2. Oxidation Blowers
3. Compressors

DAMPERS & GATES

1. Manually Operated Damper
2. Pneumatically Operated Damper
3. Electrically Operated Damper
4. Manually Operated Gates
5. Pneumatically Operated Gate
6. Electrically Operated Gate

DUCT WORK

1. Flue Gas Ducting
2. Expansion Joints
3. Observation & Access Door

CRANES AND ELEVATORS

1. Crane
2. Hoists
3. Passenger cum goods elevator

POWER TRANSMISSION

1. Power Transmission Gear Box
2. Bearings
3. Couplings

FGD & AUX.SYSTEM

1. Agitators
2. Air Motor
3. Process trestle
4. Limestone feeder
5. Vacuum belt filter

6. Limestone ball mill
7. Limestone Hydrocyclones
8. Primary Hydrocyclones
9. Secondary Hydrocyclones
10. Absorber internals
11. Absorber Auxiliaries

ELELCTRICAL

1. D.C. Motor
2. HV Squirrel Cage Induction Motor
3. 415 V Squirrel Cage Induction Motor
4. Motor Operated Actuators
5. Transformers
6. Aux. Control and Relay Panel Desk
7. HT & LT SWITCHGEARS/MCC
   - (I.) STANDARD CHECLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM
   - (II.) PT CARRIAGE AND CUBICLES
   - (III.) CABLE/BUS DUCT/BUS BARS
   - (IV.) CONTRACTOR MODULE
   - (V.) SWITCH FUSE MODULE
   - (VI.) MASTER PANEL OF LUBE OIL PANEL
   - (VII.) FEEDER PANEL OF LUBE OIL PANEL
   - (VIII.) SPACE HEATER AND CABLE MODULE
   - (IX.) HT CIRCUIT BREAKER
   - (X.) 415 V CIRCUIT BREAKER
8. POWER CABLE
9. AUXILIARY CABLE
10. D.C. CABLE
11. EXPLOSION PROOF ELECTRICAL EQUIPMENT
12. JUNCTION BOX
13. CONTROL TRANSFORMER MODULE

14. BRUSH GEAR ASSEMBLY
15. AUX. CONTROL AND RELAY PANEL DESK
16. INDICATING INSTRUMENT
17. RECORDING INSTRUMENT
18. INTEGRATING INSTRUMENT
19. D.G SET
20. STATION LIGHTING

CONTROL & INSTRUMENTATION

1. Conductivity Measuring Equipment Including Test Procedures
2. pH Analyser Including Test procedure
3. Silica Analyser
4. Level Switch (Float Actuated)
5. Level Switch (Electrode Type)
6. Level Switch (Displacer Actuated)
7. Transmitter (Float Operated Pneumatic Output including Testing procedures
8. Level indicator (Float/Pulley Type)
9. Local Temperature Indicator Including Test Procedure
10. Resistance Thermometer Element Including Test procedure
11. Thermocouple Element and Connecting Cable
12. Thermocouple and Resistance Thermometer Convertor/Transmitter Including Test Procedures
13. Temperature Switch Including Test Procedure
14. Cold Junction Boxes
15. 0_2Analyser
16. SO2 analyzer
17. 0_2 in Hydrogen including Test procedures
18. Pressure and Vacuum Gauge
19. Pressure and Vacuum Switch Including Test procedures
20. Differential Pressure Transmitter including Test Procedures
21. Differential pressure switch including Test procedures
22. Flow indicator (Variable Area)

23. Orifice plate
24. Flow Switch
25. Nozzle
26. Flow Integrator (pneumatic input) including test procedure
27. Flow indicator (Float Operated) Including Test Procedure
28. Venturi (Fluid)
29. Flow Switch (Magnetic Type)
30. Limit Switches
31. Turbine Supervisory Measuring System
32. Position Measurement & Indication Including Test procedures
33. Vibration Measurement
34. Digital Indicator
35. Moving Coil Indicator Including Test Procedures
36. Recorder Including Test procedure
37. Flame Scanner
38. Electrical Auto Manual Control Station
39. Push Button Module
40. Test Procedure for Electronic Modules of DDCMIS
41. Alarm Annunciator Equipment Including Test Procedure
42. Test procedure for Adjustment of Modulating Controller-PID Term
43. Test Procedure Indicating Controller-Electrical Input & Pneumatic Output
44. Density monitors
45.

AIR CONDITIONING & VENTILATION SYSTEM

FIRE FIGHTING SYSTEM

ZERO LIQUID DISCHARGE SYSTEM (IF PROVIDED)

ANNEXURE-II

TESTING / COMMISSIONING PROCEDURES

Following is an indicative list of equipments / systems for which Testing / Commissioning procedures are to be submitted. The actual list will depend on the equipment / system being supplied by the Contractor.

S. No	DESCRIPTION
	FGD
1.	Booster Fan
2.	Absorber System
3.	Limestone grinding system
4.	Absorber system
5.	Gypsum dewatering system
6.	Zero Liquid Discharge System (if provided)

ANNEXURE-III

COMMISSIONING PROCEDURES REQUIRING APPROVAL OF EMPLOYER

S.NO.	DESCRIPTION
1.	AIR & GAS TIGHTNESS TEST
2.	OIL FLUSHING OF LUB OIL SYSTEM OF ROTARY EQUIPMENTS
3.	LIMESTONE GRINDING SYSTEM
4.	GYPSUM DEWATERING SYSTEM

ANNEXURE-IV

BRIEF WRITE UP ON THE CONTENTS OF TESTING / COMMISSIONING PROCEDURE

Testing / Commissioning Procedure is required to be of a standard format in order to maintain consistency of presentation, content and reporting. These should contain the following sections to make the document a self contained one.

1. Plant Details / Design data
2. Objective
3. Proposal
4. Services Required
5. Safety Precautions
6. Emergency Procedures
7. State of the Plant (Status in respect of erection completion of Mech, Elect and C&I items)
8. Method
9. Completion / Acceptance Criteria
10. Appendix
    - Result
    - Log sheet
    - Drawing etc.

NTPC Limited

(A Government of India Enterprise)

NCTPP, DADRI, STAGE-II (2X490MW)
IGSTPP JHAJJAR (3X500MW)

(PART –A)

SECTON – VI

TECHNICAL SPECIFICATION

FOR

FLUE GAS DESULPHURISATION (FGD)

SYSTEM PACKAGE

BIDDING DOCUMENT NO. : CS-6130/0330-109-9

NTPC Limited

(A Government of India Enterprise)

NCTPP, DADRI, STAGE-II (2X490MW)
IGSTPP JHAJJAR (3X500MW)

(PART –A)

SECTON – VI

TECHNICAL SPECIFICATION

FOR

FLUE GAS DESULPHURISATION (FGD)

SYSTEM PACKAGE

BIDDING DOCUMENT NO. : CS-6130/0330-109-9

NCTPP DADRI ST-II (2X490MW) & IGSTPP JHAJJAR (3X500MW)

SECTION - VI

TECHNICAL SPECIFICATION
FOR
FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE

THE TECHNICAL SPECIFICATION, SECTION - VI COMPRISE OF THE FOLLOWING PARTS

PART – A

PART – B (DETAILED TECHNICAL SPECIFICATION)

SUB-SECTION-I-M (MECHANICAL SYSTEM)

SUB-SECTION-I-M1	FLUE GAS DESULPHURISATION SYSTEM
SUB-SECTION-I-M2	AIR CONDITIONING & VENTILATION SYSTEM
SUB-SECTION-I-M3	COMPRESSED AIR SYSTEM
SUB-SECTION-I-M4	FIRE DETECTION & PROTECTION SYSTEM
SUB-SECTION-I-M5	EQUIPMENT COOLING WATER SYSTEM
SUB-SECTION-I-M6	LIME STONE & GYPSUM HANDLING SYSTEM
SUB-SECTION-I-M7	PIPING
SUB-SECTION-I-M8	OPERATION & MAINTENANCE PHILOSOPHY

PART – B (DETAILED TECHNICAL SPECIFICATION)

SUB-SECTION-II-E (ELECTRICAL SYSTEM)

SUB-SECTION-II-E1	GENERAL ELECTRICAL SPECIFICATION
SUB-SECTION-II-E2	MOTORS
SUB-SECTION-II-E3	MEDIUM VOLTAGE BUS DUCTS
SUB-SECTION-II-E4	LT POWER CABLES
SUB-SECTION-II-E5	LT CONTROL CABLES
SUB-SECTION-II-E6	CABLING EARTHING & LIGHTNING PROTECTION
SUB-SECTION-II-E7	HT CABLES
SUB-SECTION-II-E8	ELECTRIC ACTUATORS WITH INTEGRAL STARTERS
SUB-SECTION-II-E9	HT SWITCHGEAR
SUB-SECTION-II-E10	LT SWITCHGEAR & LT BUSDUCT
SUB-SECTION-II-E11	DIESEL GENERATORS
SUB-SECTION-II-E12	OUTDOOR TRANSFORMERS
SUB-SECTION-II-E13	ELEVATOR ELECTRICAL
SUB-SECTION-II-E14	FIRE PROOF CABLE PENETRATION SEALING SYSTEM

SUB-SECTION-V-QM6	COMPRESSOR AIR SYSTEM

(ELECTRICAL)

SUB-SECTION-V-QE1	MOTORS
SUB-SECTION-V-QE2	MEDIUM VOLTAGE BUS DUCTS
SUB-SECTION-V-QE3	LT POWER CABLES
SUB-SECTION-V-QE4	CONTROL CABLES
SUB-SECTION-V-QE5	CABLING EARTHING & LIGHTNING PROTECTION
SUB-SECTION-V-QE6	HT CABLES
SUB-SECTION-V-QE7	ELECTRIC ACTUATORS WITH INTEGRAL STARTERS
SUB-SECTION-V-QE8	HT SWTIGCHGEAR
SUB-SECTION-V-QE9	LT SWTIGCHGEAR
SUB-SECTION-V-QE10	DIESEL GENERATORS
SUB-SECTION-V-QE11	AUXILIARY TRANSFORMERS
SUB-SECTION-V-QE12	ELEVATOR
SUB-SECTION-V-QE13	VFD MODULE
SUB-SECTION-V-QE14	STATION LIGHTING

(CONTROL & INSTRUMENTATION SYSTEM)

SUB-SECTION-V-QC1	MEASURING INSTRUMENTS (PRIMARY & SECONDARY
SUB-SECTION-V-QC2	INSTRUMENTATION CABLES
SUB-SECTION-V-QC3	POWER SUPPLY SYSTEM
SUB-SECTION-V-QC4	DDCMIS
SUB-SECTION-V-QC4	CONTROL VALVE
SUB-SECTION-V-QC5	ELECTRICAL ACTUATOR WITH INTEGRAL STARTERS

(CIVIL WORKS)

SUB-SECTION-V-QD1

SUB-SECTION- VI

(PRE-COMMISSIONING ACTIVITIES, COMMISSIONING OF FACILITIES AND INITIAL OPERATIONS)

PART - C

GENERAL CONDITIONS OF CONTRACT

PART - D

ERECTION CONDITIONS OF CONTRACTS

PART - E

LIST OF TENDER DRAWINGS

PART - F

ATTACHMENT-12 TO SECTION-VII (TECHNICAL DATA SHEETS)

PART – A

SUB-SECTION-I

INTENT OF SPECIFICATION

1.00.00 **INTENT OF SPECIFICATION**

1.01.00 **Scope of the proposal**

The scope of the proposal for Engineering, Supply, Construction, Erection, Testing & Commissioning works for each project of Flue Gas Desulphurisation (FGD) System Package for **NCTPP, Dadri Stage-II (2 X 490 MW)** ~~**& IGSTPP, Jhajjar (3 x500 MW)**~~ Projects shall be on the basis of a single point responsibility, completely covering the following activities and services in respect of all the equipment specified and covered under the specifications and read in conjunction with "Scope of Supply & Services", Sub-section-III, Part-A, Section – VI of Technical Specification.

a) ~~Basic Engineering of the plant including preparation of Plant Definition~~ Manuals for the Project;

b) ~~Detailed design of all the equipment and s~~ystem(s) including civil, structure steel works included in bidder's scope for the Project.

c) Providing engineering drawings, ~~equipment sizing~~ & p~~erformance data~~, ~~instruction manual~~s, as built drawings and other information;

d) Compliance with statutory requirements and obtaining clearances from statutory authorities, wherever required;

e) ~~Complete manufacturing including shop testing/type testing;~~

f) Complete Civil, Structural and Architectural works, including survey, providing construction offices, field laboratory and construction equipments;

g) Packing and transportation from the manufacturer's works to the site including customs clearance & port clearance, port charges, if any.

h) ~~Receipt, storage, preservation, handling and conservation of equipment a~~t the site;

i) ~~Fabrication, pre-assembly, if any, erection, testing, commissioning and completion of facilities including putting into satisfactory operation all the equipment including successful completion of initial operation~~;

j) Reliability tests, performance and guarantee tests after successful completion of facilities;

k) ~~Furnishing of spares on FOR site basis~~;

l) Reconciliation with customs authorities, as required.

m) Satisfactory conclusion of the contract.

n) Insurance and other requirements for the complete FGD package in accordance with the provisions of general conditions of contract (Section-IV) of the bidding document.

o) Operation and Maintenance of FGD system including spares & consumables for the period of 10 years.

1.02.00 The requirements, conditions, appendices etc. given in Technical Specifications (Section-VI, Parts A, B, C, D, E & F and shall apply to and shall be considered as a part of this volume as completely as if bound here with. The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices, etc., stated in Section GCC, which shall be considered as a part of the Technical Specification (Section VI) as completely as if bound herewith. The Contractor shall be responsible for providing all material, equipment and service, which are required to fulfill the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. It is not the intent to specify completely herein, all aspects of design and construction of equipment, nevertheless, the equipment shall conform in all aspects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the Employer, who will interpret the meaning of the specification, drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable international standards mentioned elsewhere in the specification.

Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specification. Before, submitting their offer, Bidder is required to visit the Project site for assessing the feasibility & layout for FGD System. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. In the event of conflict between the Technical Specifications and the Conditions of Contract, the requirements as indicated in the technical specification shall govern, unless confirmed otherwise by the Employer in writing before the award of this contract, based on a written request from the Bidder for such a clarification. However, if the Bidder feels that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

The Bidder may also make alternate offers provided, such offers are superior in his opinion, to the requirements of these specifications in which case, adequate technical information, operating feed back, etc., are to be enclosed with the offer, to enable the Employer to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumption etc., shall be clearly brought out for the Employer to make an overall assessment. In any case, the base offer shall

	necessarily be in line with the specifications. Under no circumstances the specified equipment and services shall be brought out as an alternative offer. In case, all the above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
1.03.00	F**ollowing are the equipment covered in this specification:**
1.03.01	~~Wet limestone based Flue gas desulphurization (FGD) for the project, capable of reducing to the specified limits the emissions of Sulphur Dioxide in flue gas produced by specified coal being fired in boiler, complete with all accessories and auxiliary equipment's as per specification requirements including Booster Fans f~~or each unit, Absorber for each unit with Slurry re-circulation pumps & Oxidation ~~blowers, common Limestone Grinding & slurry preparation system, common Gypsum dewatering system, Limestone handling and storage system, Gypsum~~ handling and storage system.
1.03.02	~~One (1) number of elevator for each absorber and One (1) number of elevator f~~or ~~Limestone Grinding System building~~.
1.03.03	Steel Sheds with side open covering the Slurry re-circulation pumps/Oxidation blowers, Shop fabricated building for Limestone Grinding System and Gypsum dewatering system. Common Shop fabricated building for FGD control Room cum MCC room.
1.03.04	~~All motors, HT & LT Switchgears, DC System, Transformers, Electrical Actuators, HT & LT power & control cables, DG set (if applicable), cabling, lighting e~~tc.
1.03.05	Not used
1.03.06	~~Separate Low Height Wet Chimney(s) or Chimney above absorber arrangement f~~or each project can also be considered as per bidder's proven design. However, the ~~bidder shall furnish the necessary supporting documents in the bid for the chimney above absorber arrangement and the offered design/ arrangement should have been in successful operation in one (1) plant for a period not less than one (1) year prior t~~o the date of Techno-Commercial bid opening.
1.03.07	~~Associated Control & Instrumentation (C&I) equipments.~~
1.03.08	Associated Civil, Structural and Architectural works including foundation as specified in Technical Specification.
1.04.00	Wherever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood to be descriptive only and not restrictive. Such description indicates the equipment type, function and quality desired. Other manufacturer's products may be considered

provided sufficient information so as to enable the Employer to determine that the products proposed are equivalent to those named.

2.00.00 Additional Requirements

(a) Before submitting his bid, the Bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.

(b) Bidder shall take all necessary precautions to protect all the existing equipment, structures, facilities and buildings etc. from damage. In case any damage occurs due to the activities of the contractor on account of negligence, ignorance, accidental or any other reason whatsoever, the damage shall be immediately made good by the contractor at his own cost to the satisfaction of the Employer. The contractor shall also take all necessary safety measures with specific reference to excavation in rock, at his own cost, to avoid any harm or injury to his workers and staff from the equipment and facilities of the power plant.

(c) For his site office and covered store buildings, the contractor shall adopt pre-engineered / pre-fabricated constructions made of steel with single / double skin, insulated or uninsulated roof and wall coverings (fabricated out of permanently color coated metal sheets). Alternatively, contractor can adopt readymade 'Porta cabin' or similar construction. Contractor shall ensure that all such constructions are well engineered, neatly constructed and overall present a pleasing look.

(d) In line with Gazette Notification on Ash Utilization issued by MOEF and its amendment thereafter, contractor shall use ash and ash based products in works as specified in these specifications, drawings and as per instructions of the Engineer. He shall also use ash and ash based products in construction of his offices, stores, staff quarters and labour huts etc. He shall furnish a compliance report along with all details of use of ash and ash based products along with each bill.

(e) Contractor shall establish/set up at site suitable repair facilities for construction plant, equipment and machinery (like piling rigs, cranes batching plant, dewatering pumps etc.) In case of piling rigs, cranes, batching plant etc. he will also make arrangements / tie up with equipment manufacturers / suppliers for periodic overhaul/maintenance and for major breakdown, if any. He shall also keep adequate stock of spares at site for various plant, equipment and machinery to meet day to day requirements as recommended by the equipment manufacturer/suppliers or as instructed by the Engineer. Contractor shall deploy dedicated qualified, full time mechanical/electrical foreman/supervisors for manning the repair facilities as specified above.

3.00.00 **APPLICABLE DRAWINGS**

The drawings listed below and forming part of the specification (Refer Part-E) shall supplement the requirements specified herein. The scope and terminal points of the equipment to be furnished under this FGD package shall be as identified in these drawings and read in conjunction with text of the specification:

(A) SCHEMES

Sl. No	Drawings Title	Drawings No.	Rev. No.	No. of Sheets
1)	Scheme of Absorber system	6130/0330-109-POM-A-001	A	2
2)	Scheme of FGD Milling system	6130/0330-109-POM-A-002	A	1
3)	Scheme of Gypsum De-watering system	6130/0330-109-POM-A-003	A	1
4)	Standard P&ID Diagram for ECW System of FGD	0000-109-POM-A-004	A	1

(B) CONTROL & INSTRUMENTATION

Sl. No.	Drawings Title	Drawings No.	No. of Sheets
1.	Standard configuration diagram for PLC	0000-151-POI-A-013	1
2.	G.A. of Junction Box	0000-999-POI-A-017	1
3.	Instrumentation cabling diagram grounding scheme for cabinets/panels/Power Supply	0000-999-POI-A-019A	2
4.	Scheme of 24V DC Power supply system	0000-999-POI-A-019B	1
5.	Scheme for Uninterruptible	0000-999-POI-A-019C	1

Sl. No.	Drawings Title	Drawings No.	No. of Sheets
	Power Supply System		
6.	Instrumentation/control/power supply cabling diagram	0000-101/102-POI-A-021	3
7.	Instrument Source Connection details	0000-999-POI-A-035	14
8.	Typical GA of Local Instrument Enclosure, purging scheme, DP transmitter	0000-999-POI-A-036	1
9.	Interfacing of actuators	0000-999-POI-A-063	1
10.	Interfacing of field instruments/Electrical interface/PLC Interface	0000-999-POI-A-065	15

(C) ELECTRICAL

Sl. No.	Drawings Title	Drawings No.	No. of Sheets
1.	Electrical single line diagram for FGD System– Dadri	6130/0330-109-POE-J-001/A	1
2.	Electrical single line diagram for FGD System– Jhajjar	6130/0330-109-POE-J-001/B	1

Note : All the above drawings are indicative of Employer's requirements to enable the Bidder to make a suitable offer. All variations/alternations shall be clearly brought out in the technical deviation schedule with implications, if any. Such variations may be acceptable, after assessment of its implication and shall be subjected to the Employer's approval. However, the flexibility of operation and maintenance desired by the schemes and layouts shall be binding.

Electrical drawings (except Electrical single line diagram) are attached with respective Electrical Chapters in Part b, Section VI.

4.00.00 **QUALIFYING REQUIREMENTS FOR EQUIPMENTS/SYSTEMS**

4.01.00 **Provenness criteria for critical equipment, auxiliaries, systems and bought out items:**

The Bidder / Bidder's sub-vendor(s) is required to meet the provenness criteria and/or qualification requirement for critical equipment, auxiliaries, system and bought out items as per criteria stipulated below:

4.01.01 Booster Fans, Slurry Recirculation Pumps, Oxidation Blowers, Wet Limestone Grinding Mills, Slurry Pumps, Agitators & Vacuum Belt Filters for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previously designed (either by itself or under collaboration / licensing agreement), manufactured / got manufactured the respective equipment(s) of the type, application and minimum equipment rating as stipulated below such that the respective equipment(s) should have been in successful operation in at least one (1) plant for a period not less than one(1) year reckoned as on the date of consideration for approval but not later than six months to award date of contract to the Main bidder:

Type and Rating for Qualification

Sl. No.	Name of Equipment	Type of Equipment	Application	Equipment Rating
(a)	Booster Fans	Axial type with variable pitch control	Coal fired power plant	80% of the flow & 100% of the head of the offered Booster Fan with Fan Speed 900 rpm (maximum)
(b)	Slurry Recirculation Pumps	Centrifugal type	Wet Limestone based FGD application in Coal fired power plant	80% of the flow & 100% of the head of the offered Slurry Recirculation Pump
(c)	Oxidation Blowers	Centrifugal/ positive displacement type blower	Wet Limestone based FGD application in Coal fired power plant or any other process application	80% of the flow & 100% of the head of the offered Oxidation Blower
(d)	Wet limestone Grinding mills	Horizontal Wet Ball mill	Wet Limestone based FGD application in Coal fired power plant	80% of the offered Ball mill capacity with pulverizing fineness not less than 90% thru 325 mesh

Sl. No.	Name of Equipment	Type of Equipment	Application	Equipment Rating
(e)	Slurry Pumps	Centrifugal type	Wet Limestone based FGD application or ash slurry application in Coal fired power plant	80% of the flow & 100% of the head of the offered Slurry Pump(s)
(f)	Agitators	Vertical/Horizontal	Wet Limestone based FGD application in Coal fired power plant	Agitator rating not less than that supplied for 500 MW or higher size unit for similar application
(g)	Vacuum Belt filters	Belt type	Wet Limestone based FGD application in Coal fired power plant	80% of the offered Vacuum Belt filter capacity

Bidder shall offer and supply only the type of the above equipment(s) for which he himself or the manufacturer proposed by the bidder for the above equipment(s) is qualified.

The provenness criteria for equipment (Booster Fans) stipulated at Sl. No. 4.01.01 (a) above shall also be considered acceptable provided the rating parameters (i.e., flow, head and rated rpm) is covered within the operating regime of the respective fan performance curve of the reference plant equipment.

The provenness criteria for equipment (Slurry Recirculation Pumps) stipulated at Sl.No.4.01.01 (b) above shall also be considered acceptable provided the rating parameters (i.e., flow and head) is covered within the operating regime of the respective Slurry Recirculation Pump performance curve of the reference plant equipment.

4.01.02 In case the Bidder or the proposed sub-vendor is not manufacturer of proven Booster Fans as per clause 4.01.01 (a) above but is a manufacturer of such equipment for units of at least **200 MW** rating, the Bidder or the proposed sub vendor can manufacture such equipment for **490/500 MW** units also, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who meet the requirements stipulated at clause 1.2 (a) above for the Booster Fans.

4.01.03	A JV / Subsidiary Company formed for manufacturing and supply of equipment(s) as listed at clause no. 4.01.01 above in India, can also manufacture such equipment(s), provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at clause 4.01.01 above (or the technology provider of the qualified equipment manufacturer) for the respective equipment(s). Before taking up the manufacturing of such equipment(s), the bidder/ his sub-vendor(s) must create /have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for such equipment(s). Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/ subsidiary company, at least 26% equity participation in the Indian Joint Venture Company/ Subsidiary Company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such Joint Venture/ Subsidiary or upto the end of defect liability period of the contract, whichever is later.
4.01.04	In case the Bidder or the proposed sub-vendor is not manufacturer of proven Oxidation Blowers as per clause 4.01.01 (c) above but is a manufacturer of Blowers/compressors for minimum 50 NM^3/min capacity, the Bidder or the proposed sub-vendor can also manufacture Oxidation Blowers, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Oxidation Blowers in India with such manufacturer who meet the requirements stipulated at clause 4.01.01 (c) above for the Oxidation Blowers. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments.
4.01.05	**(i)** In case the Bidder or the proposed sub-vendor is not manufacturer of proven Wet limestone Grinding mills as per clause 4.01.01 (d) above but is a manufacturer of dry Grinding mills for power or cement industry of minimum 20 T/h capacity, the Bidder or the proposed sub-vendor can also manufacture Wet limestone Grinding mills, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Wet limestone Grinding mills in India with such manufacturer who meet the requirements stipulated at clause 4.01.01 (d) above for the Wet limestone Grinding mills. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments. In addition, the Bidder along with the qualified equipment manufacturer shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for Wet limestone Grinding mills. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on

demand bank guarantee for INR 10 Million (Indian Rupees Ten Million only) for each project.

OR

(ii) In case, the bidder or proposed sub vendor is not a manufacturer of proven Wet Limestone Grinding Mills as per clause 4.01.01 (d) above, but have designed, manufactured & supplied dry Grinding Ball Tube mills for at least 500 MW pulverized coal fired power plant, the Bidder or the proposed sub-vendor can also manufacture Wet limestone Grinding Mills provided it has a licensing agreement with a Wet limestone Grinding mills manufacturer who meet the requirements stipulated at clause 4.01.01 (d) above for the Wet limestone Grinding mills and provides extended warranty of three (3) years for the Wet Limestone Grinding Mills. In such a case Bidder shall provide an additional on demand bank guarantee for INR 10 Million (Indian Rupees Ten Million only) for each project.

4.01.06 In case the Bidder or the proposed sub-vendor is not manufacturer of proven Agitators as per clause 4.01.01 (f) above but is a manufacturer of Agitators for similar process/duty application in petrochemical or metals and mining industry, the Bidder or the proposed sub-vendor can also manufacture Agitators, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Agitators in India with such manufacturer who meet the requirements stipulated at clause 4.01.01 (f) above for the Agitators. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipments.

