shall hitherto be referred to as “spring supported foundation”. The part of the structure, which is below the spring shall hitherto be called “supporting structure”.

5.07.21.02 The Contractor should do the Engineering / design, supply and erection of vibration isolation system consisting of steel helical spring units and viscous dampers supporting the top deck which in turn would support the coal crushers. The vibrations isolation system supplied shall be of a proven make. The Contractor or his sub - contractor who designs and supplies the system should have designed, supplied and installed such systems for not less than five machines of speeds and unbalance forces comparable to the machine proposed by the vendor. The vibration isolation systems installed by the contractor or his sub - contractor in such machines should have been working satisfactorily for atleast five years.

5.07.21.03 Engineering

Design of the vibration isolation system using steel helical springs and viscous dampers to support an R. C. C. top deck supporting the coal crusher. This includes the static and dynamic analysis of the vibration isolation system with the R. C. C. top deck and the coal crusher.

Structural design of the R. C. C. top deck including preparation of General Arrangement drawings, detailed reinforcement drawings, bar - bending schedules etc.

Calculation of loads on the structure supporting the springs and viscous dampers, their points of application and the stiffness requirements of the supporting structure.

Drawings showing embedments and their locations and details on the R. C. C. top deck.

Drawings showing blockouts, recesses etc. on the top deck.

Design of the supporting structure, including preparation of detailed drawings and bill of materials.

5.07.21.04 Supply including packing and transportation to site

Steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

Frame (s) for pre-stressing of spring elements.

Suitable hydraulic jacks system including electric pumps, high pressure tubes etc. required for the installation, alignment etc. of the spring units, two extra hydraulic jacks, one hand operated pump and spares for the hydraulic jack system as required.

5.07.21.05 Erection and Commissioning

Complete erection and commissioning of the vibration isolation system including :

Pre-stressing of spring elements, placing of spring elements in position, checking clearances on the shuttering of the R. C. C. top deck, construction of the supporting structure and the R. C. C. top deck, releasing to pre-stress in spring elements and making final adjustments and alignments after machine installation etc.

5.10 Plant Storm Water Drainage System & Rain Water Harvesting

Plant storm water drain shall be designed taking into account the finished ground levels of the plant area, drainage pattern, intensity of rainfall, etc with a return period of 50 years. These values shall be based on the "Detailed Area Drainage Study" subject to minimum rainfall intensity of 75mm/hr. All RCC drains shall be either RCC Cast-in-Situ or RCC Pre-cast drains. The minimum grade of concrete shall be M25 for RCC Cast-In-Situ drains and M30 for RCC Pre-cast drains. The maximum velocity for RCC open drains shall be limited to 1.8 metre per second. However, minimum velocity of 0.6 metre per second for self - cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided.

Open RCC rectangular section, unless required otherwise due to functioned requirement, shall be provided for all drains. The thickness of side walls and bottom slab of RCC drains shall be minimum 200 mm or as per design considerations whichever is higher. The drains shall be provided on both sides of the double lane roads and single lane roads. The drains shall be provided on one side of the patrol roads. These shall be designed to drain the road surface as well as all the free and covered areas, etc. Box culverts shall be provided at all rail, road and other crossings.

RCC drains located within and along both sides of peripheral roads of the main plant shall be covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 metre intervals. Similarly all artillery drains and the drains along the periphery of all buildings shall also have perforated precast RCC cover of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 metre intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. All drains in the main plant area shall be provided with heavy duty galvanized steel grating.

All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

The invert levels of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main / trunk drains under all conditions.

The invert levels of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level.

5.11 Diversion of Existing Drainage and Discharge Of Plant Drainage into Natural Drainage System

All existing drains crossing the project / site shall be diverted suitably and shall be discharged into a natural drainage outside plant boundary.

The controlled drainage from plant area and ash pond shall also be discharged at a single point. The final disposal point shall be same which is indicated for diverted drains. Bidder scope shall be upto an existing natural drain/ natural stream.

All external discharge / diversion drains shall be in trapezoidal section lined with 150mm thick RCC in M20 grade concrete.

The controlled drainage from plant area and ash pond including the discharge of all existing drains crossing project/site shall be discharge in natural drain / natural stream.

5.12 Roads

All roads shall be of rigid pavements unless otherwise specified. The design of rigid pavement shall be carried out as per IRC: 58. The effects of design wheel load, maximum tyre inflation pressures, tyre contact area for the vehicle, traffic loads, environmental factors such as temperature changes in the pavement, other factors, like impact, load repetitions, etc., are to be taken. Detailed plate load tests to determine the modulus of sub grade reaction "K" shall be carried out as per the procedure outlined in IS: 1888. The design traffic load shall be a minimum value of 4 million standard axles. The road shall be designed for 30 years of life and considering a minimum traffic growth rate of 1 per cent per annum. The concrete pavement for roads shall be minimum 250 mm thick slab.

The road construction including its shoulders, base, sub base and concrete pavement shall be as per IRC standards. IRC: 58 shall be followed for the pavement design and IRC: 15 shall be followed for the construction of the concrete pavement.

The road base shall be with minimum 150 mm thick dry lean concrete over granular sub base. Dry lean concrete shall be laid by a mechanical paver and compacted by vibratory rollers. Concrete pavement of the road shall be done with fully mechanized paver fitted with electronic sensors for construction techniques. Dry lean concrete shall be minimum M10 grade and concrete pavement slab shall be minimum M35 grade concrete.

The finished top (crest) of all roads shall be 350 mm above the surrounding finished ground level.

The sub grade under all roads and its shoulders shall be compacted to achieve 95 per cent or more of Standard Proctor's Density MDD using mechanical means.

Cutting / extending / rerouting / remaking of existing roads including associated works to maintain continuity of road system / network shall also be carried out.

All culverts and RCC bridges at crossings of all roads / rail tracks / facilities with drains / nallahs / channels / roads / rail tracks / pipes / other facilities, etc. are to be designed and constructed.

Unless otherwise specified, all roads (excluding access roads to all buildings / facilities / structures, patrol road along boundary wall and road inside the switchyard) shall be double lane roads.

5.12.01 Double lane roads:

The double lane roads shall be (12 metres wide) with 7.5 metres wide concrete pavement and 2.25 metres wide raised shoulders on both sides of the roads.

The raised shoulders (on both sides of the road) shall comprise of 75mm thick inter locking precast designer concrete blocks (M35 grade) at the top, over 20 mm thick sand layer. A 200mm diameter NP3 pipes shall carry the surface water from the road through a PCC drain trench (M20) on both sides of the roads to the drain. The pipes shall run over PCC (M 20) continuous cradle bedding. The pipes shall be laid at 10 metres centre to centre. A layer of 100 mm (average) thick PCC (M15) shall be laid over the pipes and below the sand layer. All roads shall be provided with edge protection on both sides of the road using pre - cast kerb

blocks (450 mm long x 250 mm wide x 500 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.02 Single lane roads:

All access roads to all buildings / facilities / structures, road approaches / connections, access roads to liquid fuel storage areas and other equipment areas where access is necessary from inspection, operation and maintenance point of view and all roads inside the switchyard shall be single lane roads. These shall be single lane roads (6.75 metres wide) with 3.75 metres wide concrete pavement and 1.5 metres wide shoulders on both sides of the roads. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar.

5.12.03 Patrol roads:

All patrol roads along the boundary wall shall be single lane roads with 3.75 metres wide concrete pavement and 1.5 metres wide shoulders on one side of the road. The shoulders shall also have 150 mm thick dry lean concrete and 75 mm thick inter locking blocks over compacted granular sub base of two layers of 75mm thick WBM grade III 53-22.4mm. All roads shall be provided with edge protection on both sides of the road using PCC blocks (300 mm long x 250 mm wide x 150 mm deep) (M25) laid in 1 (cement) : 6 (coarse sand) cement mortar. The road shall slope towards the inner drain. The centre line of the black top of the road shall run at a distance not less than 2625 mm from the centre line of the boundary wall.

5.13 Administration Building

5.13.01 Salient Features

The Administration Building shall be a multi–storeyed RCC frame superstructure. The building shall have an RCC Lift structure accommodating the Lifts. The structural framing plan and elevations shall be based on the architectural concept to be developed by the bidder. The minimum thickness of Lift Superstructure RCC Wall shall be 230mm.

5.13.02 Design Concept

The building shall be designed as moment resisting RCC sway frame in both the orthogonal directions. For general design guidelines IS 456 shall be followed and for ductile detailing (against seismic load) IS: 13920 shall be followed.

5.13.03 Architectural Features

This building shall be designed as GRIHA (Green Rating for Integrated Habitat Assessment) compliant Green building seven storied (G+6 stories above) and area 5500 sq.m. with RCC Frame structure & Autoclave Aerated Concrete Block masonry. Floor-to-floor height shall be minimum 4.50m. The building shall have a central atrium covered with polycarbonate sheet dome.

Hermetically sealed double glazing with toughened Glass to be provided for external glazing.

There shall be provisions for Exhibition Hall, Conference Room for 50 persons, Canteen for 30 persons, Bank, Bank ATM space, AHU, MCC Room, First Aid Centre, Library, offices. In addition, adequate space shall be provided for IT & Communication Area. Separate toilet facilities shall be provided for ladies and gents in each floor. One toilet shall be provided for physically handicapped at each floor. The building shall have provision of attached toilet with the cabin for senior executives and conference rooms. The Administrative Building shall also have adequate floor area reserved for SATCOM facility. Dish antenna for SATCOM purpose shall be placed on the roof of the Admin Building.

2Nos Panoramic Lifts and minimum 2Nos stairs shall be provided. Atrium with dome shall be provided.

The provision for car and scooter parking shall be made. Covered Parking space for 28 Nos. cars and 28 Nos. scooters shall be provided. Minimum 23 Sq.m. area per car (including circulation area) and 2.5 Sq.m per scooter shall be considered for working out covered parking space. Covered parking shall be of RCC construction.

The rain water down comers shall be provided as per General architectural specification.The rain water down comers shall be suitably concealed by the external wall enclosure.

External finish shall be combination of solvent based exterior paint & aluminium composite panel.

5.14 Auditorium

5.14.01 Salient Features

Auditorium shall be an RCC framed superstructure. The building shall have large span Roof structure over the Auditorium Hall. The large span roof structure shall comprise either RCC beams (with camber at bottom surface) and roof slab or structural steel girders/ roof truss (with adequate lateral stability through tie & rafter level bracings / girders in orthogonal direction) and RCC slab over profiled metal deck sheets with purlins.

All the external wall shall be of Autoclaved aerated concrete block wall 250 thick for this fully covered Auditorium with additional internal & external plastering. Handrail for all balconies & staircases shall be made of stainless steel. Floor wall and false ceiling details shall be as per architectural specification.

5.14.02 Architectural Features:

This building shall be of RCC Frame structure & Autoclave Aerated Concrete Block masonry. The area of building shall be 1000 sq.m. and shall have seating capacity of 150 persons.

There shall be provisions for Main Entrance Foyer, Lounge, AHU, AC Plant room, MCC room, stage, Green rooms, pantry etc. Separate toilet facilities shall be provided for Ladies & Gents & physically handicapped people.

Provisions for air-conditioning for the building for all the areas except toilets, and other service areas shall be kept. External finishing shall be of Premium Acrylic Smooth Paint, and Coloured Aluminium Composite panel. False ceiling & wall panelling shall be provided as per Acoustical consideration.

The rainwater down comers shall be provided as per General Arch. Specification and they shall be suitably concealed inside wall enclosure.

External finish shall be combination of solvent based exterior paint & aluminium composite panel.

5.15 Main Gate Complex & CISF Building

The Gate Complex shall comprise two (2) mild steel vehicle entry gates of minimum 8.0m width and height 3.0m and shall be electrically operated. Minimum one room for security personnel shall be located at each end of the gates.

Two (2) separate mild steel pedestrian gates minimum 3.0m high and 3.0m width shall be provided at the each end.

The Central Industrial Security Force (CISF) Building shall be a two (2) storied RCC super structure with office complex in ground floor & first floor. The building shall be constructed with 230mm thick brick wall with provisions for doors, windows & ventilators. The first floor shall also have a viewing gallery. The floor area and architectural details shall be as per the Arch spec. mentioned hereafter in this Specification.

5.15.01 Design Concept:

The CISF building shall be designed as moment resisting sway frame in both orthogonal directions and shall be designed as per IS: 456, IS: 1893 and IS: 13920 (for seismic ductility requirement) and as per design criteria mentioned hereafter in this specification.

5.15.02 Architectural Features

The CISF Building shall be 2-storied building. It shall be of RCC Frame structure & Brick masonry. The floor area of this building shall be minimum 700 sq m

The Gate Complex and CISF building shall have sufficient no: of guards rooms to regulate movement of men and material and overall security, using latest modern technology like turnstile type/ boom type access control with magnetic cards and close circuit TV sets, computerized time and security office, etc shall be made. For any other gate provided for entry or exit, provision for a suitable small security hut/shed shall be made.

Space provision for CISF personal staff, time office including time machine, reception, lounge, Arms store, Detention Room, Conference room, Toilets and pantry shall be provided as per functional requirement including toilets for Ladies, Gents, Physically handicapped.

In addition, provision for space for open parking (for trucks, cars, scooters, cycles) and covered parking for staff shall be provided.

External finishing shall be of solvent based exterior paint & Aluminium Composite Panel combination.

5.15.03 Gates along Boundary Wall:

The gates shall be provided at the entry & exit points of ash bunker movement road, at the entry of railway line, at the entry of material access road to the plant, at the entry of plant from township. No. of gates in Bidder's Scope are as identified in General Layout Plan Drawing No.: 4410-999-POC-F-001.

The gate shall comprise of two mild steel double panelled openable shutter of minimum 7.75 m clear width and minimum height of 3.0m from top of road.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminum ball bearing, castor wheel etc.

All gates shall be given anti-corrosive treatment in three coats.

The structural steel shall confirm to IS: 2062 (latest) and all other relevant IS codes.

Beside the each gate one room of size not less than 3m X 3m shall be provided for security guards. The room shall be made of brick/ RCC and with RCC roof. In addition to the room, one toilet block shall also be provided.

5.16 Permanent Store Building

5.16.01 Salient Features:

The Permanent Store Building shall comprise the following

a) Heavy Material Storage Hall

b) Light Material storage Hall (With 3 tier Racking System)

c) General Light Material Storage Hall

d) Office Complex.

a) The Heavy Material Storage Hall shall have a Single Bay framed superstructure with RCC / Structural steel construction. In case of Steel, construction, the roof of the Heavy Material Store shall be 40mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck. An EOT crane shall be provided with chequered plate walkways at both ends inside the bay of the Heavy Storage Hall. The capacity of the EOT crane shall be 30 T. The clear height up to the bottom of roof beam/girder of the Heavy material storage hall shall be finalized based on equipment/ spare to be handled.

b) The Light Material Storage Hall with 3 tier Rack system shall have a Single Bay framed superstructure with RCC/ structural steel construction. In case of Steel, the roof of light material Light Material Store shall be 40 mm thick RCC slab (with additional water proofing) supported on permanent coloured metal deck sheet.

c) The General Light Material Store shall be framed superstructure with RCC construction. The RCC building shall be two storied and all beam-column joints shall be designed and detailed for adequate ductility.

d) The office complex of this store shall be a single storied RCC building.

5.21.02 **Architectural Features**

This building shall be of RCC Frame structure & Autoclave Aerated Concrete Block masonry. The area of building shall be 1000 sq.m.

The building shall have entrance lobby, dining hall for staff, dining room for executives, pantry, kitchen, office, stores, wash areas, rest room for kitchen staff, toilets, etc.

External finish shall be of Premium Acrylic Smooth Paint.

There shall be separate service road and entrance for supply of cooking materials and garbage disposal.

5.22 **Fire Station Building**

Salient Features: The Fire Station Building shall be a RCC framed superstructure. The building shall be designed as per the latest guidelines of IS:456, IS 1893 & IS 13920(for seismic ductility requirement)

5.22.01 **Architectural Features**

It shall be of RCC Frame structure& Brick masonry. The building shall be provided with area 650 sq m required to accommodate Fire tenders and fire personnel including Dy./Asst. Commandant's (Fire) office. The number of fire tenders shall be provided as per CISF norms. One drill tower per station shall be provided. Facilities for the staff including Kitchen, Dinning Hall, Rest Rooms, Stores, and First Aid Room shall be provided as applicable.

External finish shall be of Premium Acrylic Smooth Paint.

5.23 **Dozer Shed**

5.23.01 **Architectural Feature**

This building shall be prefabricated steel framed structure with brick wall up to window sill height & prefabricated insulated double skin metal sheeting cladding above it. Roof of the building shall be prefabricated insulated double skin metal sheeting on steel roof truss. The building shall provide for Dozer shed space, Workshop space, Office Rooms, Stores, Toilet & Pantry as per functional requirement. Minimum size of the dozer shed shall be 500 Sq.m.

Metal side cladding shall be composed of different colour shades to match with the other buildings. External finish for brick walls shall be of Premium Acrylic Smooth Paint.

5.24 **Area Paving in Main Plant Block**

RCC paving of minimum 150 mm thick with M25 grade concrete, over an underbed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The underbed for paving shall consist of

preparation and consolidation of sub-grade to the required level, laying of stone soling of 200mm compacted thickness for normal duty paving and 400mm compacted thickness for heavy duty paving with 63 mm and down aggregate with interstices filled with selected moorum followed by 75 mm thick PCC of M7.5 grade with 40 mm nominal size aggregate. Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification.

Entire main plant area from chimney to transformer yard as enclosed within the peripheral roads of the main plant area shall be provided with paving (on chimney side, paving shall be upto the edge of the storm water drain by Bidder.

Passages shall be provided inside the main plant block connecting to the outer periphery road to have access to the various facilities/buildings. The passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping.

Heavy duty paving shall be provided for the areas in the Mill bunker building, equipment lay down area in the TG hall and handling areas for PA/FD fans with 50 mm thick metallic hardener topping.

The ground floor area in the boiler shall be provided with normal duty paving and shall be finished with 50 mm thick metallic hardener topping.

Lightly loaded areas such as corridors below trestle and other areas in the main plant block where no heavy traffic movement is envisaged shall be provided with interlocking concrete block paving with RCC concrete blocks of minimum M 35 grade and minimum 80 mm thickness underlain by 200mm thick with 63 mm and down aggregate with interstices filled with selected moorum.

All other area inside the main plant block shall be provided with normal duty paving. 2.5 m wide paving around periphery of all sumps and underground tanks without metallic hardener shall be provided.

Suitable drains shall be provided to dispose off storm water as well as floor wash of the main plant block. The paving shall be provided with slope of 1:500 to dispose the surface water/wash water to the nearest drain. Drains shall be provided to dispose the floor wash water of ESP to a sump of suitable size. Further, the overflow from the sump shall be drained to the nearest storm water drain.

Sewer lines (Cast Iron), interconnected by sewer manholes (RCC) at regular intervals (not exceeding 30 meter centre to centre) shall be provided to dispose off sewage from ESP area, Main Plant Building, Control Room, CD bay & transformer yard area to sewage treatment plant.

5.25 Hydrogen Generation Plant Building

5.25.01 Architectural Features:

This building shall be RCC Frame structure with brick masonry. The area of the building shall be as per functional requirement.

This building falls under hazardous building category. The entire building campus shall be properly fenced to prevent unauthorised access.

The roof system shall comprise minimum 40mm thick RCC slab on top of profiled permanent metal deck sheet. The permanent metal deck sheets shall be fixed to the top flange of secondary beams by means of arc welding (stud welding) of headed shear anchor studs to the purlins directly through the metal sheet. The details of shear anchor studs are specified elsewhere in this specification. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

The RCC slab shall be designed without considering any composite action effect of metal deck sheet (ie the structural strength of metal deck sheet shall not be considered for RCC slab design.

b) For Mill Bunker Building, Transfer Points

Insulated sandwiched metal sheet for roofing shall be provided comprising troughed permanently colour coated sheet at top and plain permanently colour coated sheet at bottom with 50mm thick insulation sandwiched between the two sheets, the details of which are specified elsewhere in this specification.

c) Other RCC Buildings.

Cast-in-Situ RCC slab shall be provided using removable plywood shuttering. Water proofing treatment to roof slab shall be provided as per details specified elsewhere in this specification).

6.03.38 Design Criteria For Foundation

The founding depth / cut off level of piles shall be decided based on functional requirement.

Where structural steel columns are envisaged, the bottom of the base plate shall be kept suitably below the paving level such that the top level of the gusset plate and foundation bolt remain at least 200 mm below the top level of paving except for Main power House Building columns, Boiler Structure, Bunker Building Columns, TP & Trestle Columns, ESP Control Building Columns for which the requirement of levels for bottom of base plates is specified elsewhere in this specification. Further the gusset plate and foundation bolts are to be encased in concrete up to the top of the paving level. For outdoor structural steel columns, about 300 mm height of steel columns above the top of paving level /formation level shall be provided with at lease 125 mm thick encasement with minimum reinforcement to prevent corrosion of the steel columns from surface water

a) OPEN Foundations

For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system and geotechnical data specified in the foundation chapter include hereafter in this specification.

For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification.

The sizing of foundation, design criteria & clear cover shall conform to IS:1904, IS:456 and other relevant Indian codes. However minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456.

No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC of grade M7.5.

b) PILE Foundations

Minimum centre to centre spacing of the piles shall be 3 times the diameter of pile. Incase single piles are used, these piles are to be interconnected with tie beams along both orthogonal directions perpendicular to each other.

Minimum penetration of piles into Pilecap shall be 75 mm and clear cover to the main reinforcement at the bottom face of the pile cap shall be 100 mm. Structural design of pile cap and reinforcement shall conform to IS:2911 and IS:456. However minimum reinforcement of 0.12% of cross section of the pile cap shall be provided on the top face of the pile cap along two orthogonal directions and minimum percentage of reinforcement at bottom face of pile cap shall be same as that stipulated for beam as per IS:456.

Detailed requirement of pile foundation have been presented in the foundation chapter specified hereafter in this specification.

6.04 Corrosion Protection

6.04.01 General

(a) All equipments, pipes, etc. shall be painted as per the requirements specified in the relevant section of the specification.

(b) All Steel structures (except those embedded in Concrete) shall be provided with Painting as given below which is designed for a minimum maintenance free life of more than Fifteen (15) years (High Durability), as per ISO 12944 Part 1.

(c) All Paints shall be of high build constitution.

(d) All Painting shall be done as per approved Painting scheme of the Vendors / Manufacturers, which shall be submitted by the Bidder and as approved by the Employer. Painting scheme shall also include Item codification / Description of all Coats of Paints for manufacturer's, from whom the Paint is intended to be procured.

(e) All steel structures shall be designed by following basic design criteria given in ISO 12944 Part 3 in order to avoid pre-mature corrosion and de-gradation of coating or structure.

6.04.02 Painting of Steel Surfaces embedded in Concrete:

(a) For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).

(b) All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, sleeves, etc. shall be coated with temporary rust preventive fluid and during execution of civil works, the dried film of coating shall be removed using organic solvents.

6.04.03 Painting of Steel Surfaces (other than those embedded in Concrete)

(a) All Steel surfaces shall be provided with two component self curing Inorganic Zinc ethyle Silicate Primer Coat (Solid by Volume Minimum 62±2% and Zinc Dust %age

on dry film minimum 80%). Zinc dust pigment shall conform to ISO 3549 and Zinc dust pigment content shall be determined in accordance with ASTM D 2371. Minimum Dry Film Thickness (DFT) of primer coat shall be 60 Micron. It shall be applied over shot blast cleaned surface to near white metal finish conforming to Sa 2 ½ finish of Swedish standard SIS-05-5900 and shall have profile of 20 to 30 micron. The Primer Coat shall be applied in Shop immediately after blast cleaning by Airless spray technique.