4.01.07 In case the Bidder or the proposed sub-vendor is a manufacturer of Slurry Pumps who meets the requirements stipulated at clause 4.01.01 (e) above, the Bidder or the proposed sub-vendor can also manufacture Slurry Recirculation Pumps, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who meet the requirements stipulated at clause 4.01.01 (b) above for the Slurry Recirculation Pumps. Before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.

4.01.08 Before taking up the manufacturing of such equipment(s) as per clause 4.01.02, 4.01.03, 4.01.04, 4.01.05(i), 4.01.06 & 4.01.07 above, the Bidder / its sub vendor(s) must create (or should have created) manufacturing and testing facilities at its works as per Collaborator / licenser's design, manufacturing and quality control system for such equipments duly certified by the Collaborator / licensor. Further, the Collaborator / Licenser shall provide (or should have provided) all design, design

calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipments.

4.01.09 Bidder shall offer and supply only the type of the above equipment(s) for which it, itself or the manufacturer / Collaborator(s) / Licenser(s) proposed by the Bidder for the above equipment(s) is qualified.

4.01.10 The Employer reserves the right to fully satisfy himself regarding capability and capacity of Bidder / its sub-vendor(s) and the proposed arrangement and may prescribe additional requirement before allowing manufacture of the equipment listed above for this contract.

Note to clause 4.01.01

(1) Whenever the term 'coal fired' is appearing above, "Coal" shall be deemed to also include bituminous coal/brown coal/Anthracite Coal/lignite.

4.02.00 **Sub QR for Civil Works:**

4.02.01 [illegible]

Amendment no.1(Technical) (Section VI), Sl no.55
4.02.01 Bidder or its agency should have in past executed civil and structural works for 200 MW or higher capacity Coal based/ Lignite based power plant including earthwork in filling involving mechanical compaction and cutting in hard rock, piling, foundations, Bulk material handling plant involving underground storage hopper and underground tunnels.

4.02.02 Bidder can engage more than one agency, in case the Bidder itself is not able to

Amendment no.1(Technical) (Section VI), Sl no.56
4.02.02 Bidder can engage more than one agency, in case the Bidder itself is not able to meet the requirement at 4.02.01.The agency being engaged for a particular work should have in the past executed such works of 200 MW or higher capacity plant.

4.02.03 ~~For Chimney, Bidder or its agency should have in the past built at least one (1) reinforced concrete chimney of minimum 100m height.~~

4.02.04 In case Bidder or its agency do not meet the requirements at 4.02.01and the Bidder proposes to engage agency (ies) for civil & structural works on work volume basis (except for Chimney), Bidder or its agency (ies) should have executed such works in the past and the annual rate of execution in the reference works should not be less than eighty percent (80%) of the asking rate of such works, (structural steel fabrication & erection, RCC, earthwork in filling involving mechanical compaction

and cutting in hard rock, piling, RCC in underground storage hopper and underground tunnels) for which it is being engaged.

Successful Bidder shall finalize the agency (ies) for each work in consultation with Engineer-in-charge at site before engaging them.

Design agency for Civil & Steel Structural Works:

4.02.05 Bidder or its agency (ies) should have carried out the design and detailed engineering of following works:

(i) Civil & Structural works associated with at least one bulk material handling plant for **200 MW** or higher capacity coal based/Lignite based power plant.

(ii) For Chimney, Bidder or its design agency (ies) should have carried out design & detailed engineering of at least one reinforced concrete chimney with steel flues, of minimum 100m height.

(iii) Machine foundations such as Mill foundations/ Block foundations.

4.02.06 Bidder can engage more than one agency (of repute), in case the Bidder itself is not able to meet the requirement at 4.02.05.

The design agency (ies) proposed by the Bidder shall be subject to Employer's approval.

~~**4.03.00 PROVENNESS CRITERIA FOR ELECTRICAL EQUIPMENTS**~~

4.03.01 HT MOTORS

~~4.03.01.01 **BOOSTER FAN MOTOR**~~

The offered Squirrel cage Induction motor shall be from such a Manufacturer who has manufactured and supplied motor of 4MW or above rating, which should have been in successful operation for at least one (1) plant for a period not less than one (1) year reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.

~~**4.03.02 LT SWITCHGEAR**~~

4.03.02.01 ROUTE 1

4.03.02.01 (i) Bidder/ Sub Vendor should have manufactured and supplied at least a total of four hundred & fifty (450) nos. draw out type Air Circuit Breaker Panels and / or draw out type Motor Control Centre Panels with fault rating of at least 45kA for 1 second and 105kA peak under a single order and these panels should have been in successful operation for a period of not less than two (2) years reckoned as on

	the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.02.01	(ii) Bidder/ Sub Vendor should have manufactured and supplied at least one hundred & fifty (150) nos. of Air Circuit Breakers having fault rating of at least 105kA MAKING and 45kA BREAKING, and their associated draw out type Air circuit breaker panels having fault rating of at least 45kA for 1 Second and 105kA peak, which should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.02.02	**ROUTE 2**
4.03.02.02	(i) Bidder/Sub-vendor should have manufactured and supplied at least a total of two hundred & twenty five (225) nos. draw out type Air Circuit Breaker Panels and / or draw out type Motor Control Centre Panels with fault rating of at least 45kA for 1 second and 105kA peak under a single order and these panels should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.02.02	(ii) Bidder/Sub-vendor should have manufactured and supplied at least seventy five (75) nos. of draw out type Air Circuit Breaker panels having fault rating of at least 45kA for 1 second and 105kA peak, which should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.02.02	(iii) Bidder/Sub-vendor shall Associate/Collaborate with a manufacturer who meets the requirements stipulated in Route 1. In such a case, Bidder/Sub-vendor should furnish a Deed of Joint Undertaking executed by Bidder/Sub-vendor and its Associate/Collaborator as per the format enclosed in the bidding document in which the Bidder/Sub-vendor and its Associate/Collaborator are jointly and severally liable to the Employer for successful performance of the LT Switchgears under this package. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 1 Million (Indian Rupees One Million only) **per project.** **Note:** Each Single Front Panel shall be counted as one (1) Panel, Double Front Panel as one (1) Panel and Air Circuit Breaker Panel as one (1) Panel.

4.03.03	**11 KV / 3.3 KV SWITCHGEARS**
	Route 1
4.03.03.01	The Bidder/ Sub Vendor should have manufactured and supplied on an average one hundred (100) numbers of 11kV and /or 6.6kV Switchgear panels per annum during the last three years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.03.02	The Bidder/ Sub Vendor should have designed, manufactured and supplied at least one hundred (100) numbers of 11kV and /or 6.6kV Switchgear panels complete in all respects with fault rating of at least 40kA for one (1) second and 100kA (peak), which should have been in successful operation for a period of at least two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.03.03	The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) numbers of Vacuum Circuit Breakers for 11kV and /or 6.6kV panels with a rating of 40kA rms BREAKING, 100kA peak MAKING and 40kA withstand for one (1) second, which should have been in successful operation in 6.6kV or higher voltage application for a period of at least two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
	Route 2
	Bidder/ Sub Vendor based on technological support of its Associate or Collaborator, can also participate provided
4.03.03.04	The Bidder/ Sub Vendor should have manufactured and supplied on an average one hundred (100) numbers of 11kV and /or 6.6kV Switchgear panels per annum during the last three years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.03.05	The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) numbers of 11kV and /or 6.6kV Switchgear panels complete in all respects with fault rating of at least 40kA for one (1) second and 100kA (peak). The Bidder/ Sub Vendor should have type tested the offered type of panels as specified.
4.03.03.06	The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) numbers of Vacuum Circuit Breakers for 11kV and /or 6.6kV panels with a rating of 40kA rms BREAKING, 100kA peak MAKING and 40kA withstand for one (1) second, reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.

4.03.03.07	Bidder's/ Sub Vendor's Associate or Collaborator meets the qualifying requirement stipulated at 4.03.03.02 & 4.03.03.03 stipulated under Route 1.
4.03.03.08	Bidder/ Sub Vendor furnishes a Deed of Joint Undertaking jointly executed by it and its Associate/ Collaborator as per format enclosed in the bidding document in which the Bidder/ Sub Vendor and its Associate/ Collaborator are jointly and severally liable to the Employer for successful performance of the MV Switchgears. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 1 Million (Indian Rupees One Million only) **per project.** **Note:** Equipment designed by the Bidder itself or through its Collaborator/Associate for reference plant, shall also be considered meeting the requirement of design.
4.03.04	**NUMERICAL RELAYS & NETWORKING**
4.03.04.01	Numerical Relays shall be offered from a Manufacturer who has manufactured and supplied and successfully configured at least 100 No's of Numerical Relays with IEC 61850 used for application in Feeder Protections/Transformer Protections/Motor Protections. These relays should have been in successful operation for at least one (1) year reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.04.02	The Numerical Relay Network system shall be offered from an Integrator /Manufacturer who has designed and successfully done FAT for a network on IEC 61850 with at least 100 no's of Communicable Numerical Relays reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.03.05	**AUXILIARY OIL FILLED TRANSFORMERS**
4.03.05.01	The Bidder/ Sub-Vendor should have manufactured & supplied at least two numbers (one each at two different installations) of 16 MVA, 11KV or higher rating oil filled transformers which should have been in successful operation for a period of at least two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder. **And**
4.03.05.02	Bidder/ Sub-Vendor should have his own facilities for conducting all routine and type tests as per IS: 2026 (except short circuit test). **And**

4.03.05.03	16 MVA, 11 KV Class or higher rated oil filled transformer manufactured by Bidder/ Sub-Vendor should have been successfully short circuit tested. **Note**: i) Two different installations mean two different project sites or two different contracts. ii) Equipment designed by the Bidder/Sub-vendor by itself or through its Collaborator/Associate for reference plant, shall also be considered meeting the requirement of design.
4.04.00	**Not used**
4.05.00	**Not Used**
4.06.00	**Agency for Wet Stack Flow Model Study** Wet Stack Flow Model Study shall be carried out by an agency which has successfully performed at least two (2) flow model studies, in separate coal fired power plants, of wet stack installed after wet limestone based FGD Absorber (without reheating of cleaned flue gas), and based on the studies developed at least two (2) wet stack liquid collection systems which are in successful operation for a period of at least two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
4.07.00	**Balance equipments/ systems** The Bidder at his option can source the balance of plant equipment/systems not covered in clause 4.01.00, 4.02.00**,** 4.03.00, 4.04.00, 4.05.00 & 4.06.00 above. However for such balance of plant equipment/systems, the Employer reserves the rights to satisfy himself on the provenness of the equipment and capability and capacity of the manufacturers.
4.08.00	Notwithstanding anything stated above, the Employer reserves the right to assess the capabilities and capacity of the Bidder/his collaborators/ licenser/ his sub-contractors to perform the contract, should the circumstances warrant such assessment in the overall interest of the Employer.
4.09.00	To enable the approval of sub-vendors, the Bidder shall provide all necessary data such as type, design, make, capacity, duty conditions, date of commissioning/ operation etc.

SUB-SECTION-IIA

PROJECT INFORMATION – JHAJJAR

INDIRA GANDHI STPP, JHAJJAR (3X500 MW)

1.00.00 BACKGROUND

A memorandum of understanding was signed on 24th August 2006 between National Thermal Power Corporation Ltd. (NTPC), Haryana Power Generation Corporation Ltd. (HPGCL) and Indraprastha Power Generation Co. Ltd. (IGPCL), A Govt. of NCT of Delhi Undertaking, for the development of 1500 MW Coal Based Power Plant in the State of Haryana. The allocation of power would be made in the ratio of 50:50 between Haryana and Delhi. The Plant shall be set up by NTPC on concept to commissioning basis for the exclusive use of Delhi and Haryana on long-term management contract of at least 25 years on terms to be decided. The total management control of the power plant from concept to commissioning and subsequently its operation shall remain with NTPC

1.01.00 **LOCATION AND APPROACH**

The proposed power project 'JHAJJAR JOINT VENTURE POWER PROJECT (3X500 MW)' shall be located between Goria, Mohan Bari, jharli and Khanpur Khurd in Jhajjar District at a Latitude $28^0$29' 04" N and Longitude 76^0 22' 35"E respectively. The nearest railhead, Jharli (Jhajjar) is at a distance of 1.5 Kms on Rewari-Hissar Broad Gauge section of North Western Railway from the project site. Sudhrana Railway Station is located about 5 Kms away from the site. The site is connected to Delhi, Rewari and Hissar by the State Highway and is situated at a distance of about 90 Kms from Delhi. The nearest airport, Delhi, is about 80 Kms from the project site.

Vicinity Plan of the project is placed at **Exhibit No. 1.**

1.02.00 **LAND**

Land comprising of about 2065 acres for plant & associated facilities, located between Goria, Mohan Bari, jharli and Khanpur Khurd in Jhajjar District have been identified for development .

1.03.00 **WATER**

Governments of Haryana vide letter dated 22.09.1988 accorded in-principle commitment of 150 cusecs of water from JLN feeder operating in roaster of 16 days in 32 days period from the common pool of WJC system for the proposed project.

QUALITY OF WATER

The analysis of DM water which will be supplied by the Owner for the purpose of make-up to condenser is given at **Annexure- 3**.

1.04.00 **COAL AVAILABILITY AND COAL TRANSPORTATION**

1.05.01 **Coal Availability**

Ministry of Coal vide letter dtd. 22.09.06 has been requested to accord long term coal linkage of 8.0MTPA.

1.05.02 **Coal Transportation**

The envisaged mode of coal transportation from the coalmines to the power plant is by Indian Railways rakes in BOBR wagons/BOX-N wagons. Railway Board, Ministry of Railways has conveyed the possible long term rail linkage from South East Central Railway and railway siding connecting Jharli/Sudhrana railway station and plant. for this stage of the project.

1.06.00 **CAPACITY**

3x500MW (1500 MW) - Proposed for this stage.

1.07.00 **METEOROLOGICAL DATA**

The Meteorological data from the nearest observatory obtained is enclosed as at **Annexure-4.**

1.08.00 **Plant Water Scheme**

The Plant water scheme is described below :

1.08.01 **Condenser Cooling (CW) Water System**

It is proposed to provide recirculating type CW system with natural draft type cooling towers. For the re-circulating type CW system, it is proposed to supply clarified water as makeup. CW system shall be operated at a C.O.C. of about 5.0 with chemical treatment. The expected circulating water analysis is given in Annexure -1 of this sub-section. For carrying circulating water from CW pump house to TG area and from TG area to cooling tower, steel lined concrete encased duct with would be provided. For interconnecting CW duct with CW pump, condenser and cooling towers, steel pipes would be used. Cooled water from cooling tower will be led to CW pump house through the cold water channel by gravity.

1.08.02 **Equipment Cooling Water (ECW) System (Unit Auxiliaries)**

The plant auxiliaries of Steam Generator shall be cooled by Demineralised water (DM) in a closed circuit. The primary circuit DM water shall be cooled through plate type heat exchangers by Circulating Water tapped from CW system in a closed secondary circuit. The hot secondary circuit cooling water shall be cooled in the cooling towers and shall be returned back to the system.

2.00.00 Station Auxiliaries Cooling Water System

The station auxiliaries such as air compressors, compressors of ash handling plant, cooling water circuit of air conditioning systems of main plant & service building etc shall be cooled by a separate cooling water system using separate set of pumps and cooling towers.

3.00.00 **Ash Water System**

(a) It is proposed to operate ash water system in a closed circuit. The ash water from the ash dyke shall be recirculated. During re-circulation mode, the make up to the ash water system (to compensate for the ash water blow down and evaporation loss in ash dyke) shall be supplied from CW Blow down..

(b) During initial stage when decanted ash water is not available, the ash water system shall be operated in once through mode and make up water to ash water system shall be given from the raw water reservoir.

(c) Considering total ash handling plant water requirement of 3750Cu.M/hr. (excluding the water required for cooling of air compressors and vacuum pumps but inclusive of seal water of ash slurry pumps during re-circulation mode operation, it is expected that about 3585M³/hr of decanted ash water shall return to the ash handling system after accounting for evaporation loss.

4.00.00 **Other Miscellaneous Water Systems**

(a) CW system blow down water shall be used for the plant service water requirement, dust suppression system of coal handling plant, ash slurry pumps sealing, make-up to ash handling plant, make-up to fire water storage tanks. The service (wash water) water collected from various areas shall be treated using oil water separators, tube settlers, coal settling pits etc. as per requirement and treated water from liquid effluent treatment plant shall be recycled back to the service water system for re-use. The excess service water shall be led to central monitoring basin for disposal.

(b) Separate water Pre-treatment plants are proposed for Circulating water (PT-CW) system, Demineralisation Plant (PT-CW) plant and potable (PT-Pot) water systems.

(c) The drinking water requirement of the plant and colony shall be provided from the above mentioned water (PT-Pot) pretreatment plant

(d) Steam Cycle make-up water, makeup to the primary circuit of ECW (unit auxiliaries) system, boiler fill water and makeup to the hydrogen generation plant shall be provided from Demineralising plant.

(e) The quality of filtered (potable) water and DM water is given in Annexure -2 & 3 of this sub-section.

5.00.00 **Criteria for Earthquake Resistant Design of Structures and Equipment**

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete Structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B$/ V_B. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

APPENDIX– I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration (MCE)	: 0.16g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	

a)	for special moment resisting steel frames designed and detailed as per IS:800	: 0.04
b)	for special concentrically braced steel frames designed and detailed as per IS:800	: 0.03
c)	for special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.024
d)	for RCC chimney	: 0.08
e)	For Liquid retaining tanks	:0.048
f)	for Steel chimney, Absorber tower, Vessels	: 0.06
g)	for design of structures not covered under 2 (a) to 2 (f) above and under 3 below in general (excluding special structure/ configuration/materials)	: 0.04
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.08

Note:

1.g = Acceleration due to gravity

2.For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS (In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0.000	1.000	1.000	1.000
0.030	1.000	1.000	1.000
0.031	1.034	1.027	1.021
0.050	1.690	1.522	1.379
0.060	2.038	1.768	1.546
0.070	2.387	2.007	1.704
0.080	2.738	2.239	1.853
0.086	2.949	2.377	1.940
0.088	3.020	2.422	1.968
0.090	3.090	2.467	1.996
0.095	3.267	2.579	2.065
0.098	3.373	2.646	2.106
0.100	3.443	2.690	2.133
0.103	3.550	2.757	2.173
0.108	3.727	2.866	2.238
0.110	3.798	2.910	2.264
0.112	3.869	2.953	2.290
0.115	3.975	3.018	2.328
0.118	4.081	3.082	2.366
0.121	4.188	3.147	2.404
0.122	4.224	3.168	2.417
0.125	4.330	3.232	2.454
0.127	4.402	3.274	2.478
0.130	4.510	3.338	2.515
0.132	4.510	3.380	2.539
0.133	4.510	3.401	2.551
0.134	4.510	3.422	2.564
0.140	4.510	3.550	2.635
0.145	4.510	3.550	2.694
0.150	4.510	3.550	2.750
0.200	4.510	3.550	2.750
0.250	4.510	3.550	2.750
0.300	4.510	3.550	2.750

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0.350	4.510	3.550	2.750
0.400	4.510	3.550	2.750
0.431	4.510	3.550	2.750
0.442	4.510	3.550	2.750
0.450	4.510	3.550	2.750
0.474	4.510	3.550	2.750
0.488	4.510	3.550	2.750
0.500	4.510	3.550	2.750
0.517	4.510	3.550	2.750
0.525	4.510	3.550	2.750
0.542	4.510	3.550	2.750
0.550	4.510	3.550	2.750
0.562	4.510	3.550	2.750
0.576	4.510	3.550	2.750
0.588	4.510	3.550	2.750
0.597	4.510	3.550	2.750
0.603	4.510	3.550	2.750
0.609	4.510	3.550	2.750
0.615	4.510	3.550	2.750
0.625	4.510	3.550	2.750
0.640	4.510	3.550	2.750
0.650	4.510	3.550	2.750
0.658	4.456	3.550	2.750
0.667	4.396	3.550	2.750
0.670	4.376	3.550	2.750
0.700	4.188	3.550	2.750
0.710	4.130	3.500	2.750
0.750	3.909	3.313	2.750
0.755	3.883	3.291	2.731
0.800	3.665	3.106	2.578
0.850	3.449	2.924	2.426
0.900	3.258	2.761	2.291
0.950	3.086	2.616	2.171
1.000	2.932	2.485	2.062

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
1.050	2.792	2.367	1.964
1.100	2.665	2.259	1.875
1.150	2.550	2.161	1.793
1.200	2.443	2.071	1.718
1.250	2.346	1.988	1.650
1.300	2.255	1.912	1.586
1.350	2.172	1.841	1.527
1.400	2.094	1.775	1.473
1.450	2.022	1.714	1.422
1.500	1.955	1.657	1.375
1.550	1.892	1.603	1.330
1.600	1.833	1.553	1.289
1.650	1.777	1.506	1.250
1.700	1.725	1.462	1.213
1.750	1.675	1.420	1.178
1.800	1.629	1.381	1.146
1.850	1.585	1.343	1.115
1.900	1.543	1.308	1.085
1.950	1.504	1.274	1.057
2.000	1.466	1.243	1.031
2.050	1.430	1.212	1.006
2.100	1.396	1.183	0.982
2.150	1.364	1.156	0.959
2.200	1.333	1.130	0.937
2.250	1.303	1.104	0.916
2.300	1.275	1.080	0.897
2.350	1.248	1.057	0.877
2.400	1.222	1.035	0.859
2.450	1.197	1.014	0.842
2.500	1.173	0.994	0.825
2.550	1.150	0.975	0.809
2.600	1.128	0.956	0.793
2.650	1.106	0.938	0.778
2.700	1.086	0.920	0.764

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
2.750	1.066	0.904	0.750
2.800	1.047	0.888	0.736
2.850	1.029	0.872	0.724
2.900	1.011	0.857	0.711
2.950	0.994	0.842	0.699
3.000	0.977	0.828	0.687
3.050	0.961	0.815	0.676
3.100	0.946	0.802	0.665
3.150	0.931	0.789	0.655
3.200	0.916	0.777	0.644
3.250	0.902	0.765	0.634
3.300	0.888	0.753	0.625
3.350	0.875	0.742	0.616
3.400	0.862	0.731	0.606
3.450	0.850	0.720	0.598
3.500	0.838	0.710	0.589
3.550	0.826	0.700	0.581
3.600	0.814	0.690	0.573
3.650	0.803	0.681	0.565
3.700	0.792	0.672	0.557
3.750	0.782	0.663	0.550
3.800	0.772	0.654	0.543
3.850	0.762	0.645	0.536
3.900	0.752	0.637	0.529
3.950	0.742	0.629	0.522
4.000	0.733	0.621	0.516

6.00.00

Criteria for Wind Resistant Design of Structures and Equipment

All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures : 1.6%

d) Steel stacks : As per IS:6533 & CICIND Model Code whichever is more critical.

ANNEXURE-B

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "V_b" at ten metres above the mean ground level : 47 metres/second

b) The risk coefficient "K_1" : 1.07

c) Category of terrain : Category-2

7.00.00 **FOUNDATION SYSTEM AND GEOTECHNICAL DATA**

7.00.01 Geotechnical data and foundation system for the respective project are enclosed at annexure-I. The corresponding bore logs are enclosed at annexure-II.

7.00.02 The available geotechnical data is of vicinity to proposed structures, therefore, bidder shall carryout his own detailed geotechnical investigation for facilities under this package and shall be as per the scheme approved by owner**.** The scheme for geotechnical investigation shall be as given at Clause 7.07.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.00.03 The Bidder should note that nothing extra whatsoever on account of variation between geotechnical data furnished by Owner and that found by the contractor during geotechnical investigation by him or during execution of works, shall be payable.

7.00.04 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, if any.

b) Entire loose/ soft 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.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent Clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 **General Requirements**

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

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.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) No foundation shall rest on the black cotton soil.

e) Before execution of work the bidder shall ensure that there is no obstruction to underground/overground facilities like sewer lines, pipe lines etc. Any such damage and remedial/ rectification measures shall be at the contractors cost.

f) Bidder shall also ensure that there is no damage to existing nearby foundations and the foundations pertaining to this package are not placed at shallower depth than the nearby foundations. If required depth of foundation is deeper than the existing foundations, proper protection shall be provided to existing foundations.

g) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

h) The water table for design purpose shall be considered at Finished Ground Level.

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

j) Foundation for equipment on ground floor

For equipment of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall 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 4T/m2. 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 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block 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 pedestal for the full depth of the floor slab.

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 (1:4:8) up to designed foundation level.

7.02.03 Pile Foundations –

(a.) 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/conventional tripod rig. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

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 as per approved geotechnical report & as enclosed in relevant annexure:

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

iv) The Contractor 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 test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) 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.

vi) 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.

Uplift

vii) 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).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout 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.

ix) 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.

x) 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.

xi) 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.

xii) 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.

xiii) 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 with concrete blocks.

xiv) 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.

xv) Either of Static routine load test or High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least two numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

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 as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.03.00	**Special Requirements**
7.03.01	Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.
7.04.00	**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 any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. 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 80% of relative density for non-cohesive soils Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.04.04	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.
7.04.06	The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides. Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.
7.05.00	**EXCAVATION IN ROCK** Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialized agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02

a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 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 while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.07.00 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.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 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), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 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. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03	The minimum tests are indicated in Clause No. 7.08.00. 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.
7.07.02.04	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.
7.07.02.05	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 geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc. Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.
7.07.03.00	Geotechnical investigation work shall be got executed by the Contractor through the following agencies. 1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata 2. Cengrs Geotechnica Pvt. Ltd, New Delhi 3. M.K. Soil Testing Laboratory, Ahmedabad 4. SECON Pvt. Ltd, Bangalore 5. Soil Engineering Consultants, New Delhi 6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack

7. KCT Consultancy Services, Ahmedabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 **Geotechnical Investigation Scheme**

a) **Boreholes (Minimum)**

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	FGD	Minimum 14 Nos.	Depth of boreholes shall be 30m to 35m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 25% whichever is earlier.
2	Crusher House	Minimum 2 Nos.	Depth of boreholes shall be 30m to 35m.	
3	Gypsum and Lime storage area	Minimum 10 Nos.	Depth of boreholes shall be 15m to 25m	
4	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
5	Chimney	Minimum 2 Nos.	35 to 40m	

b) Other Field Tests (Minimum)

1.	Cyclic Plate Load Test (CPLT)	3 nos.	Test Depth from 2 to 4 m	
2.	Trial Pit (TP)	5 Nos.	Depth - 3 m	
3.	In Situ Permeability Test in Boreholes	In minimum 3 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m,	

			8.0m and 12.0m.	
4.	ERT	Minimum 10 Nos.		

- Depth and location of Boreholes and other field tests (PLT, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

Annexure-I (Jhajjar)

SOIL DATA AND FOUNDATION SYSTEM

Employer has carried out geotechnical investigation in vicinity to the proposed area. Logs of representative boreholes for bidder's information in the vicinity of proposed area are enclosed with this Annexure. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The natural ground level is varying as per enclosed contour/spot level drawing.