(b) Primer Coat shall be followed with the application of Intermediate Coat of Polyamide Cured pigmented Micaceous Iron Oxide (MIO content minimum 30%) Epoxy based Paint (Solid by Volume Minimum 62±2%) of Minimum 75 Micron DFT. This Coat shall be applied in Shop after an interval of Minimum overnight (from the application of Primer Coat) by Airless spray technique.

(c) Intermediate Coat shall be followed with the application of Finish Coat of Polyamide Cured colour pigmented Epoxy based Paint (Solid by Volume Minimum 60%) of Minimum 75 Micron DFT. This Coat shall be applied after an interval of Minimum overnight and maximum indefinite (from the application of Intermediate Coat) either before Erection by Airless spray technique or after Erection by brush and / or airless spray. Colour and shade of the Coat shall be as approved by the Employer.

(d) Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented Paint (Solid by Volume Minimum 55±2%) of Minimum 50 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat), after Erection by brush and / or airless spray. Colour and shade of the Coat shall be as approved by the Employer.

6.04.04 Touch-up Painting on damaged areas

(a) For Coatings damaged up to metal surface

Surface preparation shall be carried out by Manual Cleaning. Minimum 6 inches adjoining area with existing Coating shall be roughened by Wire brushing, emery paper rubbing etc., for best adhesion of patch Primer.

Over this Primer Coat, Intermediate Coat, Finish Coat and Final Finish Coat shall be applied as covered above by brush with Intermediate Coat applied within maximum seven (7) days of application of touch up Primer.

(b) For Coatings damaged upto Intermediate Coatings (i.e. where Primer Coat is intact).

Damaged area including Minimum 6 inches adjoining area with existing Coating should be roughened by wire brushing, emery paper rubbing etc., for best adhesion of patch Primer without damaging the Primer Coat.

Touch-up Primer, Intermediate, Finish and Final Finish Coats shall be applied as specified above for Coatings damaged up to metal surface.

6.04.05 Painting of Welded areas / Painting of areas exposed after removal of temporary supports / Touch-up Painting on damaged areas Structures, where inter-connection, Welding / modification etc. has been carried out by the Bidder.

(a) Clean the surface to remove flux spatters and loose rust, loose Coatings in the adjoining areas of Weld seams by wire brush and emery paper.

(b) Painting procedure to be followed as mentioned above for Touch-up Painting on damaged areas.

6.04.06 Dry film thickness of each coat shall be checked and measured as per the procedure specified in paint application standard no. 2 by SSPC: The Society for Protective Coating. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of technical specification.

6.04.07 Coating for Mild Steel parts in contact with Water.

(a) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 Gms / Sq. M. for galvanised Structures and shall comply with IS : 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS : 2629.

(b) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS : 3416, unless otherwise specified.

6.04.08 Gratings

All gratings shall be blast cleaned to Sa 2 ½ finish of Swedish standard SIS-05-5900 and shall be hot dip galvanised at the rate of 610 Gms / Sq. M.

6.04.09 Hand Railings and Ladders

All handrails and ladders shall be galvanised at the rate of 610 Gms / Sq. as per IS : 4736.

6.04.10 Sea Worthiness

All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti corrosive Paint before shipment to take care of sea worthiness.

6.04.11 All structural steel members in switchyard (excluding fencing and gate) shall be hot dip galvanised as specified elsewhere.

6.04.12 For reinforced concrete work

i) The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion.

This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc.,

Bidder shall furnish the details of corrosion protection measures.

7 FOUNDATION SYSTEM SOIL DATA AND GEOTECHNICAL INVESTIGATION

7.01 Soil Data

7.01.01 Owner has carried out preliminary geotechnical investigation in the vicinity of project site and the borelog are enclosed at Annexure-c for Bidder's reference. The onus of correct

assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder.

7.01.02 Contractor shall carry out detailed geotechnical investigation for structures under his scope as per scheme given at Annexure-I

7.01.03 The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundations and allowable bearing pressure/pile capacity for various structures/facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundations.

7.01.04 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil.

b) Entire expansive soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses.

7.02.01 General Requirements

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil. If the encountered sub-strata is black cotton soil, the same shall be either replaced upto the full depth or black cotton soil shall be stabilized by suitable treatment.

c) No other foundation shall rest on the filled up ground / soil.

d) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards. The water table for design purpose shall be considered at Finished Ground Level.

e) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

f) Foundation for equipments on ground floor

For equipments of static weight upto 1.5T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab may be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 5T/m^2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5T, the equipment foundation shall be taken to below the Natural Ground Level (NGL) or built up with PCC upto the specified level as per functional requirement. The equipment foundation shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment foundation for the full depth of the floor slab. However, in no case, the foundation depth shall be less than 1.0 m.

7.02.02 Open Foundations

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC up to designed foundation level.

e) No foundation shall rest in black cotton soil.

f) During design the Allowable Bearing Pressure shall be adopted after approval of detailed geotechnical investigation report. However, the maximum allowable bearing pressure shall be as per geotechnical report and shall be limited to the values as furnished in Table-1.

Table-1

Founding Depth/ Stratum	Net Allowable Bearing Pressure T/m2	
	Isolated and combined footings width upto 6.0 m	Rafts (width > 6m)

In case any loose/soft pockets in rocky strata is encountered at founding level, the same shall be removed completely upto the hard strata and filled up with PCC (1:4:8).

g) For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 / IS: 13063 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated & Raft (BTG Area Footings except ESP Footings)	25 mm
Isolated & Strip (Other than BTG Area)	40 mm
Raft (ESP Foundations and other Offsite Structures footings)	75 mm
Foundations in Weathered rock / rock	12 mm

Incase pile foundations are to be adopted the requirements under para "Pile Foundations" shall be adhered to.

7.02.03 Pile Foundations –

In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

The piling work in river/water body shall be carried out with temporary or permanent MS liner and approved construction methodology. If piles are extending, above bed level of river/water body, in water, permanent MS liner of minimum 8mm thickness shall be provided.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be limited to the values given below:

Pile	Dia. (mm)	Vertical compression capacity (T)
Bored cast-in-situ pile	600	140
	760	250
	1000	310
	1200	375

Cut Off Level (COL) is considered as 3.0 m below Finished Ground Level (FGL)

The uplift and lateral load capacity shall be respectively restricted to 35% and 5% of the allowable load capacity in vertical compression.

However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

iii) The pile shall be socket into rock with minimum socket length of 5 times the diameter of pile below the socket horizon. Socket horizon shall be considered where core recovery is more than 30 %. The minimum grade of concrete for pile shall be M25 with minimum cement content of 400 Kg / Cum.

iv) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

v) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as initial test piles, locations of initial test piles etc.) for Engineer's approval. Initial test pile shall be a trial pile other than a job pile.

vi) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vii) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral — Minimum of 2 Nos. in each mode up to 2000 number of piles. Additional set of initial test shall be done for every additional 1000 nos of piles or part there of.

Uplift

viii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

ix) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

x) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

xi) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xii) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xiii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiv) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge.

xv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed for the allowable safe pile capacities with combinations i.e. compression + bending case or tension + bending case, irrespective of the actual load on each job pile.

7.03 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment, cement type, grade of concrete, type of reinforcement, cover to reinforcement and protective coating to foundations, etc. shall be as per detailed geotechnical investigation to be carried out by bidder.

Bidder shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.

7.04 Excavation, Filling and Dewatering

7.04.01 For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth .

7.04.02 Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M 7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.

7.04.03 Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 75% of relative density for non cohesive soils. In any case, black cotton soil shall not be used in back filling without providing cushion of 1m of non expansive cohesive soil / moorum around the footings. In case of roads in the area of black cotton soil, minimum 0.4m moorum shall be provided.

7.04.04 The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.

7.04.05 CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.

7.05 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation, executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.06 ANNEXURE-I

7.06.01 **Geotechnical Investigation**

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.06.02 **Scheme of geotechnical Investigation**

Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), 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), Seismic Refraction Test (SRT), Pressure Meter Test (PMT), In situ field permeability tests, collection of water samples, etc.

The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum.

7.06.03 The minimum tests are indicated in **Appendix A**. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. 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. SPT 'N' of 100 and above shall be referred as refusal. 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.

7.06.04 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.

Laboratory Tests on Soil Samples

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.

Laboratory Tests on Rock Samples

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.

7.06.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain

8.00.00 GENERAL SPECIFICATION

8.01.01 **Joints in Concrete Structures**

Construction Joints

All horizontal construction joints shall be provided with a groove (shear key) for transfer of shear force.

Expansions Joints

In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS: 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS:12118 or silicon sealing compound shall be used.

IS:3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.

8.01.02 All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti corrosive paint before shipment to take care of sea worthiness.

8.01.03 A screed or concrete layer not less than 100 mm thick and of grade not weaker than M 10 conforming to IS: 456 shall be provided below all water retaining structures.

8.01.04 Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

8.01.05 Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.

8.01.06 Wherever possible all floor openings shall be provided with 100 mm thick 150 mm high RCC kerb all around.

8.01.07 Angles 75 x 75 x 6 mm (minimum) with 8mm dia and 150mm long MS lugs @ 150 c/c shall be provided for edge protection all around cut outs/openings in floor slabs. Angles 50 x 50 x 6mm with effective anchor lugs shall be provided for edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.

8.01.08 Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.

8.01.09 Anti termite chemical treatment shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS: 6313 and other relevant Indian Standards.

8.01.10 Trenches located outside the buildings shall project at least 200mm above the finished formation level unless noted otherwise elsewhere in this specification so that no storm water shall enter the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500.The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. The precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers. The trenches shall be given a slope of 1 in 250 in the direction perpendicular to the

	run of the trenches. PVC water stops shall be provided at all expansion joints of all trenches. Trench covers near entry or at road crossings shall be designed for 10 T wheel load at centre. Pre - cast covers shall be designed for central point load of 75 Kgs. R. C. C. cable slits shall be filled with sand after erection of cables, up to top level and covered with pre - cast R. C. C. covers.
8.01.11	All steel platforms above grade shall be provided with 100 x 6 thick kick plates at edge of platform.
8.01.12	Duct banks consisting of PVC conduits conforming to IS:4998 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.
8.01.13	Independent network of lines for sewerage and drainage shall be provided.
8.01.14	The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)
8.01.15	Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS: 9758 shall be followed as general guidance for dewatering.
8.01.16	Structural steel column base plates and bolts, gussets, etc., shall not project above the floor level. These shall be encased by concrete cover upto floor level with concrete grade M 30.
8.01.17	Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. Minimum grade of grout shall be M-30. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/mm^2 at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.
8.01.18	Fencing for fuel oil area, switchyard, and transformer yard area shall be of the same type as specified, elsewhere in this specification.
8.01.19	Plant effluent shall not be mixed with either storm water or sewage.
8.01.20	Rail-track in transformer yard area shall be provided with rigid type RCC foundation. Rail weighing 52 kg/m shall be used.
8.01.21	All building shall be design to take care of Rain Water harvesting & ground water recharging.
8.01.22	Ground Floor Slab & Area / Pathway Paving: For Ground floor / Area paving or path - way having earthen sub-grade, the paving work shall consist of following parts i.e. 150 mm thick RCC M - 25 Grade base slab, 75 mm thick PCC M7.5 Grade 275 mm thick (compacted thickness) stone / rubble soling sub base with 63 mm down aggregate compacted to 85% of original volume and interstices filled with well graded selected sand on compacted and dressed sub - grade. Reinforcement of the RCC slab shall consists of minimum 8mm dia bars @ 200 mm c / c at top in both directions.
8.01.23	As required suitable steel frames shall be provided around openings in the roof and external walls for mounting exhaust fans.
8.01.24	All foundation embedments, inserts, blockouts required for mounting of equipments and supporting any other facility like pipes etc. shall be provided.

8.01.25	Grouting of all pockets, blockouts, sleeves and the openings around the embedment, inserts, bolts etc. and under pinning below the base / sole plate shall be with non - shrink flowable grout. Grade of grout shall be one grade higher than concrete. However minimum grade of grout shall be M - 30.
8.01.26	All cable trenches shall be provided with suitable insert plates for fixing support angles of cable trays.
8.01.27	All internal cable trenches shall have minimum 6mm thick (o / p) chequered plate covers while external cable trenches shall have pre - cast RCC covers. However, the portion of the cable trench behind and sides of control panel / MCC shall be provided with suitable chequered plate covers as directed by the Engineer.
8.01.28	All foundations and surfaces of substructures coming in contact with earth shall be applied with three coats of hot applied industrial bitumen conforming to IS : 702 (latest), of Grade 85 / 25, at the rate 1.7 Kg / Sq.m / coat.
8.01.29	All the liquid retaining structures shall be tested for water tightness with full water level in accordance with IS : 3370 (Part - I).
8.01.30	All structures receiving acid / alkali resistant lining shall be tested for water tightness and made leak proof before lining work.
8.01.31	Base slab of large tanks may be cast in number of panels viz. I, II, III etc. Starting with I, the slab panels shall be cast alternately in chess board fashion, with proper construction joints. Adjacent panels shall be cast with sufficient time interval, so that first cast concrete would have undergone most of its shrinking before the second cast concrete is poured against it. The construction joints shall be provided with chemical injection grouting treatment. The construction joints shall have continuity of reinforcement and shall be provided with suitably keys. The size of panels shall be as per IS : 3370 recommendations.
8.01.32	For construction joint in concrete wall, the maximum height of any lift should not exceed 2 meters. However, the time interval between the successive lifts should be as small possible and the wall should be built to its full height in the least possible time.
8.01.33	1000mm wide x 100 mm thick plinth protection in PCC (M-15) shall be provided around all buildings, pits / sumps, clarifiers, tanks, etc.
8.01.34	All masonry walls shall be provided with Damp Proof Course at plinth level.
8.01.35	Wherever required PVC coated chain - link fencing shall be provided as per specification.
8.01.36	Expansion joints for all underground structures shall be made water tight by using ribbed PVC water stops with central bulb or of kicker type. The thickness and width of PVC water stops shall be as per the requirement of design. However, the minimum thickness and width shall be 6mm and 225mm respectively. Two - part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.
8.01.37	All monorail openings in the walls shall be provided with double plate flush steel door shutters with suitable access platform and ladder as required.

8.01.38	a) All drains inside the building shall have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. b) All drains outside building shall have perforated precast RCC covers of minimum 50mm thickness with provision of openable steel grating cover at about 4.0m interval. In areas where vehicular loads would be coming precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided.
8.01.39	Hand rail height , size and material to be adopted shall be as per general architectural specification.
8.01.40	In all buildings, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting etc. shall be provided for each floor with suitable floor drains.
8.01.41	All cable & pipe routing in outlying area shall be clubbed and shall run over ground on steel trestles or other supporting structures at a height specified elsewhere in this specification except in some localised area (as approved by Employer) where the same can run in trenches. In case cable route is not envisaged in the area, pipe shall be routed on ground over RCC pedestals at a height of not less than 500 mm. All trenches shall be of RCC with removable RCC covers.
8.01.42	Water supply line & drainage of pump house shall be connected with the nearest Employer's water supply & drainage line.
8.01.43	Unless specified all sand filling shall be compacted to minimum 75% of the relative density and backfilled earth shall be compacted to minimum 90% of the Standard proctor density at OMC. However, sub - grade for the roads shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC).
8.01.44	All liquid retaining structures shall be leak-proof. Water proofing of all liquid retaining structures shall be done by addition of plastciser cum water proofing admixture conforming to IS : 9103, in the concrete at the time of mixing and through external treatment by chemical injection grouting at all construction joints as described in the specification. Addition of admixture should not reduce the strength of the concrete below the specified strength in any case. In addition, limit on permeability as given in IS : 2645 shall also be met with. Further if required, chemical injection grouting treatment shall be applied to make the structure leak proof, if leakage is observed during hydro - test or otherwise, with no cost implication to the Employer.
8.01.45	Plywood formwork shall be used for all water retaining/ conveying structures (only on the face having contact with water) and for all overground concrete works. It shall also be used for the inner face of sump of pump (i.e. faces of piers back walls, breast walls and baffle walls having contact with water. For all other areas steel/ plywood formwork shall be used.
8.01.46	All buildings shall be provided with peripheral drains by the side of plinth protection for catering to the rain water from roofs and storm water from adjacent area.
8.01.47	Under drainage arrangement for under ground structures shall be provided as applicable in line with relevant codal provisions.

8.01.48 2.0m wide walkway with concrete paving shall be provided connecting all buildings and facilities. The top of walkway shall be minimum 200mm above FGL.

8.01.49 For all buildings, finished floor level (FFL) shall be minimum 500mm above finished ground level (FGL).

8.01.50 **Acid/ Alkali Resistant Lining**

The acid / alkali resistant lining shall be provided broadly in the areas identified. The Bidder shall give a guarantee for satisfactory functioning of the lining for a period of 36 months from the date of completion of the work or date of handing over the site to the Engineer, whichever is later. The Bidder shall replace / rectify defects is any, observed in the lining to the satisfaction of the Engineer without any extra cost during this period.

8.01.51 **Bituminous Coating**

Bituminous coating shall be applied on the inside faces of the water retaining structures and also on that portion of water retaining structure which are in contact with ground water. Surface to be treated shall be absolutely dry, clean and dust free. The surface shall be sand papered, before applying the coating.

The external surfaces of concrete which are in contact with ground water shall be applied with hot industrial bitumen conforming to IS : 702, of grade 85 / 25. The rate of application shall not be less than 1.70 Kg / sq.m / coat, in three coats and it should be heated to about 120°C before application. Anti stripping compound shall be added wherever necessary. After application of third coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading sand, before back filling is done in order to allow the final coat to dry up completely.

The internal surfaces of water retaining structure which are in contact with water shall be applied with one coat of suitable primer followed by minimum 3 coats of bitumen paint conforming to IS 9862 to achieve a DFT of 150 micron of bitument coat

8.01.52 40mm Dia. MS rods as earthing mat, placed at a distance of 1.0M away and at depths between 0.60M and 1.00M shall be supplied and laid all around the periphery of buildings, structures, and out door equipment, as per approved drawings. Riser of 40mm Dia. MS rods and connecting to the above Earthing mat shall also be supplied and laid in position by the Contractor, as per the approved drawings. Raiser shall be laid up to a height of 300 mm above the local Ground level, at each of the columns of the buildings on the outside of the buildings, and minimum 2 (two) numbers of structures and equipment. The contractor also supply and lay necessary number of 3.0 M deep 40 mm Dia. MS rods Earthing electrodes and connecting them to the Earthing mat, as per the approved drawings and supplying and laying of 40 mm Dia. MS rods for connecting the Contractor's earthing mat with the Employer's earthing mat separately of two locations.

8.02 **Concrete**

General

a) Concrete work shall be carried out as per IS:456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS:10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.

b) Minimum grade of reinforced cement concrete for all foundations including piling shall be M25 unless noted otherwise. Minimum grade of concrete for other structures/areas (other that machine foundations) shall be M25 for all superstructure and substructure unless noted otherwise elsewhere in this specification.

c) The minimum grades of concrete for different machine foundations and some of other important structural members shall be as follows:

Sl. No.	Description	Minimum grade of concrete
i)	TG Top Deck	M-35
ii)	ID, FD and PA fan Deck	M-30
iii)	Coal Mill foundation	M-30
iv)	Sub structure supporting top decks of TG, ID/FD/PA Fans, Mills including raft/ footings	M-30
v)	BFP foundations including deck	M-30

d) Higher grade of concrete than specified above may be used at the discretion of the Bidder.

e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works.

f) For thin concrete sections such as roof slab over profiled metal deck sheets, 12mm and down coarse aggregates shall be used for coarse aggregates.

g) All underground concrete structures like trenches, substructures of pump houses, all water retaining / carrying structures , etc., shall have super-plasticizer cum water proofing cement additive conforming to IS:9103. In addition, limit on permeability as given in IS:2645 shall also be met with.

h) Minimum grade of concrete for Plain Cement Concrete (PCC) has been specified in the preceeding section

Special requirements for concreting of major equipment foundations shall be as given below.

a) **Coarse Aggregates**

Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases, high percentage of reactive silica content, aggregate may be allowed where low alkali content cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations). However, in case other types of suitable aggregate is not available, the Engineer may allow the use of lime stone aggregate provided the Bidder gets the sample tested from a reputed testing laboratory for satisfactory performance under high temperature and repeated temperature cycle.

Unless otherwise specifically approved by the engineer, the tests shall be carried out for a temperature range from 10 °C to 65 °C and for 60 (sixty) temperature cycles.

b) **Temperature Control of Concrete**

The temperature of fresh concrete shall not exceed 25 deg C when placed. For maintaining the temperature of 25 deg C in the top decks of machine foundations, crushed ice (if required) shall be used in mixing water.

c) **Admixture**

Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-ratarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG,	-	150 mm to 200 mm
BFP, ID/PA/FD Fans,		
Mill deck	-	100 mm to 150 mm
Block foundation	-	100 mm to 150 mm
Column	-	100 mm to 150 mm
Piling (bored cast-in-situ)	-	150 mm to 180 mm

d) **Form work**

Plywood with film face form work shall be used for the top decks of all machine foundations and also for columns of TG foundation.

e) **Placing of Concrete**

Base Raft and top deck of machine foundations shall be cast in a single pour.

f) **Ultrasonic Testing**

Ultrasonic pulse velocity test shall be carried out for the top decks of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cu.m. of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing shall be done as per IS:13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.,

g) **Scheme for Concreting**

Weigh Batching Plants, transit mixer, concrete pump shall be mobilised. Arrangements for standby Plant and Equipment shall also be made.

h) **Reinforcement Steel**

Reinforcement Steel shall be of grade Fe500 TMT conforming to IS1786. However minimum elongation shall be 14.5%.

8.03.0

Formwork

Formwork for building RCC Slabs/ Beams & Columns shall be of 2 different types.

Type 1 Formwork: (For RCC slab of Structural Steel Framed Buildings Only)

Troughed metal deck sheets shall be used as permanent shuttering. These profiled metal deck sheets shall be fixed to the structural steel secondary beams/ Purlins using Headed shear anchor studs. The metal deck sheet for turbine bay roof shall have permanent colour coating on bottom side of metal deck in addition to metallic coating as specified elsewhere in the specification. The detailed material property requirement of metal deck sheet is specified elsewhere in this specification.

The shear anchor studs for fixing metal deck sheet to floor structural beams shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 19mm diameter and 100mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

The shear anchor studs for fixing metal deck sheet to roof structural purlins shall conform to Type-B studs specified in AWS D1.1/D1.1M or equivalent as shear connector of 16mm diameter and 65mm length manufactured from cold drawn round steel bars conforming to the requirement of ASTM A 29, of grade designation 1010 through 1020, of standard quality with either semi-killed or killed, welded by Drawn Arc Stud Welding through metal deck sheet.

Type 2 Formwork: (For RCC Buildings)

Plywood with film face formwork shall be used for floor & roof slabs, Columns & Beams of all RCC buildings

8.04.0

Fencing and Gate

Fencing

Fencing with gate shall be provided around transformer yard, switchyard area, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications.

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer.

Toe walls either of brick masonry with bricks of minimum 50 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings.

Gate along fencing

All gates shall be of structural steel of minimum 3.75 metres width for single lane access road and 8.00 m width for double lane access roads. The height of gate shall be same as that of the fence unless noted otherwise. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS:513.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminum ball bearing arrangement, castor wheel, etc.

8.05.0 **Grating**

All gratings shall be electroformed types. Minimum thickness of the grating shall be 40 mm. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm or as per design requirement whichever is higher. All gratings shall be hot dip galvanised at the rate of 610 g. per sq.m. after surface preparation by means of shot blasting / chemical cleaning.

8.06.0 **Fabrication**

The fabrication shall be done as per fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld.

Welding

a) Welding of Structural steel shall be done by an electric arc process and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:2014, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, Bidder shall give appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standards as relevant.

b) Submerged arc-welding shall be used for welding longitudinal fillet welds (connecting flange with web) and longitudinal / transverse butt joints for fabrication of columns,

framing beams and crane girders and all other built-up members, unless manual arc welding is specifically approved by the Engineer. Necessary jigs and fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible. 'Open-Arc-Welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

c) Wherever welding is done for assembling the components of structures, the job shall so positioned that down hand welding is possible.

d) Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions in such type of joint that is welded.

e) All records for entire welding operations such as welders identification marks, the joints welded by the each welder, the welding procedures adopted, welding machine employed, pre and post heating done and any non destructive test done and stress relieving /heat treatment performed on such joints shall be accessible to the Engineer for scrutiny.

f) In a fabrication of plated columns/beams and built up members all shop splices in each component part shall be done before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting between components to be assembled by welding, these welds shall be ground flush prior to assembly.

g) The members to be jointed by fillet welding shall be brought and held as close together as possible and in no event shall be separated locally by more than 3mm. If the local separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

Edge preparation for welding as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

Electrodes

a) The electrodes used for welding shall be of suitable type and size depending upon specification of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plate thickness above 20 mm.

b) All low hydrogen electrodes shall be baked and stored before use as per manufacturer recommendation. The electrodes shall be rebaked at 250^0C - 300^0 C for one hour and later on cooled in the same oven to 100^0C. It shall be transferred to an holding oven maintained at 60^0C - 70^0C. The electrodes shall be drawn from this oven for use.

c) Where coated electrodes are used they shall meet the requirements of IS:814 and relevant ASME-Sec. Covering shall be heavy to withstand normal conditions of handling and storage.

d) Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing

e) Where bare electrodes are used, these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall

conform to the requirements of F-60 Class of AWSA-5-17-69 and IS:3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

f) 308L and 309L electrodes / fillers shall be used for welding of stainless steel to stainless steel and stainless steel to mild steel respectively.

g) Specific approval of the Engineer shall be taken by Bidder for the various electrodes proposed to be used on the work before any welding is started.

Preheating inter-pass temperature and post weld heat treatment.

a) Mild steel plates conforming to IS:2062 and thicker than 20mm, may require preheating of the parent plate prior to welding as mentioned in Table-I.

However, higher preheat and interpass temperatures required due to joint restraint etc. and will be followed as per approved welding procedure. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

c) Base metal shall be preheated, not withstanding provisions of IS:9595, to the temperature given in Table-1 prior to welding or tack welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum temperature while welding is in progress.

TABLE – 1
MINIMUM PREHEAT and INTER PASS TEMPERATURE FOR WELDING

Thickness of thicker part at point of Welding	Welding using Low hydrogen electrodes or Submerged arc welding
Upto and including 20mm	None
Over 20mm and upto and including 40m	20 ^{0}C
Over 40mm and upto and including 63mm	66 ^{0}C
Over 63mm	110 ^{0}C

c) Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending upto a distance of four times the thickness of the plate on either side of the welding joint is obtained.

d) Thermo-chalk, thermo-couple or other approved methods, shall be used for measuring the plate temperature.

e) All butt welds with plates thicker than 50mm and all site butts weld of main framing beam shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done upto 600 deg.C and rate of application shall be 200 deg.C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5cm. thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas.

Sequence of Welding

a) The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.

b) Each case shall be carefully studied before finally following a particular sequence of welding.

c) Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.

d) The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.

e) All welds shall be finished full and made with correct number of runs, the weld being kept free from slag and other inclusions, all adhering slag being removed.

f) Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

g) Pudding shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

h) Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.

i) The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approval means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end be welded to provide the ends with the required reinforcement.

j) The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.

k) All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the design drawings.

l) Intermittent welds shall be permitted only when shown in the design drawings.

m) The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.

Testing of Welders

All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX/AWS D1.1. All the necessary arrangements required for the testing of welders are to be provided by the Bidder.

Inspection of Welds

a) **Visual Inspection**

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the welds run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, stages on the surface and visible cracks.

Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag, etc., If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic/ultrasonic examination shall be undertaken.

b) **Production Test Plate**

Test plates shall be incorporated on either side of at least one main butt welds of each flange plate and web plate of every main frame columns and crane girder. The weld shall be continuous over the test plate. The test plate extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Engineer or his authorised representative. Should any of these tests fail, further radiographic examination of the welds shall be done. These tests for test plates and radiographic examination are additional to those contemplated under inspection and testing.

c) **Non-destructive and special testing**

Radiographic / ultrasonic or other non-destructive examination shall be carried out. All tests of welds shall be carried out by the Bidder at his own cost. The cordoning of radiation zone, while Radiography testing is going on, shall be done.

In case of failure of any of the tests, re-testing of the joints shall also be carried out after rectification is done.

d) **Rectification of defective welding work**

Wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc., are noticed by visual inspection/other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes.

Inspection and Testing

a) **Fillet Welds**

i) All fillet welds shall be checked for size and visual defects.

ii) Macroetch examination on production test coupons for main fillet weld with minimum one joint per built up beam, column and crane girder, etc.

iii) 25% weld length of tension members of crane girder shall be subjected to dye-penetration test.

iv) On all other welds, dye-penetration test on 5% of weld length with minimum 300mm at each location shall be carried out.

b) **Butt Welds**

i) 100% visual examination.

ii) Dye penetration test on all butt welds after back gouging shall be carried out.

iii) Mechanical testing of production test coupons - minimum one joint/built up beam, column and crane girder. The engineer may reduce the frequency of the test, after getting consistently satisfactory results of initial 10 tests.

iv) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder and bunker supporting girders. All other butt welds shall be subjected to radiography test on 10% of weld length of each welder.

c) **Dimensional Tolerance and Acceptance Criteria of Welds**

i) Every first and further every 10th set of identical structure shall be checked for control assembly at shop before erection.

ii) All structures, components/members shall be checked for dimensional tolerance during fabrication and erection as per IS:7215 and IS:12843 respectively.

iii) Dry film thickness after painting shall be checked by using elchometer.

iv) Acceptance criteria of NDTs on welds shall be as per AWS D-1.1 (Dynamically loaded structures - Tension welds).

Correction of Defective Welds

Correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed magnetic particles inspection or any other equally positive means shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed.

Erection of Structures

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

d) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc., Bidder shall take up the erection work only after he has obtained the approval of the erection scheme from the Engineer.

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc.

c) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

8.07.0 **Steel Helical Springs And Viscous Dampers**

8.07.01 **General Requirement**

This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of pre-stress, alignment, commissioning, etc. of Steel helical springs and viscous dampers.

The Steel helical springs and viscous dampers supplied should be of proven make.

8.07.02 Codes and Standards

Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below:

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.

DIN : 2089 Helical compression springs out of round wire and rod : calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

VDI : 2056 Criteria for assessing mechanical vibrations of machine.

VDI : 2060 Criteria for assessing the state of balance of rotating rigid bodies.

8.07.03 Design & Supply of Material

i) Supply

Steel helical springs and viscous dampers and associated auxiliaries shall consist of:

(a) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.

(b) Frames for pre-stressing of spring elements.

(c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided.

(d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers.

ii) Design

The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 Hz. The damper units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50℃. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units.

The Steel helical springs and viscous dampers shall be designed for a minimum operating life of 30 years.

8.07.04 Manufacturing & Testing

Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the contractor / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include

(a) Manufacturing schedule and quality check exercised during manufacturing.

(b) Detail of test to be carried out at the manufacturing shop with their schedule.

(c) Special requirements, if any, regarding concreting of top deck.

(d) Complete step-by-step procedure covering the installation and commissioning of the spring system.

(e) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers.

(f) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers.

(g) Checklist for equipment required at each stage of erection.

(h) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

(i) Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers.

(j) Any other details which may be necessary to facilitate design and construction of the foundations / structures.

8.07.05 The Springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedure shall be finalised on the basis of the above codes and the quality plans be drawn accordingly.

8.07.06 Transportation

Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.

8.07.07 Erection and Commissioning

Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor.

The contractor shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period".

8.07.07 Supervision

The supervision of installation of Steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.

8.07.08 Realignment of Spring System

If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.

8.07.10 Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096.

Following acceptance criteria shall be followed:

General workmanship is being good as recommended by the manufacturer and approved by the Engineer.

Tolerances are within the specified limit.

Material test certificate (MTC) is in compliance with the applicable codes / standards.

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.

8.08.0 **SHEETING WORKS**

8.08.01 **General Requirement**

This part of the specification covers the technical requirements of colour-coated sheet and allied works for roofing, decking and cladding, with or without thermal insulation. Supply and installation of the profiled sheeting shall be done by same agency. During handling / stacking, if any damage is done to sheets like distortion of edges, formation of dents, scratches on sheet etc., then such damaged sheet shall stand rejected and shall be immediately replaced by the contractor.

8.08.02 **Material**

8.08.03 Metal Decking

(a) Troughed permanently colour coated metal decking sheet of steel for floor/roof decking shall conform to the requirements of Table-1.

(b) Alternatively aluminium feed material of minimum 0.9 mm (bare metal thickness) thick colour coated aluminium alloy of series 31,000 and above as per IS 737 and IS 1254 can also be used for metal decking.

(c) Steel/ aluminium alloy shall be colour coated with total coating thickness of 35 microns (nominal) dry film thickness (DFT) comprising of silicon modified polyester (SMP with silicon content 30% to 50%) paint or polyester paint, of 20 microns (nominal) SMP or polyester paint on one side (exposed side) on 5 micron (nominal) primer coat and 5 microns (nominal) SMP or polyester paint over 5 micron (nominal) primer coat on the other side. SMP and polyester paint systems shall conform to Product type 4 as per AS/ANZ 2728.

(d) Sheet shall be of approved profile, sectional properties, colour and shade.

(e) Chemical composition of troughed permanently colour coated metal decking sheets shall conform to the provisions of the same reference code to which the mechanical properties conform to.

(f) Mechanical properties shall be confirmed by relevant tests

8.10.0 **HEADED SHEAR STUDS**

8.10.01 **General**

This part of specification covers the technical requirement of Headed shear studs. The studs shall be welded to steel beams either directly or through metal deck sheet whichever is applicable. In case metal deck sheet is used as permanent shuttering, it shall not be considered as structural element for slab design.

8.10.02 **Material**

(a) Studs shall be manufactured from cold drawn round bars conforming to the requirement of ASTM A 29 of grade designation 1010 through 1020 or equivalent, inclusive either semi-killed or killed (aluminium or silicon deoxidation).

(b) Mechanical properties and other requirements of studs shall conform to requirement of Type-B studs specified in AWS D1.1/D1.1M or equivalent.

(c) The diameter of stud shall be 16mm (5/8 inch.) for roof slab and 19 mm (3/4 inch.) for other slabs.

(d) Before weld, length of 16mm (5/8 inch.) diameter stud shall be 65mm and that of 19mm (3/4 inch.) stud shall be 100mm.

8.10.03 **Installation and fixing**

(a) Headed shear studs shall be welded to top flange of floor beams either directly or through metal deck by Drawn Arc Stud Welding by stud gun with arc shields/ferrules. After welding, arc shields/ferrules shall be broken free from studs.

(b) The distance between the edge of a stud and edge of steel beam flange shall not be less than 25mm.

(c) In no case studs shall be welded through more than two plies of metal decking.

(d) Stud welding procedure specification, procedure qualification record, operator/welder's qualification and acceptance norms shall conform to ASME IX.

8.10.04 **Workman ship**

(a) At the time of welding, the studs shall be free from rust, oil, moisture or other deleterious matter that would adversely affect the welding operation.

(b) The studs shall not be painted, galvanized or cadmium-plated prior to welding.

(c) The areas to which the studs to be welded shall be made free of scales, rust, moisture or other injurious material to the extent necessary to obtain satisfactory welds and prevent objectionable fumes.

(d) The arc shields/ferrules shall be dry. Any shields/ferrule which shows signs of surface moisture from dew or rain shall be oven dried at 1200 C for two hours before use.

(e) If there is any damage to the panting of steel members or metal deck sheet, same shall be repainted by the Bidder.

8.11.0 **AUTOCLAVE AERATED CONCRETE BLOCKS (AAC BLOCKS)**

8.11.01 **General Requirements**

Autoclave Aerated Concrete Blocks shall be used for external walls and internal partitions. They shall be factory made in the form of blocks.

8.11.02 **Codes and Standards**

Some of the relevant Indian Standards are referred to here below:

IS-2185(III) - 1984	:	Aotuclaved Aerated Concrete Block.
IS-6041 - 1985	:	Construction of Autoclaved Aerated Concrete Block Masonary.
IS-6441 - 1972	:	Methods of Test for Autoclaved Cellular Concrete product.

8.11.03 **Material**

8.11.04 The blocks shall be made up of a mixture comprising of fine Fly Ash, quicklime, cement, gypsum as binding agents and water, aluminium powder as a foaming agent. The mixture shall be moulded into blocks of required shape and size and steam cured in high pressure Autoclaves.

8.11.05 The general size of finished blocks shall have dimensions of 625mm x 250 mm, with thickness ranging from 100mm to 300 mm and shall conform to IS:2185 (part III), for dimension and tolerance.

8.11.06 AAC blocks shall have the following physical properties :

-	Density (over dry)	-	550-650 kg/cum
-	Compressive Strength	-	Min. 30 kg / sq.cm
-	Thermal Conductivity	-	0.162W/mk (avg)
-	Resistant to fire	-	2-6 hrs depending upon thickness
-	Drying shrinkage	-	0.02% (avg)
-	Design gross density	-	800 kg/cum (approx)

8.11.07 **Installation & Laying**

Installation shall be done as per the working drawings.

Laying of AAC Blocks masonary shall be in accordance with the recommendations of IS:6041 of 1985 and IS:1905 of 1987. This shall hold valid for other structural requirements like stiffening of masonary, joint reinforcements, etc.

The jointing cement sand mortar in the composition of 1:6 (1 Cement : 6 sand) shall be used with suitable plasticizer. Sand having modules of fineness 1:1 shall be used. The horizontal & vertical joint thickness shall be approximately 10mm thick. In case of partition walls (100 mm / 125 mm) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure.

Once the masonary erected, the curing shall be minimum, with more requirements at the joints. 5-6 courses shall be erected maximum in a day.

Before plastering, cement slurry shall be applied on the walls and only leaner mix shall be applied. The thickness of the plaster shall be min. 12mm.

The openings for doors, windows, ventilators, pipes, cables, ducts, fans, ACs etc. shall be created as required. Blocks shall be cut with a saw. Wherever chasing to be done in AAC Blocks, rotary cutters shall be used. The chases shall be refilled with lean mortar and chicken mesh applied on that area.

While laying AAC blocks, safety precautions shall be taken for the safety of the requirement, structure and personnel located / working in the area.

8.12.0 **MODULAR AERATED CONCRETE PANELS**

8.12.01 **General**

Modular aerated concrete panels shall be used for external walls and internal partitions. These shall be factory made in the form of modular panels.

8.12.02 **Material**

The panels shall be made up of two 4 mm thick cellulose fiber reinforced cement bonded plain sheets (as per IS:14862) on either side of a light weight concrete core composed of portland cement, fly ash, mica and sand aggregate. The compressive strength of concrete shall not be less than 35kg/sq.cm and the density shall be between 700-900 kg/cu.m.

The thickness of the panel shall be 50 mm and 75 mm. The minimum fire rating as per BS:476 (Part-20 to 22) shall be 1 hour and 2 hours respectively for 50 mm and 75 mm panel thickness. The necessary certificate in this aspect shall be furnished by the contractor.

The panel shall generally be of 600mm width and of varying length as per requirement.

The flexural strength of panel shall be sufficient for their installation on a span of upto 4.5 m. and limiting the deflection to span / 250 under wind loading condition.

The minimum thickness of U-channel shall be 1.25 mm and shall be galvanised to grade 180 as per IS: 277.

All expansion fasteners / screws shall be of stainless steel from established and reputed manufacturers.

Silicone acrylic paste, glass fiber tape and all other material shall be of best quality from established and reputed manufacturers.

8.12.03 **Installation (fixing in position)**

Installation shall be done as per the working drawings

The contractor shall carry out the necessary design and get the third party testing done on the panels in order to establish that the deflection of the panels are limited to span/325 over a span of 4.5 m. corresponding to designed wind loading.
The U-channels shall be fixed to the concrete and/or to primary steel members (provided by the owner), which are placed at a maximum vertical spacing of 4.5 m. with the help of expansion fasteners. The spacing of the fasteners shall be decided from the consideration of the load transfer from U-channel to concrete/steel members. However, the minimum size of the fastener shall be 8 X 35 mm long placed at a maximum spacing of 600 mm C/C.

The panels shall be fixed in the U-channel with the help of screws (8x35 mm) and placed at a maximum spacing of 600 mm C/C or lesser, if required, as per design.

The panels shall be placed preferably in tongue and groove jointing system. The joints shall be subsequently finished on both faces with silicone acrylic paste. These shall be made water tight by application of glass fiber strip of minimum 50 mm wide and 0.5 mm thick and/or by any other suitable material.

The openings for doors, windows, ventilators, pipes, cables, ducts, fans, ACs etc. shall be created as required. The face of the opening shall be finished with the same U-channel as that been used for fixing of panels.

The total construction shall be weather proof and the surfaces shall be flush for painting. Undulations, if any, on the surface shall be finished with silicone acrylic paste.

The complete installation of the panels shall be done in a mechanised way using power tools, hoists etc. All openings shall be neatly cut with the power tools.

While fixing the panels in position necessary safety precautions shall be taken for the safety of the equipment, structure and personnel located/working in the area.

9.00.00 Architectural Concepts and Design

9.01.00 For Architectural Concepts and Design refer to 5.00.01 in this specification.

9.02.00 General Architectural Specifications

9.02.01 **General**

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., wherever the height of the building is more than 12m, railing ht to be 1.2m. All handrails and ladder pipes (except at operating floors) shall be 32 mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanised as per IS : 4736 and finished with suitable paint. All rungs and ladders shall also be galvanised. Minimum weight of galvanising shall be 610 g/sqm. The spacing of vertical posts shall be maximum 1500mm. Two number of horizontal rails shall be provided including the top

member. In addition, toe guard/ kick plate of min size 100x6th shall be provided above the floor level.

In Service Building, Administrative Building, Plant Auditorium and Canteen Building RCC stairs and passages/ corridors hand railing with posts shall be made of stainless steel and be 1200mm high. For Atrium areas, same shall be provided with 10mm thick laminated Glass infill panels.

For RCC stairs, passages & Atriums in buildings, around all floor openings at operating floors, 1000 mm /1200mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided. The spacing of vertical posts shall be 1500mm. Two number of horizontal rails shall be provided including the top member. Toe guard and kick plate shall be provided above the floor level.

b) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise. For Administration Building& Service Building, stairs width shall be minimum 1500 mm, with Riser 150mm and Tread 300 mm.

c) All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb at the edge of the floor along the metal cladding. 1000 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view.

d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC staircase shall be provided for main entrance of Turbine building; control tower area and all other RCC construction buildings.

f) Parapet, Chajjas 450mm over window and 600mm door heads,750mm over rolling shutters, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

g) All fire exits shall be painted with fire resistant paint P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

h) Ramps & Lifts for physically challenged persons shall be provided for barrier free access to the buildings.

9.03.00 **Water Supply and Sanitation**

9.03.01 Two numbers of roof water tanks (one for storing service water and another for potable water) of adequate capacities depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc.

Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required.

Sand Cast Iron pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level. All Buildings shall be designed with Toilets as per NBC norms.

Minimum one number main toilet block for Gents & ladies separately, with required facilities shall be provided on each floor of Service building Administration building and Canteen building. Toilets for physically handicapped shall be provided as mentioned. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.

9.03.02 Each Toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of Chromium plated brass (fancy type). For GRIHA rated Buildings all fittings shall conform to GRIHA requirements, for water efficiency.

a) One number wall mounted coloured (excluding premium colours) glazed vitreous China European water closet and flushing valve system, water faucet, toilet paper holder as per IS:2556

b) One number white glazed vitreous China Orissa pan (580 x 440 mm) and flushing valve system, toilet paper holder as per IS:2256

c) One number colour (excluding premium colours) glazed ceramic oval shaped wash basin 450x 550 mm (approx.) mounted over 20mm thick granite beveled edge counter fitted with photo-voltaic control system for water controls, bottle trap as per IS:2556. For common toilets, number of washbasins shall be as per requirement. However for Pump Houses the same shall be provided without photo voltaic control system for water control.

d) For Male Toilets Urinal as per requirements, with all fittings with photovoltaic control flushing system as per IS: 2556.

e) One number looking mirror 600 x 900 x 6 mm, edge mounted with teak beading and minimum 12 mm thick plywood backing, one number stainless towel rail 600 x 20 mm, one number liquid soap dispenser

f) One toilet with required facilities shall be provided for physically challenged persons as per National Building Code requirements in GRIHA rated buildings.

g) In addition to the facilities stipulated elsewhere Bathroom with rotating type chromium plated shower including all fitting and fixtures shall also be provided in toilet at ground and operating floor of main plant and any other building as per functional requirement.

h) Janitor Space & space for drinking water cooler.

i) Electric operated hand dryer with photo voltaic control.

j) The pantry shall consist of one number stainless steel pantry sink, as per IS : 13983, of size 610 x 510 mm, bowl depth 200 mm with drain board of at least 450 mm length with trap, hot and cold water mixer, one number geyser of 25 liters capacity, with inlet and outlet connections, one number HDPE loft type / over head water storage tank, as per IS : 12701 and of 500 liters capacity, complete with float valve, overflow drainage pipe arrangement, GI concealed water supply pipe of minimum 12

mm dia of medium class, cast iron sanitary pipe (with lead joints) of minimum 75 mm diameter, floor trap with Stainless

Steel grating, inlet and outlet connections for supply and drainage, with all bends, tees, junctions, sockets, etc., as are necessary for the commissioning and efficient functioning of the pantry (all sanitary fittings shall be heavy duty chrome plated brass, unless noted otherwise)

k) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556 (Part-5).

l) In addition, adequate number of portable toilet units with adequate plumbing and sanitary arrangement, shall be provided during construction stage.

9.04.00 **Flooring**

Floor finishes of approved shade and colour (non - premium colours), over under bed of cement mortar / concrete, at all levels and for all kind of works, elevations, on horizontal and vertical surfaces for all types of work (like flooring, skirting, dado, wall lining & facing, tread and risers etc.), including topping, spreading white cement slurry at an average rate of 2.5 kg/Sq. M., (unless noted otherwise), jointing and joint filling with white cement (unless noted otherwise) slurry mixed with colour pigment, to match the shade of the finishing material, laying to plumb and water level in desired pattern, line and flush butt square jointing, curing, rubbing, grinding, polishing, edge moulding, finishing and cleaning, testing, providing opening of required size and shape, casting in panels wherever specified.

9.04.01 The nominal total thickness of floor finish shall be 50 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete M20 grade (1 part cement, 1.5 part sand and 3 part stone chips by volume). Stone chips shall be 12.5 mm down well graded(& proper filling shall be done with brick bats/cinders). Flooring like Tiles/ Stones shall be laid with 1:4 cement sand mortar and Tile/ Stone Cladding on wall shall be laid with 1:3 cement sand mortar.

9.04.02 Sunken slabs shall be made water tight by suitable water proofing treatment.

9.04.03 Metallic hardener topping -with ordinary grey cement shall be- 12 mm thick (insitu) or finishing the concrete / mortar surfaces topping shall be furnished with neat cement slurry (with ordinary grey cement)

9.04.04 Heavy duty cement concrete tiles 300 mm x 300 mm shall be in using white cement with pigment, with hard and abrasion resistant carborundum / quartz chips for wearing course as per IS:1237. Laying of tiles shall be as per IS: 1443.