The bidder is required to carry out his own detailed geotechnical investigation as per Clause No 7.08.00 and ascertain the pile capacity and bearing capacity.

a) The foundation system to be adopted for different structures shall be as given in Table – 1 below

Table – 1: Net Allowable Bearing Pressure

STRUCTURE	TYPE OF FOUNDATION TO BE ADOPTED
FGD and related structures	Open/Piles

b) Bidder is required to carry out geotechnical investigation in this area. The allowable bearing pressure shall be adopted after approval of geotechnical investigation report by owner. However, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-2.

Table – 2: Net Allowable Bearing Pressure

Founding Depth/ Stratum	Net Allowable Bearing Pressure(T/m^2)		
	Isolated and combined footings including raft for 25mm permissible settlement	Isolated and combined footings for 40mm permissible settlement	Rafts (width > 6m) for 75mm permissible settlement
	Width upto 6.0m		
2.5m below NGL	8	12	15
3.5m below NGL	10	15	18

4.5m below NGL	12	18	20

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

c) Permissible Settlement of Foundations:

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

Isolated, Strip & Raft (Mill foundations/machine foundation)	25 mm
Isolated & Strip (Other than Mill foundations/machine foundation)	40 mm
Raft (widths greater than 6 m) (Other than Mill foundations/machine foundation)	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

d) The diameter of pile, minimum length and maximum allowable capacity of piles shall be as given below:

Area/ Location	Pile Diameter (mm)	Minimum Length of Bored Pile Below Cut-off Level (m)	Safe Load Capacity in		
			Vertical Comp. (MT)	Pullout (MT)	Lateral (MT)
FGD and related structures	600	23.0	140.0	28.0	7.0
	760	26.0	250.0	50.0	12.5

- Cut off Level (COL) is assumed at 3.0 m below FGL.

e) The criteria for Pile Termination (founding level) shall be as given below:

The termination level of the pile shall be decided based on the following criterion

i) Minimum length of the pile below COL (cut off level) shall be as specified above

ii) The minimum pile length for each group of piles shall be determined based on the nearest borelog. A minimum embedment of 5.0 m and 6.0 m into strata with SPT 'N' greater than 50 for 600 mm dia pile and 760 mm dia pile respectively before termination and at pile termination minimum SPT 'N' shall be 60, while deciding the minimum length of pile. For pile termination, SPT 'N' values shall be used from the nearby borelog data. The boreholes are in the bidder's scope and shall be conducted as per the approved scheme.

iii) However, in no case the length of pile shall be less than the minimum length determined as in (i) or (ii) above whichever is longer, for that pile group.

TABLE – 1
COAL CHARACTERISTICS*

Sl. No.	Characteristics	Unit	Range of 95% Coal supplies			Range of Coal (5%)
			Design Coal	Worst Coal	Best Coal	
1	2	3	4	5	6	7
1.0	**PROXIMATE ANALYSIS** (As received basis)					
1.1	Total Moisture	%	13.00	15.00	10.00	10.00- 16.00
1.2	Ash	%	41.00	45.00	30.00	29.00 - 47.00
1.3	Volatile Matter	%	21.00	18.00	26.00	26.00 - 17.00
1.4	Fixed Carbon	%	25.00	22.00	34.00	35.00 - 20.00
2.0	**ULTIMATE ANALYSIS** (As received basis)					
2.1	Carbon	%	34.05	30.15	46.2	46.85 - 27.8
2.2	Hydrogen	%	3.05	2.90	3.20	3.30 - 2.80
2.3	Nitrogen	%	1.40	0.60	1.70	1.80 - 0.40
2.4	Oxygen (by difference)	%	6.05	5.25	7.30	7.35 - 5.05
2.5	Sulphur	%	0.30	0.50	0.36	0.30 - 0.50
2.6	Carbonates	%	0.85	0.50	1.02	1.10 – 0.35
2.7	Phosphorous	%	0.30	0.10	0.22	0.30 - 0.10
2.8	Total Moisture	%	13.00	15.00	10.00	10.00 - 16.00
2.9	Ash	%	41.00	45.00	30.00	29.00 - 47.00
2.10	Gross Calorific Value (as received basis)	(Kcal/Kg)	3500	3200	4500	4600 - 3000
2.11.	Hard Grove Index		55	50	60	65 – 45
2.12	YGP	(mg/kg)	70	80	60	55 - 85

(Sheet 2 of 2)

Sl. No.	Characteristics	Unit	Range of 95% Coal supplies			Range of Coal (5%)
			Design Coal	Worst Coal	Best Coal	
1	2	3	4	5	6	7
3.0	**ASH ANALYSIS**					
3.1	Silica (SiO_2)	%	58.65	59.00	58.20	56.90 - 59.20
3.2	Alumina (Al_2O_3)	%	28.80	28.00	29.50	30.00 - 27.70
3.3	Iron Oxide (Fe_2O_3)	%	5.50	6.00	4.70	4.50 - 6.50
3.4	Titania (TiO_2)	%	1.80	2.00	1.70	1.50 - 2.10
3.5	Phosphoric (P_2O_5) Anhydride	%	0.70	0.60	0.90	0.95 - 0.40
3.6	Lime (CaO)	%	1.50	1.20	1.90	2.10 - 1.00
3.7	Magnesia (MgO)	%	1.30	1.50	1.20	2.10 - 1.50
3.8	Sulphuric (SO_3) Anhydride	%	0.50	0.60	0.40	0.40- 0.62
3.9	Sodium Oxide (Na_20)	%	0.10	0.08	0.30	0.35 - 0.08
3.10	Balance Alkalies (By Difference)	%	1.15	1.02	1.20	1.20 - 0.90
4.0	**ASH FUSION RANGE (Reducing Atmosphere)**					
4.1	Initial Deformation Temperature (IDT)	°C	1100	1100	1100	1150-1100
4.2	Hemispherical Temperature	°C	1300	1250	1350	1400-1250
4.3	Fusion Temperature	°C	1400	1400	1400	1400-1400

Note : * The above coal data is for information purpose only. For FGD sizing refer Salient Design Data Sub-Section-V of Part-A.

TABLE-2

FUEL OIL CHARACTERISTICS

Sl. No.	Characteristics	Heavy Furnace Oil Grade IS-1593-1982	Low Sulphur Heavy HV Stock (LSHS) IS-11489-1985	Heavy Petroleum Stock (HPS) IS-11489-1985
1.	Total sulphur content	4.5% Max.	1.0% Max.	4.5% Max.
2.	Gross calorific value (Kcal/kg) (Min)	of the order of 10,000	of the order of 10,000	9,500 of 10,000
3.	Flash Point (Min)	66 deg C	66 deg C	72 deg C
4.	Water content by volume (Max)	1.0%	1.0%	1.0%
5.	Sediment by weight (Max)	0.25%	0.25%	0.25%
6.	Asphaltene content by weight (Max.)	2.5%	2.5%	2.5%
7.	Kinematic viscosity in Centistokes at - (Max)	370 at 50deg C	100 at 100deg C	100 at 100deg C
8.	Ash Content by weight (Max.)	0.1%	0.1%	0.1%
9.	Acidity (inorganic)	Nil	Nil	Nil
10.	Pour Point (Max.)	57 deg C	66 deg C	72 deg C
11.	Sodium content	—	—	100 ppm
12.	Vanadium content	25 ppm	25 ppm	25 ppm
13.	Specific heat below pour point (Kcal/Kg °C)		0.65	

TABLE - 3

LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 1460-2000

	Characteristics	LDO
1.	Pour Point (max)	21 °C & 12°C for Summer and Winter respectively
2.	Kinematic viscosity in centistokes at 38 deg.C	2.5 to 15.7
3.	Sediment percent by mass (max)	0.10
4.	Total sulphur percent by mass (max)	1.8
5.	Ash percentage by mass (max)	0.02
6.	Carbon residue (Rans bottom) percent by pass (max.)	1.50
7.	Acidity in organic	Nil
8.	Flash point(Min.)- Pensky Martens	66 deg.C
9.	Copper strip corrosion for 3 hours at 100°C	Not worse than No. 2
10.	Water content, % by volume (max)	0.25

TABLE -4

COOLING WATER ANALYSIS

Constituent	as	ppm
Calcium	$CaCO_3$	690
Magnesium	$CaCO_3$	440
Sodium & Potassium	$CaCO_3$	74.0
Cations	$CaCO_3$	1500
Bicarbonates	$CaCO_3$	900
Chloride	$CaCO_3$	365
Sulphate	$CaCO_3$	235
Anions	$CaCO_3$	1500
Silica	$CaCO_3$	40
Iron	Fe	<1.5 mg/lt
pH Value	-	8.5-8.8
Turbidity(NTU)		<50.0
Organic Matter	(As $KMnO_4$)	Nil(<0.2 mg/lt)

Note: The C.W. system is expected to operate at about 5.0 Cycles of Concentration with suitable chemical treatment program using acid, scale & corrosion inhibitor dozing. As CW blowdown water is tapped from CW system, the values of constituents indicated in table are to be considered for CW blowdown water.

TABLE -5

CLARIFIED WATER ANALYSIS

Constituent	as	ppm
Calcium	$CaCO_3$	138
Magnesium	$CaCO_3$	88
Sodium & Potassium	$CaCO_3$	14.8
Cations	$CaCO_3$	300
Bicarbonates	$CaCO_3$	180
Chloride	$CaCO_3$	73
Sulphate	$CaCO_3$	47
Anions	$CaCO_3$	300
Silica	$CaCO_3$	8.0
Iron	Fe	<0.3 mg/lt
pH Value	-	7.6-8.2
Turbidity(NTU)		<10.0
Organic Matter	(As $KMnO_4$)	Nil(<0.04 mg/lt)

FILTERED WATER ANALYSIS (Drinking water) -

Same as clarified water except that the turbidity shall be about 2 NTU

TABLE-6

ANALYSIS OF DM WATER TO BE USED FOR MAKE-UP WATER TO CONDENSER

Sl.No.	Characteristics	Value
(i)	Silica (Max)	0.02 ppm as SiO_2
(ii)	Iron as Fe	Nil
(iii)	Total hardness	Nil
(iv)	pH value	6.8 to 7.2
(v)	Conductivity excluding the effects of free CO_2	Not more than 0.1 micro mho/cm

TABLE-7

1.00.00 STEAM GENERATOR DATA

1.	Location	Outdoor
2.	Operation	Base load
3.	Type	Pulveriser coal fired
4.	Maximum Continuous rating	1590 tons/hr
5.	Steam pressure at SH outlet	179 kg/sq.cm(a)
6.	Steam temperature at SH outlet	540^{o} C
7.	Oil for start up and flame stabilization	HFO/LSHS/HPS & LDO
8.	Fuel oil system sizing	30% of boiler MCR for heavy oil/LSHS/HPS & 7.55 for LDO
9.	Pulveriser coal size	Minimum 70% through 200 Mesh and 99% thru 50 mesh
10.	Type of pulveriser	Vertical Spindle mills
11.	Type of oil burners	Steam atomized for HFO/LSHS/HPS & air atomized for LDO
12.	No.of air heaters	Two(2) for Secondary Air & Two(2) for primary air
13.	No.of ID fans	Two(2) – Radial, both working

2.00 ESP DATA

1.	Location	Downstream side of Air preheaters
2.	Operation	Base Load
3.	Type	Rigid Discharge Frame
4.	Rapping	Intermittent

TABLE-8

List of Drawings enclosed in this sub-section:

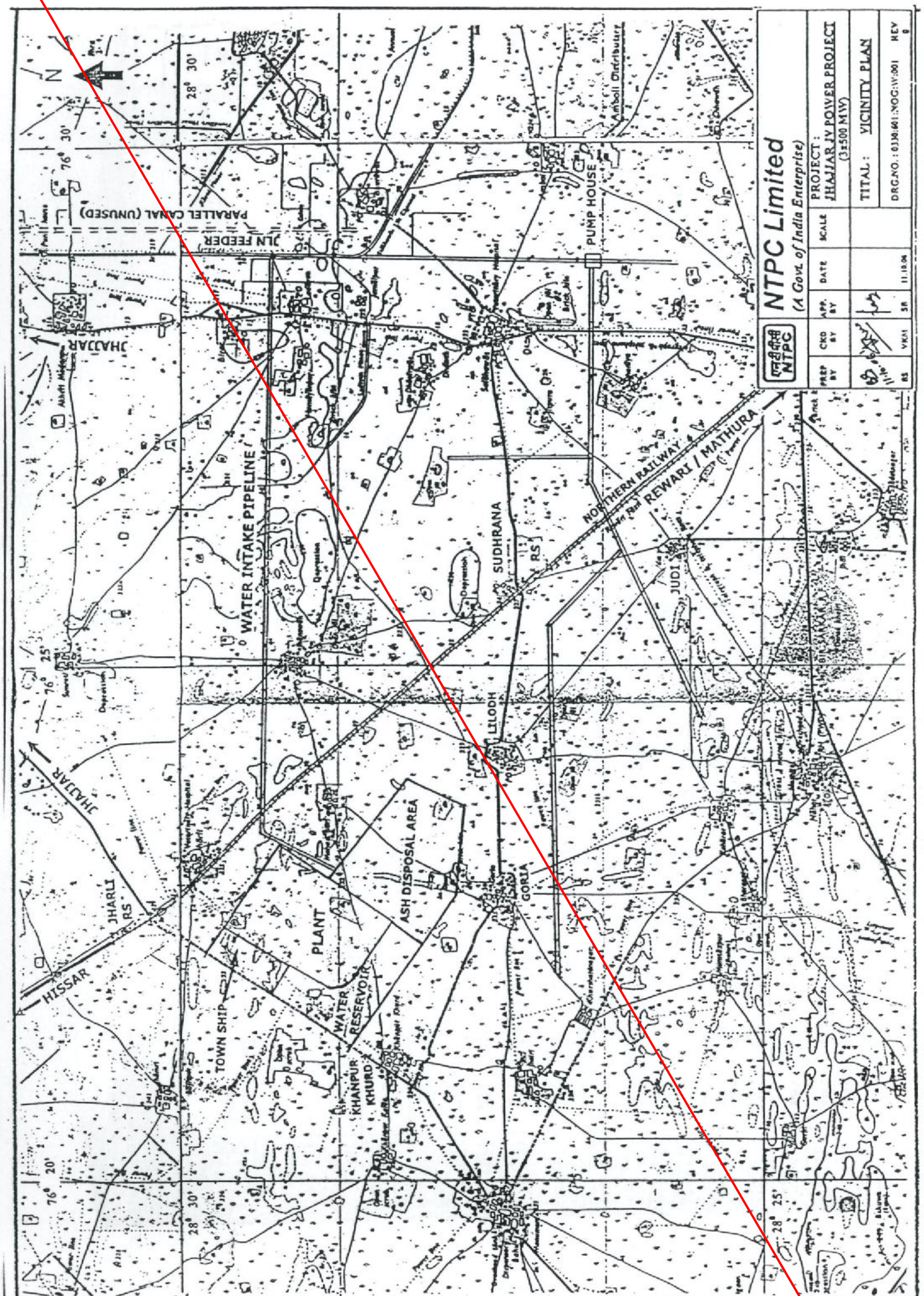
Sl.No.	Drawing Description	Drawing No.
1.	General Layout Plan	0330-999-POC-F-001
2.	Topographical Survey	0330-999-POC-F-001
3.	Main Plant Equipment Layout Plan	0330-999-POM-A-001
4.	ID system-Elevation & Plan Drawings	
a)	LAYOUT OF ID SYSTEM UNIT -1 ELEVATION	0330-101-01-TR-PVM-F-063-SH-1-5-00A
b)	LAYOUT OF ID SYSTEM PLAN UNIIT 1	0330-101-01-TR-PVM-F-063-SH-2-5-00A
c)	LAYOUT OF ID SYSTEM ELEVATION -UNIT-2&3	0330-101-01-TR-PVM-F-063-SH-3-5-02
d)	LAYOUT OF ID SYSTEM PLAN UNIT 2	0330-101-01-TR-PVM-F-063-SH-4-5-00A.
e)	LAYOUT OF ID SYSTEM PLAN UNIT3	0330-101-01-TR-PVM-F-063-SH-5-5-00A
5.	Pipe Cable Trestle Layout/Ash Pipes	1. 0330-999-POM-F-011 Sh1,2 2. 0330-999-POM-F-016 3. 0330-162-PVM-F-017 sh.1&2 4. 0330-162-PVM-F-23 5. 0330-162-PVM-F-25A
6.	In plant BA Slurry pipe line : G.A. & R.C. Details of Pipe Pedestals from BA area to slurry sump	0330-162-PVC-C-046
7.	Pipe Cable Trestle Foundation	1. 0330-315-PEC-C-591-SH1 2. 0330-315-PEC-C-593-SH1

		3. 0330-315-PEC-C-599-SH1,2,3 4. 0330-315-PEC-C-635-SH1 5. 0330-315-PEC-C-637-SH1 6. 0330-315-PEC-C-641-SH1 7. 0330-315-PEC-C-645-SH1

Chimney details

Sl. No.	Project	Chimney shell outer diameter at ground level (m)	Chimney foundation outer diameter (m)	Type of foundation	Level of Top of foundation (m)	Level of Bottom of foundation (m)
1	Jhajjar unit #1	32	44.1	Raft supported on piles	RL(+) 224.50	RL(+) 220.75
2	Jhajjar unit #2&3	34.375	46.66	Raft supported on piles	RL(+) 224.50	RL(+) 220.25

ANNEXURE-I


NTPC Limited
(A Govt. of India Enterprise)
PROJECT : JHAJJAR JV POWER PROJECT (3x500 MW)
TITAL : VICINITY PLAN
PARALLEL CANAL (UNUSED)
JLN FEEDER
JHAJJAR
PUMP HOUSE
WATER INTAKE PIPELINE
SUDHRANA
NORTHERN RAILWAY
REWARI / MATHURA
JUDI
LILLOH
ASH DISPOSAL AREA
GORIA
PLANT
JHARLI RS
HISSAR
TOWN SHIP
WATER RESERVOIR
KHANPUR KHURD

ANNEXURE-II

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन: नई दिल्ली (पालम)(ए) STATION: New Delhi/Palam (A) — अक्षांश LAT 28°34' N देशांतर LONG 77°07' E — माध्य समुद्र तल से ऊँचाई HEIGHT ABOVE M. S. L. 233 मीटर METRES

1952 से 1980 तक के प्रेक्षणों पर आधारित / BASED ON OBSERVATIONS FROM 1952 TO 1980

Month	Station level pressure (hPa)	Air temp. Mean Dry bulb (°C)	Mean Wet bulb (°C)	Mean Daily max (°C)	Mean Daily min (°C)	Mean Highest in the month (°C)	Mean Lowest in the month (°C)	Extremes Highest (°C)	Date and year	Extremes Lowest (°C)	Date and year	Relative humidity (%)	Vapour pressure (hPa)	Cloud amount All clouds (Oktas of sky)	Low clouds (Oktas of sky)	Rainfall Monthly total (mm)	No. of rainy days	Total in wettest month with year (mm)	Total in driest month with year (mm)	Heaviest fall in 24 hours (mm)	Date and year	Mean wind speed (Kmph)
जनवरी JAN I	990.4	8.7	7.4	21.0	6.0	25.4	1.4	27.7	07 1973	-2.2	11 1967	79	6.9	2.5	0.7	14.6	1.3	55.0 1973	0.0	45.5	26 1952	
II	988.1	18.6	12.6									48	9.0	2.5	0.7							
फरवरी FEB I	988.2	11.9	9.5	24.1	8.4	29.6	2.6	33.4	05 1937	-1.6	[illegible]	72	10.3	2.2	0.5	14.1	1.5	89.6 1979	0.0	47.6	20 1979	
II	985.9	22.5	14.4									36	10.1	2.4	0.7							
मार्च MAR I	985.5	16.5	14.2	30.2	13.5	36.0	6.8	39.3	29 1973	3.4	[illegible]	61	12.6	2.3	0.5	9.3	1.0	34.0 1970	0.0	30.0	11 1970	
II	982.7	28.6	17.6									30	10.8	2.3	0.8							
अप्रैल APR I	981.7	26.4	16.0	37.0	20.0	42.0	13.3	45.3	25 1970	8.6	[illegible]	41	13.8	1.9	.4	6.1	0.6	51.1 1977	0.0	22.0	30 1977	
II	978.3	35.6	20.2									21	10.8	2.6	.9							
मई MAY I	977.2	30.8	20.8	40.5	24.4	45.0	15.0	47.2	[illegible] 1978	14.6	[illegible]	33	16.3	1.5	.4	16.9	1.5	74.5 1959	0.0	35.6	24 1976	
II	973.7	36.8	22.3									21	13.0	2.1	1.2							
जून JUN I	973.5	32.1	24.3	40.2	27.5	44.9	23.0	[illegible]	19 1972	19.8	06 1970	[illegible]	24.0	2.7	1.2	54.2	3.5	128.8 1936	7.2 1964	60.0	12 1953	
II	969.7	36.0	24.0									[illegible]	20.8	3.2	1.9							
जुलाई JUL I	973.0	29.2	25.9	35.1	26.2	40.6	22.5	44.5	02 1974	17.8	07 1954	77	30.7	5.3	2.9	241.1	10.9	605.1 1977	39.5 1963	265.8	09 1972	
II	969.9	32.8	25.7									63	29.9	5.5	3.3							
अगस्त AUG I	974.0	27.9	25.5	33.2	[illegible]	37.1	22.6	41.9	03 1972	20.2	30 1958	84	31.4	5.7	3.4	251.3	10.7	540.5 1937	32.6 1979	167.8	03 1957	
II	972.0	31.0	26.7									72	31.3	5.6	2.3							
सितम्बर SEP I	979.2	27.0	24.0	33.7	23.2	36.9	19.8	40.6	02 1979	13.5	23 1972	78	27.3	2.9	1.6	119.4	4.9	347.4 1963	0.2 1953	190.?	16 1963	
II	976.4	31.7	25.1									59	25.9	3.2	2.0							
अक्तूबर OCT I	985.1	23.4	19.1	33.2	18.2	36.6	13.5	39.6	02 1951	9.9	30 1934	65	18.5	1.1	0.5	16.8	1.4	61.3 1959	0.0	34.7	20 1951	
II	982.1	30.1	21.0									42	17.3	1.3	0.7							
नवम्बर NOV I	989.3	16.3	12.7	28.3	11.7	32.1	6.8	35.2	06 1978	2.1	30 1955	64	12.1	1.1	0.2	6.4	0.2	77.7 1972	0.0	75.4	27 1972	
II	985.6	24.4	16.5									41	12.3	1.3	0.2							
दिसम्बर DEC I	990.9	10.4	8.4	22.6	7.0	27.0	2.5	30.0	12 1958	-1.3	30 1973	75	9.3	2.3	0.5	8.6	0.8	69.5 1967	0.0	33.7	03 1957	
II	988.4	19.3	13.6									50	10.7	2.3	0.3							
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN I	982.4	21.9	17.5	31.6	17.6	45.3	1.1	47.2		-2.2		63	15.0	2.6	1.1	754.0	38.3	1363.0	403.0	705.0		
II	979.5	29.3	20.1									43	16.9	2.9	1.3			1967	1965			
वर्षों की सं. NUMBER OF YEARS I	28	28	28	25	25	25	25	25		25		26	22	26	23	22	22	22	22	22		
II	28	28	28									28	22	28	23							

जलवायवी सारणी
CLIMATOLOGICAL TABLE

STATION: Delhi/Palam (A)

SUB-SECTION-IIB

PROJECT INFORMATION - DADRI

NCTPP,DADRI STAGE-II (2X490MW)

1.00.00 BACKGROUND

Details of proposed Stage / Units

Project name	:	NATIONAL CAPITAL THERMAL POWER PROJECT(NCTPP)
Project stage	:	Stage-II
No. of Units x capacity	:	2 X 490 MW
Project setting up by	:	NTPC Ltd.

The SG with ESP package and TG package of the subject project was executed by M/s. BHEL.

1.01.00 LOCATION AND APPROACH

Project Location	:	(i) Place : Dadri
	:	(ii) District : Gautam Budh Nagar
	:	(iii) State : Uttar Pradesh
Latitude and Longitude of project location	:	North : 28 deg. 36' (N) East : 77 deg. 36' 25" (E)
Nearest Railway station	:	Dadri
Distance of project location from the Railway station	:	8.5 KM (Approx.)
Nearest Major Town	:	Dadri
Distance of the town from the Project site	:	6.75 KM
Nearest Commercial Airport	:	Delhi
Distance of airport from the project site	:	70 KM
Nearest Highway	:	National Highway-3&24
Vicinity plan	:	Vicinity plan of the project enclosed at Annexure-I.

	Any other information	:	Further to the information given in this sub-section, Bidders are advised to visit the project site and collect data on local site conditions.
1.02.00	**NOT USED**		
1.03.00	**WATER**		
	Nearest Water Source	:	Upper Ganga Canal system
	Proposed water requirement for the Stage	:	2450 m^3/h considering dry ash disposal system and closed cycle cooling water system using NDCT.
	Proposed source / arrangement to the meet the water requirement	:	Upper Ganga Canal system

1.04.00 **COAL and WATER, Utility details:**

(i) Coal Quality Parameters and Fuel Oil Characteristics

Source: Pachra and Pachra south blocks in North Karanpura coalfields

Requirement: 5 MTPA

The Coal quality parameters and Fuel Oil Characteristics are enclosed at Table-1, & Table-2A & 2B of this Sub-Section.

Water data

(ii) Process water:
Process water quality based on COC in Table-3.

(iii) Clarified water:
Clarified water quality is indicated in Table-3.

(iv) DM water for Equipment cooling water system.
DM water quality is indicated in Table-4.

1.05.00 **Steam Generator and ESP data:** refer Table-5

1.06.00 Drawings are enclosed as per Table-6 for initial overview to the Bidder.

2.00.00 NOT USED

3.00.00 **RAILWAY SIDING**

For bringing the equipment and material to the power house through rail, railway siding is proposed to be constructed from nearest railway station.

4.00.00 **METEOROLOGICAL DATA**

Meteorological data of the nearest observatory Dehri station is enclosed as Annexure-II to this subsection.