9.04.05 Heavy duty (grade-5) dust pressed ceramic tiles (300mmx300mm shall be as per IS 15622. Designer ceramic wall tiles of size 300 mm x 200 mm / (300x600mm).

9.04.06 20mm / 38mm / 75 mm/ 115mm thick acid resistant tile on horizontal and vertical surfaces, at all levels for all type of works shall include one coat of bitumen primer followed by 12 mm thick bituminastic layer, 20mm / 38mm/ 75 mm / 115mm thick A.R. tiles, 6 mm thick under-bed by potassium silicate mortar, pointing of joints of tiles with acid/alkali resistant epoxy/furane mortar up to a depth of 20 mm and bituminastic end sealing.

9.04.07 Mirror polished/ Matt finish (80:20) Vitrified ceramic tiles (min 9.5mm thk) with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of

Laticrete or approved equivalent in approved colour to match colour of tile. Sizes of the tiles shall be as under:

a) 600 mm x 600 mm

b) 800mm x 800mm

9.04.08 For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used. 1000 wide pathways shall be provided for maintenance on rooftops of all buildings.

9.04.09 PVC flooring, wherever used, shall be minimum 2 mm thick (virgin) as per IS: 3462. The laying of flooring shall be as per IS: 5318.

9.04.10 Epoxy Flooring

Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primer.

It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant.

9.04.11 Wherever required, carpet flooring shall be provided over cement concrete floor as in conference room of main control room complex. The carpet shall be of tile/roll form, machine/hand made tupled un-cut loop pile and lay with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.

9.04.12 Mirror polished (6 layers of polish) Granite stone (slab) - 20 mm Thk (minimum) shall be provided in areas as mentioned in finishing Schedule. Flame finish (making top surface rough by burning / shot blasting) granite stone (slab) - 20 mm Thk (minimum) shall be provided in ramps for Physically Challenged Persons in Administration building, Service Building, Auditorium Building and Canteen Building.

Mirror polished Marble stone (slab) - (Rajnagar) Plain white -20 mm thick shall be provided in main stairs & 18mm thick kota stone shall be provided in the fire escape stairs.

9.04.13 Decorative/designer prepolished, plain and pigmented, high wearing resistance concrete tiles of 20mm thickness (minimum) in various non-standard interlocking patterns.

9.04.15 Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto 2200 mm height from finished floor level. Dado shall match with the floor finish.

9.04.16 Wherever required, removable metallic false flooring system shall be provided. Nominal height of the false flooring shall be 600 mm. The same shall comprise of special grade steel panels (of size 600x600mm). without any dimensional tolerance 1.2mm thick die cast to shape having 1mm thick top MS sheet spot welded together to form a composite steel panel, sitting on aluminum diecasted heads & mounted on steel pedestals of 25mm dia rod of adjustable height and supporting 1.2mm thick channel frame work at-top and 2mm thick 150x150mm base plate. The top finish shall be 2mm thick antistatic PVC sheet or High

pressures laminate. Cavity area below the false flooring shall be made dust proof by using Polyurethane paint.

9.04.17 Interlocking concrete blocks shall be of various sizes and thickness having M 35 grade of concrete and pigmented to specified colours, in different pattern (in different textures chequered or other patterns in indentation for guiding band/s for visually impaired persons) including the preparation of sub base with 20mm thick sand and filling of joints with sand.

9.04.18 Matt finish (with grooves) Porselin tiles (for guiding band/s for visually impaired persons) shall be with 3mm groove joints as per approved pattern pointed neatly with 3X4mm stainless epoxy grout SP- 100 of Laticrete or approved equivalent in approved colour to match colour of tile.

24 mm x 24 mm x 3.8 mm thick (minimum) glass mosaic tiles in decorative murals and pattern.

Laminated wooden flooring shall be provided in VIP area, conference rooms & auditoriums.

9.04.19 **Paving**

a) Ground floor of all buildings shall be provided with normal duty paving with 50mm thick metallic hardener floor finish. For details of normal duty paving refer to description elsewhere in this specification.

b) PCC paving of nominal mix 1:2:4 (1 part cement: 2 parts sand: 4 parts aggregate), 100 mm thick laid over 75 mm thick bed of dry brick aggregate shall be provided for following areas:

i) 750 mm wide plinth protection around all buildings other than those covered under paved area.

ii) 2.0 m wide pathway all along pipe/ cable corridor and all around each cooling tower. 2.0 mm wide ways inter connecting all cooling towers with each other.

9.05.00 **Acid/ Alkali Resistant Lining**

9.05.01 The material shall conform to the following:

i) Bitumen primer shall conform to IS: 158.

ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.

iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.

iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.

9.05.02 Requirements for acid/ alkali resistant flooring and lining for different areas shall be as given Table-A enclosed at the end of this specification. Battery Room in all buildings shall be provided with acid/ alkali resistant tiles on flooring & dado 1200mm high.

9.06.00 **Roof**

9.06.01 Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile having minimum base metal thickness of 0.8mm of galvanised (with minimum rate of galvanisation of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 40 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.

9.06.02 Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM - C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade conforming to IS: 13801 shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

9.06.03 For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.

9.06.04 For Building where metal cladding is envisaged medium class galvanised mild steel pipes conforming to IS: 1239/IS:3589 with welded joints shall be provided to drain off rain water from the roof. For rest of the buildings cast-iron pipes with lead caulked joints conforming to IS:1230 shall be used. These shall be suitably concealed with masonry work, cement concrete / or sheeting work to match with the exterior finish. The number and size of down comers shall be governed by IS:1742 and IS:2527. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures. Gratings shall be of stainless steel.

9.06.05 Roof of the buildings shall conform to minimum 4 star GRIHA Rating shall have Overdeck insulation of minimum 40 mm thick impervious sprayed close cell free rigid Polyurethane foam confirming to IS: 12432 Part-III, with density of foam 40 TO 45 KG/ cum. Overdeck insulation shall be fixed over a coat of polyurethane primer applied @ 6 to 8 litre/ sqm, applied over cleaned surface of cement sand mortar (1:4) screed (laid for the part of Roof Water Proofing Treatment. 400 Gauge polythene sheet shall be laid over polyurethane

spray. The top of the polyurethane foam shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and broken white glazed tiles of 5 mm thickness laid over mortar at green stage.

9.06.06 **Roof Water Proofing**

Roof water proofing treatment shall be as follows:

a) For roofs having structural slope:

Top surface of sloped R.C.C. slab shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid. The elastomeric shall comprise of high solid content liquid applied urethane laid over reinforcing layer of polyscrim cloth or non woven geo-textile. The top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness wherever applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

b) For roofs having no structural slope:

Screed concrete mix (M-15 grade) grading having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of grading underbed shall be finished with 15mm thick cement plaster (1:4). Over the finished surface elastomeric membrane shall be laid and top of the elastomeric membrane shall be finished with 20 mm thick cement: sand (1:4) mortar with chicken wire mesh and pressed precast concrete tiles of 20 mm thickness where applicable shall be laid over mortar at green stage. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also

9.06.07 Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.

9.06.08 RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided. Alternatively parapet wall comprising structural steel post, runner and sheeting may be provided for buildings with metal sheet cladding.

9.06.09 Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.

9.06.10 Pathways for handling of materials and movement of personnel shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm .

9.07.00 **Walls**

9.07.01 All walls shall be non-load bearing infill panel walls.

9.07.02 For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever metal cladding is specified.

9.07.03	All internal walls shall be with one brick thick in cement sand mortar (1:6). However, internal partition walls for toilets shall be with half brick masonry with cement sand mortar (1:4).
9.07.04	For Administration building, Service Building, Auditorium Building and Canteen Building Autoclaved Aerated Concrete blocks shall be used. Autoclaved Aerated Concrete (AAC) block masonry shall be with blocks having dimensions of 625 mm x 250 mm thickness ranging from 100 mm to 300 mm conforming to I.S. :2185(part-III) .The jointing cement sand mortar in the composition of 1: 6 (Cement: sand) shall be used with suitable plasticizer(optional). Sand having modulus of fineness 1.1 shall be used. The horizontal and vertical joint thickness shall be approximately 10 mm. In case of partition walls (100 mm /125 mm thk.) the joint reinforcement i.e. 1 number of 6-8 mm diameter bars shall be placed at every alternate course to be anchored properly with the main structure. All other structural requirements like stiffening of masonry , joint reinforcement etc. in the AAC masonry work strictly be carried out as per instructions laid down in .I.S 6041 – 1985, I.S -1905.
9.07.05	For control room , control equipment room and ESP building wall shall be of factory made composite modular light weight aerated concrete panels,(minimum 4 hours of fire rating) consisting of 2 fiber reinforced cement sheets (minimum 4 mm thick) on either side of light weight concrete core, having minimum compressive strength of 35 Kg / Cm2 and the density in the range of 700-900 Kg. / cu.m. of the thickness and fire rating as specified below, to provide external wall and internal partition at all levels, capable of sustaining wind pressure of 4.50 M height (H) within limiting deflection of span/250, fixed in position in tongue and groove jointing system by screwing the panels to top and bottom U channels, (channels minimum 1.25 mm thick and galvanised to grade 180 (minimum) as per IS : 277), fixing U profiled top and bottom channels to concrete / primary steel members which are placed at the maximum vertical spacing of 4.5m with the help of galvanised steel expansion fasteners, filling the joints from both faces with silicon acrylic paste and making the same water tight by covering with fibre glass tape (minimum 50 mm wide and minimum 0.5 mm thick) or by any other suitable material, so as to ensure that the entire construction done with the light weight aerated concrete panels are weather proof and panel surfaces are flush for painting, creating opening for doors / windows /ventilators / ducts / pipes/fans/AC etc. and finishing the opening face with the same U profiled galvanized steel channel which is used at the top and bottom.
9.07.06	For Main plant building, Control tower and other buildings, the type, thickness and initial height of external cladding facing the transformer yard shall be according to the requirements. External face of Toilets, Air-conditioned and pressurised areas shall be provided with masonry wall as per functional / aesthetic requirements. (Inside the metal cladding wherever provided).
9.07.07	50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS:702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.
9.08	**Plastering**
9.08.01	Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.
9.08.02	Preparation of all types of plastered and / or exposed concrete surface, in all kind of works,at all levels, by providing minimum 2mm of polymer based water resistant putty (wall putty) to give an even and smooth surface.
9.08.03	All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.

9.08.04	All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.
9.08.05	Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.
9.08.06	All plastering work shall conform to IS:1661.
9.09	**Painting & Aluminium Composite Panel Cladding**
9.09.01	All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.
9.09.02	All paints shall be of approved make including chemical resistant paint.
9.09.03	Minimum 2 finishing coats of paint shall be applied over a coat of primer.
9.09.04	Premium Acrylic Smooth Exterior Paint: The paint should be applied in minimum 2 coats @1.43litre/10 sqm over and including priming coat of exterior primer applied @ 2.20 kg/10 sqm, on new plastered surfaces inclusive of all required tools, material, scaffolding and other painting accessories etc. The paint shall be applied as per the manufacturer's specifications and instructions and to the entire satisfaction of engineer-in-charge. The paint shall have excellent water resistant property.
9.09.05	Stone work for wall lining etc. (Veneer work) over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with grey cement slurry @3.3kg/sq.m, including rubbing and polishing in complete. (Black polished granite stone slab, 20 mm thk / polished Sadarhally grey granite slab 20 mm thk). The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.
9.09.06	Acrylic emulsion paint shall be as per IS:15489. Acrylic distemper shall be as per IS:428. Cement paint shall conform to IS:5410, white wash/colour wash shall conform to IS:627.
9.09.07	Fire resistant transparent paint as per IS:162 shall be provided on all wood work over French polish or flat oil paint. French polish shall conform to IS:348. Flat oil paint shall conform to IS:137.
9.09.08	All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.
9.09.09	For painting on concrete, masonry and plastered surface IS: 2395 shall be followed. For painting on wood work IS: 2338 shall be followed.
9.09.10	For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.
9.09.11	Bitumen primer used in acid/alkali resistant treatment shall conform to IS:158.
9.09.12	All internal paints shall be of low VOC content conforming to GRIHA rating for reduction of VOC content.
9.09.13	Resin bonded granular textured finish, for external applications shall consist of crushed stone / quartz chips of 2.5 mm size and of approved colour/ shade and bonded with synthetic

10.00.00 MATERIAL SPECIFICATION

10.01.00 **Cement**

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.

Ordinary Portland Cement (OPC) shall necessarily be used for the following structures.

a) TG foundation top deck

b) Spring supported decks of all machine foundations such as PA/FD/ID Fans and TDBFP/MDBFP

c) RCC for Chimney shell.

d) NDCT shell and racker columns of NDCT.

The grade of cement shall be Grade 43 for OPC conforming to IS:8112.

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

10.02.00 **Aggregates**

a) **Coarse aggregate**

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.

b) **Fine aggregate**

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.

10.03.00 **Reinforcement Steel**

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%.

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.

10.04.00 **Structural Steel**

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.

10.04.01 **Mild Steel**

a) Rolled sections shall be of grade designation E250, Quality BR, Semi-killed/ killed conforming to **IS 2062.** All steel plates shall be of Grade designation E250, **Quality BR (fully killed),** conforming to **IS 2062 and shall pass the impact test value at room temperature.** 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.

b) Pipes shall conform to IS: 1161 (Hand rails only).

c) Hollow (square and rectangular) steel sections shall be hot formed conforming to IS: 4923 and shall be of minimum Grade Yst 240. Minimum thickness of hollow sections shall be 4mm.

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 E250 Quality BR semi killed of IS: 2062 or equivalent grade conforming to ASTM & BS standards only.

10.04.02 **Medium and High Tensile Steel**

Rolled Sections and plates shall be of grade designation E350, **Quality B0 (Fully killed),** conforming to **IS 2062**. All steel plates beyond 12mm thickness and upto 40mm thickness shall be controlled rolling. 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.

10.05.00 **Bricks**

Bricks shall be table mounted/ machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 50kg/cm^2. 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.

10.06.00 **Foundation Bolts**

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 1of IS432 and/ or grade A of IS:2062. Hexagonal nuts and lock nuts shall conform to IS 1363 & IS1364 up to M36 diameter and IS 5624 for M42 to M150 diameter.

10.07.00 **Stainless steel**

The material specification for stainless steel plates are mentioned in the design concept area of Mill Bunker building.

10.08.00 **Water**

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.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

10.08.00 **Statutory Requirements**

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.

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.

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.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

11.00.00 Inspection, Testing And Quality Control

11.01.00 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.

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.

11.02.00 Workmanship and dimensional shall be checked as stipulated below.

12.00.00 ANNEXURES

(a) List Of Codes And Standards

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.

Annexure-(a)

LIST OF CODES AND STANDARDS

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 wronght 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.
IS:1566	Hard drawn steel wire fabric for concrete reinforcement.

	IS:1786	High strength deformed steel bars & wires for concrete reinforcement.
	IS:2062	Hot Rolled Low, Medium and High Tensile Structural Steel
	IS:2116	Sand for masonry mortars.
	IS : 2185 (Part 1) (Part 2)	Hollow & solid concrete blocks. Hollow & solid light weight concrete blocks.
	IS:2386 (Part I-VIII)	Testing of aggregates for concrete.
	IS:3812	Specification for fly ash for use as pozzolona and admixture.
	IS:4082	Recommendation on stacking and storage of construction materiel and components at site
	IS:8112	43 grade ordinary portland cement.
	IS:8500	Structural steel-Microalloyed (Medium and high strength qualities).
	IS:12269	53 grade ordinary portland cement.
	IS:12894	Specification for fly ash lime bricks.
	IS:13757	Burnt clay fly ash building bricks.
	Cast in-situ Concrete and Allied Works	
	IS:280	Mild steel wire for general engineering purpose.
	IS:456	Code of practice for plain and reinforcement concrete.
	IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
	IS:516 IS:1199	Method of test for strength of concrete. Methods of sampling and analysis of concrete.
	IS:1791	General requirement for batch type concrete mixers.
	IS:1834	Hot applied sealing compound for joints in concrete.
	IS:1838	Preformed fillers for expansion joints in concrete pavement and structures.
	IS:2438	Specification for roller pan mixers.
	IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
	IS:2505	Concrete vibrators - immersion type.
	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.
IS:11384	Code of practice for composite construction in structural steel and concrete.
IS:12118	Two parts polysulphide based sealants.
IS:12200	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.

IS:13311	Non destructive testing of concrete - methods of test.
(Part 1)	Ultrasonic pulse velocity.
(Part 2)	Rebound hammer.
SP-16	Design codes for reinforced concrete to IS:456-1978.
SP-23	Hand book of concrete mixes.
SP-24	Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS : 456)
SP-34	Hand book on concrete reinforcement and detailing.
ACI-318	American Concrete Institute code for structural concrete.

Precast Concrete Works

SP:7	National Building Code - Structural Design
(Part 6/Sec.7)	Prefabrication and system building and mixed / composite construction.
IS:10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS:10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
IS:15658	Pre-cast concrete block for paving.

Masonry & Allied Works

IS:1905	Code of practice for structural use of unreinforced masonry.
IS: 2185	Part-1 Concrete Masonry Units - Specification Part 1 Hollow and Solid Concrete Blocks Part-3 Specification for concrete masonry units: Part 2 Hollow and solid light weight concrete blocks
IS:2212	Code of practice for brick work.
IS:2250	Code of practice for preparation and use of masonry mortars.
IS:2572	Code of practice for construction of hollow concrete block masonry.
SP:20	Hand book on masonry design and construction.

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).
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 chequred 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.
IS:9595	Recommendations for metal arc welding of carbon & carbon manganese steel.
IS:12843	Tolerances for erection of steel structures.
SP:6 (Part 1 to 7)	ISI Hand book for structural Engineers.

Plastering and Allied Works

IS:1661	Code of practice for application of cement and cement lime plaster finishes.
IS:2402	Code of practice for external rendered finishes.

IS:2547 (Parts 1&2)	Gypsum building plaster.
Acid and Alkali Resistant Lining	
IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS:412	Expanded metal steel sheets for general purpose.
IS:4441	Code of practice for use of silica type chemical resistant mortars.
IS:4443	Code of practice for use of resin type chemical resistant mortars.
IS:4456 (Part I & II)	Method of Test for chemical resistant tiles.
IS:4457	Ceramic unglazed vitreous acid resisting tiles.
IS:4832	Specification for chemical resistant mortars.
(Part - 1)	Silicate type
(Part - 2)	Resin type
(Part - 3)	Sulfur type
IS:4860	Acid resistant bricks.
IS:9510	Bitumastic acid resisting grade.
Water Supply, Drainage and Sanitation	
IS:458	Precast concrete pipes (with & without reinforcement).
IS:554	Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
IS:651	Salt glazed stoneware pipes and fittings.
IS:774	Flushing cisterns for water closets and urinals.
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.
IS:4111 (Part 1 to 5)	Code of practice for ancillary structure in sewerage system.
IS:4127	Code of practice for laying of glazed stone ware pipes.
IS : 4733	Methods of sampling and testing sewage effluents.
IS:4764	Tolerance limits for sewage effluents discharged into inland surface waters.
IS:1068	Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
IS:5329	Code of practice for sanitary pipe work above ground for buildings.
IS:5382	Rubber sealing rings for gas mains, water mains and sewers.
IS:5822	Code of practice for laying of electrically welded steel pipes for water supply.

IS:5961	Specification for cast iron grating for drainage purpose.
IS:7740	Code of practice for construction and maintenance of road gullies.
IS:8931	Copper alloy fancy single taps combination tap assembly and stop valves for water services.
IS:9762	Polyethylene floats for float valves.
IS:10592	Industrial emergency showers, eye and face fountains and combination units.
IS:12592	Specification for precast concrete manhole covers and frames.
IS:12701	Rotational moulded polyethylene water storage tanks.
IS:13983	Stainless steel sinks for domestic purposes.
SP:35	Hand book on water supply and drainage with special emphasis on plumbing.
CPH&EEO	Manual on sewage and sewage treatment
Publication	- as updated.

Doors Windows and Allied Works

IS:204	Tower Bolts.
(Part 1)	Ferrous metals
(Part 2)	Non - ferrous metals
IS:208	Door Handles.
IS:281	Mild steel sliding door bolts for use with padlocks.
IS:362	Parliament Hinges.
IS:419	Putty, for use on window frames.
IS:451	Technical supply conditions for wood screws
IS:733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
IS:1003 (Part I)	Timber panelled and glazed shutters (doors shutters).
IS:1003	Timber panelled and glazed shutters
(Part-1)	door shutters.
IS:1038	Steel doors, windows and ventilators.
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

IS:1285	Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
IS:1341	Steel butt hinges.
IS:1361	Steel windows for Industrial buildings.
IS:1823	Floor door stoppers.
IS:1868	Anodic coatings on Aluminium and its alloys.
IS:2202	Wooden flush door shutters (solid core type) particle
(Part-2)	board face panels and hard board face panels.
IS:2209	Mortice locks (vertical type)
IS:2553	Safety glass.
(Part-1)	General purposes
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated)
IS:3614	Specification for fire check doors :
(Part-1)	plate, metal covered and rolling type.
(Part-2)	Resistance test and performance criteria.
IS:4351	Specification for steel door frames.
IS:5187	Flush bolts.
IS:5437	Figured, rolled and wired glass.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:6315	Specification for floor springs (Hydraulically regulated) for heavy doors.
IS:7196	Hold fast.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type)
IS:12823	Prelaminated particle boards.

Roof Water Proofing and Allied Works

IS:3067	code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
ASTM	Standard specification for high solid content cold
C836-89a	liquid applied elastomeric water proofing membrane for use with separate wearing course.
ASTM	Standard guide for high solid content cold
C898-89	liquid applied elastomeric water proofing membrane for use with separate wearing course.

Floor Finishes and Allied Works

IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	White portland cement.
IS:13755	Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
IS:13801	Chequered cement concrete tiles.

Painting and Allied Works

IS:162	Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
IS:428	Distemper, oil, emulsion, colour as required.
IS:1477	Code of practice for painting of terrous metals in buildings.
(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.
ISO 12944	Paints and varnishes – Corrosion Protection of Steel Structures by protective paint systems

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.
VIN:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing the st of balance of rotating rigid bodies.
DIN:2089	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.
IRC:15	Standard specifications and code of practice for construction of concrete roads.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and Code of practice for water bound macadam.
IRC:21 (Section-III)	Standard specifications and Code of practice for road bridges. Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in water logged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:58	Guidelines for the design of rigid pavements for highways.
IRC:73	Geometric Design standards for rural (non-urban) highways.
IRC : 86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.

IRC - Publication	Ministry of Surface Transport (Road wing), specifications for road and bridge works.
IS:73	Paving bitumen.
Loading	
IS:875	Code of practice for design loads (other than earthquake) for (Relevant parts) buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of practice for design and construction of foundation for transmission line towers and poles.
IRC:6 (Section-II)	Standard specifications & Code of practice for road bridges. loads and stresses
Safety	
IS:1641	Code of practice for fire safety of buildings - General principles of fire grading and classification.
IS:1642	Code of practice for fire safety of buildings - Details of construction.
IS:3696 (Part-1&2)	Safety code for scaffolds and ladders.
IS:3764	Excavation work - code of safety.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Demolition of buildings - code of safety.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection of structural steel work.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials.
Indian Explosives Act 1940)	(As updated)
Architectural Design of Buildings	
SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)
ECBC	Energy Conservation Building Code
GRIHA	Green Rating For Integrated Habitat Assessment.

Chimney

IS:4998	Criteria for design of reinforced chimneys
IS:6533	Code of practice for design and construction of steel chimneys
ICAO	International Civil Aviation Organisation (ICAO)
DGCA	Instruction of Director General of Civil Aviation , India
ACI:307	Specification for the design and construction of reinforced concrete chimneys
BS:4076	Specification for steel chimneys
CICIND	Model Code for concrete chimneys Model code for steel chimneys
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.
IS:1554	PVC insulated (heavy duty) electric cables
IS:2606	Alloy lead anodes for chromium plating
IS:3043	Code of Practice for Earthing
IS:9537	Conduits for electrical installations. The Indian Electricity Rules The Indian Electricity Act The Indian Electricity (Supply) Act The Indian Factories Act
IS:2309	Practice for protection of buildings and allied structures against lightning

Miscellaneous

IS:802 (Relevant parts)	Code of practice for use of structural steel in overhead trans-mission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Criteria for design of lined canals and guidance for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
IS 11504	Criteria for structural design of reinforced concrete natural draught cooling towers
BS:4485 (IV)	British Standard : Code of design for water cooling towers
CIRIA Publication	Design and construction of buried thin-wall pipes.
IS 4671	Expanded polystyrene for thermal insulation purposes.

ANNEXURE (b)

CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanised from the start of the work.

All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydaulically controlled grouting equipment.

Roadwork shall be done using pavers, rollers and premix plant.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

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Annexure-(f)

QA REQUIREMENT

All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of this Specification.

ANNEXURE – (h)

Specification For High Performance Moisture Compatible Corrosion Resistant Coating System (for Concrete Surfaces of IDCT)

a) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

b) The coating system shall conform to the following :

PROPERTIES OF PAINT

Coating System	High Performance Moisture Compatible Corrosion Resistant Coating System
Volume Solids	70%
Specific Gravity (ASTM-D-1475)	1.25 ± 0.1
Dry Film Thickness (ASTM-D-1186)	160 ± 10 µm per coat
Coverage	4 - 4.5 sq.m/ ltr
Touch Dry	2 Hours
Recoating	24 Hours

PROPERTIES OF COATING

Salt Spray (ASTM-B 117)	2000 Hour
Resistance to sea water (Carried out up o 6 mont s)	Passes
Coating Resistance (Carried out upto 6 months)	10^9 Ω. cm^2
Ad esion (ASTM-D 4541)	4.5 kN minimu
Flexibility (ASTM-D-522) Elo gation	1/8" passes 33%
Impact (ASTM G 14–04)	45 cm passes

Annexure-(i)

List of tender drawings attached with this specification include

Sl No.	Title	Drg No.
1)	General Layout Plan	4410-999-POC-F-001- Rev. 1
2)	Site Levelling Works	4410-001-POC-A-001- Rev. A
3)	Topographical Survey Detail	4410-001-PVC-A-001 – Rev. 0

NTPC Limited

(A Government of India Enterprise)

NORTH KARANPURA SUPER THERMAL POWER PROJECT (3x660MW)

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

PART – B (QUALITY ASSURANCE)

(BOOK 5 OF 5)

SECTION - VI

BIDDING DOCUMENT NO.: CS-4410-001-2

NTPC Limited

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NORTH KARANPURA SUPER THERMAL POWER PROJECT (3x660MW)

TECHNICAL SPECIFICATION

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PART – B (QUALITY ASSURANCE)

(BOOK 5 OF 5)

SECTION - VI

BIDDING DOCUMENT NO.: CS-4410-001-2

(This document is meant for the exclusive purpose of bidding against this Package and shall not be transferred, reproduced or otherwise used for purposes other than that for which it is specifically issued).

PART – B

QA CIVIL

PART – B QUALITY ASSURANCE (CIVIL)	
E-71	QUALITY ASSURANCE AND INSPECTION FOR CIVIL WORKS

SUB-SECTION – E-71

QUALITY ASSURANCE AND INSPECTION FOR CIVIL WORKS

QUALITY ASSURANCE AND INSPECTION FOR CIVIL WORKS

1.0.0 INTRODUCTION

1.1.0 This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all civil and structural works covered in this specification.

1.2.0 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.3.0 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / contract documents shall be carried out at no extra cost to the NTPC.

1.4.0 The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer. If required, work methodology may be revised/ reviewed at every stage of execution of work at site, to suit the site conditions by the contractor at no extra cost to the NTPC.

2.0.0 QUALITY ASSURANCE PROGRAMME

2.1.0 The contractor shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipments and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the contractor and shall be finally accepted by the NTPC or their authorized representative after discussions before the start of work. The QAP shall be generally in line with IS/ISO Systems.

The contractor shall furnish complete QA & QC programme for the work envisaged which may include the following

- Organization structure for the management and implementation of the proposed quality assurance programme
- Quality System Manual
- Design Control System
- Documentation and Data Control System
- Qualification data / details for Contractor's key personnel
- The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased, etc.
- System for shop manufacturing and site erection controls including process, fabrication and assembly

- Control of non-conforming items and system for corrective actions and resolution of deviations
- Inspection and test procedure both for manufacture and field activities
- Control of calibration and testing of measuring testing equipment
- System for Quality Audits
- System for identification and appraisal of inspection status
- System for authorizing release of manufactured product to the NTPC
- System for handling, storage and delivery
- System for maintenance of records
- Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work/ equipment/component.

3.0.0 QA AND QC MANPOWER

3.1.0 The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the contractor's QA coordinator to NTPC. NTPC shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the contractor and their sub-vendors on one hand & with NTPC on the other hand.

3.2.0 The contractor shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of contractor's QA&QC manpower required to be deployed at site is enclosed at Annexure-I. Based on the finalized L-2 network and the approved Field Quality plan, the contractor shall finalize and submit a deployment schedule of QA&QC personnel along with their details to NTPC for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

3.3.0 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the contractor shall consist of qualified and experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.4.0 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the contractor based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.0.0 SAMPLING AND TESTING OF CONSTRUCTION MATERIALS

4.1.0 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.

4.2.0 The contractor shall carry out testing in accordance with the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans.

Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the engineer or his authorized representative.

4.3.0 Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as NCB-Ballabhgarh, CSMRS-Delhi, IIT's, etc. as agreed by the engineer. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the engineer.

4.4.0 The contractor shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the engineer.

4.5.0 Evaluation of aggregate for potential alkali-aggregate reactivity shall be carried out as per following scope of work

A. Evaluation of Aggregates for Mechanical / Physical Properties

a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and flakiness index, as per IS: 2386.
b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material, soundness, silt content, clay content and organic impurities as per IS: 2386.
c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates.

B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity:

a) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test).
b) If rock type is limestone, alkali carbonate reactivity test shall also be carried out wherein the parameters shall be reported in conjunction with the petrographic analysis. Additionally, X-Ray diffraction test (XRD) shall be carried out to determine critical clay mineral in the rock for preliminary conclusions. For limestone aggregates to be used in dynamic foundations like TG, BFP, Fans, mills and crushers, repeated temperature cycle test shall also be carried out, to determine residual expansion of aggregate for concrete.
c) To prepare a report based on test results of a) and b) above and to advise regarding suitability of aggregates to be used and further testing required if any.

5.0.0 LABORATORY AND FIELD TESTING

5.1.0 The field laboratory for QA and QC activities shall be constructed and set-up by the contractor in line with the indicative field QA&QC laboratory set-up enclosed at Annexure-II. The Laboratory building shall be constructed and installed with the

adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for NTPC acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.2.0 All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the NTPC. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to NTPC.

5.3.0 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by NTPC engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to NTPC.

5.4.0 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled / agreed.

6.0.0 PURCHASE AND SERVICE

6.1.0 The major items/ equipments/ components to be manufactured in the shop of the contractor i.e. in-house items and those procured from sub-vendors / sub- manufacturer / sub-contractors i.e. bought out items (BOIs) shall be listed out by the contractor in their bid proposal.

6.2.0 An indicative list of major bought out items (not exhaustive) and services for civil works is enclosed at Annexure- III, for which the contractor shall submit the requisite details / lists of manufacturer's in their bid proposal. The list of manufacturers/ sub-vendors for all the BOIs envisaged in contract including shall be included in the bid proposal by the contractor which shall be discussed / reviewed by the NTPC during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the contractor shall propose the manufacturer's / sub-vendor's details for review / approval of NTPC, prior to initiating the procurement of such materials.

6.3.0 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the NTPC for approval in the prescribed NTPC format within the period agreed at the time of post bid discussions. The contractor's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed. The formats for furnishing above

details shall be given to the Contractor at post bid discussion stage. Monthly progress reports on sub-contractor detail submission / approval shall be furnished. Such manufacturers / sub-vendors approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

6.4.0 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to NTPC. Approval of material / sample by the engineer shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.5.0 Structural steel and Reinforcement steel shall be procured from Main Steel Producers as agreed and approved by NTPC in advance.

7.0.0 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.1.0 All materials / components and equipment covered under the scope of work, shall be procured by the contractor for the purpose of the contract, after obtaining the written approval of the NTPC, which are to be manufactured at shop/ factory of the vendor/sub vendor shall be covered under a comprehensive quality assurance programme. The contractor's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub-supplier/ sub-vendor. The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by contractor's / sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/ performance testing. Such quality plans of the vendors / sub-vendors shall be submitted to the NTPC for approval for MQP and such approved quality plans shall form a part of the purchase order / contract between the contractor and sub-contractor. The quality plans shall be submitted on electronic form e.g. CD or E-mail in addition to hard copy, for review and approval of NTPC. After approval the same shall be submitted in compiled form on CD in addition to hard copy.

7.2.0 The contractor shall furnish copies of the reference documents/ plant standards / acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference documents/standards etc. will be subject to NTPC approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, NTPC shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the NTPC engineer or his authorized representative and beyond which the work shall not proceed without consent of NTPC in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to NTPC along with technical justification for approval and dispositioning.

7.3.0 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the NTPC for reference / record by the contractor along with a report of the purchase orders placed so far for the contract.

7.4.0 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) and obtain approval of NTPC, which shall detail out for all the works, equipments, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure – IV (Indicative FQP for civil works) & Annexure –V (Indicative FQP for structural steel works).

8.0.0 DISPOSITIONING OF NON CONFORMITIES

8.1.0 The non-conformity for the site works on being detected / noted shall be reported by the contractor in the standard format of NTPC under the system of dispositioning of non conformity report (NCR) to the engineer. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction / erection

shall describe the proposed correction and also include the preventive / corrective action plan for future.

9.0.0 QUALITY AUDIT

9.1.0 NTPC reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the contractor or their sub-contractor. The contractor shall provide all necessary assistance to enable the NTPC carry out such audit and surveillance. The contractor shall also take necessary measures, raise NCRs wherever required based on the audit findings / observations.

10.0.0 QA DOCUMENTATION PACKAGE

10.1.0 The contractor shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark. Typical contents of QA documentation pertaining to field activities as per approved MQP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non-destructive examination results / reports, Heat Treatment Certificate/Record, Non-conformance Reports, CHP, Certificate of Conformance (COC) and MDCC.

11.0.0 GENERAL QA REQUIREMENTS

11.1.0 The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the NTPC's site or at any other place of work are in accordance with the NTPC technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

11.1.1 STORAGE AND HANDLING OF CONSTRUCTION MATERIALS

All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in NTPC Technical Specification.

11.1.2 EXCAVATION AND FILLING WORKS

The contractor shall submit a work methodology covering various items of works for all stages of excavation and filling works. This methodology shall broadly include the quantity wise and classification wise identification of source of excavation and filling, suitability tests as per specification requirements, method of stockpiling, transportation, placement, spreading , compaction, equipment, list of protocols, in-situ tests, third party lab test if required, acceptance checks for final clearance.

For blasting work at site if required, the contractor shall associate themselves with the reputed specialized blasting agency such as CMRI, NIRM for trials blasts, design blasts, blasting pattern, monitoring of blast during the blasting operations at site. The contractor shall install and operate equipment (such as tri-axial seismograph) for continuous monitoring and control of blast induced vibrations, noise level/ air pressure, dust, silica and noxious gases during all blasting operations in line with the technical specification requirements in association with the specialized blasting agency. The contractor shall submit the un-priced copy of the award on the specialized blasting agencies to NTPC,

highlighting the scope of services / work awarded to them by contractor. The services of such specialized blasting agency shall be available through out the period in which the blasting work is undertaken at site. The blasting operation shall remain in charge of a responsible, competent, authorized and experienced supervisor (man-in-charge) and thoroughly acquainted workmen. All blasting work shall be done as per approved blasting scheme/ design/ pattern in line with the technical specification requirements and all statutory laws, rules, regulations, relevant standards pertaining to the acquisition, transport, storage, handling along with use of explosives shall be strictly followed by the contractor.

Tolerance for finished surface level shall be within 20 mm of the level shown in the drawing. For an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the engineer. However, these tolerances shall be applicable for localized areas only.

Acceptance criteria shall be

a) When only one set of sample is tested, then all individual samples collected and tested should pass without any deviation

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

11.1.3 MASONRY AND ALLIED WORKS

The execution, finishing, testing and acceptance of masonry related works shall be as per the provisions of technical specifications / relevant practices IS code. Local depressions on account of faulty workmanship, broken / chipped edges shall not be acceptable.

All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry works shall be as below:

Sl. No.	Type of Check	Tolerance
	Deviation in verticality in total height of any wall of a building	Shall not exceed ± 12.5mm (more than one storey) ± 6mm per 3m height (within a storey)
	Deviation from the position shown on the plan of any brickwork	Shall not exceed 12.5mm (more than one storey)
	Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment	Shall not exceed 6mm
	Deviation of bed joint from horizontal in any length, and it	Shall not exceed 6mm (upto 12m) Shall not exceed 12.5mm total (in any length over 12m)
	Deviation from the specified thickness of bed-joints, cross-joints or perpends	Shall not exceed ± 3mm

	Finished plastered surface	Deviation not more than 4 mm when checked with a straight edge of 2 m length placed against the surface
	The average thickness of plaster	Not be less than the specified thickness
	The minimum thickness over any portion of the surface	Not less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster

11.1.4 CONCRETE WORKS

For concreting works provisions of technical specifications and IS: 456 shall apply. A detailed methodology for concrete works shall be submitted by the contractor to NTPC for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for concrete works shall broadly contain the suitability of source of aggregates, cement, admixture, water and reinforcement steel, etc. The available concrete mix design recommended from a specialist institute, results of trial mix carried out at site, method / control of batching, mixing, transportation, layer wise placement, compaction, fixing / removal of form work, staging, fixing of water stops at appropriate locations along with specials, expansion joints, contraction joints and construction joints, cover blocks and method of curing, methodology of repair of newly placed hardened concrete, testing and sampling of concrete during production and placement and acceptance checks for final clearance.

The equipment, deployment of manpower and machinery shall arranged by the contractor to ensure the continuous rate of placement of specified grade of concrete so as to prevent segregation, bleeding, formation of cold joints, temperature control for concreting in extreme weather conditions and for mass concreting works.

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of placing concrete in case of ordinary Portland cement, not be less than 10 days for concrete exposed to dry and hot weather conditions, at least 10 days or period may be extended to 14 days where mineral admixtures or blended cements are used. Approved curing compounds may be used in lieu of moist curing with the permission of engineer-in-charge.

Reinforcement steel shall conform to relevant IS codes. Lapping / spacing of reinforcement shall be so staggered that under no circumstances more than 50% of bars at any cross section shall be lapped. Corrosion resistance Steel shall be used for the foundations wherever specified in the technical specification. Sample test for 3% of the number of mechanical bars grips subject to a minimum of three, shall be carried out up to the yield strength of reinforcement of bars.

Test shall be conducted for the water tightness of the liquid retaining structures as per technical specifications, IS 3370 and IS 6494.

All the materials, equipments, processes used in pre cast concrete work shall conform to the requirements for the cast-in-situ concrete.

If fly ash is used in concrete, source of supply shall be checked for suitability as per IS 3812 (Part-I). Routine tests for retention of particles on 45μ sieve and loss on ignition shall be carried out on each lot of fly ash before its use. The storage of fly ash shall be

similar to that of cement. Separate Silo for fly ash shall be provided in the batching plant. Validation of Mix design using fly ash shall be carried out by an approved specialist agency, before start of concrete production.

The acceptance criteria of concrete shall be in accordance with clause no.16 of IS 456. However in exceptional circumstances and that too in non-critical areas, the engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS 456. For such accepted work, payment shall be made at a reduced rate pro rata to the concrete cube strength obtained, against that stipulated.

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to NTPC for their record and future reference.

a. Testing data / report of aggregates including petrographic examination & potential reactivity of aggregate and repeated temperature cycle tests wherever specified

b. Mix design details and record of trial mixes carried out at site

c. Testing records of admixture as per IS-9103 / ASTM C494 including third party test reports.

d. Approved scheme for concreting

e. Hourly records of concreting including pour card

f. Protocol indicating the dimensional tolerance and details of inserts

g. Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used

h. Bar bending schedule

i. Location and details of mechanical anchoring used for reinforcement

j. Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings

k. Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification

l. Temperature control record of concrete at the time of placement if applicable

m. Details of curing, staging and fixing / removal of formwork, checklist for formwork as per Clause 9.9 and Annexure-C of IS 14687 including all machine foundations

n. Batching Plant shall be calibrated regularly at least once in a 3 months. Computerized output shall be taken for each batch of production of concrete. For concreting works of ash pipe pedestals, mixer with weight batcher may be used. Production and supply of concrete from batching plant shall conform to the provisions of IS 4926

o. Dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances for pre cast members as per NTPC Technical Specification. Load test on Pre cast members (except pre- cast tiles to be laid in the reservoir) shall be carried out @ 2% up to 1000 nos., @1% from more than 1000 nos. precast members of one type. The load test shall be carried out as per the provisions of IS-456

TOLERANCES			
Description of Item/ Structural Element		**Max (mm)**	**Min (mm)**
Cast In Situ Concrete			
1.	Faces of concrete in foundations and structural members against which back fill is placed	+25	-10

TOLERANCES

	Description of Item/ Structural Element		Max (mm)	Min (mm)
2.	Eccentricity of footing as percentage of footing width in the direction of placement		2% but limited to 50mm	
3.	Top surfaces of slabs and of concrete to receive base plates to be grouted		+5	-5
4.	Alignment of beams, lintels, columns, walls, slabs and similar structural elements		+5	-5
5.	Cross sectional dimensions of walls, slabs and similar structural elements		+5	-5
6.	Deviation from specified dimensions of cross-section of columns and beams		+12	-6
7.	Alignment of holding down bolts without sleeves		+1.5	-1.5
8.	Alignment of holding down bolts with sleeves		+5	-5
9.	Level of holding down bolt assemblies		+10	-10
10.	Embedded Parts (in any direction).		+5	-5
11.	Level of embedment for equipment support		+1.5	0
12.	Level of embedment for other embedded parts		+5	-5
13.	Centers of pockets or holes with greatest lateral dimension not exceeding 150mm		+10	-10
14.	Variation in steps • Riser • Tread		 +1.5 +3.0	 -1.5 -3.0
	Pre- Cast Concrete			
15.	Length:	+/- 0.1 percent	+/- 5	+ 10
16.	Straightness or Bow	1/750 of the length	+/- 5	+/- 10
17.	Cross-sectional dimensions	+/- 3 mm or +/- 0.1 percent whichever is greater		
18.	Squareness:	When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.		
19.	Flatness:	The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.		
	Placing of reinforcement and for cover		Clause 12.3.1 and 12.3.2 of IS 456	
	Formwork		Clause 9.6 of IS 14687 and 11.1 of IS 456	
	Batching		Clause 10.2.2 of IS 456	

11.1.5 STRUCTURAL STEEL WORK

For structural steel works provisions of technical specifications and IS: 800 shall apply. A detailed methodology for structural steel works shall be submitted by the contractor to NTPC for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The contractor shall submit the welding procedures specification (WPS), heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection

work at site. All welding and brazing shall be submitted to the NTPC and carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the NTPC.

All brazers, welders and welding operators employed on any part of the contract either in the contractor's / sub-contractor's works or at site or elsewhere shall be qualified as per AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the NTPC.

The records of welding procedure qualification and welder qualification test results shall be furnished to the NTPC for approval. However, where required by the NTPC, the tests shall be conducted in presence of NTPC / authorized representative.

No welding shall be carried out on cast iron components for repair. All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All Non-destructive examination shall be performed in accordance with written procedures as per International Standards and as mentioned elsewhere in the technical specification. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. The records of RT (Films) and UT (inspection records or printed reports if possible) shall be documented and produced to NTPC.

Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specification / approved WPS.

The requirements of pre-heating shall be

Thickness of thickest part at the area of welding / heat affected zone	Welding using other than low hydrogen welding electrodes IS 2062	Welding using low hydrogen welding electrodes or submerged arc welding IS 2062
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	Not allowed	20^0 C
Over 40 mm to 63 mm (including)	Not allowed	66^0 C
Over 63 mm	Not allowed	110^0 C

The following tests / checks shall be carried out for structural steel works

SL. NO.	TESTS / CHECKS	QUANTUM / STANDARD
1.	Physical and chemical properties of material if supply in the scope of contractor	As per relevant codes, review of correlated mill test certificates or check testing in absence of MTC
2.	Ultrasonic test on plates above 40mm	As per ASTM A435
3.	Welding procedure & welders qualification test	AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards
Fillet Weld		
4.	Macro-etch examination on production test coupons for main fillet welds	Minimum one joint per built up beams, columns and crane girder etc.
5.	Tension member of crane girder	Dye penetration test on 25% weld length
6.	All other fillet welds	DPT on 5% of weld length with minimum 300mm at each location
Butt Weld		
7.	DPT	100% after back gouging on all butt welds except for coal bunker bins 10% after back gouging-For coal bunker bins
8.	Mechanical testing of production test coupons	Minimum one joint per built up beam, column and crane girder.
9.	Radiography test on butt welds (In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1. Wherever RT is not feasible UT to be carried out with the approval of the engineer)	100% RT on butt welds of tension flange (bottom flange) of crane girders 10% RT weld length of each welder on butt welds, except for crane girders and coal bunker 5% spot RT on butt welds / at inaccessible locations UT on butt welds- For coal bunker bins
10.	Ultrasonic testing on full penetration welds (other than butt welds)	100% UT on the web to flange joint of crane girder 10% UT on other full penetration joints
11.	Control assembly check in shop before erection	1st and further every 10th set of identical structure
12.	Dimensional tolerances during fabrication and erection	as per IS-7215 and IS-12843
13.	Surface Preparation and Paint thickness	SA 2 1/2 , By elcometer random after each coat, each member

SL. NO.	TESTS / CHECKS	QUANTUM / STANDARD
CW Liners site fabrication (Field shop) test		
14.	WPS,PQR& welder's Qualification	100%
15.	DPT on root run	100% DPT for pipes upto 1200mm diameter
16.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
17.	UT	Not recommended.
18.	RT	5% RT
19.	DPT on finished butt welds	10% DPT
20.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher.
CW Liners erection site test		
21.	WPS,PQR& welder's Qualification	100%
22.	DPT on root run	100% DPT for pipes upto 1200mm diameter
23.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
24.	UT	Not recommended.
25.	RT	5% RT
26.	DPT on finished butt welds	10% DPT
27.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher. In cases where hydraulic test is not possible the same may be substituted with 100%RT
28.	Tolerances	As per approved drawings, as per IS : 7215 for fabrication and IS : 12843 for erection of steel structures

Note: The contractor shall make all arrangements for testing of shop welded joints of fabricated CW liner before erection at site. The erection joints shall also be hydro tested after the laying of CW liner in suitable lengths. The testing methodology for conducting the hydro test shall be submitted well in advance for review.