5.00.00 **CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a)	Steel structures	:	2%
b)	Reinforced Concrete structures	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	Steel stacks	:	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B$/ V_B. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

APPENDIX – I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration	: 0.24g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	
a)	for special moment resisting steel frames designed and detailed as per IS:800	: 0.06
b)	For special concentrically braced steel frames designed and detailed as per IS:800	: 0.045
c)	for special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.036
d)	for RCC chimney	: 0.12
e)	For Liquid retaining tanks	:0.072
f)	for Steel chimney, Absorber tower, Vessels	: 0.09
g)	for design of structures not covered under 2 (a) to 2 (f) above and under 3 below, in general (excluding special structure/ configuration/materials)	: 0.06
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.12

Notes:

1.g = Acceleration due to gravity
2.For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
(In units of 'g')

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0	1	1	1
0.03	1	1	1
0.05	1.605	1.531	1.413
0.1	3.049	2.729	2.259
0.12	3.61	3.178	2.556
0.124	3.735	3.266	2.621
0.127	3.735	3.332	2.744
0.133	3.735	3.330	2.744
0.2	3.735	3.330	2.744
0.25	3.735	3.330	2.744
0.3	3.735	3.330	2.744
0.35	3.735	3.330	2.744
0.4	3.735	3.330	2.744
0.45	3.735	3.330	2.744
0.5	3.735	3.330	2.744
0.55	3.735	3.330	2.744
0.6	3.735	3.330	2.744
0.622	3.735	3.330	2.744
0.634	3.666	3.330	2.744
0.65	3.575	3.249	2.744
0.667	3.487	3.166	2.744
0.7	3.32	3.017	2.613
0.75	3.099	2.816	2.439
0.8	2.905	2.640	2.286
0.85	2.734	2.485	2.152
0.9	2.582	2.347	2.032
0.95	2.446	2.223	1.925
1	2.324	2.112	1.829
1.05	2.213	2.011	1.742
1.1	2.113	1.920	1.663
1.15	2.021	1.837	1.59
1.2	1.937	1.760	1.524
1.25	1.859	1.690	1.463
1.3	1.788	1.625	1.407

1.35	1.721	1.564	1.355
1.4	1.66	1.509	1.306
1.45	1.603	1.457	1.261
1.5	1.549	1.408	1.219
1.55	1.499	1.363	1.18
1.6	1.453	1.320	1.143
1.65	1.408	1.280	1.108
1.7	1.367	1.242	1.076
1.75	1.328	1.207	1.045
1.8	1.291	1.173	1.016
1.85	1.256	1.142	0.989
1.9	1.223	1.112	0.963
1.95	1.192	1.083	0.938
2	1.162	1.056	0.915
2.05	1.134	1.030	0.892
2.1	1.107	1.006	0.871
2.15	1.081	0.982	0.851
2.2	1.056	0.960	0.831
2.25	1.033	0.939	0.813
2.3	1.01	0.918	0.795
2.35	0.989	0.899	0.778
2.4	0.968	0.880	0.762
2.45	0.949	0.862	0.747
2.5	0.93	0.845	0.732
2.55	0.911	0.828	0.717
2.6	0.894	0.812	0.703
2.65	0.877	0.797	0.69
2.7	0.861	0.782	0.677
2.75	0.845	0.768	0.665
2.8	0.83	0.754	0.653
2.85	0.815	0.741	0.642
2.9	0.801	0.728	0.631
2.95	0.788	0.716	0.62
3	0.775	0.704	0.61
3.05	0.762	0.692	0.6
3.1	0.75	0.681	0.59
3.15	0.738	0.670	0.581
3.2	0.726	0.660	0.572
3.25	0.715	0.650	0.563
3.3	0.704	0.640	0.554
3.35	0.694	0.630	0.546
3.4	0.684	0.621	0.538
3.45	0.674	0.612	0.53
3.5	0.664	0.603	0.523
3.55	0.655	0.595	0.515

3.6	0.646	0.587	0.508
3.65	0.637	0.579	0.501
3.7	0.628	0.571	0.494
3.75	0.62	0.563	0.488
3.775	0.616	0.559	0.485
3.8	0.612	0.556	0.481
3.85	0.604	0.549	0.475
3.9	0.596	0.542	0.469
3.95	0.588	0.535	0.463
4	0.581	0.528	0.457

6.00.00 CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than “5” and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures : 1.6%

d) Steel stacks : As per IS:6533 & CICIND Model Code whichever is more critical.

ANNEXURE-B

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "V_b" at ten metres above the mean ground level : 47 metres/second

b) The risk coefficient "K_1" : 1.07

c) Category of terrain : Category-2

1.00.00 FOUNDATION SYSTEM AND GEOTECHNICAL DATA

7.00.00 Geotechnical data and foundation system for the respective project are enclosed at Annexure-I. The corresponding bore logs are enclosed at annexure-II.

7.00.01 The available geotechnical data is of vicinity to proposed structures, therefore, bidder shall carryout his own detailed geotechnical investigation for facilities under this package and shall be as per the scheme approved by owner**.** The scheme for geotechnical investigation shall be as given at Clause 7.07.00 and shall be approved by owner before execution. Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.00.02 The Bidder should note that nothing extra whatsoever on account of variation between geotechnical data furnished by Owner and that found by the contractor during geotechnical investigation by him or during execution of works, shall be payable.

7.01.03 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, if any.

b) Entire loose/ soft 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.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent Clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 General Requirements

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

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.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) No foundation shall rest on the black cotton soil.

e) Before execution of work the bidder shall ensure that there is no obstruction to underground/overground facilities like sewer lines, pipe lines etc. Any such damage and remedial/ rectification measures shall be at the contractors cost.

f) Bidder shall also ensure that there is no damage to existing nearby foundations and the foundations pertaining to this package are not placed at shallower depth than the nearby foundations. If required depth of foundation

is deeper than the existing foundations, proper protection shall be provided to

For underground facilities survey, Ground Penetration Radar (GPR) may be used.

g) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

h) The water table for design purpose shall be considered at Finished Ground Level.

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

j) Foundation for equipment on ground floor

For equipment of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall 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 4T/m2. 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 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block 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 pedestal for the full depth of the floor slab.

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 (1:4:8) up to designed foundation level.

7.02.03 Pile Foundations –

(a.) 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/conventional tripod rig. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

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 as per approved geotechnical report & as enclosed in relevant annexure:

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

iv) The contractor 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 test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) 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.

vi) 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.

Uplift

vii) 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).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout 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.

ix) 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.

x) 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.

xi) 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.

xii) 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.

xiii) 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 with concrete blocks.

xiv) 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.

xv) Either of Static routine load test or High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least two numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carry out the test shall be submitted to the Engineer. The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner. Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

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 as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.03.00	**Special Requirements**
7.03.01	Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried out by contractor. Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.
7.04.00	**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 any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. 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 80% of relative density for non-cohesive soils Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.04.04	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.
7.04.06	The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides. Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

7.05.00 **EXCAVATION IN ROCK**

Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.

7.05.01 Controlled blasting shall be done by a specialized agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).

7.05.02 a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 **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 while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.07.00 **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.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 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), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 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. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No. 7.08.00. 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.

7.07.02.04 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.

7.07.02.05 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 geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation for different type of structures envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. Cengrs Geotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.N	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	FGD	Minimum 14 Nos.	Depth of boreholes shall be 30m to 35m.	Depth of boreholes shall be as mentioned in column "Depth of Borehole" or
2	Crusher House	Minimum 2 Nos.	Depth of boreholes shall be 30m to 35m.	

3	Gypsum and Lime storage area	Minimum 10 Nos.	Depth of boreholes shall be 15m to 25m	5m continuous in rock with RQD > 25% whichever is earlier.
4	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
5	Chimney	Minimum 2 Nos.	35 to 40m	
b)	**Other Field Tests (Minimum)**			
1	Cyclic Plate Load Test (CPLT)	3 nos.	Test Depth from 2 to 4 m	
2	Trial Pit (TP)	5 Nos.	Depth - 3 m	
3	In Situ Permeability Test in Boreholes	In minimum 3 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
4	ERT	Minimum 10 Nos.		

- Depth and location of Boreholes and other field tests (PLT, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.

- Investigation in any other building / structure / facilities / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

Amendment No.1

Annexure-XIV (Dadri)

SOIL DATA AND FOUNDATION SYSTEM

Employer has carried out geotechnical investigation in vicinity to the proposed area. Logs of representative boreholes for bidder's information in the vicinity of proposed area are enclosed with this Annexure. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The natural ground level is varying as per enclosed contour/spot level drawing.

The bidder is required to carry out his own detailed geotechnical investigation as per Clause No 7.08.00 and ascertain the pile capacity and bearing capacity.

a) The foundation system to be adopted for different structures shall be as given in Table – 1 below

Table – 1: Net Allowable Bearing Pressure

STRUCTURE	TYPE OF FOUNDATION TO BE ADOPTED
FGD and related structures	Open/Piles

b) Bidder is required to carry out geotechnical investigation in this area. The allowable bearing pressure shall be adopted after approval of geotechnical investigation report by owner. However, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-2.

Table – 2: Net Allowable Bearing Pressure

Founding Depth/ Stratum	Net Allowable Bearing PressureT/m2		
	Isolated and combined footings including raft for 25mm permissible settlement	Isolated and combined footings for 40mm permissible settlement	Rafts (width > 6m) for 75mm permissible settlement
	Width upto 6.0m		
2.5m below NGL	-	6	8
3.5m below NGL	-	8	10
4.5m below NGL	8	10	12

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

c) Permissible Settlement of Foundations:

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

Isolated, Strip & Raft (Mill foundations/machine foundation)	25 mm
Isolated & Strip (Other than Mill foundations/machine foundation)	40 mm
Raft (widths greater than 6 m) (Other than Mill foundations/machine foundation)	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

d) The diameter of pile, minimum length and maximum allowable capacity of piles shall be as given below:

Area/ Location	Pile Diameter (mm)	Minimum Length of Bored Pile Below Cut-off Level (m)	Safe Load Capacity in		
			Vertical Comp. (MT)	Pullout (MT)	Lateral (MT)
FGD and related structures	600	25.0	140.0	42.0	7.0
	600	21.0	90.0	27.0	7.0
	760	27.0	250.0	75.0	12.5

- Cut off Level (COL) is assumed at 3.0 m below FGL.

e) The criteria for Pile Termination (founding level) shall be as given below:

The termination level of the pile shall be decided based on the following criterion

i) Minimum length of the pile below COL (cut off level) shall be as specified above

ii) The minimum pile length for each group of piles shall be determined based on the nearest borelog. A minimum embedment of 3 m (for 90MT – 600mm dia) & 5.0 m (for 140 MT – 600mm dia) and 7.0 m (for 250MT – 760mm dia) into strata with SPT 'N' greater than 50 respectively before termination and at pile termination minimum SPT 'N' shall be 60, while deciding the minimum length of pile. For pile termination, SPT 'N' values shall be used from the nearby borelog data. The boreholes are in the bidder's scope and shall be conducted as per the approved scheme.

iii) However, in no case the length of pile shall be less than the minimum length determined as in (i) or (ii) above whichever is longer, for that pile group.

f) **TREATMENT FOR RCC CONSTRUCTION BELOW GROUND LEVEL**

The exposed surfaces of the RCC construction below finished ground level shall be treated against salt attack by applying one coat of bitumen primer and two finish coats of bitumen. This shall be followed by providing of 300mm thick sand jacket all around the foundation concrete surface in contact with soil. The sand shall be compacted with hand rammers or vibratory compactor.

Annexure-I (Dadri)

SOIL DATA AND FOUNDATION SYSTEM

Employer has carried out geotechnical investigation in vicinity to the proposed area. Logs of representative boreholes for bidder's information in the vicinity of proposed area are enclosed with this Annexure. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The natural ground level is varying as per enclosed contour/spot level drawing.

The bidder is required to carry out his own detailed geotechnical investigation as per Clause No 7.08.00 and ascertain the pile capacity and bearing capacity.

a) The foundation system to be adopted for different structures shall be as given in Table – 1 below

Table – 1: Net Allowable Bearing Pressure

STRUCTURE	TYPE OF FOUNDATION TO BE ADOPTED
FGD and related structures	Open/Piles

b) Bidder is required to carry out geotechnical investigation in this area. The allowable bearing pressure shall be adopted after approval of geotechnical investigation report by owner. However, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-2.

Table – 2: Net Allowable Bearing Pressure

Founding Depth/ Stratum	Net Allowable Bearing Pressure(T/m2)		
	Isolated and combined footings including raft for 25mm permissible settlement	Isolated and combined footings for 40mm permissible settlement	Rafts (width > 6m) for 75mm permissible settlement
	Width upto 6.0m		
2.5m below NGL	-	6	8
3.5m below NGL	-	8	10
4.5m below NGL	8	10	12

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

c) Permissible Settlement of Foundations:

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

Isolated, Strip & Raft (Mill foundations/machine foundation)	25 mm
Isolated & Strip (Other than Mill foundations/machine foundation)	40 mm
Raft (widths greater than 6 m) (Other than Mill foundations/machine foundation)	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

d) The diameter of pile, minimum length and maximum allowable capacity of piles shall be as given below:

Area/ Location	Pile Diameter (mm)	Minimum Length of Bored Pile Below Cut-off Level (m)	Safe Load Capacity in		
			Vertical Comp. (MT)	Pullout (MT)	Lateral (MT)
FGD and related structures	600	25.0	140.0	42.0	7.0
	760	27.0	250.0	75.0	12.5

- Cut off Level (COL) is assumed at 3.0 m below FGL.

REFER : Amendment No.1
Annexure-XIV (Dadri)

e) The criteria for Pile Termination (founding level) shall be as given below:

The termination level of the pile shall be decided based on the following criterion

i) Minimum length of the pile below COL (cut off level) shall be as specified above

ii) ~~The minimum pile length for each group of piles shall be determined based on the nearest borelog. A minimum embedment of 5.0 m and 7.0 m into strata with SPT 'N' greater than 50 for 600 mm dia pile and 760 mm dia pile respectively before termination and at pile termination minimum SPT 'N' shall be 60, while deciding the minimum length of pile. For pile termination, SPT 'N' values shall be used from the nearby borelog data. The boreholes are in the bidder's scope and shall be conducted as per the approved scheme.~~

iii) ~~However, in no case the length of pile shall be less than the minimum length determined as in (i) or (ii) above whichever is longer, for that pile group.~~

f) ~~**TREATMENT FOR RCC CONSTRUCTION BELOW GROUND LEVEL**~~

~~The exposed surfaces of the RCC construction below finished ground level shall be treated against salt attack by applying one coat of bitumen primer and two finish coats of bitumen. This shall be followed by providing of 300mm thick sand jacket all around the foundation concrete surface in contact with soil. The sand shall be compacted with hand rammers or vibratory compactor.~~

REFER : Amendment No.1
Annexure-XIV (Dadri)

TABLE-1

COAL CHARACTERISTICS*

Sl. No.	Description	Symbol	Design Coal	Worst Coal	Best Coal	Range of Adequacy Coal
1	2	3	4	5	6	7
A.	**PROXIMATE ANALYSIS** (As received basis)					
1.	Total Moisture	%	13.00	15.00	10.00	10.00-16.00
2.	Ash	%	41.00	45.00	30.00	29.00-47.00
3.	Volatile matter	%	21.00	18.00	26.00	26.00-17.00
4.	Fixed carbon	%	25.00	22.00	34.00	35.00-20.00
B.	**ULTIMATE ANALYSIS** (As received basis)					
1.	Carbon	C%	34.05	30.15	46.2	46.85-27.8
2.	Hydrogen	H2%	3.05	2.9	3.2	2.8-3.3
3.	Nitrogen	N2%	1.4	0.6	1.7	.4-0-1.8
4.	Oxygen (By difference)	O2%	6.05	5.25	7.3	5.5-7.35
5.	Sulphur	S%	0.3	0.5	0.36	0.30-0.50
6.	Carbonates	CO3%	0.85	0.5	1.02	0.35-1.1
7.	Phosphorous	P2%	0.3	0.1	0.22	0.1-0.3
8.	Total Moisture	H2O%	13.00	15.00	10.00	10.00-16.00
9.	Ash	%	41.00	45.00	30.00	29.00-47.00
10.	Gross Calorific Value	KCal/Kg	3500	3200	4500	3000–4600
11.	Hard grove index		55	50	60	45-65
C.	**ASH ANALYSIS**					
1.	Silica	(SiO2)%	58.85	59.00	58.2	59.9-59.2
2.	Alumina	(Al2O3)%	28.8	28.00	29.5	27.7-30
3.	Iron Oxide	(Fe2O3)	5.5	6.00	4.7	4.5-6.5

Sl. No.	Description	Symbol	Design Coal	Worst Coal	Best Coal	Range of Adequacy Coal
1	2	3 %	4	5	6	7
4.	Titania	(TiO2)%	1.8	2	1.7	1.5-2.1
5.	Phosphoric Anhydride	(P2O5)%	.7	.6	.9	.4- .95
6.	Lime	(CaO)%	1.5	1.2	1.9	1.0-2.1
7.	Magnesia	(MgO)%	1.3	1.5	1.2	1.5-2.1
8.	Sulphuric Anhydride	(SO3)%	.5	.6	.4	.6 - .4
9.	Alkalies (By Difference)	(Na2O+K 2O)%	1.15	1.02	1.2	09-1.2

Note: Na_2O content in the above shall not be more than 0.1%

D.	ASH FUSION RANGE (Under reducing atmosphere)					
a)	Initial Deformation Temperature (IDT)	°C	1100	1100	1100	1100-1150
b)	Hemispherical temperature	°C	1300	1250	1350	1250-1400
c)	Flow temperature	°C	1400	1400	1400	1400-1400

Note : * The above coal data is for information purpose only. For FGD sizing refer Salient Design Data Sub-Section-V of Part-A.

TABLE – 2A

FUEL OIL CHARACTERISTICS

Sl. No.	Characteristics	Heavy Furnace Oil grade HV (HFO) IS-1593-1982	Low Sulphur Heavy Stock (LSHS) IS-11489-1985	Heavy Petroleum stock (HPS) IS-11489-1985
1.	Total sulphur content	4.5% Max.	1.0% Max.	4.5% Max.
2.	Gross calorific value (KCal/kg)	of the order of 10,000	of the order of 10,000	of the order of 10,000
3.	Flash Point (Min)	66 deg C	76 deg C	66 deg C
4.	Water content by volume (Max)	1.0%	1.0%	1.0%
5.	Sediment by weight (Max)	0.25%	0.25%	0.25%
6.	Asphaltene content by weight (Max.)	2.5%	2.5%	2.5%
7.	Kinematic viscosity in Centistokes	370 at 50deg C	100 at 100deg C	100 at 100deg C
8.	Ash Content by weight (Max.)	0.1%	0.1%	0.1%
9.	Acidity (inorganic)	Nil	Nil	Nil
10.	Pour Point (Max.)	57 deg C	66 deg C	72 deg C
11.	Sodium content	—	—	100 ppm
12.	Vanadium content	25 ppm	25ppm	25 ppm
13.	Specific heat below pour point (KCal/Kg °C)		0.65	

TABLE – 2B

LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 1460-2000

	Characteristics	LDO
1.	Pour Point (max)	21 deg.C & 12°C for Summer and Winter respectively
2.	Kinematic viscosity in centistokes at 40 deg.C	2.5 to 15.7
3.	Sediment percent by mass (max)	0.10
4.	Total sulphur percent by mass (max)	1.8
5.	Ash percentage by mass (max)	0.02
6.	Carbon residue (Rans bottom) percent by pass (max.)	1.50
7.	Acidity in organic	Nil
8.	Flash point(Min.) - Pensky Martens	66 deg.C
9.	Copper strip corrosion for 3 hours at 100°C	Not worse than No. 2
10.	Water content, % by volume(max)	0.25
11.	GCV (Kcal/kg)	10,000

Table-3

DESIGN CLARIFIED WATER ANALYSIS

S.No	Constituent	As	mg/l (except pH & turbidity)
1.	Calcium	$CaCO_3$	131
2.	Magnesium	$CaCO_3$	52
3.	Sodium + Potassium	$CaCO_3$	65
4.	Total Cations	$CaCO_3$	248
5.	Chloride	$CaCO_3$	20
6.	Sulphate	$CaCO_3$	93
7.	Nitrate	$CaCO_3$	10
8.	Alkalinity	$CaCO_3$	125
9.	Total Anions	$CaCO_3$	248
10.	Iron(total)	Fe	0.3
11.	Total Silica	SiO_2	22
12.	pH value	---	7.0-8.2
13.	Turbidity	NTU	10

Note: Clarified water is used for CW system as make up & the CW system is expected to operate at about 5.0 – 5.5 Cycles of Concentration (COC) with suitable chemical treatment program using acid, scale & corrosion inhibitor dozing. As CW blow down water is tapped from CW system, the water quality of CW blow down shall accordingly be arrived by the bidder.

Table-4

ANALYSIS OF DM WATER

Sl.No.	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as SiO2
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 to 7.2
5.	Conductivity	Not more than 0.1 μs/cm

Table-5

STEAM GENERATOR DATA

1.	Location	Outdoor
2.	Operation	Base load
3.	Type	Pulverised coal fired
4.	Maximum Continuous Rating	1428.4 Tons/hr.
5.	Steam pressure at SH outlet	179 Kg/cm²(a)
6.	Steam temperature at SH outlet	540°C
7.	Oil for start up and flame stabilization	Heavy Oil/LSHS/HPS/LDO
8.	Fuel oil system sizing	30% of Boiler MCR for Heavy oil/ LSHS/HPS (7.5% for LDO)
9.	Pulverised coal size	Minimum 70% through 200 Mesh and 99% thru 50 mesh
10.	Type of pulveriser	Vertical spindle mills
11.	Type of oil burners	Steam atomised for HFO/LSHS/HPS & Air atomised for LDO
12.	No. of air heaters	Two (2) nos. for Primary Air & Two (2) Nos. for Secondary Air
13.	No. of ID Fans	Two (Radial type, both working)

2.00.00 ESP DATA

1.	Location:	Downstream side of Air preheaters
2.	Operation:	Base load
3.	Type:	Rigid Discharge frame
4.	Rapping:	Intermittent

TABLE-6

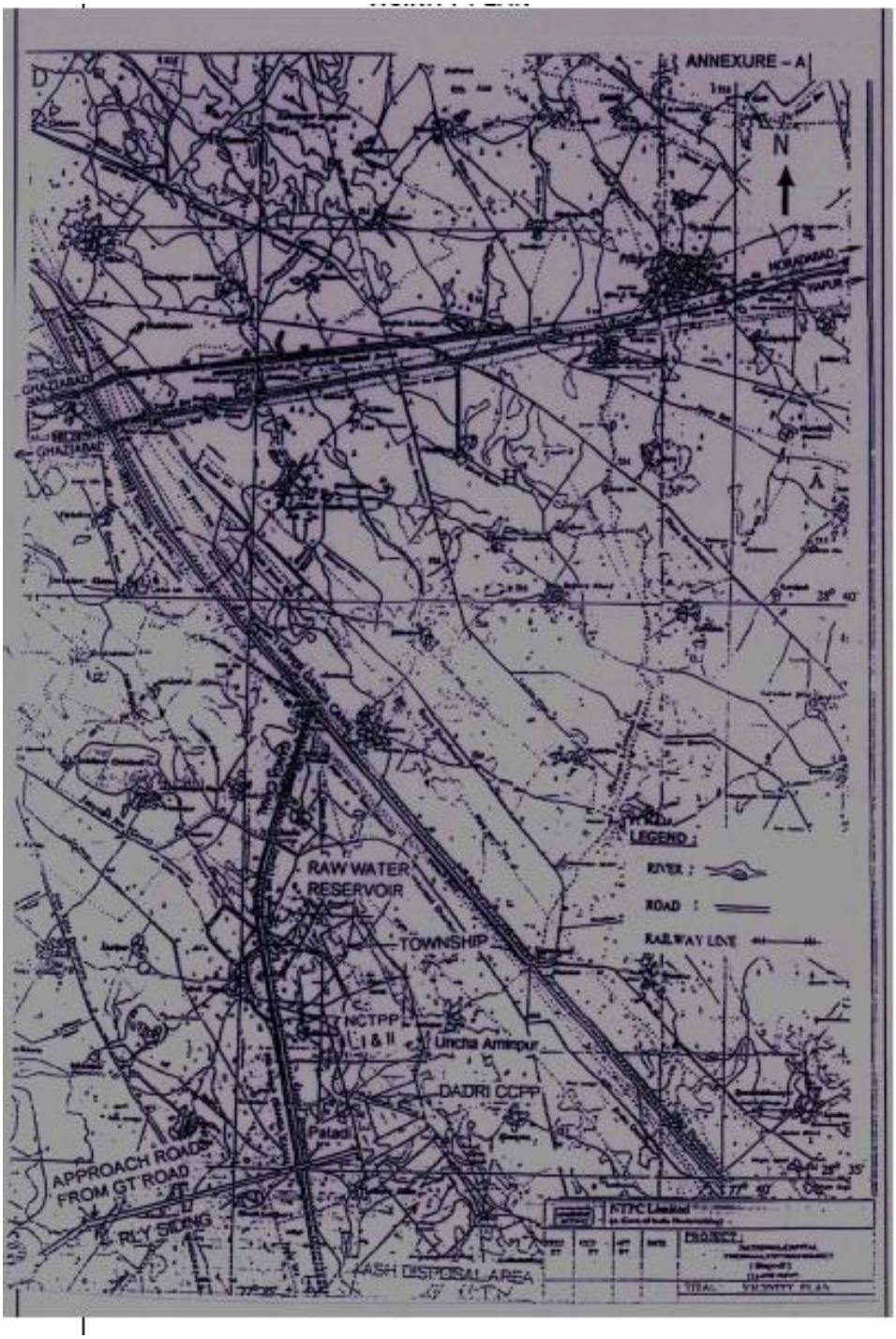
List of Drawings enclosed in this sub-section:

Sl.No.	Drawing Description	Drawing No.
1.	Vicinity Plan	5710-999-POC-F-001
2.	Equipment Layout Plan	6130-999-POM-A-001
3.	ID system-Elevation & Plan	1. 6130-108-04TR-PVM-F-153-SH-01 of 03 2. 6130-108-04TR-PVM-F-153-SH-02 of 03 3. 6130-108-04TR-PVM-F-153-SH-03 of 03
4.	Pipe Cable Trestle Layout	1. 6130-322-POC-C-0590 Sh-1 &2 2. 6130-322-POC-C-0596-SH-2 , 3 & 4 3. 6130-322-POC-C-0592-SH-2,3
5.	Pipe Cable Trestle Foundation	1. 6130-322-POC-C-0589 2. 6130-322-POC-C-0596-SH-1 3. 6130-322-POC-C-0591
6.	**Chimney foundation details**	

	Chimney shell outer diameter at ground level (m)	Chimney foundation outer diameter (m)	Type of foundation	Level of Top of foundation (m)	Level of Bottom of foundation (m)
Dadri-II	32	42.2	Raft supported on piles	RL(+) 208.75	RL(+) 205.00

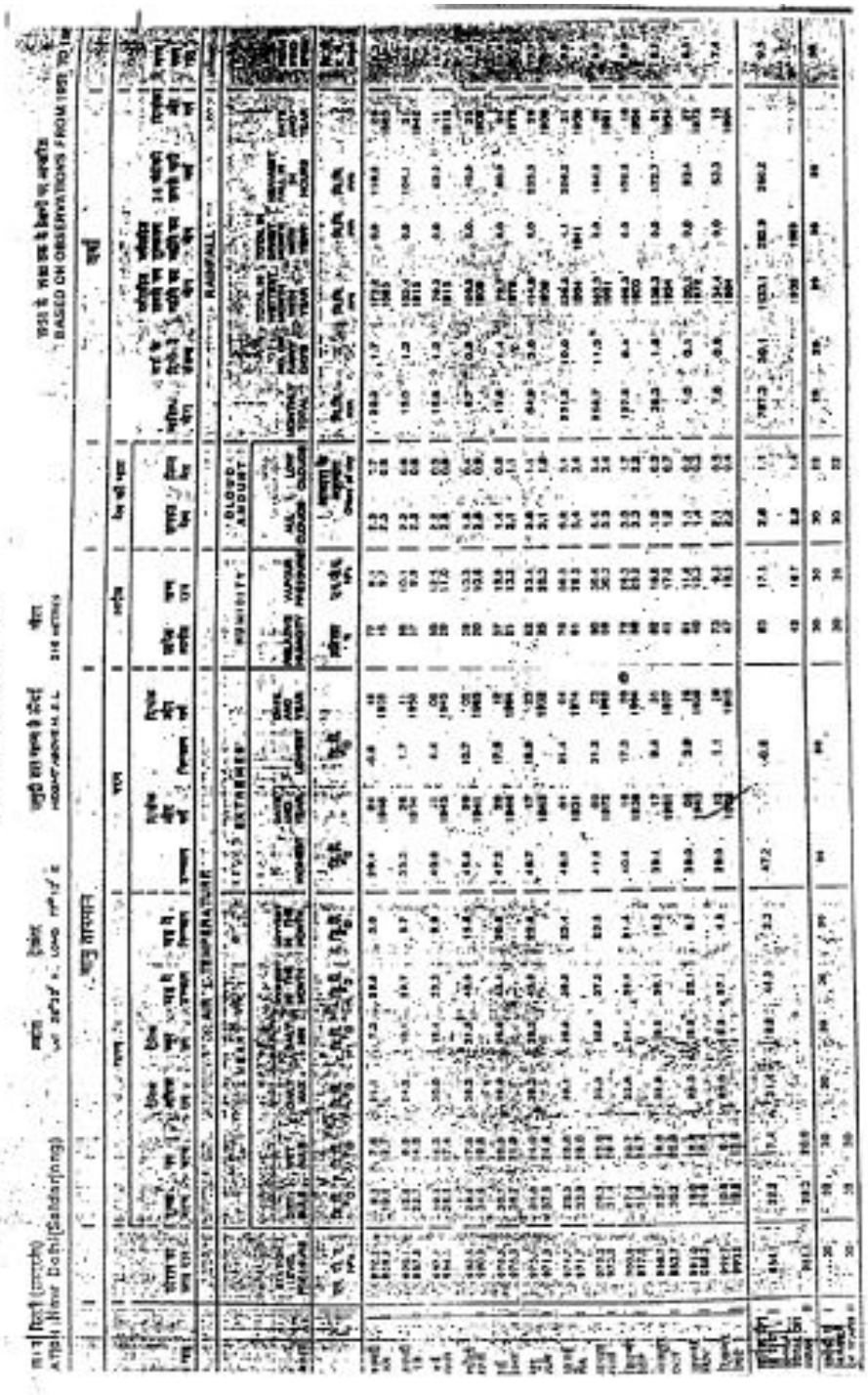
ANNEXURE-I

VICINITY MAP



ANNEXURE-II

METROLOGICAL DATA



CLIMATOLOGICAL TABLE

SUB-SECTION-III

SCOPE OF SUPPLY & SERVICES

SUB-SECTION-III-A

MECHANICAL EQUIPMENTS & SYSTEMS

SUB-SECTION-III-A1

FLUE GAS DESULPHURISATION SYSTEM

SCOPE OF SUPPLY

1.00.00 The contractor's scope of supply shall include engineering, design, manufacture, supply, erection, commissioning and testing ~~of complete mechanical, electrical, C~~&I and associated civil and structural works for Flue Gas Desulphurization system and its auxiliaries for **NCTPP, Dadri Stage-II (2 X 490 MW) & IGSTPP, J~~hajjar (3 x~~500 MW) Projects which are already under operation**, as detailed in this specification. Steam generator (in Employer's scope) shall be Sub-critical, balance draft, dry bottom, pulverised coal fired type. The characteristics of the coal, ash and other relevant design data is given in Part-A, Sub section-V of this specification. The FGD system shall be necessarily based on Wet Lime Stone FGD technology and is intended to reduce the emissions of Sulphur Dioxide in flue gas produced by coal being fired in boiler to the limits specified elsewhere in the technical specification.