11.1.5.1 STOPLOG AND TRASH RACKS

Structural design of stop log gate shall be as per IS 5620 and IS 4622 and as per details given in technical specifications. The trash rack to be provided shall be Type-1 trash rack (removable section rack), conforming to IS: 11388 (latest). Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specification. The leakage measured shall not be more than 5 liters/ minute /meter of length of seal under maximum head. Radiographic examination or

magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the contractor as per the technical specification requirements. The contractor shall submit a manufacturing and field quality plans in NTPC format incorporating all the quality aspects mentioned in the technical specifications.

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS 13591 shall be referred for measurement of the deflection and acceptance criteria.

11.1.5.2 COAL TAR ANTI-CORROSION TAPE (if applicable)

Coal tar anti corrosion tape shall conform to the requirements of technical specifications. The Manufacturers test certificate for each lot of supply of the coal tar anti corrosion tape shall contain the softening point, needle penetration, filler content, breaking load in the longitudinal direction, service temperature, direct impact test, cathodic disbanding and solubility. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to NTPC.
Tests for Adhesion, holiday test and thickness shall be carried out at site.

11.1.5.3 EXTERNAL COATING FOR SPECIAL SECTIONS, CONNECTIONS & FITTINGS OF BURIED STEEL PIPELINES

External coatings for special sections, connections & fittings of buried steel pipelines shall conform to the requirements of technical specifications. The manufacturer's test certificate for each lot of supply of the coating material shall contain the test results envisaged in AWWA C 209-00 and as specified in the NTPC technical specifications. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to NTPC.
Tests for thickness of coating system and holiday detection on each special section shall be carried out at site.

11.1.5.4 FIELD JOINT ANTI-CORROSION COATING OF BURIED 3 LPE COATED PIPELINES

Field joint anti-corrosion coating of buried 3 LPE coated pipelines shall conform to the requirements of technical specifications. The manufacturer's test certificate for each lot of supply of the coating material shall contain the test results envisaged in EN 12068 and as specified in the NTPC technical specifications. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to NTPC.

Qualification of application procedure as per NTPC technical specifications, visual inspection (mastic extrusion on either ends of the sleeve, appearance, presence of voids by knocking on the sleeves, weld bead profile visible through the sleeve), thickness of coating system on each joint and other routine tests as per finalized field quality plan shall be carried out at site.

11.1.6 PAINTING WORKS

Painting works shall be carried out as per the provisions of technical specifications. A detailed methodology for painting works shall be submitted by the contractor to NTPC

for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for painting works shall broadly contain the source of approved brand of paints, shot / sand blasting as specified, minimum acceptable size of shot used for blasting, application of primer, intermediate coat and final coat, experience of applicator, etc. testing of painting work and acceptance checks for final clearance. For PU coating works if specified, material shall be procured from NTPC approved source and the application of the PU coating shall be carried out by an experienced authorized applicator of the material supplier approved by NTPC. A separate quality plan and methodology for PU coating works shall be submitted by the contractor for approval of NTPC. Based on the approved quality plan, the tests on material and works shall be got conducted at specialist laboratories like IICT Hyderabad, CECRI Karaikudi.

11.1.7 SHEETING WORKS

All bought out items shall be procured from the manufacturer's approved by engineer and tested as per relevant IS Codes/ Specification. Raw material of colour coated sheets shall meet the chemical & physical properties as per relevant standards / codes referred in the approved data sheet. It shall be tested for colour match, bare metal thickness, weight of Z/AZ coating, thickness of painting system, reverse impact, T-Bend adhesion, scratch resistance, salt spray test for 1000 Hrs and any other test / properties as specified in the technical specifications. Colour coated sheets shall be marked with video jet printing at the interval not more than 2m bearing manufacturer's name, date and time of manufacturing. Fasteners shall also be tested for 1000 hrs salt spray test as per the requirement of technical specifications.

Bonded Mineral Wool Insulation shall meet the requirements of thickness, density, thermal Conductivity, all other tests as per the technical specifications and IS-8183.

For sheet installation no gas cut opening g shall be allowed at the site, whenever opening is specified these shall be properly cut in the factory and shall be filled with lipping / flashing for true shape / dimension etc. The sheets/ packets shall be stacked neatly clear off the ground at an angle to the ground, over a base pallet to provide drainage. Water / moisture should not be allowed to stagnate on surface, or in between layers. This can damage the coating, and cause corrosion.

11.1.8 TILE WORKS

The execution, finishing, testing and acceptance of tile works shall be as per the provisions of technical specifications. The material for tile works shall be procured from the NTPC approved brand / source. Local depressions on account of faulty workmanship, tiles / natural stones with cracked or broken / chipped edges shall not be acceptable.

The tests shall be carried out on acid resistant bricks / tile- water absorption, compressive strength, resistance to acid, flexural strength, dimensions and all other tests as per IS 4860 and IS 4457, bitumastic ready mixed paint as per IS 158, bitumastic as per IS 9510, potassium silicate, resin type and sulphur type mortars as per IS 4832, part I, II and III, surface preparation for painting as per IS 2395, epoxy painting shall be carried for required coating thickness and dry film thickness.

11.1.9 FIRE PROOF DOORS

Fire Proof doors shall be tested for the requirements mentioned in the Technical Specification. The type test of the doors shall be carried out at CBRI Roorkee for

minimum 2 hours fire rating and its Fabrication drawing shall also be approved by CBRI, Roorkee. DFT of paint of Fire Proof Doors and its fittings and fixtures as per BOQ shall be checked. The doors shall be finished with suitable fire retardant painting system

11.1.10 WATER PROOFING

The execution, finishing, testing and acceptance of water proofing works shall be as per the provisions of technical specifications. The material for the works shall be procured from the NTPC approved brand / source and the works shall be executed by the authorized applicator of the supplier.

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel / drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and well junctions etc. which have been subjected for testing. The above testing shall be carried out prior to application of wearing course.

11.1.11 PILING WORK

For piling works provisions of technical specifications, approved drawings, BOQs and relevant IS codes / standards shall apply. The piling works shall be executed by the agency meeting the qualifying requirements as specified. A detailed methodology for piling works shall be submitted by the contractor to NTPC for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for piling works shall broadly contain the method of boring, stability of bore hole, termination criteria, tests / checks for termination level, fabrication of cage, cage lowering, concrete batching / mixing, transportation, placing, recording of the time of construction operations, method of conducting initial and routine load tests, testing and sampling of concrete during production and placement and acceptance checks on piles for final clearance.

The equipment, deployment of manpower and machinery shall be arranged by the contractor to prevent the collapse of bore hole and to ensure continuous rate of placement of specified grade of concrete.

The piling works shall be executed as per the technical specifications, approved drawings, relevant codes / standards, FQP and BOQ. In addition to the requirements of technical specifications, the following shall also be ensured while execution of piling works:

a) Time gap between completion of pile boring and start of concreting should be kept to the minimum. However the maximum time gap shall not be more than 6 hours.

b) Muck Debris should be removed from the pile bore by air lift technique(by keeping the tremie & air pipe as close as to bottom of pile bore) i.e. after completion of boring, after completion of SPT(wherever applicable), after lowering reinforcement cage, but before start of concreting.

c) Density of bentonite slurry shall be checked from the sample taken from the bottom of pile bore(not at 1.0 m above the bottom of the pile bore)

d) Minimum two welding sets shall be kept ready to join the two cages of reinforcement by engaging 3 or more welders. This will ensure the lowering of R/F cage in minimum time.

e) While lowering the R/F cage into the pile bore, two hooks shall always be used to ensure balanced/symmetrical insertion of cage into the pile bore.

f) Concrete cover blocks at the junction of two R/F cage shall be ensured before lowering the second segment.

g) Surge concreting of about 1.0 cum shall be ensured at the start of concreting (i.e. in the first pour), by suddenly allowing to fall through the tremie pipe from the funnel. This will help in displacing left out muck/debris in the pile bore (by the impact).

h) Continuous feeding of concrete shall be ensured by deploying at least two transit concrete mixers (if required to be deployed) and mixing done through concrete batching plant (if deployed). Cold joints in the pile shall be avoided.

i) In a pile group, SPT shall be carried out at termination level in the pile, taken up first.

j) Bentonite slurry circulation to be ensured from start of boring to start of concreting. Flushing of bentonite slurry will only ensure maintaining of density of bentonite slurry uniformly and will not allow bentonite jelly to settle at the bottom, whereas air lift technique with bentonite circulation will ensure removal of muck debris from the bottom of pile bore.

k) Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, minimum once per week or as found necessary by the engineer. One sample consisting of 3 specimens shall be tested for the above.

l) Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Technical Specification. This test shall be suitably used to identify the piles for routine tests. High Strain dynamic test shall be done as per the technical specification. The frequency of the test shall be as per the BOQ

m) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

PILE LOAD TEST

Pile load testing shall conform to the requirements of IS-2911 (Part IV) and the technical specification. Initial load tests as specified in the contract documents shall be conducted to assess the safe load carrying capacity of pile before start of work. To verify the load carrying capacity of the working piles, routine load test shall be conducted.

Pile load-testing procedure and the test setup / scheme shall be submitted for approval of NTPC. The contractor shall use the test setup having arrangement for anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge for both vertical compression and uplift (tension) Load test (initial) on piles. The cost of reaction system / piles shall deem to be included in the cost of test piles

All the gauges and instruments shall be calibrated before the start of the tests on test piles and working piles and the calibration record shall be verified before start of execution of the test.

11.1.12 WATER SUPPLY, DRAINAGE & SANITATION

Material used for sanitary and plumbing fittings and fixtures shall conform to and be tested as per the requirements of relevant IS Codes specified in NTPC technical specification.

The obstructions in sewer lines shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under test / working condition of pressure and flow, when all draw-off taps are closed. The service pipes shall be checked for satisfactory support and protection from damage, corrosion and frost.

11.1.13 ARCHITECTURAL & MISC. WORKS

Material used for sanitary and plumbing fittings and fixtures, floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in NTPC technical specification.

Fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. shall be checked for correctness of locations and smoothness of operation and fixtures. All controls and locking devices shall give fault free performance. Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 2.5 mm.

Materials used in glass and glazing shall be procured from source approved by NTPC and shall conform to the requirements of the Technical Specification and IS Codes.

False ceiling panels shall be best quality material in thickness and properties called for in the specification / schedule of items. Material Test Certificate to be submitted before bulk supply.

All bought items covered in the scope of contract shall be procured from sources approved by NTPC and shall conform to the requirements of the technical specifications and referred standards /codes.

11.1.14 ROAD WORK

Quality Assurance and testing requirements for roadwork shall be as per the MOSRTH-Specification (Section 900), IRC specifications or CPWD specifications as specified in the technical specifications and BOQ of the contract.

The testing and sampling shall include the checks on earth work for embankment and subgrade, sub bases and bases and bituminous constructions. The sampling and testing of concrete pavements shall be as per the respective items of earthwork, subgrade / sub-base, concrete, etc.

11.1.15 FABRIC EXPANSION COMPENSATOR:

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstandability test.

Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS:8183.

Tests and checks on all other items shall be carried out as per relevant codes.

11.1.16 SLIPFORM SHUTTERING

1. The monitoring of the leveling of the yoke and the platform of the slip form shuttering to be done in each shift to avoid tilt during the casting of the chimney shell.
2. Manning of each shift shall be done by at least two experienced operators and a foreman particularly in night shift.
3. Suitable removal/ reduction of overhung / excess yoke beam length shall be affected with the decrease in the diameter of Chimney shell, as per the approved plan.
4. The laser centering method to be deployed for chimney alignment and Monitoring of chimney centre should be done by laser instruments at least two points. Monitoring/Recording of the same shall be done in each shift of 8 hours
5. Shuttering plates to be used for slip form shall be new and the grade of steel shall conform to the specification requirements.
6. The outage of the alignment of chimney centre shall be prevented by creating a counterbalance for alignment purpose to avoid differential loading, arising out of placement of reinforcement bars at one side or unloading of concrete in a hopper at one side of the platform for slip form shuttering.

11.1.17 NOT USED

11.1.18 PRE CAST CONCRETE WORKS

1. All the materials used in Pre cast Concrete work shall be tested and conform to the requirements of IS codes and NTPC Tech. Specification.
2. Concrete mix for Pre cast members shall conform to IS-456-2000.
3. All relevant QA requirements pertaining to cast insitu concrete shall be applicable.
4. Load test on Pre cast members shall be carried out for the type of members as decided by NTPC Engineer as per IS-456-2000.
5. Pre Cast Concrete member shall be checked for dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances shall be as per NTPC Technical Specification.

11.1.19 **PLASTERING & ALLIED WORKS**

1. Materials like sand, lime for preparation of putty, coarse aggregate, gypsum etc. shall confirm to the relevant IS codes specified in NTPC Technical Specification.

2. Check proper mixing of mortar

3. Plaster surface shall be checked for following defects and the remedial measures for the same shall be adopted as per IS-1661.

a) Blistering
b) Bond filer or loss of adhesion.
c) Cracking and crazing
d) Efflorescence
e) Grinning
f) Irregularity of Surface Texture
g) Popping or blowing
h) Recurrent surface dampers
i) Softness or chalkiness

4. Trueness of Plastering System:

Finished plaster surface shall not show any deviation more than 4mm when checked with straight edge of 2 m length.

5. Check thickness of plaster.

12.0.0 **SHOP TEST EOT Cranes, Other cranes & Hoist**

1.0 HOOKS

1.01 ALL TESTS INCLUDING PROOF LOAD TEST AS PER RELEVANT IS/BS/DIN SHALL BE CARRIED OUT.
1.02 MPI/DPT SHALL BE CARRIED OUT AFTER PROOF LOAD TEST.

2.0 STEEL CASTING

2.01 DPT ON MACHINED SURFACE SHALL BE CARRIED OUT.

3.0 GIRDERS, END CARRIAGE,CRAB, GEAR BOX AND ROPE DRUM

3.01 THE PLATES OF THICKNESS 25MM AND ABOVE SHALL BE ULTRASONICALLY TESTED.
3.02 NDT REQUIREMENTS ON WELDMENTS SHALL BE AS FOLLOWS:

a) BUTT WELDS IN TENSION:- 100% RT AND 100% DPT
b) BUTT WELDS IN COMPRESSION:- 10% RT AND 100% DPT
c) BUTT WELDS IN ROPE DRUM:- 100% RT AND 100% DPT
d) FILLET WELDS:- RANDOM 10% DPT

4.0 FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)

4.01 ALL FORGINGS GREATER THAN OR EQUAL TO 50 MM DIAMETER OR THICKNESS SHALL BE SUBJECTED TO ULTRASONIC TESTING.

4.02 DPT/MPI SHALL BE DONE AFTER HARDFACING AND MACHINING.

5.0 WIRE RPOE SHALL BE TESTED AS PER RELEVANT STANDARD.

6.0 REDUCTION GEARS SHALL BE TESTED FOR REDUCTION RATIO, BACKLASH & CONTACT PATTERN. GEAR BOX SHALL BE SUBJECTED TO NO-LOAD RUN TEST TO CHECK FOR OIL LEAKAGE, TEMPERATURE RISE, NOISE AND VIBRATION.

7.0 THE CRANES SHALL BE COMPLETELY ASSEMBLED AT SHOP FOR FINAL TESTING. ALL TESTS FOR DIMENSION, DEFLECTION, LOAD, OVERLOAD, HOISTING MOTION, CROSS TRAVEL ETC. AS PER IS-3177 SHALL BE CARRIED OUT AT SHOP.

8.0 ALL ELECTRIC HOISTS SHALL BE TESTED AS PER IS-3938 AND CHAIN PULLEY BLOCKS SHALL BE TESTED AS PER IS-3832.

13.0.0 CATHODIC PROTECTION

Quality of cathodic protection system shall be as per given table.

IMPRESSED CURRENT CATHODIC PROTECTION

Transformer Rectifier Unit

Attributes/ Characteristics → / Items / Components / Sub- assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Operational & Functional Checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of TRU as per NTPC specification	Efficiency Test on TRU & Transformer	Heat Run Test	Ratio & Polarity Test on TRU	HV & IR Test
Rectifier Transformer (IS : 2026)	Y				Y			Y			Y
Electronic Components	Y				Y						
PCB & Electronic Cards	Y				Y						
Control & Selector Switches (IS : 6875)	Y			Y	Y						
Indicating Meters (IS : 1248)	Y			Y	Y						
Indicating Lamps (IS: 13947)	Y			Y	Y						
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y	Y						
Control Terminal Blocks (IS : 13947)	Y				Y						
Control Transformer (IS : 12021)	Y			Y	Y						
Push Buttons (IS : 4794)	Y			Y	Y						
MCB (IS : 8828)	Y			Y	Y						
PVC insulated Copper control wires (IS : 694)	Y				Y						
Sheet Steel (IS : 513)	Y	Y	Y		Y						
Synthetic Rubber Gaskets	Y	Y			Y						
Annunciator	Y			Y							
Transformer Rectifier Unit	Y					Y	Y	Y	Y	Y	Y

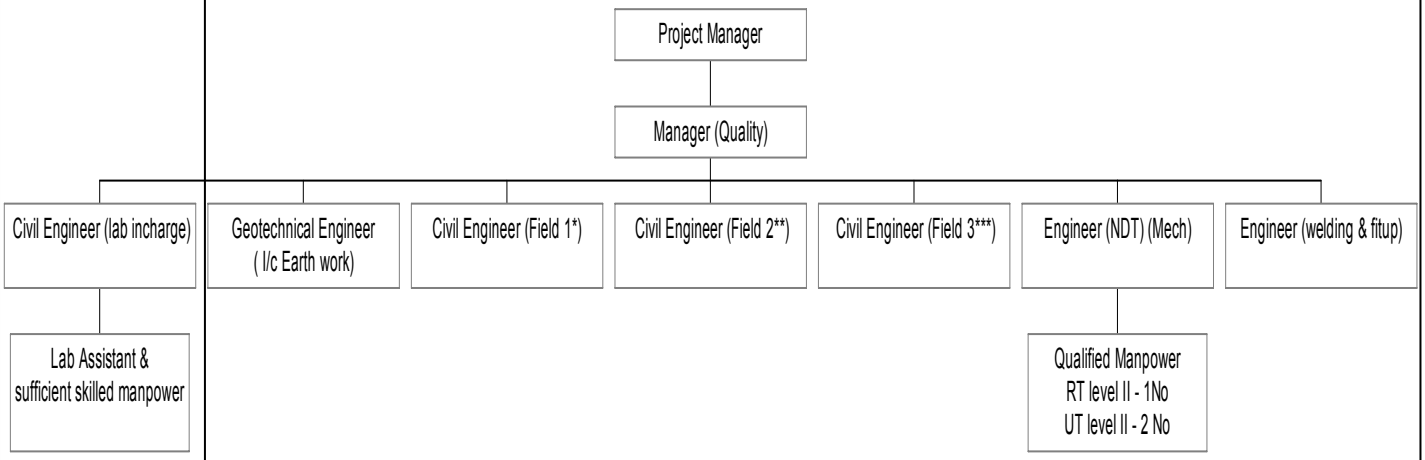
Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Makes of all major Bought Out Items will be subject to NTPC approval.

ANNEXURE-I

QA&QC ORGANISATION SETUP



NOTE:

1. The above organization setup is minimum however their deployment shall be as per the agreed deployment schedule. The contractor shall prepare a manpower deployment schedule in line with the finalized work plan and the same shall be submitted to the engineer-in charge for acceptance/ approval.
2. The contractor shall mobilize the QA& QC manpower in line with the finalized manpower deployment schedule and shall ensure their availability well in advance (15 days approx.) of the beginning of the concerned activity/ work.
3. The contractor shall further mobilize required number of skilled & supporting staff and additional resources, if any to meet the work schedule.
4. * For concrete work 2 Nos (one for foundation work & one for superstructure)
5. ** For lines and levels - 1 No.
6. *** For Finishes and cladding work - 1 No

ANNEXURE-II

TYPICAL QA/QC LAB EQUIPMENT

S.No	Equipment	Nos.
1	Vicat Apparatus with deskpot	2
2	Le chatelier flask	2
3	Le chatelier Mould	2
4	Cube Moulds for cement testing	12
5	Vibration Machine	1
6	Length comparator	2
7	Shrinkage Bar mould	2
8	Sieve shaker	1
9	Sieves for sand, coarse & fine aggregate	1 set for each
10	Sieves for coarse aggregate for Road	1 set
11	Proctor testing equipment	2 sets + 18 cores
12	Slump testing equipment	6 sets
13	Oven	2
14	Physical balance	1
15	Rapid moisture meter	2
16	Thermometer	4
17	Burret	2
18	Measuring cylinders	9
19	Measuring flasks	3
20	Compression testing machine	2 sets of 2000 kN capacity each
21	Cube moulds	30
22	Electronic balance	2 (12 kg capacity), 2 (200 mg capacity)
23	pH balance	As per requirement
24	Radiographic facilities	As per requirement, Party should deploy BARC approved agency for carrying out RT
25	Mechanical weighing machine	1 (100 kg capacity)
26	Ultrasonic testing machine	As per requirement
27	D.P. Test kit	10
28	Vernier 300 mm, 600 mm	2
29	Micrometer (0.25 mm) out side (25.00)	2
30	Radiography film viewer	2
31	Inside Micrometer 25-750 dia	2
32	Digital elcometer for paint thickness	2
33	Baking oven for electrode	3
34	Portable ovens	2
35	Rebar detector to locate the reinforcement before core cutting operation	1
36	Concrete coring machine (55mm, 60mm upto 150 mm dia core bit)	1
37	Rebound hammer	1
38	Ultrasonic pulse velocity tester	May be arranged from specialist laboratory.

Note :

1. The equipments listed above are indicative and required to be mobilised as minimum requirement. additional equipment if any ,required for successful completion of work shall be provided /arranged by the contractor.
2. All test reports/ inspection reports have to be computerized and maintained on LAN with an access to the NTPC
3. Computers - 2 Nos shall be deployed with Windows operating system and connected to the NTPC server
4. Based on the schedule (L2/L3 Network), Quality control & Quality Assurance work plan shall be finalized by the contractor and the same shall be submitted to the engineer-in-charge for acceptance/approval. The Finalized work plan shall be maintained on the computer to be accessed by the NTPC for database and day to day monitoring.

एनटीपीसी NTPC	PROJECT: NORTH KARANPURA STPP (3X660 MW)	LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: EPC PACKAGE					REV. NO.	0
	MAIN SUPPLIER:					DATE	
	CONTRACT NO.: CS-4410-001-2						
SR. NO.	**ITEM**	**QAP / INSP. CAT**	**QAP NO.**	**PROPOSED SUB SUPPLIER**	**PLACE OF MANUFACTURING**	**APPROVAL STATUS**	**REMARKS**
1	CEMENT						
2	REINFORCEMENT AND SRUCTURAL STEEL						
3	CONSTRUCTION CHEMICALS - ADMIXTURES, PLASTISIZERS, RETARDERS, WATER PROOFING COMPOUNDS, GROUTS, RESINS, EPOXY ETC.						
4	COLOUR COATED SHEET(FOR COIL)						
5	PROFILERS FOR DECKING SHEETS						
6	PROFILERS FOR CLADDING SHEETS						
7	ELECTROFORGED GRATING						
8	PAINT AND PAINTING SYSTEM						
10	GI PIPES						
11	INSULATION WOOL						
12	PVC WATER STOP						
13	PLASTIC/ PVC PIPES						
14	FLOOR TILES						
15	FIRE PROOF DOORS						
16	PARTICLE BOARDS, PLYWOOD, MDF						
17	ALUMINUM SECTIONS						
18	ROOF WATER PROOFING						
19	ALUMINUM COMPOSITE CLADDING						
20	NEOPRENE BELLOW STRAPS						
21	RCC PIPES						
22	FALSE CEILING - GLASS REINFORCED GYPSUM SYSTEM, MINERAL FIBRE BOARD SYSTEM, PREPAINTED COIL COATED STEEL SYSTEM						
23	BITUMEN ASPHALT						
24	BITUMEN IMPREGNATED FIBER BOARD JOINT FILLER, JOINT SEALING COMPOUND, BITUMINOUS COMPOUND, JOINT SEALANT, BITUMINOUS PAINTS						
25	GLASS AND GLAZINGS						
26	RESIN BONDED GRANULAR TEXTURE						
27	SANITARY ITEMS						
28	CP BRASS TAP AND OTHER SANITARY FITTINGS						
29	POLYTHENE WATER STORAGE TANKS - IS 12701						
30	POLYCARBONATE SHEETS						
31	PTFE BEARING / ELASTOMERIC BEARING						
32	FOUNDATION BOLTS						
33	HSFG BOLTS						
34	ANCHOR FASTENER						

एनटीपीसी NTPC	PROJECT: NORTH KARANPURA STPP (3X660 MW)	LIST AND STATUS OF ITEM REQUIRING QP AND SUB-SUPPLIER APPROVAL				NTPC DOC NO	
	PACKAGE: EPC PACKAGE					REV. NO.	0
	MAIN SUPPLIER:					DATE	
	CONTRACT NO.: CS-4410-001-2						
SR. NO.	**ITEM**	**QAP / INSP. CAT**	**QAP NO.**	**PROPOSED SUB SUPPLIER**	**PLACE OF MANUFACTURING**	**APPROVAL STATUS**	**REMARKS**
35	ACID / ALKALI RESISTANCE TILES, AR BRICKS(IS 4860), AR CEMENT (POTASSIUM SILICATE BASED CEMENT MORTAR-IS 4832 PART I, PHENOLIC BASED RESIN CEMENT-IS 4832 PART II) AND AR BITUMASTIC (IS 702)						
36	ELECTRICALLY OPERATED HOIST						
37	STOP LOG GATES, TRASH RACK AND LIFTING BEAM						
38	FABRIC EXPANSION COMPENSATOR						
39	THERMAL INSULATION (FOR CHIMNEY WORKS)						
40	CHIMNEY ELEVATOR						
41	GEOMEMBRANE (HDPE LINER)						
42	GALAVANISED STEEL STRUCTURES FOR TRANSMISION LINE						
43	GALVANISED STEEL STRUCTURE (LATTICE & PIPE)						
44	HEXAGONAL BOLTS, NUTS, SPRING WASHERS, PLAIN WASHERS						
45	COAL TAR ANTICORROSIVE COATING						
46	PORTA CABIN						
47	ELASTOMERIC POLYURETHANE COATING						
48	HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM						

LEGENDS:
1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)
A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter “A” in the list along with the condition of approval, if any.
DR – For these items “Details required” for NTPC review. To be identified with letter “DR” in the list.
'N' NOTED – For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with ‘NOTED.’

2. QP/INSPN CATEGORY:
CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.
CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved
CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.
UNITS/ WORKS : Place of manufacturing Place of Main Supplier of multi units/works.

NOTE: For the items placed in CAT-III for Civil Works, the review and final acceptance shall be done by NTPC-EIC/ FQA on the basis of certificate of conformance submitted by the main supplier/ main contractor.

NTPC Limited

(A Government of India Enterprise)

NORTH KARANPURA SUPER THERMAL POWER PROJECT (3X660 MW)

PART - C

GENERAL TECHNICAL REQUIREMENTS

SECTION - VI

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

BID DOCUMENT NO. : CS-4410-001-2

NTPC Limited

(A Government of India Enterprise)

NORTH KARANPURA SUPER THERMAL POWER PROJECT (3X660 MW)

PART - C

GENERAL TECHNICAL REQUIREMENTS

SECTION - VI

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

BID DOCUMENT NO. : CS-4410-001-2

(This document is meant for the exclusive purpose of bidding against this Package and shall not be transferred, reproduced or otherwise used for purposes other than that for which it is specifically issued).

PART - C

GENERAL TECHNICAL REQUIREMENTS

GENERAL TECHNICAL REQUIREMENTS

PART - C

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1.00.00 **INTRODUCTION**

This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in Section-VI, the Technical Specification and the Technical Data Sheets.

2.00.00 **BRAND NAME**

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.

3.00.00 **BASE OFFER & ALTERNATE PROPOSALS**

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognised that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer alongwith the bid to enable the Employer to determine the acceptability of these proposals.

4.00.00 **COMPLETENESS OF FACILITIES**

4.01.00 Bidders may note that this is a turnkey contract. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be provided.

4.02.00 All equipments furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All same standard components/ parts of same equipment provided, shall be interchangeable with one another.

4.03.00 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Employer.

5.00.00 **CODES & STANDARDS**

5.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following :

a) Indian Electricity Act

b) Indian Electricity Rules

c) Indian Explosives Act

d) Indian Factories Act and State Factories Act

e) Indian Boiler Regulations (IBR)

f) Regulations of the Central Pollution Control Board, India

g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India

h) Pollution Control Regulations of Department of Environment, Government of India

i) State Pollution Control Board.

(j.) Rules for Electrical installation by Tariff Advisory Committee (TAC).

(k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996

(l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998

(m.) Explosive Rules, 1983

(n.) Petroleum Act, 1984

(o.) Petroleum Rules, 1976,

(p.) Gas Cylinder Rules, 1981

(q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981

(r.) Workmen's Compensation Act, 1923

(s.) Workmen's Compensation Rules, 1924

(t.) NTPC Safety Rules for Construction and Erection

(u.) NTPC Safety Policy

(v.) Any other statutory codes / standards / regulations, as may be applicable.

5.02.00 Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply :

a) Bureau of Indian standards (BIS)

b) Japanese Industrial Standards (JIS)

c) American National Standards Institute (ANSI)

d) American Society of Testing and Materials (ASTM)

e) American Society of Mechanical Engineers (ASME)

f) American Petroleum Institute (API)

g) Standards of the Hydraulic Institute , U.S.A.

h) International Organisation for Standardisation (ISO)

i) Tubular Exchanger Manufacturer's Association (TEMA)

j) American Welding Society (AWS)

k) National Electrical Manufacturers Association (NEMA)

l) National Fire Protection Association (NFPA)

m) International Electro-Technical Commission (IEC)

n) Expansion Joint Manufacturers Association (EJMA)

o) Heat Exchange Institute (HEI)

p) IEEE standard

q) JEC standard

5.03.00 Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

5.04.00 As regards highly standardised equipments such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

5.05.00 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

5.06.00 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.

5.07.00 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

5.08.00 A detailed list of standards apart from those mentioned in the respective detailed specifications in other parts of Section-VI to which all equipment/systems/civil works should conform as indicated in this Part C and elsewhere in the specification.

6.00.00 **EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The functional guarantees of the equipment under the scope of the Contract is given in Section-VI Part - A & B of Technical Specifications. These guarantees shall

supplement the general functional guarantee provisions covered under Defect liabilities Section-IV, General Conditions of Contract.

6.02.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

7.00.00 **DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**

7.01.00 **DESIGN OF FACILITIES**

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.02.00 **MAINTENANCE AND AVILABILITY CONSIDERATIONS**

Equipment/works offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours , clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks ,etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.

8.00.00 **DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**

8.01.00 Bidders may note that this is a turnkey contract. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical and power systems, control & instrumentation, civil & structural works.

The Contractor shall furnish engineering data /drawings in accordance with the schedule of information as specified in Technical Data Sheets and Technical Specification.

A comprehensive engg and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in **Annexure-VI** to this Part-C, Section-VI of the Technical Specification.

8.03.00 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:

8.03.01 A) **BASIC ENGINEERING DOCUMENTATION**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

i) System description of all the mechanical, electrical, control & instrumentation & civil systems.

ii) Technology scan for each system / sub-system & equipment.

iii) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

iv) Optimisation studies including thermal cycle optimisation.

v) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations alongwith all calculations justifying and identifying the sizing and the design margins.

vi) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

vii) Water Balance diagram.

viii) Operation Philosophy and the control philosophy of the Main Plant and other plants.

ix) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

x) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area, transformer yard, switchyard and other areas included in the scope of the bidder.

xi) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Employer.

B) **DETAILED ENGINEERING DOCUMENTS**

i) General layout plan of the station.

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

iii) Flow diagram, process and instrumentation diagrams along with write up and system description.

iv) Start up curves for boiler and both turbines and boiler combined together as a unit for various start ups, viz. cold, warm and hot start up.

v) Piping isometric, composite layout and fabrication drawings.

vi) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the Employer's specifications as a base for placement of orders on their sub vendors.

viii) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries like mills, fans, BFPs, CEPs, Heaters/ Deaerators, Condensers, vacuum pumps etc.

ix) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

x) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data alongwith stress analysis isometrics showing nodes..

xi) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).

xii) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.

xiii) Comprehensive list of all terminal points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

xiv) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

xv) Protection system diagrams and relay settings.

xvi) Cables schedules and interconnection diagrams.

xvii) Cable routing plan.

xviii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xix) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xx) Sequence and protection interlock schemes.

xxi) Type test reports, insulation co-ordination study report and power system stability study report.

xxii) Control system configuration diagrams and card circuit diagrams and maintenance details.

xxiii) Detailed DDCMIS system manuals.

xxiv) Detailed flow chart for digital control system.

xv) Mimic diagram layout, Assignment for other application engg.

xxvi) Civil and Structural works drawings and documents for all structures, facilities, architectural works, foundations underground and overground works and super-structural works as included in the scope of the bidder civil calculation sheets including structural analysis and design alongwith output results.

xxvii) Underground facilities, levelling ,sanitary, land scaping drawings.

xxviii) Geotechnical investigation and site survey reports (if and as applicable).

xxix) Model study reports wherever applicable.

xxx) Functional & guarantee test procedures and test reports.

xxxi) Documentation in respect of Quality Assurance System, and Documentation in respect of Commissioning, as listed out elsewhere in this specification.

The Contractor's while sumitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in **Annexure-IV.** The Contract shall not be considered to be completed

for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

A) ERECTION MANUALS

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection and General Safety procedures to followed during erection/installation.

h) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

j) Procedure / Check list for pre-commissioning activities.

k) Procedure / Check list for commissioning of the system.

l) Safety precautions to be followed in electrical supply distribution during erection.

B) OPERATION & MAINTENANCE MANUALS

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the

manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows :

1) Chapter 1 - Plant Description : To contain the following sections specific to the equipment/system supplied

(a) Description of operating principle of equipment / system with schematic drawing / layouts.

(b) Functional description of associated accessories / controls. Control interlock protection write up.

(c) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

(e) Design data against which the plant performance will be compared.

(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.

(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement..

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.03.03 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the

Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.03.03 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

8.03.03.01 **PLANT HANDBOOK**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03.02 **PROJECT COMPLETION REPORT**

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

8.03.04 **DRAWINGS**

a) i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering.The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per **Annexure-VI** of Part-C . The soft copies shall be uploaded by the vendors in C-folders, a Web-based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.

Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per **Annexure-VI** of Part-C.

iv) The completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer, along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with 2 work stations (latest configuration for server & workstation) with one A4 size colored laser printer and one A0 size colored plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer.

The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Engineering Office Complex at Noida as per mutually agreed schedule.

All softwares provided shall necessarily include the cost for perpetual license(s) for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

b) All documents/text information shall be in latest version of MS Office or MS Excel as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature.

f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project . The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer.

However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer piror to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this turnkey package.

Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

j) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to “as built” conditions and submit no. of copies as per **Annexure VI**.

k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

l) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When

changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.04.00 **ENGINEERING INFORMATION SUBMISSION SCHEDULE**

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

ii) Information that would be submitted for Employer's information only.

The Master Drawing List(MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.06.00 Engineering Co-ordination Procedure

8.06.01 The following principal coordinators will be identified by respective organizations at time of award of contract :

NTPC Engineering Coordinator (NTPC EC) :

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

8.06.02 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.06.03 Contractor's/Vendor's Drawing Submission and Approval Procedure :

a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term "drawings".

b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.

d) Employer and contractor shall follow their own numbering systems for the drawings. However, Employer shall intimate the contractor, NTPC drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate NTPC's drawing number in subsequent Submission,

in the space provided for this purpose in title plate, in addition to his own drawing number.

e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

f) **Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.**

g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :

CATEGORY- I:	Approved
CATEGORY- II	Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments.
CATEGORY –III	Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.
CATEGORY -IV	For information and records.

h) Contractor shall resubmit the drawings approved under Category II, III & IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the

Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to NTPC for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

j) It is responsibility of the Contractor/ Vendor to get all the drawings approved in the Category I & IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.

l) These comments will be taken care by the contractor while submitting the revised drawing.

The contractor shall use a single transmittal for drawings. Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

8.05.00 **ENGINEERING PROGRESS AND EXCEPTION REPORT**

8.05.01 The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including

a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

b) Drawings which were not submitted as per agreed schedule.

8.05.02 The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.

9.00.00	**TECHNICAL CO-ORDINATION MEETING**
9.01.00	The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.
9.02.00	The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule.The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks_from the date of receipt of the drawing .The comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.
9.02.01	The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
9.02.02	Should any drawing remain unapproved for more than six (6) weeks after it's first submission ,this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.
9.03.0	Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.
10.00.00	**DESIGN IMPROVEMENTS**
	The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.
	If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.00.00 **EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.00.00 **PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.00.00 **LUBRICANTS, SERVO FLUIDS AND CHEMICALS**

13.01.00 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants, servo fluids, gases essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

13.02.00 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer alongwith lubrication requirements.

14.00.00 **LUBRICATION**

14.01.00 Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

15.00.00 **MATERIAL OF CONSTRUCTION**

15.01.00 All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.

16.00.00 **RATING PLATES, NAME PLATES & LABELS**

16.01.00 Each main and auxiliary item of plant shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.

16.02.00 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.

16.03.00 Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.

16.04.00 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

16.05.00 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support.

16.06.00 Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire.

16.07.00 Safety and relief valves shall be provided with the following:

a) Manufacturer's identification.

b) Nominal inlet and outlet sizes in mm.

c) Set pressure in Kg/cm^2 (abs).

d) Blowdown and accumulation as percentage of set pressure.

e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.

16.08.00 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

16.09.00 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

17.00.00 **TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. In case these tools and tackles are used by the Contractor during erection, commissioning or initial operation the same shall be refurbished repaired/replaced as required to the satisfaction of the Employer before handing over to the Employer. All the tools and tackles shall be of reputed make acceptable to the Employer.

18.00.00 **WELDING**

18.01.00 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.

19.00.00 **COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

19.01.00 All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.

20.00.00 **PROTECTION AND PRESERVATIVE SHOP COATING**

20.01.00 **PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with

either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Part-A & B of the Technical Specification.

20.02.00 **PRESERVATIVE SHOP COATING**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.

Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.

20.03.00 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.

20.04.00 All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.

20.05.00 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.

20.06.00 Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.

21.00.00 **QUALITY ASSURANCE PROGRAMME**

21.01.00 To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor’s works or at his sub-contractor’s premises or at the Employer’s site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance

programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001. A quality assurance programme of the contractor shall generally cover the following:

a) His organisation structure for the management and implementation of the proposed quality assurance programme

b) Quality System Manual

c) Design Control System

d) Documentation Control System

e) Qualification data for Bidder's key Personnel.

f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

g) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

h) Control of non-conforming items and system for corrective actions.

i) Inspection and test procedure both for manufacture and field activities.

j) Control of calibration and testing of measuring testing equipments.

k) System for Quality Audits.

l) System for indication and appraisal of inspection status.

m) System for authorising release of manufactured product to the Employer.

n) System for handling storage and delivery.

o) System for maintenance of records, and

p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as **Annexure-I** and **Annexure-II** respectively.

22.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

22.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-1/F3-R0. Monthly progress reports shall be furnished.

22.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media through C-folders, a web based system of NTPC ERP in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM (As per format at Annexure-I)

22.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site (As per format at Annexure – II).

22.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

22.05.00 The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the format enclosed at **Annexure-V.** The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding

	procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.
22.06.00	The contractor shall have suitable Field Quality Organization with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP) and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organizational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.
22.07.00	No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
22.08.00	All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details
22.09.00	All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
22.10.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
22.11.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer..
22.12.00	For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, other piping shall be as per relevant code. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding

22.13.00 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

22.14.00 No welding shall be carried out on cast iron components for repair.

22.15.00 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

22.16.00 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 50mm shall be ultrasonically tested..

22.17.00 The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished preferably on enclosed format at **Annexure-IV.** Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

22.18.00 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three

weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.

22.19.00 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

22.20.00 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.21.00 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.22.00 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.23.00 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

22.24.00 **Environmental Stress Screening**

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following.

1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

Or

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

2) Burn in Test Cycle

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

22.25.00 The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

23.00.00 **QUALITY ASSURANCE DOCUMENTS**

23.01.00 The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓)mark.

23.01.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

23.02.00 Typical contents of QA Documentation is as below:-

(a.) Quality Plan

(b.) Material mill test reports on components as specified by the specification and approved Quality Plans.

(c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

(d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

(e.) Heat Treatment Certificate/Record (Time- temperature Chart)

(f.) All the accepted Non-conformance Reports (Major/Minor)/deviation, including complete technical details / repair procedure).

(g.) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

(h.) Certificate of Conformance (COC) wherever applicable.

(i.) MDCC

23.03.00 Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

23.04.00 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

(a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

(b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

(c.) If a decision is made for despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.05.00 **TRANSMISSION OF QA DOCUMENTATION**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.00.00 **PROJECT MANAGER'S SUPERVISION**

24.01.00 To eliminate delays and avoid disputes and litigation, it is agreed between the

parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC, the Contractor shall proceed to comply with the Project Manager's decision.

24.02.00 The work shall be performed under the supervision of the Project Manager.

The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

(a.) Interpretation of all the terms and conditions of these documents and specifications:

(b.) Review and interpretation of all the Contractor's drawing, engineering data, etc:

(c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

(d.) Inspect, accept or reject any equipment, material and work under the contract :

(e.) Issue certificate of acceptance and/or progressive payment and final payment certificates

(f.) Review and suggest modifications and improvement in completion schedules from time to time, and

(g.) Supervise Quality Assurance Programme implementation at all stages of the works.

25.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

25.01.00 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

25.02.00 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

25.03.00	The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
25.04.00	The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
25.05.00	When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.
25.06.00	In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.
25.07.00	The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.
25.08.00	To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each

calendar month.

25.09.00 All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

25.10.00 **Associated document for Quality Assurance programme**

25.10.01 Manufacturing Quality Plan Format No. : QS-01-QAI-P-09/F1-R1 enclosed at **Annexure-I.**

25.10.02 Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1 enclosed at **Annexure-II.**

25.10.03 List of items requiring quality plan and sub supplier approval. Format No.: QS-01-QAI-P-01/F3-R0 **(Annexure-III).**

25.10.04 Status of items requiring Quality Plan and sub supplier approval. Format enclosed at **Annexure-IV.**

25.10.05 Field Welding Schedule Format enclosed at **Annexure-V.**

25.11.00 **TESTING OF MAJOR DESIGN FEATURES:**

The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within four months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfill the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following.

a) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.

b) Loop reaction time for sample loops/ logics.

c) SOE functionality tests.

d) Server changeover.

e) Various response times, having serious implication on operation & maintenance philosophy.

f) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.

g) Unified HMI for DDCMIS.

The results of the above tests, after its acceptance by the Employer, shall be properly documented and submitted to Employer.

25.12.00 **DEMONSTRATION OF APPLICATION ENGINEERING**

25.12.01 Based on NTPC inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following.

(i) Logics/Loops:

a) Drive logics implementation for each type of binary drive along with its display in HMI.

b) Sequence implementation along with its display in HMI.

c) Single non-cascade controller implementation.

d) Cascade loop implementation.

e) Master slave implementation with different slave combination.

f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable.

(ii) HMI Functions:

a) LVS Annunciation.

b) Graphics.

c) HSR

d) Logs/Reports.

e) Calculations (Basic & Performance Calculations).

25.12.02 The above typical cases shall be finalized with the Employer through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on NTPC inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Employer and demonstrate to Employer at Employer premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Employer premises & the results shall be documented as part of test report.

25.12.03 During the integrated testing at the Contractor's works, only sample checks shall be done by the Employer for the items covered in above application engineering demonstration.

26.00.00 **PRE-COMMISSIONING AND COMMISSIONING FACILITIES**

26.01.00 (a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included in Part-D, Section-VI and elsewhere in the Technical Specifications.

(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(c) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Employer six months prior to the respective implementations. The Employer will approve final verification of cleanliness.

(d) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(e) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule to be agreed by Employer.

(f) The Contractor during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.01.00 Contractor shall furnish the commissioning organization chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain :

(1.) Biodata including experience of the Commissioning Engineers.

(2.) Role and responsibilities of the Commissioning Organisation members.

(3.) Expected duration of posting of the above Commissioning Engineers at site.

26.02.00 **Initial Operation**

(a) On completion of all pre-commissioning activities/ tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

(b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

(c) Any loss of generation due to constraints attributable to the Employer shall be construed as Deemed Generation.

(d) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for with- holding the aforesaid permission.

26.03.00 **Guarantee Tests**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test. Such test will be commenced, within a period of **three (3) months** after the successful completion of Initial Operations. Any extension of time beyond the above **three (3) months** shall be mutually agreed upon.

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class shall be as per specified test codes. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Employer's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Contractor, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specifications.

27.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be with held nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.00.00 **TRAINING OF EMPLOYER'S PERSONNEL**

28.01.00 The scope of service under training of Employer's engineers shall include a training module covering the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Employer:

(a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipments.

(b) Training for Electric Systems including VFD and Electric power supply system.

(c) Training for other SG/TG related C&I systems/equipments including training on Flame Monitoring System, Furnace and Flame Viewing System , Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.

(d) Training for special packages for various PC based systems specified elsewhere in Part-B of Technical Specification, Section-VI.

(e) Training for various C&I systems/equipment supplied includes the following:

i) DDCMIS - Human Machine Interface – Hardware & Operating System

ii) DDCMIS-Human Machine Interface System Engineering & Application Software.

iii) DDCMIS – Control System Hardware and Control system Application Software.

iv) DDCMIS – Operator Training : Use of the system at Works + at site.

v) DDCMIS – Specialized Network security.

(f) Training for power cycle piping/critical piping.

(g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analysers, CCTV and 24 VDC system.

(h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.

(i) Details of training modules for SG, TG and C&I systems are given at **Annexure – VII, VIII & IX.**

The exact details, extent and schedule for training shall be as finalised during detailed engineering and shall be subject to Employer's approval.

28.03.00 The scope of services under training shall also necessarily include training of Employer's Engineering personnel covering a training module as indicated in **Annexure – VII, VIII & IX** . This shall cover all disciplines viz, Mechanical, Electrical, C&I , QA etc. and shall include all the related areas like Design familiarization, training on product design features and product deign software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing erection, welding etc.

28.04.00 Contractor shall also arrange for training of Employer's personnel in respect of fire detection and protection systems and other Balance of Plant equipments.

28.05.00 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Employer's approval. Consolidated training period included above [i.e. **Annexure – VII, VIII & IX** for O&M and Engineering] is indicative only. Employer reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

28.06.00 Exact details, extent of training and the training schedule shall be finalized based on the Bidder's proposal within two (2) months from placement of award.

28.07.00 In all the above cases, wherever the training of Employer's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Employer's personnel shall be at the cost of Bidder.The Bidder shall make all necessary arrangements towards the same.

28.08.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Employer reserves the right to include or exclude these item(s) during placement of Award.