1.01.00 ~~Complete Electrical & Control & Instrumentation system as required for the FGD system shall be included in the scope of supply. All electrical drives and actuators required for the equipment/valves/dampers shall be in the contractor's scope~~. Complete Civil works, structures, foundation required for all the equipment etc. is included in the contractor's scope of work. The contractor shall also include all supporting and structural works, like pipe trestles, platforms, staircases in their scope of work.

1.02.00 ~~The scope of supply identified for FGD system here are minimum requirements and~~ unless specifically excluded from the contractor's scope in sub-section-V (Terminal ~~Points and Exclusions), any equipment/system not included in this specification but~~ integral to the system offered by the contractor to meet the intent of this ~~specification, shall also be included in the scope of the con~~tractor.

1.03.00 ~~The FGD system shall have an independent absorber for each unit, common limestone milling systems and common gypsum dewatering system for each **NCTPP, Dadri Stage-II (2 X 490 MW) & IGSTPP, Jhajjar (3 x500 MW)** Project. The contractor shall also supply an auxiliary absorbent tank, common for the two units in~~ Dadri-II and Common for three unit for Jajjhar, for storage of absorber slurry of one ~~unit. The contractor's scope shall include the absorbers, common limestone grinding~~ system and gypsum dewatering system.

1.04.00 ~~The scope of the contractor for FGD system shall include all items as shown in~~ Tender drawings 6130/0330-109-POM-A-001/002/003 (4 sheets). All ducting, ~~dampers, expansion joints, pumps, valves, supports, structures etc. as required for completeness of system of absorbers, common limestone grinding system & common gypsum dewatering system shall also be in the scope of the contractor for~~ each ~~**NCTPP, Dadri Stage-II (2 X 490 MW) & IGSTPP, Jhajjar (3 x500 MW)**~~ Project.

2.00.00 **SYSTEM DESCRIPTION**

2.01.00 The FGD system shall be based on Wet Limestone Forced Oxidation process. Each unit shall be provided with an independent absorber.

2.02.00 Gas from terminal point on ID fan discharge duct shall be taken directly to the absorber through Booster Fans. In the absorber, SO_2 in flue gas shall be removed by a spray of recirculating slurry, pumped by slurry recirculation pumps. Alternatively, the gas shall be bubbled through the absorber slurry to remove the SO_2 from flue gas. Only proven system supplied earlier by the FGD vendor shall be supplied by the contractor.

2.03.00	Compressed oxidation air shall be blown through the slurry in the oxidation tank, to oxidize the Calcium sulfite to gypsum. The oxidation system may be either grid sparge type or lance jet type or Jet Air Sparger or any other proven system as per the practice of the FGD vendor.
2.04.00	Clean gas from the absorber shall be taken to the Wet Chimney (a separate chimney or integrated with absorber), to be provided by the Contractor, through three stage mist eliminators. Provision shall be made for facilitating operation of unit with FGD bypass through existing stack. All modifications required including providing bypass damper & Gate in the common flue gas duct to chimney is included in the scope of the Contractor.
2.05.00	Limestone to the absorbers of the units shall be supplied by a wet limestone grinding system, common for the units. Limestone shall be fed to the Limestone day silos which in turn will feed the Limestone to wet ball mill through a gravimetric feeder. The classified limestone slurry from the mills shall be stored in two (2 no) limestone slurry storage tanks to be provided by the contractor, from where the slurry shall be pumped to the individual absorbers by dedicated limestone slurry pumps.
2.06.00	The gypsum from the absorber(s) shall be pumped by dedicated gypsum bleed pumps to a common Gypsum Dewatering system consisting of two streams (2x100%) of primary and secondary hydrocyclone and vaccum belt filters for gypsum dewatering. The water removed from the absorber shall be recycled to the absorbers. The waste water from the system shall be collected and neutralized using lime and neutralized effluent shall be pumped at required pressure to waste water terminal point as indicated in Sub-section IV, Part A of the Technical Specification. Contractor shall provide complete automated waste water neutralization system along with automated lime feeding and dosing system to ensure required pH of waste water is ensured before being discharged at the terminal point. Washed and dewatered gypsum from the dewatering system shall be fed to a belt conveyor which shall be further transported to gypsum storage silo/building (specified elsewhere in the specification).
2.07.00	A common auxiliary absorbent tank shall be provided for storage of absorber slurry of one absorber along with slurry pumps for pumping the slurry back to any of the absorber.
3.00.00	**LIMESTONE GRINDING AND SLURRY PREPARATION SYSTEM (COMMON FOR ALL UNITS IN EACH PROJECT) FOR NCTPP, Dadri Stage-II (2 X 490 MW) & IGSTPP, Jhajjar (3 x500 MW) PROJECT**
3.01.00	The contractors scope shall include a common limestone grinding system for all the units and shall comprise of:
3.01.01	~~Two numbers Limestone storage silos each having maximum total limestone requirement of all the units at Design point with minimum 24 hours storage capacity equivalent to the requirements of all the units.~~ The storage silo shall be complete with supporting steel structure, platforms, staircase, air canons, power operated gates, gravimetric feeders, level switches, air relief devices, etc.
3.01.02	~~Two numbers of wet horizontal ball mills with each mill sized to meet 110% of the~~ maximum total limestone requirement of all the units at Design point.
3.01.03	~~Two (2) limestone slurry tanks, each tank sized to meet 12 hrs total limestone slurry~~ storage requirement for of all the units at Design point, complete with all accessories and Agitator(s).

3.01.04	2x100% limestone slurry pumps for each absorber connected to each of the limestone slurry tank. Each pump catering to slurry requirement of each unit's absorber.
3.01.05	Limestone slurry piping to each absorber, along with recirculation lines, all isolation and control valves.
3.01.06	Each mill shall be fed from an independent Limestone bunker. Each mill shall be complete with the following items, as a minimum requirement: i. A bunker outlet gate ii. A gravimetric limestone feeder along with its drive and all other auxiliaries iii. 1 no. separator tank with agitator(s). iv. 2x100% Mill circuit pump. v. 1 set of hydro-cyclone vi. A peripheral/central drive system with motor, speed reducer gearbox and other auxiliaries. vii. An auxiliary motor for inching operation with speed reducer. viii. Complete lubricating system with appropriate lubricating medium storage facility (i.e. 1 no. lube oil tank for storage of lube oil and/or 1 no. grease storage drum as required). ix. Lube oil pumps, coolers, duplex oil filters, connecting piping and necessary load & remote indicating instruments. Each lube oil pump and cooler shall have a 100% identical stand-by.
3.01.07	All connecting pipes / chutes along with necessary valves between various systems of the mill and from hydro-cyclone to common slurry storage tanks shall also be in the scope of the contractor. Necessary pipes, pipe supports, trestles etc. as required for the routing of the pipes shall be under the contractor's scope. Any item not included above but necessary for safe and reliable operation of the milling system proposed by the contractor shall also be in the contractors' scope.
3.01.08	The complete Limestone Grinding System shall be installed inside a shop-fabricated building to be provided by the Contractor as per specifications specified elsewhere. The shop-fabricated building must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipment's of above systems by providing adequate maintenance space, handling facilities, walkways, staircase & one (1) number passenger cum goods elevator of minimum capacity of 1000 kgs for easy access & movement of man/materials etc. The shop-fabricated building shall be sufficiently ventilated.
4.00.00	**ABSORBER SYSTEM**
4.01.00	An independent Limestone Forced Oxidation (LSFO) type absorber system shall be provided for each unit. Each absorber system shall be complete with :
4.01.01	Absorber tower complete with re-circulating slurry spray header(s) and nozzles, three stage mist eliminators, wash water nozzles, oxidation tank integral to tower, oxidation headers and nozzles, and agitators and all internal systems integral to the working of the absorber.

4.01.02	2x100% re-circulating slurry pump for each level of spray. Alternately, the contractor may offer a spare level of spray with each spray level served by an independent 100% pump. In case the contractor offers a single level of spray, one number of standby pump of the same capacity & head as the working slurry recirculation pumps shall be provided. (In case the bidder offers an absorber with gas bubbling through the slurry, the complete gas distribution system to the slurry shall be in bidder's scope. No re-circulating pump and spray header and nozzles shall be required in such case.)
4.01.03	Complete Ducting System from ID fan common outlet duct to absorber tower & from absorber outlet to wet stack chimney.
4.01.04	2x100% Centrifugal/ positive displacement type oxidation blowers / compressors.
4.01.05	1 No. Emergency water tank for spraying water at inlet of Absorber for upset condition.
4.01.06	All connecting piping and valves required by the system.
4.01.07	2x100% gypsum bleed pumps.
4.01.08	Piping from gypsum bleed pumps to gypsum dewatering system, along with recirculation lines (if required) necessary isolation and control valves.
4.01.09	Routing of the duct/piping system complete with supports, structures, trestles, absorber platforms, as required shall be in the contractor's scope of supply.
4.01.10	Passenger cum Goods elevator for each Absorber of minimum capacity of 1000 kgs.
4.01.11	All Slurry re-circulating slurry pumps & Oxidation blowers shall be installed inside a shed with side open to be provided by the Contractor as per specifications specified elsewhere. All pumps & Oxidation blowers shall be in straight line. The Shed must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipment's of above systems by providing adequate maintenance space, handling facilities, walkways, staircase etc. The shed shall be sufficiently ventilated.
5.00.00	**GYPSUM DEWATERING SYSTEM (COMMON FOR ALL UNITS IN EACH PROJECT) FOR NCTPP, Dadri Stage-II (2 X 490 MW) & IGSTPP, Jhajjar (3 x500 MW) PROJECT**
5.01.00	The bidder shall envisages a common gypsum dewatering system for two units in NCTPP, Dadri Stage-II (2 X 490 MW) and for three units IGSTPP, Jhajjar (3 x500 MW). The common dewatering system shall receive the gypsum slurry from each absorber through slurry feed pipes and shall comprise of two sets of dewatering equipment.
5.02.00	Each set (suitable for handling /dewatering of all the units in each project) of dewatering equipment (01 working set + 01 standby set) shall comprise of the following items as a minimum requirement: i. One set of primary hydro-cyclones ii. One vacuum belt filter iii One no. vacuum receiver iv. One no. vacuum pump

	v. One set of secondary hydro-cyclones
	vi. Complete piping and valves for the system along with wash water line.
5.03.00	This system shall be comprising of 2x100% gypsum dewatering system with each stream sized to dewater 110% of the maximum gypsum produced by all the units of each project operating simultaneously at Design Point, with any range of limestone specified. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.
5.04.00	The filtrate water from belt filter dewatering and wash water from washing system and the under flow from the secondary hydro-cyclone shall be taken to a common filtrate water tank. 2x100% pump shall be provided to supply wash water (for cake washing as well as belt cloth washing) to the belt filters. In addition, 2x100% Filtrate water pump (common for all units in each project) shall be provided to recycle the filtrate to the absorber. The contractor shall include the necessary piping and valves in their scope.
5.05.00	The gypsum slurry from each Absorber shall be fed to a common Primary hydro cyclone feed tank (sized for minimum 1 hr storage capacity) from where it will be fed to each primary set of hydro-cyclone through 2x100% Primary hydro cyclone pumps. The overflow from the primary set of hydro-cyclone shall be taken to a common Secondary hydro cyclone feed tank. 2x100% Secondary hydro cyclone pumps shall be provided to feed 2x100% secondary hydro-cyclones. The underflow from the primary hydro-cyclone shall be fed to the 2X100% vacuum belt filter system.
5.06.00	The under flow from the secondary hydro-cyclone shall be taken to the filtrate water tank. The over flow from the secondary hydro-cyclone shall be taken to a waste water neutralization system to be provided by the Contractor. The waste water system shall be complete with lime feeding & storage system, neutralization tank, waste water tank, 2x100% waste water pumps along with complete piping, instrumentation, valves, piping support etc. to discharge waste water at required pressure to waste water terminal point as indicated in Sub-section IV, Part A, Section VI of the Technical Specification. All the piping with supports, trestles as required shall be in the contractors' scope. The contractor shall also include any other item not included above but necessary to make the system complete.
5.07.00	The complete Gypsum Dewatering System shall be installed inside a shop-fabricated building to be provided by the Contractor as per specifications specified elsewhere. The shop-fabricated building must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipment's of above systems by providing adequate maintenance space, handling facilities, walkways for easy access & movement of man/materials etc. The shop-fabricated building shall be sufficiently ventilated.
6.00.00	**AUXILIARY ABSORBENT TANK**
6.01.00	The bidder shall provide a common auxiliary absorbent tank, common for all the units in each project, of sufficient capacity for storage of absorber slurry of one unit.
6.02.00	The contractor shall provide 1x100% slurry pumps for pumping the slurry back to the absorber of any of the units in 8 hrs (max.). All agitators, piping, valves, fittings and other structures required for the system shall be included in the scope of the contractor.

7.00.00	**PROCESS WATER & COOLING WATER STORAGE & PUMPING SCHEME**
7.01.00	Two (2) Process water Storage tanks (each tank catering to the requirements of all the units) along with two numbers of 2x100 % Booster water pumps, if required, (Each pump catering to the process water requirements of all the units) along with all necessary piping, valves, control & instrumentation to feed the tank from terminal point. Process water Storage level is automatically controlled at operating level by controlling the water flow from the Cooling Tower Blow down System from terminal point. The two tanks shall be interconnected with an isolation valve.
7.01.01	2x100% Process Water Pumps for each unit connected to each of the Process water ~~Storage tanks along with all necessary piping, valves, control & instrumentation~~. Each pump catering to process water requirement of one unit.
7.02.00	2x100% Mist Eliminator Wash Water Pump for each unit connected to each of the Process water Storage tanks along with all necessary piping, valves, control & instrumentation. Each pump catering to mist washing requirement of one unit. Alternatively, Contractor can use process water pumps for mist eliminator washing if it is the standard & proven practice of the Contractor or its Technology Collaborator.
7.03.00	~~Two (2) clarified water Storage tanks (each tank catering to the clarified water~~ requirement for one vaccum Belt Filter) along with two numbers of 2x100 % clarified ~~Booster water pumps, if required, from terminal point.~~
7.04.00	~~2x100% cake washing Pumps for each Vacuum Belt Filter~~.
7.05.00	~~2x100% cloth washing Pumps for each Vacuum Belt Filter~~.
7.06.00	~~Any other pump or storage system not specified but required to meet the system~~ requirement shall be provided by the contractor with the approval of the Employer.
7.07.00	All drains & overflow lines from the tanks shall be terminated to the nearest trench/drain.
7.08.00	~~All the storage tanks shall be lined with vinyl ester based flake glass lining fro~~m inside.
8.00.00	**SUMP & ~~SUMP PUMPS~~**
8.01.00	The contractor shall provide sumps of adequate capacity in each of the following area: A. Each Absorber Area B. Limestone Grinding system C. Gypsum dewatering system Waste water which might be generated during flushing and cleaning procedures of the equipment shall be collected in the sump and shall possibly be reused in the wet absorber.
8.02.00	The contractor shall provide agitators and sump pumps of required capacity in each of this area along with necessary pipes, isolation / control valves etc for pumping back the water in the sump into the respective system. The Interior surface of the Sumps shall be lined with replaceable chlorobuty/bromobutyl rubber lining of minimum 5 mm thickness or with vinly ester based flake glass lining of minimum 3 mm thickness.

9.00.00	**Elevator**
9.01.00	One (1) number passenger cum goods elevator of minimum capacity of 1000 kgs for each Absorber (to be provided in case height of absorber is higher than 20m) and One (1) number passenger cum goods elevator of minimum capacity of 1000 kgs in Limestone Grinding System Building shall be provided for easy access & movement of man/materials.
9.02.00	The scope shall include all items / accessories, service along with all electrical equipment etc. required to meet all design, installation, operation, safety, protection and other requirements of IS: 14665 (latest edition) (all parts), 'Lift' and service lifts'. This scope shall include all items / devices needed to comply with the requirements indicated elsewhere in the specification. The scope shall include provision of fireman's switch.
9.03.00	One (1) nos. adequately sized, Air conditioners each having minimum cooling capacity of 2.5 Ton shall be provided for each elevator machine room to make it dust proof.
9.04.00	Complete erection, testing and commissioning including all testing and commissioning materials, consumables and other tools and tackles required for erection.
9.05.00	To obtain necessary local administration permits / approvals and make arrangements for inspection and tests required thereby.
10.00.00	**Thermal Insulation, Lagging, Cladding & Refractories**
	Thermal Insulation alongwith aluminum cladding, lagging, reinforcement wiremesh, cleats and supports, shall be provided for all the equipment/surfaces having skin temperature more than 60 degree Celsius. The insulation thickness shall be designed based on criteria specified in Part-B, Section-VI.
11.00.00	**Buildings**
11.01.00	Contractor shall provide shop-fabricated buildings for Limestone Grinding System; Slurry re-circulating pumps & Oxidation blowers / Compressors; Gypsum Dewatering System & FGD control room cum MCC room & Analyser room (if required). The buildings must be complete in all respect specially facilitating the smooth operation and maintenance of associated equipment of above systems by providing adequate maintenance space, handling facilities, walkways, staircase etc.
12.00.00	Contractor shall provide Corrosion protection painting for structures & equipment as described in the specification
13.00.00	Contractors scope shall include all Platforms, walkways, staircase, safety rails for access of each equipment, valves, dampers, gates, instruments etc. handling facilities adequately each component of FGD system.
14.00.00	The contractor scope shall also include the provision of FGD trestle for routing of air & water lines, slurry lines, steam line, waste water, etc. required for the complete process operations.
15.00.00	Contractor shall provide air conditioning for the FGD control room cum MCC room and Analyser room (if separately provided) & ventilation for the FGD system buildings as detailed in Sub-Section III-A2.

16.00.00	Contractor shall provide compressed air system for the FGD system as detailed in Sub-Section III-A3.
17.00.00	Contractor shall provide FIRE FIGHTING SYSTEM as detailed in Sub-Section III-A4.
18.00.00	Contractor shall provide EQUIPMENT COOLING WATER SYSTEM as detailed in Sub-Section III-A5.
19.00.00	Contractor shall provide Limestone & Gypsum handling & storage system for FGD as detailed in Sub-Section III-A6.
20.00.00	Not used
21.00.00	The scope of civil works shall be as per Sub-Section-III D.
22.00.00	Associated Electrical and Control & Instrumentation systems for FGD as detailed in Sub-Section-IIIB & Sub-Section-IIIC respectively of Part-A/Section-VI of this specification.
23.00.00	**Booster Fan & Isolation Gates**
23.01.00	For each unit, two (2) nos. Booster Fans of axial type, Constant speed, variable pitch controlled each with drive motor, base plates, foundation bolts and nuts, inlet box, discharge case, coupling, coupling guard and suitable arrangement to prevent rain water entry to fan motor. Each Booster Fan shall be provided with bearing lubrication and hydraulic blade pitch control unit(s) consisting of (1) 2x100% oil pumps each with motor, coupling and coupling guard. (2) 2x100% oil coolers. (3) 2x100% filters, differential pressure switches, etc. (4) One (1) oil storage tank. (5) Instrumentation, vibration monitoring, inter connected piping, valves and fittings including pressure relief valves and non return valves. (6) Electrical actuator with accessories etc. Alternatively, a forced oil lubrication system (consisting of 1to 6 above) common to bearing lubrication and for servo motor operation to each BF Fan will also be acceptable. At least two (02) nos. of duplex thermocouples or duplex platinum RTDs (100 ohm at 0°C) and one no. of temperature indicators shall be provided for bearing metal temperature measurement, control and monitoring. Booster fans shall be suitable for the type of foundation being provided.
23.02.00	Motorized Guillotine type gates with 2x100% seal air fans shall also be provided at suction & discharge of each Booster Fan. The Gates shall be designed for tight shut-off. The design of the gates shall ensure 99.95% leak tightness without seal air. The gates shall be 100% leak tight with seal air fans under the above conditions.
24.00.00	Contractor shall provide Low Height Wet Chimney(s) as per the criteria & specifications specified elsewhere in the specification for the project.

25.00.00	**Wet Stack Condensate Collection System**
25.00.01	Wet stack of **115 metre** height shall be provided with a stack condensate collection system to avoid the carryover of the condensate/acidic dews/water droplets/Gypsum coming out of the stack. Design of the wet stack condensate system should be such that all the condensate are collected in the stack itself and no water droplet/condensate come out of the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the plant/nearby area.
25.00.02	Drain piping shall be of suitable material from corrosion point of view.
25.00.03	All Stack liquid collection shall be easily accessible for O&M.
25.00.04	The design of the stack condensate collection system shall be provided by the bidders in its bid.
25.00.05	A common Nickel based alloy material storage/neutralizing tank for the both the units of storage capacity of 12 hrs of stack condensate of both the stack shall be provided. Storage tank/neutralization tank shall be complete with dosing, mixing and preparation system. After neutralization of the stack condensate collection, same shall be pumped to common drain system. Contractor shall provide 2 X100% pumps, complete with valves, piping fittings, level control/monitoring etc. Alternatively, bidder may propose its proven system for disposal of the condensate system in its bid for Employer's consideration. All the material in contact with the condensate shall be of suitable material for the operating duty.
25.00.06	Stack outlet liquid collector shall be designed in such a way so that the liquid condensate film near the exit of the stack is collected instead of carrying with the exit gas. Bidders shall provide all these details in its bid.
26.00.00	**GENERAL SCOPE OF WORKS/SERVICES FOR COMPREHENSIVE OPERATION AND MAINTENANCE**
26.00.01	Bidder has to undertake a comprehensive Operation and Maintenance (O&M) for FGD system installed by bidder including supply of spares & consumable required for O&M services with an annual availability of more than 95% from the date of successful commissioning of the FGD system up to10 years.
26.00.02	GENERAL SCOPE OF WORKS/SERVICES FOR COMPREHENSIVE OPERATION AND MAINTENANCE are as per specifications specified elsewhere.

SUB-SECTION-III-A2

~~AIR CONDITIONING, VENTILATION SYSTEM~~ & ~~COMPRESSED AIR SYSTEM~~

1.00.00

AIR CONDITIONING SYSTEM

a) General

The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning for Complete Air conditioning system consisting of D-X units with refrigerant piping & valves, Air handling units, Hi-wall split air conditioner /Cassette Air conditioners, Packaged Air Conditioners, Fresh air fans, air distribution system (ducting, filters, isolation dampers, motorized fire dampers, diffusers, grills, volume control dampers, etc.) etc., along with all electrical equipment and instrumentation as required for all the buildings which are in the scope of the bidder, as detailed out in Part-B of Section-VI.

b) **Air-conditioning system for F.G.D Control Room Building and ZLD control room building (if provided)**

Air cooled condensing units (D-X type) type air conditioners with AHU of suitable capacity with 100 % redundancy (as per actual heat load calculation) shall be provided .

c) SO2 analyzer room (if required) and other air conditioned offices/areas covered under this package shall be provided with Ductable/Non ductable Split air conditioners etc. as per Design criteria specified in Chapter Salient Design Data. Non ductable Split air conditioner shall conform to minimum three (3) star (***) rating and above of latest version of Bureau of Energy Efficiency (BEE) HVAC code issued by Ministry of Power, Govt of India.

d) Supply of Mandatory spares as specified.

e) Any additional items required to make the system complete.

f) For Air conditioning system, the Bidder shall provide all Instrumentation systems, accessories and associated equipment, which are included in Bidder's scope, in a fully operational condition acceptable to the Employer. The Bidder shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Contractor and for meeting the intent and requirements of these specifications.

g) Contractor shall provide microprocessor/PLC/GIU based control system for control and monitoring of air conditioning system as per manufacturer's standard practice. However relative humidity and temperature measurement of all control rooms and all major air-conditioned areas shall be made available in FGD/ ZLD control system. Control and monitoring of air conditioning system from FGD/ZLD control system is also acceptable.

h) Apart from the above, any area/building which are in the scope of the bidder and require air conditioning, the same shall be provided with air conditioning system, as detailed out in Part-B of Technical Specification.

1.02.00 **Redundancies of equipments:**

100% standby unit shall be kept for FGD/ZLD control room, SO2 analyzer room (if required) and other air conditioned offices/areas.

2.00.00 VENTILATION SYSTEM

a) **General**

The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning for Complete Ventilation system consisting of Modular type Unitary air filteration Units, Supply air fans, water pumps, exhaust air fans, louvers, filters, ducting, diffusers, piping, instrumentation etc., for all the buildings which are in the scope of the bidder, as detailed out in Part-B of Section-VI.

b) **Non-A/C areas of F.G.D Control Room Building and ZLD control room building (if provided)**

Minimum One (1) nos. of Evaporative type Unitary Air Filtration (UAF) unit (of metallic construction- modular type) of suitable capacity with all accessories, DIDW centrifugal fan (1 x 100%), circulating water pump (1 x 100%), etc. as detailed out in technical specification shall be provided.

c) **Miscellaneous areas:** All other areas like Limestone Grinding system building, Gypsum dewatering building, Recirculation pump & Oxidation blower/compressor building etc & all other non-air conditioned areas covered under this package shall be ventilated by a combination of supply/exhaust fans and fresh air in-take / back draft louvers. For ventilation of Battery rooms and Oil rooms, fans with flame proof motor shall be used. Further, toilets shall be provided with propeller type exhaust air fans.

d) Supply of Mandatory spares as specified.

e) Any additional items required to make the system complete.

f) For Ventilation system, the Bidder shall provide all Instrumentation systems, accessories and associated equipment, which are included in Bidder's scope, in a fully operational condition acceptable to the Employer. The Contractor shall also provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Contractor and for meeting the intent and requirements of these specifications.

g) Contractor shall provide microprocessor/PLC/GIU based control system for control and monitoring of ventilation system as per manufacturer's standard practice. Control and monitoring of ventilation system from FGD/ZLD control system is also acceptable.

Note: Common microprocessor/PLC/GIU based control system for control and monitoring for both air conditioning and ventilation system can be provided.

3.00.00 COMPRESSED AIR SYSTEM

a) Two (2) numbers (1 working+ 1 standby) oil free, rotary screw type air compressors for Instrument air and service air applications for FGD and ZLD plant (if provided) each of adequate capacity & adequate pressure, with their motor drives and other accessories as per equipment sizing criteria mentioned in Part A, Sub-section 'Salient design data' of technical specification. However, minimum capacity of each air compressor shall be 15Nm^3/min at discharge pressure of 8.5 Kgf/cm^2 (g).

b) Two (2) numbers (1 working+ 1 standby) Air Drying Plants (one for each air compressor) of adequate capacity with all interconnecting piping, valves, fittings, etc.

c) Two number Air Receiver each of capacity 2 m^3 (normal) at the discharge of each Air compressor.

d) One number Air Receiver of capacity 2m^3(normal) for ZLD plant if ZLD plant is far away from compressor location.

g) Monorail with Chain pulley block of minimum 2 tons or 125% of heaviest parts of equipment to be lifted whichever is more.

h) Complete instruments, control system with panels as required for compressed air system.

i) Complete compressed air and piping network for service air and instrument air application in FGD and ZLD system (if provided). Separate piping network for Service Air and Instrument Air shall be provided.

j) Supply of Mandatory spares as specified.

k) Any additional items required to make the system complete.

4.00.00 General

i. All associated Civil & structural work for air conditioning and Ventilation system and compressed air system.

ii. Set of commissioning spares as may be required during erection and commissioning.

iii. One (1) set Special tools and tackles required for maintenance of all the Mechanical, Electrical and C & I equipment under the scope of bidder.

iv. All steel / cast iron inserts, plates, bolts, nuts, sleeves, metallic-fasteners etc. to be grouted in concrete work and used to hold/ support the equipment/piping / ducting being supplied and erected under this specifications.

v. Any additional items required to make the system complete.

vi. Initial charge of all lubricants and grease, etc. Further, all consumables required for PG tests shall also be in Bidder's scope of supply. Grouting, dressing and final finishing of all foundations of various equipment, etc.

vii. Repairing and making good/ sealing of cutouts / openings in floors, roofs and walls, for executing the works under this system and making them water tight as directed by the engineer.

Corrosion protection painting for all equipment / items by Bidder as detailed in relevant clauses of technical specification.

SUB-SECTION-III-A3

FIRE DETECTION & PROTECTION SYSTEM

1.00.00 **FIRE DETECTION AND PROTECTION SYSTEM:**

The scope includes Engineering, Supply, Construction, Erection, Testing and Commissioning for Fire Detection and Protection System for FGD area. Following system has been envisaged:

1.1 Hydrant System:

Complete hydrant system (pipe, hydrant valves, landing valves, water monitors, hoses, branch pipes and nozzles etc) for FGD area shall be provided as per TAC norms. Tapping for hydrant system shall be provided from nearby existing hydrant header.

1.2 HVW Spray System:

Automatic fire detection cum high velocity water spray system shall be provided for various transformers (having oil capacity 2000 liters or more) envisaged under this package. Tapping for HVW spray system shall be provided from nearby existing spary header.

1.3 MVW Spray System:

Automatic fire detection cum medium velocity water spray system for the various cable galleries envisaged under this package. Tapping for MVW spray system shall be provided from nearby existing Spray header.

1.4 Fire Extinguishers

The contractor shall supply the following quantity (minimum) of fire extinguishers and install the same at various locations of FGD system as per TAC requirement.

(1) Pressurized water type (9lit. capacity as per IS 15683): 5 Nos.

(2) CO2 type (4.5 kg Cap IS:15683): 5 Nos.

(3) Dry chemical type (6 kg Cap IS:15683) : 5 Nos.

1.5 Analogue addressable type Fire Alarm System / Annunciation Panels: Analogue addressable type Fire Alarm System consisting of Multi sensor type detectors, Linear Heat Sensing Cable (LHSC) detector, cabling, junction boxes, instrumentation, Fire Alarm cum control panels, repeater panels, etc. for various areas/equipment as detailed out below:-

a) All MCC / switch gear room / Control room shall be provided with Multisensor type detectors.
b) All Conveyors and Cable Galleries shall be provided with Linear Heat Sensing Cable detectors.
c) All cable galleries shall be provided with Multisensor type detectors.

1.6 The Contractor is responsible for getting the complete approval of the system elaborated in this specification from TAC accredited professional(s).

1.7 If the contractor feels, it is necessary to include any other items, which, in his opinion, may be required to comply with TAC regulations, other than those indicated in the specification, the same shall also be supplied, erected and commissioned. Any amendments, modified rules to the latest TAC regulations till techno-commercial bid opening date should be considered by contractor to fulfill the above condition.

1.8 Successful contractor shall furnish complete hydraulic calculation.

1.9 Supply of complete mandatory spares as specified elsewhere.

1.10 Set of commissioning spares as may be required during erection and commissioning.

1.11 One (1) set Special tools and tackles required for maintenance of all the mechanical, electrical and C & I equipment under the scope of Contractor.

1.12 Any additional item/ equipment required to make the system complete.

1.13 Grouting, dressing and final finishing of all foundations of various equipment, etc.

1.14 Supply of structural supports for piping in trench and for above ground piping wherever applicable.

1.15 Supply & application of protective coatings and wrapping for buried pipes and pipes in RCC trenches, and painting for above ground piping, valves, pipe supports, etc. as detailed in technical specifications.

1.16 Excavation, preparation of bed, laying, backfilling with compaction of soil for all underground/buried piping. Also, breaking and re-erection of paving for buried piping (if any)

1.17 Preparation of necessary detailed drawings including schematics, layouts, isometrics, fabrication drgs, erection drgs, etc. as required and also development of “As Built Drgs”.

1.18 Conductance of Performance and Guarantee test as per Standard Guaranteed test procedure given elsewhere in the specification.

1.19 All pylons required for transformers, shall be anchored to soak pit base slab of individual transformer, paved area outside soak pit, etc. using anchor fasteners of adequate capacity. Subsequent to fixing the pylons, lower part of pylon which would be within filled up gravel portion shall be encased with concrete by Employer for corrosion protection.

SUB-SECTION-III-A4

EQUIPMENT COOLING WATER SYSTEM

EQUIPMENT COOLING WATER SYSTEM
(FOR NCTPP STG-II- 2 X 490 MW)

1.00.00 **SCOPE**

1.01.00 **Equipment Cooling Water System**

The Bidder shall provide common Equipment Cooling water system for all two units with a closed circuit cooling system for cooling of the various auxiliaries of FGD system. The equipment cooling system shall include the following and as detailed out in relevant sub section of Part-B of Technical Specification.

(a) One cold water header tapped from CW Blowdown from CW pump discharge pipe.

(b) Hot secondary water pipe from the PHE's, discharging into the FGD system as process water.

(c) 2x100% capacity self cleaning strainers on the secondary side.

(d) 3 x 50% (2 working + 1 standby) capacity of plate type heat exchangers.

(e) 4 x 50% (2 Working + 2 standby) capacity FGD Auxiliary (Secondary) Cooling water pumps, along with drives.

(f) 3 x 50% (2 Working + 1 standby) capacity FGD DM (Primary) cooling water pumps along with drives.

(g) One Overhead DM water tank (ECW O/H tank).

(h) Alkali (Sodium Hydroxide) preparation tank, agitator and motor, piping, valves etc.

(i) Piping for normal makeup to ECW tank from existing DM water transfer pump, piping for emergency makeup to ECW tank from condensate transfer pump, other piping, fittings, supports, valves and specialties including instrumentation and electrical equipment as required and as specified for the system.

EQUIPMENT COOLING WATER SYSTEM
(FOR JHAJJAR - 3 X 500 MW)

1.00.00 **SCOPE**

1.01.00 **Equipment Cooling Water System**

The Bidder shall provide common Equipment Cooling water system for all three units with a closed circuit cooling system for cooling of the various auxiliaries of FGD system. The equipment cooling system shall include the following and as detailed out in relevant sub section of Part-B of Technical Specification.

(a) One cold water header tapped from CW Blowdown from CW pump discharge pipe.

(b) Hot secondary water pipe from the PHE's, discharging into the FGD system as process water.

(c) 2x100% capacity self cleaning strainers on the secondary side.

(d) 4 x 33.33% (3 working + 1 standby) capacity of plate type heat exchangers.

(e) 5 x 33.33% (3 Working + 2 standby) capacity FGD Auxiliary (Secondary) Cooling water pumps, along with drives.

(f) 4 x 33.33% (3 Working + 1 standby) capacity FGD DM (Primary) cooling water pumps along with drives.

(g) One Overhead DM water tank (ECW O/H tank).

(h) Alkali (Sodium Hydroxide) preparation tank, agitator and motor, piping, valves etc.

(ii) Piping for normal makeup to ECW tank from existing DM water transfer pump, piping for emergency makeup to ECW tank from condensate transfer pump, other piping, fittings, supports, valves and specialties including instrumentation and electrical equipment as required and as specified for the system.

SUB-SECTION-III- A5

LIME STONE & GYPSUM HANDLING SYSTEM

1.00.0 **INTENT OF SPECIFICATION**

This specification is intended to cover the following activities and services in respect of all the equipment of **Lime Stone Handling Plant & Gypsum Handling plant** to be installed for **FGD Package**, completely covering the following activities and services in respect of all the equipment specified and covered under the specifications and read in conjunction with "Scope of Supply & Services", Part-A, Section–VI of Technical Specification.

(i) Detailed design and engineering of all the equipment and equipment system(s).

(ii) Complete manufacture including shop testing/ type testing.

(iii) Providing engineering data, drawings, Commissioning procedures and O & M manuals, etc. for the Employer's review, approval and records.

(iv) Packing and transportation from the manufacturer's works to site including transit insurance, customs clearance/ port clearance, if required.

(v) Receipt, unloading, storage, preservation, conservation and insurance of equipment at site.

(vi) Fabrication, pre-assembly, (if any), erection, testing and putting into satisfactory operation of all the equipment including successful completion of facilities.

(vii) Associated civil, structural, architectural and electrical works.

(viii) Commissioning and completion of facilities and Performance Guarantee Tests after successful completion of initial operation.

(ix) Furnishing of spares on FOR site basis and handing over to NTPC stores.

(x) Reconciliation with custom authorities, if applicable.

(xi) Satisfactory completion of the contract.

1.01.00 Before submitting his bid, the Bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.

1.02.01 Based on site visit, bidder shall submit layout for Limestone handling plant & Gypsum handling facilities along with their techno-commercial bid. **All required modification and demolition work of existing facilities shall be in the bidder's scope. However if any relocation of existing facility is**

	required, the same shall be done by the employer. Bidder shall bring out all necessary modification and relocation of existing facilities, if required, along with proposed Layout submitted with the bid. *In the absence of this, the bid shall be deemed incomplete and may be liable for rejection*..
1.02.02	NTPC reserves the right to freeze a basic layout for each NTPC plant post techno commercial bid discussions.
1.03.00	The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of ensuring operability and the reliability of the complete system covered under this specification.
1.04.00	Cleaning of any debris produced by the bidder during erection and commissioning shall be done immediately at each front by the bidder.
1.05.00	Bidder to extend all help and documentary support for compliance and addressing any statutory issues raised at site which pertains to the area/ work under bidder's scope.
2.00.0	**DETAILED SCOPE**
2.01.00	**Limestone Handling Plant (LHP)**
2.01.01	Limestone will be received to power plant either through road by trucks and/or through Indian railway rakes. **Lime stone received through Road** shall be unloaded by Two (2) numbers Truck Tipplers each of minimum **40T** capacity **(Gross weight 60 T minimum)** to discharge Limestone on to Box Feeders/ Surface Feeders/ Truck Unloading Hopper, complete with all mechanical, electrical and C&I, civil & structural works for unloading Limestone by truck tipplers. Two (2) numbers Box Feeders/ Bulk-material Receiving Unit/ Surface feeder, for unloading of limestone from trucks/ self-tippling trucks/ loader shovels, complete with drives, accessories all mechanical, electrical and C&I, Civil & structural works, including its supporting foundations etc. This unit shall feed limestone onto the conveyor before Limestone crusher house. **Limestone received through Indian Railway Rakes** will be unloaded in one of the side discharge Wagon Tipplers or Track Hopper of existing Coal Handling Plant (CHP). Before existing Crusher house of CHP, the unloaded limestone will be fed to new limestone crusher house through series of new conveyors/bucket elevators. All necessary modifications involving Mechanical, Electrical, C&I, Civil and Structural works in the existing CHP for taking feed to new limestone path shall be in the scope of the bidder.
2.01.02	Limestone shall be conveyed to usage point through double stream of capacity 100% each for conveying & crushing.
2.01.03	Lime stone Belt Conveyors / Bucket Elevator complete with associated tunnel, conveyor galleries along with its supporting structures, short supports, stringers, deck plate, seal plate, conveyor foundations, drive motors, drive units, pulleys, idlers, gravity take ups including guides, pits etc., internal and external belt cleaners,

	pull chord switches, belt sway, zero speed switches, electro-hydraulic thruster brakes, all electrical etc. including all civil, structural and architectural works for tunnel, conveyor gallery, gallery supporting trestles and their associated foundations, as applicable.
2.01.04	One (1) number Lime stone crusher house (CH) complete with all civil, structural, architectural and electrical works etc. accommodating suitable nos. crushers and associated Vibrating screening feeders, R&P and Rod gates etc., passenger cum goods elevator, conveyors, chute work along with actuator operated flap gates, monorails & hoists, hoist maintenance platform, external and internal staircases, hand rails and other equipment such as sampling unit, dust extraction system etc. as specified elsewhere.
2.01.05	Suitable numbers of vibrating screening feeders in limestone crusher house to feed the limestone to crushers with drives, dust hoods, all mechanical, electrical accessories and supporting structures etc.
2.01.06	Suitable numbers of hammer crusher complete with drives, accessories all mechanical, electrical civil & structural works, including crusher supporting foundations, vibration isolation system with springs and viscous dampers, vibration monitoring system etc.
2.01.07	Crushed limestone Reclaim Hopper (RH) /Silo, machinery hatches at each of end of limestone storage shed for RH, fully / partially underground or over ground junction towers, tunnels and pent houses, complete with civil, structural, architectural, electrical and C&I works including over ground structural shed for entire length of limestone ground storage and machinery hatches, removable chequered plate covers over openings in machinery hatches for handling underground equipment like paddle feeders etc. (as applicable). For Limestone storage shed and for all buildings, other equipment such as **Dry type Dust Extraction** system, ventilation system, drinking water system, drainage system etc. as specified elsewhere in the specification.
2.01.08	Junction towers (along with underground / over ground RCC structures), tunnel/conveyor gallery / bucket elevator complete with all civil, structural, architectural, electrical and C&I works including chutes, monorails, hoists/chain pulley blocks, hoist maintenance platforms, external staircases, dust debris chutes etc. All over-ground junction towers shall have separate debris disposal chute up to the ground floor. Underground junction towers shall be provided with machinery hatches along with monorail, electric hoist for handling equipment from underground to over ground.
2.01.09	Complete chute work along with chute block switches and actuator operated flap gates, mobile discharge pulleys (as applicable) in all junction towers between various conveyors.
2.01.10	Suitable number of motorized travelling tripper / flow diverter plough (as applicable) on each feeding conveyor for feeding the crushed limestone to the covered storage shed. Trippers shall be complete with all mechanical, electrical equipment, rails, chute work, rail supporting structure (along with structural stools, as required), cables with cable festooning arrangement, thruster brakes, rail clamps, electric hoist, actuator flap gates etc.

2.01.11	One number of covered storage shed for crushed limestone. The storage shed shall be sufficient to store limestone equivalent to consumption of minimum 7 days at Design point (Generation of all units to be considered) **or 5000 MT (wherever Railway Rake unloading is envisaged) whichever is higher**. A reclaim hopper shall be provided below the limestone storage shed for the entire length of the stockpile. Alternatively, suitable number of Limestone Storage Silos to store limestone equivalent to consumption of minimum **7 days at Design point or 5000 MT (wherever Railway Rake unloading is envisaged) whichever is higher**. **The maximum capacity of each limestone storage silo shall not exceed 2000 MT.** Suitable number of Belt feeders below silos shall be provided taking feed from silo and discharging onto onward conveyors/ Bucket elevators.
2.01.12	Two (2) numbers paddle feeders (in case of covered storage shed) complete with all electrical, rails, supporting structures, end stops, cable reeling drums, trailing cables, and necessary arrangement for cabling on floor of reclaim hoppers along with accessories, shall be installed at the bottom of the reclaim hoppers to scoop the limestone from reclaim hoppers and feed limestone on to the underground conveyors.
2.01.13	Two (2) nos. of lime sampling units, one for as received limestone in crusher house and one for as used limestone in TP before feeding to limestone bunkers, complete with all accessories and electrical, civil, structural works, supporting structures, approach/maintenance platforms, hoists etc.
2.01.14	Suitable number of ploughs and its actuating mechanism shall be mounted on each conveyor to feed limestone into limestone mill bunkers. Alternatively, suitable nos. fixed Trippers on each conveyor to feed limestone into limestone mill bunkers.
2.01.15	Minimum four (4) Nos. sump pumps in limestone storage shed (in case of covered storage shed), and two (2) Nos. sump pumps in all TPs completely or partially underground complete with motors, local control panel, level switches, individual discharge piping with fittings and valves to nearest plant drain including pipes etc. upto disposal point.
2.01.16	Adequate number of ventilation equipment for ventilating the limestone reclaim hopper, underground tunnel of Conveyors, underground portion of Junction towers and limestone bunker bays (housing tripper/plough conveyors) complete with all mechanical, electrical, civil and structural works and associated foundations.
2.01.17	Pressurized Ventilation system for all Switchgear rooms, MCC rooms complete with all mechanical, electrical, accessories, civil and structural works.
2.01.18	Exhaust fans to be provided in all battery rooms and all toilets complete with electrical, civil & structural works etc. Supply and exhaust fans along with required ducting shall also be provided for all underground Structures/junction towers complete with all mechanical, electrical, civil and structural works and associated foundations.
2.01.19	One (1) number **conventional enclosure type** passenger cum goods elevator **having capacity of 16 persons (1088 kg) complying to IS:14665 (latest edition)** with drives, all electrical, mechanical, civil, structural & associated foundation works, accessories and electrical to serve various floors of lime stone crusher house. **Staircase access for machine room shall also be provided by the bidder.**

2.01.20	Two (2) numbers of in line magnetic separators (one no. on each conveyor feeding to crusher house) and two (2) number of suspended magnets, (one no. on each conveyor feeding to Limestone bunker (in case of covered storage shed)) on conveyors complete with reject chutes, reject trolleys, supporting arrangement and all mechanical, electrical, civil, structural works and accessories.
2.01.21	Four (4) numbers of metal detectors (min. one no. on each conveyor feeding to crusher house and conveyor feeding to Limestone bunker at FGD plant) complete with all mechanical, electrical, civil, structural works and accessories.
2.01.22	Four (4) numbers of electronic type belt scales (min. one no. on each conveyor feeding to crusher house and conveyor feeding to Limestone bunker at FGD plant) for continuous weighing, complete with all mechanical, electrical, civil, structural works and accessories.
2.01.23	Complete dust extraction system for control of fugitive dust in limestone storage shed / Silos, junction towers, crusher house complete with fans, drives, hoisting arrangements, ducting, piping, valves etc. electrical, accessories, civil, structural and architectural works.
2.01.24	Service water and potable water system for complete limestone handling plant. Water Pump houses & water tanks for service water, cooling water (as applicable) and potable water system.
2.01.25	Cooling water system (as applicable) for scoop couplings, for complete limestone handling plant. Air cooled type scoop couplings are also acceptable.
2.01.26	Monorails and electrically operated hoist blocks as well as hand operated chain pulley blocks for servicing/installation/easy replacement of drive machinery, different types of pulleys for all conveyors, GTU and other equipment from ground level to their locations and vice-versa & landing inside the respective Buildings.
2.01.27	One (1) number of belt vulcanizing machine, suitable for all belt widths in limestone handling system, complete with all mechanical, electrical, accessories and consumables for one year of consumption. Further belt jointing facilities as specified shall be provided.
2.01.28	Minimum one (1) no. Weighing Bridge **of capacity 100 MT** for Road trucks / Tipplers shall be provided each in Limestone unloading area and in Gypsum Loading area.
2.01.29	All buildings shall be complete with all electrical, civil, structural, architectural works, cable trenches, fire safety walls, foundation, earth mat, fencing, earthing for transformers. All cables, duct banks, trenches, cable trestles shall be complete with associated civil/ structural work and necessary civil foundations.
2.01.30	Drainage of LHP buildings, tunnels, conveyor galleries and limestone storage shed / Silos including all civil & structural works as detailed out elsewhere in the specification.
2.01.31	All equipment/fittings, supporting structure, along with insert plates, bolts, accessories, MS sleeves, base plates, grouting as may be required and proper alignment etc.

2.01.32	Complete un-used set of all special tools and tackles, which are necessary or convenient for erection, commissioning and overhauling of any equipment, covered under the scope.
2.01.33	First fill of all consumables, e.g.; oils and lubricants for one year toppings requirements.
2.01.34	Preservative shop coating, final painting of all structures and equipment.
2.01.35	All inserts, anchor bolts, foundation bolts for Contractor's equipment, platforms etc. in the entire LHP.
2.01.36	All necessary grouting & finishing of the floor after welding at all such pockets & elsewhere is in Contractor's scope.
3.00.00	**GYPSUM HANDLING PLANT (GHP)**
3.01.00	Gypsum shall be conveyed from the vacuum belt filter to the storage shed through a series of double stream conveyors and transfer points/junction towers.
3.02.00	One number of covered storage shed for gypsum. The storage shed shall be sufficient to store gypsum equivalent to gypsum generation of minimum 7 days at Design point (Generation of all units to be considered).
3.03.00	Minimum four (**4**) Nos. sump pumps in gypsum storage shed complete with motors, local control panel, level switches, individual discharge piping with fittings and valves **upto Bottom Ash Slurry Sump.**
3.04.00	Complete dust suppression system for control of fugitive dust in gypsum storage shed, complete with pumps, water tanks, drives, hoisting arrangements, ducting, piping, valves etc. electrical, accessories, civil, structural and architectural works.
3.05.00	Service water and potable water system for complete gypsum handling plant. Water Pump houses & water tanks for service water, cooling water and potable water system. Common pump house for Limestone handling plant gypsum handling plant is also acceptable.
3.06.00	Suitable number of motorized travelling tripper / Flow diverter (as applicable) on each feeding conveyor for feeding the gypsum to the covered storage shed. Trippers shall be complete with all mechanical, electrical equipment, rails, chute work, rail supporting structure (along with structural stools, as required), cables with cable festooning arrangement, thruster brakes, rail clamps, electric hoist, actuator flap gates etc.
3.07.00	Gypsum from storage shed shall be loaded to user's trucks using front end loader/ pay loader.
3.08.00	Complete ventilation system for gypsum storage shed.
4.00.00	Bidder to note that the above list is not exhaustive and any work required for integration of complete system and ensuring its satisfactory running shall be in the scope of work and supply for this package.

SUB-SECTION-III-B

ELECTRICAL SYSTEM/EQUIPMENT

ELECTRICAL SYSTEM / EQUIPMENT

1.00.00 **GENERAL**

The Contractor's scope shall include design, engineering, manufacture, type testing, inspection & shop testing at supplier's works, packing, forwarding to site including customs clearance/ port clearance (if required), receipt and unloading, in plant transportation, handling and storage (preservation & conservation of equipment) at site, erection including associated civil and structural works, testing and commissioning of the Electrical equipment/ system and works indicated in this chapter. The scope includes all interface/ interconnections with the electrical systems under this contract as required and other systems mentioned elsewhere. Unless explicitly stated to be common for all the units, the Contractor shall provide all system/equipment for each of the units. The Electrical scope shall be as described briefly in the following clauses but not limited to it.

1.01.00 **MOTORS**

Motors along with couplings and coupling guards for all rotating auxiliaries covered under this package.

1.02.00 **HT/ LT SWITCH GEAR**

HT and 415V Switchgear / Motor control centers (as shown in Electrical Single Line Diagram Drg No. 6130/0330-109-POE-J-001) Busduct / Cable (as applicable), distribution boards, AC/DC fuse boards, LDB, local emergency push button stations for all drives and local motor starters (for ventilation fans) as required for plant and equipment in contractor's scope.

HT Switchgear- All HT switchboards shall be provided with one spare motor feeder and one transformer feeder on each section as spares.

LT Switchgear- All LT Switchgears, Motor Control Centers (MCCs) & AC/DC distribution boards, etc. shall have at least twenty per cent (20%) or minimum two (whichever is higher) fully equipped switch fuse modules of each rating as spares, uniformly distributed over different vertical sections.