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

29.00.00 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

i) Working platforms should be fenced and shall have means of access.

ii) Ladders in accordance with Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

30.00.00 **NOISE LEVEL**

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment/machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

i) Safety valves and associated vent pipes for which it shall not exceed 105 dBA-115 dBA.

ii) Regulating drain valves in which case it shall be limited to 90 dBA-115 dBA.

iii) Mill noise which will be limited to 85-90 dBA.

iv) TG unit in which case it shall not exceed 90 dBA.

v) For HP-LP bypass valves and other intermittantly operating control valves, the noise level shall be within the limit of 90 dBA.

31.00.00 **PACKAGING AND TRANSPORTATION**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site

works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.

32.00.00 **ELECTRICAL EQUIPMENTS/ENCLOSURES**

32.01.00 All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specifications.

33.00.00 **JUNCTION BOXES**

The junction boxes shall be made of minimum 2 mm thick sheet steel. Gland plates shall be removable type and made of 3 mm thick sheet steel. The boxes shall be provided with detachable cover or hinged door with captive screws. Top of the box shall be arranged to slope towards the rear of the box. The box shall be hot dip galvanised and shall be provided with suitable neoprene gaskets to achieve requisite degree of protection. Adequate spacing shall be provided to terminate the external cables. The boxes shall be suitable for mounting on various types of steel structures. The terminal blocks provided shall be of 650 V grade, rated for 10 A for control cables. Suitable numbering for terminal blocks shall be done. In case of junction box for power cable, the box shall be rated for maximum current carrying capacity. Terminal blocks shall be of one piece, Klippon RSF-1 or ELMEX CSLT-1 type with insulating barriers.

34.00.00 **INSTRUMENTATION AND CONTROL**

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

34.01.00 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

1	Temperature	- Degree centigrade (deg C)
2.	Pressure	- Kilograms per square centimetre (Kg/cm^2). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.

	3. Draught	-	Millimetres of water column (mm wc).
	4. Vacuum	-	Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).
	5. Flow (Gas)	-	Tonnes/ hour
	6. Flow (Steam)	-	Tonnes/ hour
	7. Flow (Liquid)	-	Tonnes / hour
	8. Flow base	-	760 mm Hg. 15 deg.C
	9. Density	-	Grams per cubic centimetre.

34.02.00 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plan-in connection at rear.

34.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

35.00.00 **ELECTRICAL NOISE CONTROL**

The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-61000-2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems as per EN-50082-2 (1995).

36.00.00 **SURGE PROTECTION FOR SOLID STATE EQUIPMENT**

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates. etc. shall be submitted by the Bidder.

37.00.00 **INSTRUMENT AIR SYSTEM**

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

38.00.00 **TAPPING POINTS FOR MEASUREMENTS**

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Contractor will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Contractor.

i) Temperature test pockets with stub and thermowell

ii) Pressure test pockets

39.00.00 **SYSTEM DOCUMENTATION**

The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C& I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Techncial Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

39.01.00 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Employer.

40.00.00 **MAINTENANCE MANUALS OF ELECTRONIC MODULES**

The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him.The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further , the contractor shall furnish a set of operating manuals which should include block diagrams ,make, model/type ,details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

LIST OF CODES AND STANDARDS

Indian Standards	Title	International and Internationally recognised standards
IS:277	Galvanised steel sheets (plain or corrugated)	
IS:655	Specification for metal air duct	
IS:800	Code of practice for use of structural steel in general building construction	BS 449:1969 BS 5950 ASA A57, 1-1952
IS:807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Associa-tion of Australia). DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960	Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev

	BS 1757:1951 BS 2573:part-I:1960	
IS:875	Code of practice for design loads (other than earthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Building code of Canada (1953)-Part-IV Design section 4.1
IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for perform-ance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L

IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957
IS:3346	Method for the determin-ation of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
IS:3354	Outline dimensions for electric lifts.	
IS:3401	Silica gel	
IS:3588	Specification for electrical axial flow fans	
IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)	
IS:3677	Unbonded rock and slag wool for thermal insulation	
IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)

IS:3895	Specification for monocry-stallines semiconductor rectifier cells and stacks	
IS:3963	Roof extractor unit	
IS:3975	Mild steel wires, strips and tapes for armouring cables	
IS:4503	Shell and tube type heat Exchanger	
IS:4540	Specification for monory-stallines rectifire assembly equipment	
IS:4671	Expanded polystyrene for thermal insulation purpose	
IS:4736	Hot dip zinc coating on steel tubes	
IS:4894	Centrifugal fans	
IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392	Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098	Cross linked Polyethylene insulated PVC sheathed	Standard No. 1 to IPCEA (USA) Pub.

	cables No. 5-66-524
IS:7373	Specification for wrought aluminium and aluminium sheet and strips
IS:7938	Air receivers for compressed air installation
ISO:1217	Displacement compressor-Acceplance test
ASHRAE-33	Methods of testing for rating of forced circulation air cooling and air heating coils.
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particle matter.
ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.
ARI-450-6	Standard for water cooled refrigerant condensers.
ARI-550	Standard for centrifugal water chilling packages.
ARI-410	Standard for forced circulation air cooling and air heating coils
ARI-430/435	Central station AHU/Application of Central Station AHU
BS:848 (Part-1,2)	Fans
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.
BS:401	Low carbon steel cylinders for the storage & transport of liquified gases.
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.
ANSI-31.5	Refrigerant piping
ASME-PTC-23-1958	Atmospheric Water Cooling Equipment

AMCA A-21C Test Code for air moving devices

API:618 Reciprocating Compressor for general refinary services.

HYDRAULIC INSTITUTE STANDARDS.

HYDRANT SYSTEM MANUALS OF TAC.

TAC MANUALS OF SPRAY SYSTEM

NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

CODE AND STANDARD FOR CIVIL WORKS

Some of the applicable Standards, Codes and references are as follows:

Excavation & Filling

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701 Code of practice for earth work on canals.

IS: 9758 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 Specification for ordinary Portland cement, 33 grade.

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 702 Specification for Industrial bitumen.

IS: 712	Specification for building limes.
IS: 808	Rolled steel Beam channel and angle sections.
IS: 1077	Specification for common burnt clay building bricks.
IS: 1161	Specification of steel tubes for structural purposes.
IS: 1363	Hexagon head Bolts, Screws and nuts of production grade C.
IS: 1364	Hexagon head Bolts, Screws and Nuts of Production grade A & B.
IS: 1367	Technical supply conditions for Threaded fasteners.
IS: 1489	Specification for Portland-pozzolana cement:
(Part-I)	Fly ash based.
(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.

IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS: 8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.
IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures.
IS: 516	Method of test for strength of concrete.
IS: 650	Specification for standard sand for testing of cement.
IS: 1199	Methods of sampling and analysis of concrete.
IS: 1791	General requirements for batch type concrete mixers.
IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2438	Specification for roller pan mixer.
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type.
IS: 2506	General requirements for concrete vibrators, screed board type.

IS: 2514	Specification for concrete vibrating tables.
IS: 2645	Specification for Integral cement water proofing compounds.
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
IS: 2750	Specification for Steel scaffolding.
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 3025	Methods of sampling and test waste water.
IS: 3366	Specification for Pan vibrators.
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.
IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.

IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP:23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/	National Building Code- Structural design of prefabrication and Sec.7) systems building.
IS: 10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS: 10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonary and Allied Works

IS: 1905	Code of Practice for Structural Safety of Buildings-Masonry walls.
IS: 2212	Code of Practice for Brickwork.
IS: 2250	Code of Practice for Preparation and use of Masonry Mortar.
SP: 20	Explanatory hand book on masonry code.

Sheeting Works

IS:277	Galvanised steel sheets (plain or corrugated).
IS: 459	Unreinforced corrugated and semi-corrugated asbestos cement sheets.
IS: 513	Cold-rolled carbon steel sheets.
IS: 730	Specification for fixing accessories for corrugated sheet roofing.
IS: 1626	Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.
IS: 2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS: 3007	Code of practice for laying of asbestos cement sheets.
IS: 5913	Methods of test for asbestos cement products.
IS: 7178	Technical supply conditions 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: 12866	Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced).
IS: 14246	Specification for continuously pre-painted galvanised steel sheets and coils.

Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
IS: 3502	Specifications for chequered plate.
IS: 6911	Specification for stainless steel plate, sheet and strip.
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts.
IS: 6649	High Tensile friction grip washers.
IS: 800	Code of practice for use of structural steel in general building construction.
IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.

IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
IS: 9006	Recommended Practice for Welding of Clad Steel.
IS: 7215	Tolerances for fabrication steel structures.
IS: 12843	Tolerance for erection of structural steel.
IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.

IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.
IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.
	Part I Silicate type
	Part II Resin type
	Part III Sulphur type
IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.

Water Supply, Drainage and Sanitation

IS : 458	Specification for concrete pipes.

IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
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 and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.
IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
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	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.

IS : 2064	Code of practice for selection, installation and maintenance of sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.
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	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.

IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.
IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.
IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.
IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.

IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortice locks (vertical type).
IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.

IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

R oof Water Proofing and AlliedWorks

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.
IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.

IS:13801	Specification for chequered cement concrete flooring tiles.
Painting and Allied Works	
IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship
Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint
IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use

IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.
Piling and Foundation	
IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950	Code of practice for designs and construction of Raft (Part-I) foundation.
IS:2974	Code of practice for design and construction of machine
(Part-I TO V)	foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.
IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines with rotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines.
Stop Log and Trash Rack	
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.
IS:11855	General requirements for rubber seals for hydraulic gates.
Roads	
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.

IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Public-	Ministry of Surface Transport (Roads Wing), Specifications
ation	for road and bridge works.
IS:73	Specification for paving bitumen
Loadings	
IS:875	Code of practice for design loads other than earthquake) for
(Pt. I to V)	buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.
Safety	
IS:3696	Safety code for scaffolds and ladders.
(Part I & II)	
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.

IS:4130	Safety code for demolition of buildings.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.

- Indian Explosives Act. 1940 as updated.

Architectural design of buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in
(Relevant parts)	overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Creteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes.
Publication	

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).

   b) Electonic transmitters BS:6447.
2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.
4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).
5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.
6. Printed circuit boards - IPC TM - 650, IEC 326 C.
7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.
8. Edge socket connectors - IEC 130-11.

9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.

10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).

11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).

12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.

13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.

14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.

15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.

2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.

3. Water and steam in power cycle - ASME PTC 19.11.

4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.

2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472

3. Damp heat cycling test - IS:2106

4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.

2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.

3. Turbine water damage prevention - ASME TDP-1-1980.

4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.

2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.

3. Surge withstand capability test - ANSI C 37.90 1 -1989.

4. Performance testing of UPS - IEC 146.

5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.

2. Seamless carbon steel pipe ASTM - A - 106.

3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.

4. Material for socket welded fittings - ASTM - A - 105.

5. Seamless ferritc alloy steep pipe - ASTM - A - 335.

6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.

7. Composition bronze of ounce metal castings - ASTM - B - 62.

8. Seamless Copper tube, bright annealed - ASTM - B - 168.

9. Seamless copper tube - ASTM - B - 75.

10. Dimension of fittings - ANSI - B - 16.11.

11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.

2. Material of socketweld fittings - ASTM - A105.

3. Dimensions of fittings - ANSI - B - 16.11.

4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.

2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.

3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.

4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).

5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.

6. Rules for Testing insulated cables and flexible cables : VVDE - 0472

7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)

8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.

9. Oxygen index and temperature index test - ASTM D - 2863.

10. Smoke density measurement test - ASTMD - 2843.

11. Acid gas generation test - IEC - 754 - 1.

12. Swedish Chimney test - SEN - 4241475 (F3).

13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.

14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.

15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.

2. -do- Test Standards. NEMA VE-1-1979.

3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

Public Address System

1. Specifications for lod speakers - IS:7741 (Part-I, II and III)

2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301

3. Specification for Public Address Amplifiers - IS:10426.

4. Code of practice for outdoor installation of PA system - IS:1982.

5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.

6. Basic environmental testing procedures for electronic and electrical items - IS:9000.

7. Characteristics and methods of measurements for sound system equipment - IS:9302

8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732

9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)

10. Fittings for rigid steel conduits for electrical wiring - IS:2667

11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

Vibration Monitoring System

1. API 670 - 1994

2. BS : 4675 Part-2

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT :
		ITEM :	QP NO.:	PACKAGE :
			REV.NO.:	CONTRACT NO. :
		SUB-SYSTEM:	DATE:	MAIN-SUPPLIER:
			PAGE: …. OF….	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C / N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER C**:** MAIN SUPPLIER, **N**: NTPC **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** NTPC SHALL IDENTIFY IN COLUM "N" AS ' W"	एनटीपीसी NTPC	DOC. NO.:		REV…… CAT…..
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F1-R1 1/1 ENGG. DIV./QA&I

ANNEXURE-II

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT :
		ITEM :	QP NO.:	PACKAGE :
			REV. NO.:	CONTRACT NO. :
		SUB-SYSTEM:	DATE:	MAIN-SUPPLIER:
			PAGE: …. OF….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK #	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR; 'A'** SHALL BE WITNESSED BY NTPC FQA, **'B'** SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE)	एनटीपीसी NTPC	DOC. NO.:		REV……
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F2-R1 1/1 ENGG. DIV./QA&I

ANNEXURE-III

एनटीपीसी NTPC	Project : Stage :: Package : Supplier : Contractor No. :	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL SUB-SYSTEM :	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – **For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.**

DR **– For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.**

NOTED **– For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'**

QP/INSPN CATEGORY:

CAT-I **: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.**

CAT-II **: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.**

CAT-III **: For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.**

UNITS/WORKS **: Place of manufacturing Place of Main Supplier of multi units/works.**

FORMAT NO.: QS-01-QAI-P-1/F3-R0 1/1 Engg. Div. / QA&I

ANNEXURE-IV

एनटीपीसी NTPC	Project : Stage : : Package : Contractor : Contractor No. :	STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item / Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

FORMAT 1/1 Engg. Div. / QA&I

ANNEXURE-V

एनटीपीसी NTPC	Project : Stage : Contractor : Contractor No. : System :	FIELD WELDING SCHEDULE (To be raised by the contractor) Welding Code: ……	DOC. NO.: REV. NO.: DATE : PAGE : OF

Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	

NOTES:

SIGNATURE

FORMAT	1/1	**Engg. Div. / QA&I**

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	▪ Layout (A0&A1 sizes)	4	-
	▪ Other Drawings/Documents (A0&A1 sizes)	2	-
	▪ P&ID (All sizes)	4	-
	a) Final drawings/documents (Directly to site)	6	2
	b) "As Built" Drawing/Documents (Directly to site)	6	2
	c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	4 sets	2
3	Operation & Maintenance manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2
4	Plant Hand Book i) First Submission	1	1
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	--
	ii) Approved Copies (Direct to Site)	4 sets	2
7	Project Completion Report (Directly to site)	6 sets	2
8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	--
9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	--
10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	--
	ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	--
	ii) Approved copies (Direct to Site)	4 sets	2
12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
Steam Generator	Thermal design and hydraulic circulation balance Combustion and Air & gas weight calculation Pressure part calculation Pressure parts and strength calculation Tube metal temp. calculation and selection Performance Duct design Pressure parts arrangement Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners startup system, fuel firing system, fuel firing system, draft plant. Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water. **PRODUCTION DESIGN**	Familiarization with various system and equipment Performance data collection analysis and review O&M feed back Operation history of various equipments and system Failure analysis	Manufacturing process of pressure parts, and equipments Welding process Testing facilities Product development in process Future plan for technology induction R&D work in progress	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues. Familiarization of special maintenance techniques Special tool and tackles familiarization

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Layout of over all plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping trestles etc. Erection strategies, erection procedures Performance and demonstration tests.			
MANDAYS	**120**	**20**	**20**	20
CONTROL & INSTRUMENTATION DDCMIS*-Human Machine Interface - Hardware & Operating System	Hardware & Software organization of the system Basis of selection of H/W memory Sizing Operating system features, interface with other system, openness & inter-operability Upgradability System testing features	Operational feedback		
MANDAYS	**7**	**3**		

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
DDCMIS*-Human Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback		
MANDAYS	**22**	**3**		
DDCMIS* - Control System Hardware	Basic design features for system & its Modules System capabilities & system design Techniques Communication with HMI & other System	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	**10**	**2**	**3**	
DDCMIS*-Control system Application Software	Database structure Organisation & interface between application program & database Application for implementation of Control functions	Operational feedback	System integration & System capabilities testing	

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	Study of standard algorithms & development of new algorithm			
MANDAYS	**6**	**2**	**2**	
DDCMIS* - Control Loop Study	General description of closed loop controls of thermal power plant Critical analysis of few control loops e.g., boiler start up control etc.	Specific operational feedback		
MANDAYS	**4**	**2**		
DDCMIS*-Burner Management Study	Hardware logic, NFPA/VDE requirements & other safety standards Flame scanner location	Operational feedback	Manufacturing procedure & precautions for handling the system System testing facilities	
MANDAYS	**6**	**2**	**2**	
Boiler Flame Viewing system ---------- Misc. system for SG C&I	Theory & principle of operation Details of software & methods of modification/customisation	Operational feedback		
MANDAYS	**3**	**2**		
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
			Testing Methodology	
MANDAYS	**3**	**2**		
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
MANDAYS	**45**	**10**	**10**	
QUALITY ASSURANCE & INSPECTION **QA SYSTEM & PROGRAMME**	Integrated QA Management System for enhanced reliability of equipments. ● QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems. ● QA system for developing and establishing new processes and vendors. ● System of structured documentation of Engg. And test records	Operating feed backs: ● Co-relation of reliability and performance of the equipment with implementation of QA system. ● Appreciation of use of structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	● Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities. ● Appreciation of developmental activities for new processes and vendors. ● System of prequalification of special processes.	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS ANNEXURE-VII			
PRODUCT	**AREAS OF TRAINING REQUIEMENT**			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
MANDAYS	**20**	**10**	**26**	
CONTROLS & INSTRUMENTS	Familiarization with control system and instrumentation QA system for manufacture of reliable components	Feedback on performance of C&I System	Manufacturing activities for critical instruments/Items Implementation of testing programme to ensure reliability.	
MANDAYS	**6**	**4**	**4**	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine	
	Rotor dynamic behavior studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process	
	Casing & diaphragm design	Failure analysis	Future plan for technology induction	
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress	
	Selection of turbine type (i.e. Tandem vs cross compounding, separate HP/IP vs combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation Selection, design and control principle for Turbine governing system Performance calculation Steam path audit Layout principle of various equipment's of TG and its integral system Latest technological advancements			
MANDAYS	**45**	**10**	**10**	
Boiler Feed Pumps	Techno-economic syudies for Selection of BFP Configuration and its drive Criteria for selection of boiler Feed Pump parameters Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Familiarization of power plants of various makes of feed pumps for super critical units Data collection of BFP parameters and configuration Collection of data for analysis of availability of BFP	Manufacturing process of various components of BFP Assembly of BFP Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
	Impeller design and its hydraulic behavior Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps Material selection of BFP components Guiding factors for selection of BFP seals Computation of axial thrust under various flows Performance calculation Transient analysis in pump suction piping wrt NPSH margin Latest technological trends in BFP design	O&M history/problems related to BFP Comparative studies for various types of BFP& its features	measurement Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**20**	**5**	**10**	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality Condenser support selection & design Sizing of condenser w.r.t. super critical units Latest technological trends in condenser arrangement and design Condenser vacuum system design	Collection of data for analysis of availability of Condenser O&M history/problems related to condenser	Testing capability at works Product development in process Future plan for techno-logy induction R&D work in progress	
MANDAYS	**10**	**5**	**5**	
Feed Regenerative Equipment's	Thermal and mechanical design calculation of heaters Basis of selecting horizontal/vertical heaters Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate Configuration of HP heaters (2x50% v/s100% capacity	Comparative studies of salient features Analysis of data O&M history/problems related to heaters	Manufacturing process of various components of heaters Assembly Testing capability at works Product development in process	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
	Sizing criteria for De- aerator/Heaters Selection of tube & tube sheet material of heaters Latest technological trends in heaters design		Future plan for techno-logy induction R&D work in progress	
MANDAYS	**15**	**10**	**10**	
3-dimensional CFD modeling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	**20**			
Generator	Design aspects of the following area:- - Insulation system - Cooling medium and arrangement - Winding & core support systems. Design aspects of associated auxiliary Systems	- Operational feedback - Familiarisation with different sub systems	Manufacturing process for - Core - Winding bars - Assembly Testing facilities.	
MANDAYS	**30**	**7**	**23**	
Excitation systems Including AVR	Design features of various Sub-systems Exciter PMG	-Operational feedback -Familiarisation with various equipment functioning at reference	Manufacturing process & testing facilities for various equipment of excitation systems	

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
	Excitation transformers Controllers and different limiters PSS & associated system studies	plant.		
MANDAYS	**30**	**7**	**23**	
400kV Switchyard Equipments			Concepts and operational aspects for the offered equipments	
MANDAYS			**50**	
Substation Automation system				Training for site personnel for operation,maintenance& troubleshooting of total system for 5 working days at NTPC site
MANDAYS				

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	PRODUCT DESIGN	Plant Visit	Visit To Manufacturer's Work	Operation & Maintenance of Plant
MV and LT Switchgear: Numerical ralays & Switchgear SCADA syatem	Numerical relay engineering and associated training for relay software and O&M SCADA system design,engineering and associated training for SCADA and O&M			
MANDAYS	**60 (Total) (inclusive of visit to manufacturer's site)**			
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding,rotor core and winding,Insulation systems and Cooling arrangement. Study of forces and vibration. Diagnostic and testing of large Electrical machines	Operational feedback	Manufacturing process and testing facilities	
MANDAYS	**14**	**4**	**10**	

ANNEXURE-IX

Area	Topics	MANDAYS
DDCMIS-Man Machine Interface - Hardware & Operating System	• Hardware & Software organization of the system • Basis of selection of H/W memory sizing • Operating system features, interface with other system, openness & inter-operability • Upgradeability • System testing features	**20**
	• Trouble shooting and fault analysis.	
DDCMIS-Man Machine Interface System Engineering & Application Software	• Specific system customisation • Various system modules & interface with OS • Database organisation & development • Development of mimics • Other application like calculations, logs historical storage functionalities & use • Trouble shooting and fault analysis.	**40**
DDCMIS - Control System Hardware and Control system Application Software	• Basic design features for system & its modules • Manufacturing processes with special attention to handling of the modules Maintenance facilities	**50**
	• System capabilities & system design techniques • System integration & System capabilities testing	
	• Communication with MMI & other system	
	• Database structure Organisation & inter- face between application program & database	

	• Application for implementation of Control functions • Study of standard algorithms & development of new algorithms	
	• Trouble shooting and fault analysis.	
DDCMIS-Operator Training	• Use of the system at Works + at Site	**20 + 100**
DDCMIS-Specialized Network security training	• To be finalized during detailed engineering.	**15**
UPS system	• Theory & design features Manufacturing/assembly process • Testing methodology	**5**
	• Trouble shooting and fault analysis.	
24 V DC system	• Theory & design features Manufacturing/assembly process • Testing methodology • Trouble shooting and fault analysis.	**5**
SWAS	• Theory & design features • Trouble shooting and fault analysis	**5**
PA System	• Theory & design features • Trouble shooting and fault analysis	**4**
CCTV System	• Theory & design features • Trouble shooting and fault analysis	**4**

QA SYSTEM & PROGRAMME	• Integrated QA Management system for enhanced reliability of equipments. • QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems. • QA system for developing and establishing new processes and vendors. • System of structured documentation of Engg and test records. • Appreciation of implementation of QA Programme in various manufacturing, assembly and testing activities. • Appreciation of develop-mental activities for new processes and vendors. • System of pre-qualification of special processes.	**10**
Controls & Instruments	• Familiarization with control system and instrumentation • QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items. • Implementation of testing programme to ensure reliability.	**10**
Note	**One week shall constitute of five (5) man days.**	