In addition, all LT Switchgears, MCCs and AC distribution boards shall have as spares at least twenty per cent (20%) of starter modules/MCCB modules or at least one module (whichever is higher) of each rating range of the selection tables (Clause no.42.00.00) of Tech. Specification Part-B, Sub-Section E-10, equipped for the rating of the largest auxiliary fed from that range.

1.03.00 **DC SYSTEM**

Battery and Battery Charger

Lead acid plante type/ Nickel Cadmium batteries and Float cum boost chargers for plant and equipment in the scope of the contractor, as per system requirement. The DC system (Battery and Charger) shall be supplied to cater to various DC loads in the plant. The design and sizing criteria shall be as detailed out in the Sub-section-II- E1 Part-B of Technical specifications.

1.04.00 **TRANSFORMERS**

Transformers as per Electrical Single Line Diagram Drg No. 6130/0330-109-POE-J-001 and system requirement, however Contractor to provide complete sizing & selection criteria of Transformer's feeding Contractor's own systems.

1.05.00 **CABLES / BUSDUCT**

All HT/ LT power & control cables required for connection between equipment/devices in contractors scope and cables / Busduct (as applicable) between employers and contractors equipment as per Electrical Single Line Diagram Drg No. 6130/0330-109-POE-J-001.

1.06.00 **DG SET (IF APPLICABLE)**

Diesel Generator sets of stationary type comprising the following:

(1.) Diesel Engine Complete with all accessories

(2.) An alternator directly coupled to engine through flexible/rigid coupling complete with all accessories (CT's & VT's etc.)

(3.) Control Panel

(4.) Complete starting arrangement along with battery ,its charger

(5.) Base frame and foundation bolts etc.

(6.) Exhaust ducting meeting the statuary requirements, accessories, support structure and foundation bolts.

(7.) Day Oil Tank, fuel piping and accessories

(8.) Interconnection piping and accessories

(9.) Power and control cable gland and lugs at Contractor's equipment for all cables

(10.) Cable & Cabling between Contractor's equipment.

(11.) All lubricants for first filling, consumables and touch up paints etc for commissioning.

(12.) Acoustic enclosure meeting the statuary requirements. Necessary ventilation along with necessary starters & lighting shall be provided.

1.07.00 **CABLING**

1) Contractor shall provide cable trays and their accessories with support arrangements, trestle, trenches, duct bank etc. as required for the cables under his scope of supply for the complete system

2) Contractor scope shall include laying of cable from employer board as shown in Electrical Single Line Diagram Drg No. 6130/0330-109-POE-J-001 on the

employers' nearest trestle in the FGD area as shown in Drg no 5710-999-POC-F-001 for NCTPP Dadri and 0330/0331-999-POC-F-001 for IGSTPP Jajjar subject to availability of space and suitability. In case of non availability of space in employer's trestle, contractor shall make necessary arrangements for cable tray erection & cable laying.

3) Contractor shall supply, lay and terminate the cables under his scope of supply.

4) The contractor shall furnish the complete and consolidated feeder list for DC system, LT system and HT system for all loads and drives under the scope of supply of contractor to employer as per the format enclosed at Annexure-A. Contractor shall indicate the location of his equipment in feeder load list.

5) Contractor shall provide cable glands and lugs for all equipment in his scope.

6) Contractor shall provide all accessories such as rigid/ flexible conduits, fittings, junction boxes, tying materials, cable tags, and markers etc. for the cables under his scope.

7) Contractor shall provide Straight-through jointing kits for HT XLPE power cable, LT power and control cables, Cable termination kits for HT XLPE power cables, Welding receptacles, Trefoil cable clamps, Junction boxes.

8) Contractor shall provide Galvanised steel pipes/HDPE/hume pipes/PVC pipes, Miscellaneous items like M.S sections etc as required.

9) Contractor shall provide Fire proof cable penetration sealing system of Type-A and Type-B for cable galleries, cable exits etc.

10) Contractor shall also prepare complete equipment layout drawings, lighting layout drawings including cable tray layout, routing, Power and control cable schedules etc.

11) Control cable interconnection charts shall also be prepared by Contractor.

1.08.00 **LIGHTING**

Complete lighting system for internal and external areas for the FGD plant, buildings, chimney and equipment in the contractor's scope. Lighting fixtures complete with lamps & accessories, LED lighting fixture complete with driver circuit and accessories, Lighting Panels, Chimney aviation light, Receptacles, Switch boxes, Conduits, Lighting Wires, Ceiling fans with regulators, Lighting poles. Lighting masts, Earth wires and rods, Junction boxes, Battery operated automatic self contained lighting fixture, Maintenance ladders as required are included in the Contractor's scope.

Mandatory spare parts and maintenance equipment as required.

1.09.00 **EARTHING AND LIGHTNING PROTECTION**

Complete below ground earth mat and above ground equipment earthing system and lightning protection for the plant and equipment under contractors scope along with its interconnection to the nearest employers earth grid at two points.

1.10.00 ~~**PAINTING FOR ELECTRICAL EQUIPMENT**~~

The painting of all electrical equipment shall be epoxy based with suitable additives. The thickness of finish coat shall be minimum 50 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 50 microns shall be acceptable for finish coat. The Contractor shall furnish the complete painting details during detailed engineering stage.

1.11.00 **CONSTRUCTION POWER**

To meet the construction power requirement of the FGD and associated systems, the Employer shall provide Two Number 415V feeders in LT switchgears. The Contractor shall extend supply from these Construction power feeders to meet the construction power requirements at the various locations included in the Contractor's scope through suitably rated Isolation Transformers along with LT distribution boards as per requirement. LT Packaged Sub-stations with isolation transformers may also be used for this purpose. Suitable metering arrangement along with associated Instrument transformers and Metering Cubicles meeting the DISCOM requirements shall be provided by the Contractor at each Construction power feeder, for the measurement of actual energy consumed by the Contractor. The charges only for the actual energy consumed by the Contractor shall be recovered by the Employer based on prevalent rate of DISCOM.

Supply, erection, testing and commissioning of all equipments as required for further distribution for meeting the construction power requirements shall be in the Contractor's scope. All necessary statutory requirements for charging construction power of Contractor's network shall be in the Contractor's scope. Construction power supply network is a temporary arrangement which shall be used during the project construction phase. To meet this requirement, the equipments may be arranged by Contractor either by shifting their existing equipments at other installation or by fresh procurement, which may be taken back after commissioning of the project.

Even though the Employer shall make all efforts to maintain a continuous supply of construction power, the same is not guaranteed and Employer shall not be responsible for any loss or delays which the contractor may suffer on this account. Also the Employer shall not entertain any claim for exemption/reduction of liquidated damages for delay in execution of the contract due to irregular power supply. Contractor shall arrange/provide necessary backup arrangement on his own for uninterrupted power supply.

The Contractor shall maintain a minimum drawl power factor as per DISCOM regulations for their substations, and all such devices for maintaining power factor

shall be under the scope of contractor. All temporary wiring must comply with local regulations and will be subject to Employer's inspection and approval before connection to supply. Power supply shall not be provided for use in labor and staff colony.

1.12.00 **TYPE TEST**

Contractor shall carry out all type tests on electrical equipment as stipulated in relevant chapters of Part-B of technical specifications.

1.13.00 **MANDATORY SPARES**

Contractors scope shall include Mandatory Spares of all equipment as mentioned in the relevant portion of Technical Specification.

Annexure-A

STANDARD FORMAT FOR ELECTRICALFEEDER LOAD LIST

S. No.	KKS code as in vendor drawing	Description of feeder	Rating (KW/A)	Supply type	Unitised /Station	Normal / Emergency	Feeder type	Running Mode	Recommended cable size	Location Coordinates	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
GUIDE LINES TO FILL THE FORMAT											
Column No.	Legend	Designation	Description								
1	S. No.	1,2,3	Serial Number								
2	KKS code as in vendor drawing	- - -	Unique kks of the Equipment								
3	Description	- - -	Description of the bidders Equipment								
4	Rating		Name plate Rating in kW or Amps at 50 deg C								
5	Supply type	11 KV 3 ph AC / 3.3 KV 3 Ph AC / 415 V 3 Ph AC / 220 V DC / 240 V AC UPS / 240 V AC Non -UPS									
6	Unitised/Station	U	Unit(U) is applied for each unit.								
		S	STN(S) is applied for common equipment load.								
7	Normal / Emergency	N	Normal Supply								
		E	Emergency Supply(Emergency supply i.e DG supply)								
8	Feeder type	U	Unidirectional Motor feeder								
		B	Bidirectional Motor feeder								
		H	Heater feeder								
		S	SFU(switch fuse feeder)								
9	Running Mode	W	Working								
		S	Standby								
10	Recommended cable size	- /- / - /- /-	Recommended Incoming power cable size in: No of runs/no. of cores/ Size in mm2/Al or Cu/ PVC or XLPE								
11	Location		Location of the Equipment in coordinates row & columns as per layout								
12	Remarks		Any other relevant information								
Notes:	1) Electrical Load list shall be submitted as "MS Excel" sheet also in addition to that in pdf as per the format given above.										
	2) Each Row shall contain data of Only One equipment / load. i.e., if there are two numbers of the same equipment, they shall be indicated in two different rows with unique description & tag number.										

SUB-SECTION-III-C

CONTROL AND INSTRUMENTATION SYSTEM

CONTROL AND INSTRUMENTATION SYSTEM

1.00.00 GENERAL

1.01.00

a) The Contractor shall provide Independent Control & Instrumentation system for control, monitoring and operation of associated drives and auxiliaries in FGD system including Limestone grinding & handling system, Gypsum Dewatering & handling system and other systems being provided under the contract, in all regimes of operation in safe and most efficient manner. The Contractor shall provide all systems, equipment, accessories and associated equipment, which are included in Contractor's scope, in a fully operational condition acceptable to the Employer. The Contractor shall provide all material, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories, auxiliaries and associated equipments ensuring operability, maintainability and reliability. This work shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements in force.

b) The Contractor shall provide all material, equipment and services which may not be specifically stated in the specifications but are required for completeness of the equipment/systems furnished by the Contractor and for meeting the intent and requirements of these specifications. The work shall be consistent with modern FGD based power plant practices and shall be in compliance with all applicable codes, standards, guidelines and safety requirements in force on the date of award of the contract.

c) The Contractor shall also provide all the instruments along with cables, JB etc. for equipments / drives and services which may not be specifically stated in this specifications but are required for completeness of the FGD Control system shall be furnished by the Contractor and for meeting the intent and requirements of these specifications.

d) The Contractor scope shall include design, manufacture, engineering, inspection & testing at supplier's works, packing, forwarding to site, unloading, erection, testing & commissioning. The following clauses describe the brief scope of supplies. Scope shall be as described briefly in the following clauses but not limited to it. The detailed technical specifications are stipulated under Part - B, Section-VI of the specification as well as in various other Parts of the Technical Specifications.

e) All the system specified under this specification are Unitized, unless and otherwise specified specifically. Contractor to supply all systems separately for Dadri (2X500MW) and Jhajjar (3X500MW). Mandatory spares for C&I

system shall calculated separately for each project considering the total quantity for that project and supplied to respective site separately.

2.00.00 MEASURING INSTRUMENTS

The following shall be provided as a minimum, meeting specification requirements of Sub-section - MEAS INST of Part-B, Section-VI of Technical Specification.

2.01.00 Primary instruments like Microprocessor based transmitters employing HART protocol, thermocouples & RTDs along with temperature transmitters, pressure/diff. pressure/temperature/flow (Ultrasonic/electromagnetic) transmitter & gauges, flow sensing elements (orifice plates, flow nozzles etc), Ultrasonic, Radar type level transmitters, density meter (Coriolis type. In case the bidder proposes other type of density meter as per the bidder standard and proven practice, the same shall also be acceptable except Nucleonic type density meter), pH analyser, SO2 analyser, Flue Gas flow transmitter, vibration transmitter etc. for:

(a) FGD plant and other system being provided under the contract, as indicated in enclosed tender diagrams (Part E) of this specification.

(b) Integral to equipment which are not indicated in the tender drawings, but are required for control, monitoring and operation of the equipment / plant systems for which no P&IDs are enclosed, all the instruments shall be provided to meet the actual system requirements and meeting redundancy and other requirements specified under technical specifications subject to Employer's approval.

(c) For Binary and analog inputs required in major equipments of FGD system, protection triple-sensing devices shall be provided. Binary and analog inputs, which are, required for protection of more than one equipment as well as protection signals for HT Drives etc., triple sensing devices shall be provided. However, for vibration measurements and protection minimum 2 number (X and Y direction) sensors per bearing shall be provided.

(d) For other critical binary and analog inputs required for protection and interlock purpose of other equipment (e.g. those interlocks which may result in loss of production, non-availability of a major equipment etc.), triple sensors shall be provided.

(e) Temperature elements, electronic transmitters etc. are to be provided for all the cases. Use of process actuated switches is acceptable only in the cases as indicated in the tender drawings.

2.02.00 Single Input DIN rail mounting type temp transmitters (mounted in JBs) shall be provided by the Contractor for all temperature elements under Contractor's scope.

2.03.00 CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)

2.03.01 CEMS comprising of analysers and associated items for measurement of SOx, NOx, CO, CO2, Mercury, Particulate Emission (dust density/ stack opacity) monitor, Stack Flue Gas Ultrasonic Flow Meter shall be provided for each unit by the Contractor for stack emission monitoring.

A) LIST OF FLUE GAS EMISSION ANALYSERS

S. No.	KKS CODE	DESCRIPTION	RANGE	ZONE	REMARK
1	HNE10CQ005	SOx ANALYSER	0-300/0-1000PPM (SELECTABLE)	CHIMNEY	
2	HNE10CQ001	NOx ANALYSER AT CHIMNEY	0-300/0-1000PPM (SELECTABLE)	CHIMNEY	
3	HNE10CQ002	CO2 ANALYSER	0-40%	CHIMNEY	
4	HNE10CQ004	CO ANALYSER	0-1000 (SELECTABLE IN 0-100/0-200,0-500,0-999 PPM)	CHIMNEY	
5	HNE10CQ003	OPACITY ANALYSER AT CHIMNEY	0-999 mg/m3 (PROGRAMMABLE)	CHIMNEY	
6	HNE10CQ006	Mercury (Hg) Analyser	0-100 microgram/Nm3	CHIMNEY	
7	HNE10CQ007	Flowmeter (Ultrasonic Time of Transit Type	-	CHIMNEY	

Notes:- 1) SOx, NOx, CO2 and CO analyser are shown separately for the purpose of input only, otherwise SOX, NOX, CO2 and CO analyser may be supplied as a single unit/ Combined Unit (s) meeting specification requirement.

2) These are per unit quantities.

2.03.02 CEMS, instruments shall be provided with provision for bidirectional connectivity over Modbus/RS-232/RS-485 with Employer's central cloud server for real time data monitoring, remote diagnostics & remote calibration checks, etc., complying with CPCB IT Division document "Protocol for real time (Emission & Effluent) data management from industries version 1.2 (10.6.2015) or the latest regulatory requirement prevailing at the time of award of the contract. All necessary hardware and software required at instrument end shall be provided by the Contractor. Necessary details like scheme, register addresses of analyzer, etc. shall also be provided by the Contractor for implementation of above. The Contractor shall fully assist NTPC's agency involved in implementation of above connectivity.

For CEMS - In addition to above requirement, 4-20 mA connectivity to FGD-DDCMIS shall be provided by the Contractor

3.00.00 PROCESS CONNECTION & PIPING

Process connection & piping including LIE / LIR, all impulse piping, pneumatic piping/tubing, valves, valve manifolds, fittings and all other accessories shall be provided on as required basis for proper installation & completeness of impulse piping system and air supply system, as stipulated under Sub-section PCP, Part-B, Section-VI of Technical Specification.

4.00.00 INSTRUMENTATION CABLES, C & I SYSTEM, POWER SUPPLY DISTRIBUTION CABLES & CABLE SUB-TRAYS

a) All instrumentation cables (twisted & shielded, FRLS PVC insulated and sheathed), data highway / fibre optical cables including prefabricated cables (with plug-in connectors), cables as applicable for direct interconnection of two equipment/ system/ devices in Contractor's scope as well as for connection of signals from/to systems like MCC/LT SWGR/HT SWGR/ Employer's system etc. (even if they are not in Contractor's Scope.) shall be provided by Contractor on as required basis.

b) All power supply distribution cables required for directly connecting two equipment / systems devices in contractor's scope shall be provided by the contractor. All these cables shall be FRLS & as per IS-1554 Part – I latest edition.

c) Above cables shall be provided along with necessary laying & termination accessories, hardware etc. meeting requirements specified under Sub-section INST CABLE, Part -B, Section-VI of Technical Specification. All sub trays along with supporting, connecting hardware etc. required for laying of instrumentation, control, power and other cables etc. up to main cable trays are under Bidders scope.

d) Cables required for interfacing PLC control system with Employers DDCMIS (both SG and BOP) located in CER shall be in bidder's scope.

e) Cables for connectivity of CEMS signals to Employer's Unit DDCMIS located in unit CER shall be in bidder's scope.

f) Junction boxes with requisite terminals shall be provided on as required basis.

5.00.00 CONTROL VALVES & ACTUATORS

5.01.00 Control valves, actuators and accessories, shall be provided on as required basis for meeting requirements specified under Sub-section CONTROL VALVE, Part-B,

Section-VI of Technical Specification. Specially designed valves/trims to prevent cavitations and limit noise and control outlet velocity, shall be provided.

5.02.00 Microprocessor Based Electronic Positioner is to be provided on as required basis with all the Control valves and all control dampers being provided by the contractor.

6.00.00 CONTROL SYSTEM

6.01.00 The Contractor shall provide DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATON SYSTEM (DDCMIS) based control system, Two number of Operator Work Station (OWS) per Unit and one Operator Works station for common system, (i.e. 5 OWS for Dadri and & 7 OWS for Jhajjar) and A4 size color Laser printer etc. for controlling and monitoring of the FGD and associated system located in FGD control room. Instrumentation and Control System with interlocks, protection and annunciation for FGD system and other system being provided under the contract shall be provided with all required software and hardware to make the system complete and functional.

Additionally, one OWS shall also be provided with capabilities of programming station of DDCMIS and Human Machine Interface system (EWS cum OWS) for each Unit.

In order for fast, trouble-free and smooth execution and support during Operation and Maintenance period as specified elsewhere in the specification, Bidder/ Contractor/Sub-Contractor or its group of company of the offered DDCMIS system should have a well-established DDCMIS hardware and software service center in India working for at least 5 years from the date of bid opening.

Depending on the cable distance between FGD control room and FGD sub systems such as Gypsum handling system, Limestone handling system etc, requirement of Remote Input Output (RIO) shall be finalized during detail engineering, In such cases, contractor to provide RIO on as required basis. Contractor shall place RIO cabinets inside building with air conditioning environment. Building, Air conditioning, power supply for RIO cabinets shall be in contractor's scope.

6.01.01 **Control System Spare Capacity:**

(i) **I/O Modules**: Minimum 10% spare channels over and above engineered I/Os in each FG, shall be provided for each type of I/Os. Further, these spare channels and other unused channels of I/O modules shall be fully wired up to the marshalling/ termination TBs.

(ii) **FG /Controller**

(a) Each controller shall have spare software I/O acquisition blocks / logic sheet capacity (as applicable for system) to cater to additional spare

I/Os defined at (b) below. Additionally each controller shall have 20% spare functional (software) capacity to implement additional function blocks, over and above blocks required for implemented logic/ loops.

(b) Each controller shall have spare capacity to handle minimum 30 % additional I/O modules of each type, over and above I/O modules required for corresponding FG. The additional capacity will be calculated separately for 'local' and 'remote' I/Os.

6.01.02 The overall system accuracy from signal input terminals to output presentation on display and printers for the least accurate input range and maximum scan rate shall be no worse than +/- 0.1% of full scale of the engineering process range (+/- ½ LSB for 4-20 mA input) .

6.01.03 **Flue Gas De Sulphurization (FGD) DDCMIS**

FGD System comprising of binary and modulating controls of complete Flue gas desulphurization system, material handling systems etc. shall be implemented in the DDCMIS separately for Dadri project (2 X 500 MW units) and Jhajjar Project (3X 500 MW units). The Control System of FGD DDCMIS has following process blocks as minimum. Any other systems apart from the below mentioned systems shall be included in the common system. Details of control blocks with respect to process blocks shall be finalised during detailed Engineering:

i. Unit-1 FGD
ii. Unit-2 FGD
iii Unit-3 FGD (applicable for Jhajjar only)
iii. Gypsum De watering Handling common system block
iv. Lime stone preparation common system block.

6.02.00 The Bidder shall provide software license for all software being used in Bidder's System. The software licenses shall be provided for the organization i.e. it should not be site-specific and shall also not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Owner to seek a new license/renew license due to up gradation/change of hardware/machine in Bidder's System at site. All licenses shall be valid for the continuous service life of the plant.

6.03.00 NOT USED

6.04.00 NOT USED

6.05.00 The minimum quantity per unit of furniture envisaged in FGD control room is as mentioned below:

a) Chair-4 nos.

b) Printer table- 1 no

c) Computer table- 2 no.

d) Key pad- 1 no.

e) Locker set -1 no

6.06.00 Complete wiring / cabling from field devices to panels / MCC and vice versa including conduits / trays / fixtures etc. shall be in bidders scope.

6.07.00 Microprocessor based modular 24V DC power supply system shall be used for powering the control systems including its network devices.

24V DC power supply system for PLC/DCS based control system shall comprise of two sets, each set shall consist of 1 x 100% microprocessor controlled, intelligent, modular rectifier banks, Controller – one for each rectifier bank, 1 x 100% Nickel - Cadmium batteries for one (1) hour duty, 1 X 100% DC distribution board. 1x100% Microprocessor controlled Battery Health Monitoring System (BHMS)–common for both the sets.

Contractor shall provide UPS of suitable capacity for the intended application meeting the requirements of Technical Specifications.

Contractor to note that UPS of configuration C is acceptable only upto 5 KVA. In case the consolidated load requirements exceeds 5 KVA, Contractor to provide UPS with Configuration B in place of Configuration C as per Technical Specifications. For details refer Part B IIIC-5.

Bidder shall provide power supply distribution panels/cabinets/boxes for sub distribution of DC/Main UPS/Utility feeders on as required basis. The power supply distribution box shall include change over circuitry, switch fuse units, MCBs, terminal blocks etc. suitable for application.

Contractor to ensure that the various power Supply Systems offered for this package shall ensure continuous reliable operation of its consumers. The offered system design shall be tolerant towards single fault. Necessary redundancy to be ensured by the Contractor wherever required to meet above functional requirements.

For detailed requirements of FGD system, refer Part B Section VI of technical specifications.

7.00.00 TYPE TEST REQUIREMENT

The type tests to be conducted for C&I systems & equipments shall be as detailed out in Type Test Requirements, Part-B, Section-VI of Technical Specification.

8.00.00 TOOLS & TACKLES

The Contractor shall furnish a complete new set of all special tools and tackles of reputed make and model which are required for erection, ease in maintenance to

	have minimum down time, testing and calibration of all the equipments and systems to be provided by the Contractor under this specification for C&I systems.
9.00.00	**Interfacing with Employer's DDCMIS and Station LAN**
9.01.00	Hardwired Signal exchange: Hardwired signal exchange between BOP DDCMIS (under Employer's scope) and FGD PLC (under Contractor's scope) like bypass damper status, inlet and outlet gates status, ID Fans status, ESPs status, Boiler Load Index (BLI), MFT etc. shall be provided on as required basis, for implementation of protections and interlocks. Contractor shall provide Remote Input Output (RIO) for PLC per unit, placed in Central Equipment Room (CER) for the same. However, contractor to consider IOs and cables for minimum number of hardwired signal exchange per unit as follows DI – 80, DO – 80, AI – 20 and AO – 20. NTPC shall provide 2 (Two) nos. of 24V DC power supply feeders in CER for powering RIO panel.
9.02.00	Control, operation and monitoring of FGD and associated system is primarily envisaged from Contractor's OWS placed in FGD control room. In addition to above, it is also envisaged to control, operate and monitor FGD and associated system remotely from main plant Central Control Room (CCR). To achieve the above the Contractor shall provide the following: 1) The FGD plant operation from CCR shall be made available through Ethernet link following TCP/IP standard. The system shall be OPC compliant. 2) Contractor shall provide necessary hardware and software for dual fibre optic connectivity & interconnection with station wide LAN for transfer of signals. All required plant data shall be transferred to / from through links ensuring complete security. The exact number of points to be transferred through the above communication link and the format of the data shall be finalized during detailed engineering. 3) The Contractor shall provide all assistance to the BOP C&I (in Employer's scope) supplier including co-ordination and flow of required information etc. 4) Contractor shall provide complete logics for FGD and associated system such as booster fan blade pitch control, FGD bypass damper control, FGD inlet and outlet gate control etc. FGD OEM shall furnish recommendations, if any, for implementation in employer's DDCMIS for boiler control.
9.03.00	Contractor to refer the General Layout Plan (GLP) to estimate the distance between FGD control room and Employer's CCR/CER.
10.00.00	**Grounding System**
	Suitable electronic grounding is to be provided by the contractor for all C&I equipments/panels/desk in the scope of the contractor. The exact scheme shall be

as finalized during detailed engineering. Also Refer tender drawing 0000-999-POI-019A and Sub-Section titled “Basic Design Criteria” in Part-B, of this Technical Specification.

11.00.00 **Electrical Actuators**

Electric actuators with integral starters along with associated accessories etc. shall be supplied on as required basis for Valves / Dampers to meet the functional and the other specification requirements specified elsewhere in the Technical specification.

In this project Non-intrusive Hardwired Electric Actuators are to be provided. For detailed specification refer Part B Sub section-IIIC.

For erection and commissioning of above specified actuators, qualified and experienced engineers of actuator manufacturer shall be deputed at site. After successful commissioning of actuators, minimum one qualified and experienced engineer of main package supplier/ actuator manufacturer shall be continuously available at site up to completion of defect liability period (warranty) of actuators, for troubleshooting and maintenance of actuators and proper interfacing with DDCMIS. Qualified and experienced engineers indicated above shall have expertise in all aspects of non-intrusive actuators along with fieldbus protocol and interfacing with DDCMIS.

5 No.’s configuration/diagnostic tool for non-intrusive actuators (if applicable) shall be provided.

SUB-SECTION-III-D

CIVIL WORKS

1.00.00	**SCOPE OF CIVIL WORKS**
1.01.01	Scope of Bidder shall include all Civil, Structural, Architectural works including underground facilities like drainage, sewerage, trenches, earthing mat/ grounding, of all the facilities associated with complete Flue Gas Desulphurization system and its auxiliaries, as specified elsewhere in the technical specification.
1.02.00	The work to be performed under this specification consists of providing all labour, materials, construction equipment, tools and plant, scaffolding, supplies, transportation, all incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Bidder's supervision and in strict accordance with the drawings and specifications. The nature of work shall generally involve earthwork in excavation & deep underground excavation, extensive de-watering, shoring and strutting, sheet piling, back filling around completed structures and plinth protection, paving , disposal of surplus excavated materials, piling, concreting including reinforcement and form work, brick work, fabrication and erection of structural / miscellaneous steel works, inserts, architectural items & finishes such as plastering, painting, flooring, doors, windows & ventilators, glass and glazing, rolling shutters etc., permanently colour coated profiled steel sheeting, anchor bolts, R. C. C. trenches with covers, laying and testing of water pipes, sanitation, water supply, drainage, damp proofing, water proofing and other ancillary items.
1.03.00	The work shall have to be carried out both below and above ground level and shall be involving, basements, equipment foundations, grounding, slabs, beams, columns, footings, rafts, walls, steel frames, brick walls, stairs, trenches, pits, access roads, culverts, trestles, finishes, false ceiling and complete architectural works, etc. The works covered under the scope of the bidder have to be executed in an operating ***/*** under construction power station. The bidder shall take all necessary precautions to protect the entire existing equipments, structures, facilities and buildings etc. from damage. In case any damage occurs due to activities of the bidder on account of negligence, ignorance, accidental or any other reason what so ever, the damage shall be made - good by the bidder at his own cost to the satisfaction of the Owner. The bidder shall take all necessary safety measures to avoid any harm, injury to his workers/staff from the equipment / facilities of the power station.
1.04.00	If during the execution of works it is found that there is interference with the existing facilities / structures, the bidder shall revise his design / detailed drawings to clear the interference and shall provide all necessary measures for the safety of existing structures. In case the details shown in tender drawings are found to be different from actual details at site, bidder shall revise his design/ detailed drawings to suit the constraints at site. No claim in terms of cost or relaxation in time shall be entertained for any redesign, rework and for safety measures provided. If at any stage of work, any dismantling or modification or relocation of any existing facility is required to be done to complete the work in bidder's scope and which has been agreed by the Employer, the same shall be done by the bidder at no extra cost or time implication to the Employer. All such changes will be as per drawings and work plan approved by the employer.
1.05.00	Analysis, design and preparation of construction drawings for all structure/facilities under the scope of this package and getting the same approved from the owner.

SUB-SECTION-IV

TERMINAL POINTS & EXCLUSIONS

1.00.00 TERMINAL POINTS

1.01.00 **FGD**

The terminal points identified herein below shall be read in conjunction with the tender drawings, scope of supply and technical specifications of various systems covered under the package for both the projects except wherever, it is specifically indicated project wise in the relevant clause.

1.02.00 **Flue Gas Duct**

(i) Un cleaned Flue Gas **For each unit:**

i) One tapping from the common Flue Gas Duct going towards the existing Chimney (in case of twin flue chimney). No load of duct shall be transmitted on the Employers facilities.

ii) One tapping each from the two Flue Gas Duct going towards the existing Chimney (in case of single flue chimney). No load of duct shall be transmitted on the Employers facilities.

1.03.00 **Equipment Cooling Water**

1.03.01 **Normal make up to ECW tank**

Contractor shall take a tap off suitably from the existing DM normal make up header (DM normal make up pump discharge) available along C-row at CD bay rack for meeting the makeup water requirement of ECW system. The pressure available at TP will be 4Ksc (gauge) wrt FGL (approx.).

1.03.02 **Emergency make up to ECW tank**

Contractor shall take a tap off suitably from the existing DM Emergency make up header (condensate transfer pump discharge) available along C-row at CD bay rack for meeting the emergency make up water requirement of ECW system. The pressure available at TP will be 4 Ksc (gauge) wrt FGL (approx.).

1.04.00 **Process Water**

For FGD system, Contractor shall take a tap off suitably from the existing CW blow down header available near the CW pump house. The pressure available at TP will be 1.9 Ksc (gauge) wrt FGL (approx..).

1.05.00	**Gypsum Wash Water (Clarified Water)** For Gypsum washing, Contractor shall take a tap off suitably from the existing HVAC header (HVAC make up pump discharge) available along C-row at CD bay rack for meeting the water requirement of Gypsum washing. The pressure available at TP will be 4Ksc (gauge) wrt FGL (approx.).
1.06.00	**Potable water** Contractor shall take a tap off suitably from the existing potable water supply header (potable water pump discharge) available along C-row at CD bay rack for meeting the potable water requirement . The pressure available at TP will be 3Ksc (gauge) wrt FGL (approx.).
1.07.00	**Waste Water** FGD waste water pipes shall terminate along with isolation valve at 5 Meters near HCSD Mixing Tank , and 300 mm above FFL in HCSD Silo Area. Pressure at terminal point shall be 3.0 kg/cm2(g) , pH shall be 7.0 (approx.) and temperature shall be <50°C in case of IGSTPP,Jhajjar. However, in case of NCTPP,Dadri the neutralized waste water shall be taken upto the Ash mound located near the plant.
1.08.00	**Limestone** i) For unloading of Limestone through WT/Track Hopper of the existing Coal Handling Plant, limestone 'Feed Point' before existing CHP's Crusher House. ii) For unloading with Road-Truck Unloading System, entry to truck unloading area.
1.09.00	**Gypsum** Outlet of Gypsum storage silo/shed
1.10.00	**FIRE DETECTION AND PROTECTION SYSTEM** **(i) Mechanical:** Separate Hydrant and spray header (within 100 metre) available in plant area for tapping required for Hydrant and spray system for FGD/ZLD facilities. Minimum pressure available for hydrant and spray system shall be 8 Kgf/cm2.
1.11.00	All interconnections of matching flanges/expansion joints/piping/ducting etc, between employer supplied equipment/equipment supplied by other contractors and contractor supplied items at terminal points specified above shall, however, be in the scope of FGD Contractor.

1.12.00 **Electrical**

1.12.01 Terminals of Employers HT switchgear .

1.13.00 Control & Instrumentation

a) Employer's marshalling cabinets in Main plant Control Room (CER) for hardwired signal exchange with Employer system.

d) Employer's station wide LAN switch in CER.

1.14.00 The storm water drains of FGD facilities shall be connected to the existing main plant drains on sides of roads. The layout and details of existing main plant drain shall be provided during detail engineering.

1.15.00 The sewerage pipe shall be connected to the nearest Owner's sewer line. The layout and details of existing sewer line shall be provided during detail engineering.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES

1.00.00 **SCOPE OF SUPPLY AND SERVICES**

The scope of work for the equipment and accessories to be furnished in accordance with this specification shall include design, engineering, manufacture, inspection and testing at supplier's works, packing, forwarding to site, unloading, pre- assembly, assembly, erection, supervision, pre-commissioning, testing and commissioning and performance testing of the equipment/system and works indicated in this Sub-section of the technical specification. Any item or works though not specifically mentioned in this specification but needed to complete the equipment & systems to meet the intent of the Specification shall also be furnished, unless specifically mentioned under “Exclusion” in Sub-Section-IV of Part-A, Section-VI of the Technical Specifications.

1.01.00 The scope of supply & services is detailed out in the following Sub-Sections.

Sub-Section

III A	-	Mechanical equipment and associated systems
III B	-	Electrical Systems
III C	-	C&I systems
III D	-	Civil works

1.02.00 Scope of supply of the Contractor includes mandatory spares, start-up and commissioning spares and consumables. The general requirements in respect of various types of spares is given in Sub-Section-VII, Part-A of Technical Specification.

1.03.00 **Tests**

The scope of the Bidder includes all shop tests, type tests, site tests, routine tests, etc., fulfillment of complete quality assurance & inspection requirements and related activities for all the equipment & systems covered under the scope of work of Bidder as per the stipulations of Technical Specifications.

1.04.00 **Paints / Painting**

1.04.01 The Contractor's scope of work includes supply of paints and painting of all equipments and structures as per the Employer’s standard color coding scheme which shall be furnished to the Contractor during detail engineering stage. The painting of various components shall comply with the requirements stipulated in different part of this specification. However, for components where no specific requirement is stipulated, the painting conforming to the requirements stipulated below shall be provided.

(i) Surface preparation shall be blast cleaned conforming *to* Sa *2-1/2* Swiss Standard.

(ii) Primer coat shall consist of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.

(iii) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.

(iv) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat *of* polyurethane of minimum DFT of 25 microns shall be provided.

1.04.02 The flue gas swept surface of Absorber inlet ducting (excluding wet dry interface section) shall be blast cleaned conforming *to* Sa *2-1/2* Swiss Standard and applied with of 50 microns of ethyl silicate zinc primer (suitable upto minimum 400 degree Celsius).

1.05.00 **Pre-commissioning and Commissioning Activities**

1.05.01 Contractor's Scope shall include all pre-commissioning and commissioning activities, required for successful performance of all equipments and systems under this package. Contractor's scope shall also include supply of all materials and services including the following for successful conductance of pre-commissioning and commissioning activities:

1.05.02 complete pre-commissioning work including tests of facilities and all other tests as mutually agreed in the Contractor's quality assurance program as well as those identified in the specification.

1.05.03 Commissioning and initial operation of the facilities.

1.05.04 Supply of all consumables as may be required for above pre-commissioning/ commissioning activities

1.05.05 Supply of all temporary equipment such as piping including supports, valves, blowers and all necessary instrumentation for successful conductance of pre-commissioning and commissioning activities. All temporary equipments, blowers, valves etc. brought to sites, by the Contractor for pre-commissioning/commissioning purpose shall be in good working condition to ensure its safe and reliable operation at site. All such temporary equipments/components shall be brought to site at least three (3) months prior to commencement of relevant pre-commissioning/ commissioning activities. On receipt of the temporary equipments/components at site, the same shall be inspected by the Employer to ensure its safe and reliable operation and if in the opinion of the Employer the temporary equipments/ components are not in satisfactory conditions to ensure it's safe and reliable operation the same shall be immediately replaced by the Contractor.

1.05.06	The temporary equipments specifically brought by the Contractor solely for the pre-commissioning and commissioning work shall on completion of these activities, remain the property of the Contractor.
1.05.07	The selection of material of all the temporary equipments/ instruments shall be compatible with the service conditions expected during pre-commissioning/ commissioning activities.
1.05.08	All temporary equipments and instruments shall be clearly listed out in the bid.
1.05.09	Supply of all labour, skilled/ semi skilled supervisors, engineers and any other manpower.
1.05.10	The scope of Contractor shall also include necessary approach & Platforms for all the instruments required during commissioning and testing. These approach platforms shall be provided to meet all required safety norms and these shall be permanent nature.
1.06.00	**First Fill of Consumables, Oils & Lubricants** All the first fill and one year's topping requirements of consumable such as grease, oil, lubricants servo fluids etc. which will be required to put the equipments covered under the scope of specifications, into successful commissioning/initial operation and to establish completion to facilities shall be furnished by the Contractor, unless specifically excluded under the Exclusions in these specifications and documents. Limestone shall be supplied by the Employer.
1.07.00	**Guarantee Tests** The Guarantee tests for various equipment and systems shall be carried out as specified under Sub-Section-VI, Part-A of Technical Specification. All special equipment, tools and tackles, instruments, measuring devices required for the successful conductance of Guarantee Tests shall be provided by the Contractor, free of cost. All costs associated with the tests shall be included in bid price.
1.08.00	**Special Tools & Tackles and Test/Measuring Equipments** One set of all special tools and tackles including testing, calibrating and measuring instruments required for erection, assembly, disassembly and maintenance of all equipments/systems covered under the scope of the Contractor shall be supplied by the Contractor. These shall not be used for erection/commissioning purposes and shall be in an unused and new condition, when they are handed over to the Employer. A list of such special tools and tackles shall be submitted along with the offer.

CLAUSE NO.	SCOPE OF SUPPLY & SERVICES
1.09.00	The scope of the Contractor includes complete design and engineering, technical co-ordination (including participation and arranging technical co-ordination meetings), finalization of drawings/documents, submission of engineering drawing/documents and processing of their approvals by the Employer as detailed in Part-C, Section-VI and other relevant clauses given elsewhere in the technical specification. Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer.
1.09.01	Bidder shall furnish all relevant data required by the Employer, at interface points within 45 days of notification of award.
1.10.00	All overground facilities & any hindrance and evident underground facilities to be dismantled and relocated by bidder. Bidder is also advised to visit site and collect all relevant information, before submitting the Technical bid However, if any underground pipe trenches, cable trenches, foundation etc. which have not been originally identified in the specification for rerouting but become evident during execution and are required to be rerouted as per the design and execution plan proposed by the Bidder, then same shall be re-routed/removed as applicable by Employer and the material required for the same shall also be provided by the Employer. However, Bidder shall note that any re-routing and modification work that will be suggested by the Bidder in such an eventuality shall be subject to the Employer's approval and, if required, Bidder shall modify his design to suit the actual site conditions**.**

Annexure-X

1.06.00 Uniform Finished Ground Level (FGL) in FGD areas shall be made available by the owner at a level specified in tender drawing.

2.00.00 CONSTRUCTION FACILITIES

The following are also in the Bidder's scope of work:

1. Providing drinking and service water for Bidder's labour, staff and other personnel working for Bidder at the work site and in his staff/ labour colony. He shall install necessary bore wells with associated pumping or water tankers and treatment facilities to supply quality water as per standards.
2. Developing temporary staff colony and labour colony along with fencing etc. Land if required shall be arranged by the Bidder himself.

   However space required for bidder's office, storage, pre assembly and fabrication areas shall be provided by owner free of charge within the plant premises.

   The area to be allocated to the Bidder shall be discussed & finalized with the bidder after the award, keeping in view the availability of free space & similar requirement of other agencies.
3. Providing all arrangements for distribution of construction power at various locations as per his requirements from the supply point of Owner.
4. Providing all arrangements for the supply of construction water including bore-wells, water tankers etc.
5. Providing temporary construction office, construction stores (open / covered), workshops, material / field testing laboratory, any other temporary buildings
6. Providing all construction equipment, labour and materials. The Bidder shall provide all the tools and tackles required for the work.
7. Development of the pre-assembly and storage yard with fencing, drainage, internal roads, boulder soling, etc.
8. Access roads to his work sites, offices, stores, preassembly / fabrication yard, etc. as required for providing approach/access for men, materials, equipment, cranes, trailor, construction/erection activities etc., what so ever are required by the bidder, shall be constructed and maintained by the bidder. Bidder shall provide permanent access to all facilities/structures from the nearby existing roads of the Owner. Roads shall be in concrete as per IRC standards, with minimum thickness of pavement (PQC) as 250mm (in M 35 grade) and DLC of 150 thick (in M 10 grade).
   Double lane road (width 12m having 7.5m wide pavement & 2.25m wide shoulders on both sides) shall be provided.
9. Area lighting at the construction / erection site, pre-assembly and storage yard, office areas and labour / staff colony.
10. Providing all necessary fire-fighting devices / equipment / fire tender etc. required during the project execution stage. He shall maintain all such

equipment / devices in proper working conditions throughout the period of work.

11. Providing first aid facilities at the construction / erection sites, workshops, laboratories, pre-assembly and storage yard and other places of work as per the requirement.

12. The Bidder shall arrange skilled / semiskilled / unskilled manpower from local source(s) as far as available in this country. He shall also arrange supervisory staff for quality execution of all works in his scope.

13. **Bidder's office, store, workshop, laboratory or any other temporary buildings:**

    The Bidder shall adopt pre-engineered/ pre-fabricated constructions made of steel with single / double skin, insulated for un-insulated roof and wall coverings (fabricated out of permanently color coated metal sheets) for his site office, covered store workshop, laboratory or any other temporary buildings. Alternatively, bidder can adopt readymade `Portacabin' or similar construction. Bidder shall ensure that all such constructions are well-engineered, neatly constructed and overall present a pleasing look. The above requirements shall be applicable to his sub-vendors also and bidder shall be responsible for enforcing the same on his sub-vendors.

    Any other type of construction if proposed by the bidder shall be subject to approval of the owner. However, such construction shall be based on proper design and shall have aesthetic look.

14. **Use of ash and ash based products:**

    In line with Gazette Notification on Ash Utilization issued by MOEF and its amendment thereafter, Bidder shall use ash and ash based products in construction of his offices, stores, staff quarters and labour huts etc. He shall furnish a compliance report along with all details of use of ash and ash based products along with each bill. The above requirements shall be applicable to his sub-vendors also and Bidder shall be responsible for enforcing the same on his sub-vendors.

15. **Repair & Maintenance Facilities by the Bidder:**

    Bidder shall establish/set up at site suitable repair facilities for construction plant, equipment and machinery (like cranes, hydra, forklifts, welding equipments, etc.) He will also make arrangements/tie up with manufacturers/ suppliers of such construction plant, equipment & machinery, for periodic overhaul/maintenance and for major breakdown, if any. He shall also keep adequate stock of spares at site for various construction plant, equipment and machinery to meet day to day requirements as recommended by the equipment manufacturer/suppliers or as instructed by the Engineer. Bidder shall deploy dedicated qualified, full time mechanical/electrical foreman/supervisors for manning the repair facilities as specified above

Ground Motion Acceleration Time History for
NCPP Dadari Gautam Budh Nagar, U.P.
(Normalised to 1 g) at 0.01 sec interval
Read horizontally

.0000	.0001	.0008	.0029	.0050	.0045
.0075	.0128	.0153	.0127	.0173	.0332
.0577	.0759	.0872	.0993	.1175	.1404
.1415	.0964	.0268	-.0383	-.1088	-.1839
-.2558	-.2664	-.2336	-.1920	-.1707	-.1844
-.2241	-.2975	-.3479	-.3340	-.2922	-.2762
-.2866	-.2662	-.2339	-.2173	-.2787	-.3576
-.3649	-.3042	-.2620	-.2567	-.2463	-.2793
-.2931	-.2837	-.2381	-.1636	-.0270	.1533
.3235	.4312	.4890	.4849	.4550	.3485
.1447	-.0787	-.2784	-.4474	-.6054	-.5934
-.3907	-.1282	.0565	.1824	.3058	.4223
.3962	.2410	.0055	-.2459	-.3951	-.4351
-.4865	-.6101	-.6293	-.4781	-.2835	-.1377
-.0742	-.0142	.0707	.2784	.4435	.4847
.5974	.6927	.6983	.5434	.3861	.3039
.3033	.2015	.0202	-.1065	-.0934	-.0206
-.0382	-.0951	-.0850	.0345	.1537	.1960
.1531	.0560	-.1098	-.2552	-.3944	-.4503
-.5000	-.5419	-.5649	-.5333	-.4868	-.6013
-.8107	-.9336	-.9372	-.9091	-.8940	-.7513
-.4177	-.1308	-.0143	.0077	.0071	.0210
.0398	.0742	.0931	.1228	.1515	.0732
.0620	.0116	-.0526	-.1473	-.1038	.0494
.1881	.2230	.1083	.0233	-.0528	-.0566
-.0156	.0578	.0860	.1127	.2152	.2757
.0708	-.1235	-.1268	-.0814	-.1433	-.2650
-.3795	-.4473	-.4794	-.4591	-.3919	-.4247
-.5390	-.6788	-.5998	-.2486	.1234	.4168
.6206	.7571	.8771	.9231	.8157	.5437
.3281	.2863	.4367	.5223	.3933	.2020
.2350	.3509	.5049	.6229	.7060	.9054
.8650	.9449	.9504	.6836	.6506	.7789
.8062	.6404	.4028	.2669	.2554	.1663
-.0079	.0021	.2125	.3661	.3237	.2724
.2996	.1588	-.1178	-.2996	-.2726	-.2554
-.3156	-.4125	-.5303	-.6425	-.7298	-.7411
-.6320	-.5211	-.4606	-.4277	-.4404	-.5871
-.7917	-.8109	-.9132	-.8905	-.8032	-.8810
-.7377	-.6008	-.5369	-.5024	-.5037	-.4775
-.4243	-.2197	-.0931	.0217	.1720	.3515
.5400	.6249	.5978	.4425	.3892	.4118
.3996	.3863	.4174	.4967	.4958	.3758
.2418	.0523	-.1615	-.4651	-.7417	-.8547
-.8217	-.7131	-.5119	-.2514	-.0074	.2567
.4866	.5377	.5158	.4724	.4277	.4337
.5846	.7693	.8205	.8095	.7677	.7623
.6914	.5817	.3991	.3161	.3168	.4152
.4883	.4301	.3074	.2273	.2170	.1224
-.0532	-.2987	-.4168	-.2641	.0582	.1101
-.0612	-.0973	.0861	.3216	.3241	.1987

Ground Motion Acceleration Time History for
NCPP Dadari Gautam Budh Nagar, U.P.
(Normalised to 1 g) at 0.01 sec interval
Read horizontally

.1974	.2249	.1819	-.0198	-.1714	-.1808
-.1917	-.2080	-.1008	.1549	.3392	.4043
.4430	.4408	.4455	.5264	.6571	.7258
.7019	.7241	.6743	.6040	.5747	.7194
.9613	.9241	1.0000	.9937	.9769	.9472
.9141	.7976	.8621	.7116	.6487	.5669
.4799	.3119	.0895	-.0507	-.0274	.0225
-.0824	-.2158	-.1824	.0015	.2140	.3811
.4663	.4825	.4967	.4177	.2179	-.0292
-.2024	-.2547	-.2658	-.2802	-.3688	-.3570
-.2725	-.2229	-.1420	-.0179	.0475	-.0154
-.2008	-.3628	-.5772	-.7527	-.8424	-.7774
-.5639	-.4186	-.3611	-.3522	-.3721	-.5200
-.6142	-.6259	-.5713	-.5047	-.4175	-.2933
-.1277	.0120	.0843	.1600	.2412	.3106
.3087	.2605	.2124	.1069	-.0980	-.2928
-.2927	-.1367	-.0349	-.0531	-.0565	.0108
.0064	-.0835	-.2284	-.2774	-.1986	-.0361
.0648	.0738	.0632	.0641	-.0274	-.2520
-.4818	-.6650	-.8323	-.9439	-.7732	-.7910
-.9418	-.8277	-.6914	-.5770	-.3443	-.1214
-.0104	.0010	-.0366	-.0175	-.0088	-.0718
-.2264	-.3622	-.3687	-.2705	-.1715	-.0713
.0356	.1838	.4059	.6253	.7620	.7900
.7559	.7328	.6696	.5446	.4079	.3505
.3112	.2746	.1827	.0236	-.1365	-.1631
-.1047	-.1843	-.3697	-.4745	-.4621	-.4638
-.5040	-.6007	-.6815	-.7063	-.6869	-.6413
-.5319	-.4761	-.4606	-.4406	-.3996	-.4272
-.5700	-.7399	-.8630	-.8442	-.7685	-.6168
-.4219	-.2287	-.1019	-.0455	.0349	.0717
.0384	.0234	.0799	.2048	.2609	.2090
.1211	.0685	.0371	.0136	-.0148	-.0073
.0185	.0576	.0922	.1097	.1553	.2101
.2787	.2858	.2511	.2087	.1674	.0926
.0683	.1390	.2766	.3676	.3753	.3731
.3956	.3657	.2747	.2010	.1714	.1926
.2112	.2335	.2201	.2443	.3117	.3551
.3084	.2413	.2171	.1617	.0778	-.0234
-.0828	-.0555	-.0053	.0047	-.0627	-.0953
-.0805	-.0728	-.0829	-.0739	-.0297	-.0127
-.0182	-.0581	-.1013	-.1320	-.1319	-.1003
-.0522	-.0756	-.0867	-.0362	.0557	.1415
.1802	.2327	.3556	.5079	.5687	.5307
.4766	.4342	.3666	.3279	.3059	.3064
.3258	.3536	.3376	.2926	.2366	.1577
.0882	.0571	.0572	.0381	.0249	.0200
-.0059	-.0591	-.1296	-.1422	-.1158	-.0741
-.0197	.0156	-.0056	-.1136	-.2299	-.3312
-.3804	-.4315	-.4916	-.5495	-.5697	-.5145
-.4404	-.4297	-.4575	-.4367	-.3371	-.2110

Ground Motion Acceleration Time History for
NCPP Dadari Gautam Budh Nagar, U.P.
(Normalised to 1 g) at 0.01 sec interval
Read horizontally

-.1366	-.0916	-.0578	-.0082	.0188	.0254
.0142	-.0013	-.0174	-.0239	-.0144	-.0013
-.0023	.0088	.0371	.0864	.1530	.1819
.1925	.1958	.2163	.2559	.2651	.2276
.1746	.1597	.1688	.1433	.0932	.0910
.1482	.1784	.1651	.1064	.0728	.0495
-.0004	-.0872	-.1553	-.1786	-.2223	-.2557
-.2644	-.2716	-.3059	-.3297	-.3469	-.3901
-.4678	-.5278	-.5477	-.5288	-.4992	-.4409
-.3573	-.2868	-.2542	-.2600	-.2767	-.2933
-.2777	-.2462	-.2141	-.1470	-.0534	.0085
.0411	.0598	.0926	.1507	.2113	.2371
.2243	.2118	.2081	.2003	.2023	.2089
.2293	.2396	.2633	.2820	.2776	.2667
.2502	.2477	.2464	.2516	.2471	.2487
.2289	.1915	.1394	.1061	.0940	.0432
-.0547	-.1606	-.2386	-.2847	-.3263	-.3597
-.3644	-.3460	-.3088	-.2857	-.2929	-.3274
-.3468	-.3578	-.3962	-.4601	-.5068	-.5041
-.4662	-.4214	-.3729	-.3185	-.2520	-.1904
-.1482	-.1269	-.1138	-.1096	-.1101	-.0938
-.0537	-.0310	-.0479	-.0847	-.1017	-.0757
-.0722	-.0836	-.0818	-.0307	.0337	.0897
.1404	.1787	.2122	.2367	.2485	.2430
.2382	.2273	.2109	.1935	.1646	.1212
.0968	.0978	.1088	.1248	.1437	.1477
.1484	.1440	.1390	.1418	.1434	.1455
.1344	.1028	.0614	.0086	-.0486	-.1031
-.1271	-.1087	-.0807	-.0655	-.0631	-.0621
-.0653	-.0735	-.1073	-.1438	-.1507	-.1193
-.0929	-.0778	-.0666	-.0515	-.0376	-.0217
.0011	-.0032	-.0128	-.0088	.0150	.0275
.0273	.0394	.0717	.1182	.1591	.1865
.2119	.2324	.2512	.2665	.2743	.2708
.2601	.2509	.2430	.2292	.2145	.2147
.2145	.1939	.1615	.1482	.1609	.1703
.1589	.1453	.1464	.1570	.1471	.1215
.0861	.0646	.0512	.0350	.0201	.0095
-.0031	-.0297	-.0550	-.0615	-.0511	-.0423
-.0278	-.0246	-.0221	-.0212	-.0308	-.0474
-.0583	-.0594	-.0630	-.0723	-.0928	-.1125
-.1257	-.1439	-.1584	-.1587	-.1424	-.1207
-.0952	-.0648	-.0509	-.0455	-.0342	-.0153
.0021	.0140	.0215	.0302	.0416	.0570
.0729	.0934	.1104	.1218	.1267	.1307
.1317	.1264	.1149	.1075	.1163	.1239
.1265	.1205	.1253	.1405	.1580	.1675
.1698	.1725	.1798	.1802	.1604	.1244
.0812	.0465	.0226	.0037	-.0252	-.0493
-.0493	-.0404	-.0384	-.0494	-.0654	-.0842
-.1080	-.1256	-.1458	-.1690	-.1896	-.1997

Ground Motion Acceleration Time History for
NCPP Dadari Gautam Budh Nagar, U.P.
(Normalised to 1 g) at 0.01 sec interval
Read horizontally

-.2054	-.2137	-.2266	-.2380	-.2364	-.2224
-.2073	-.1947	-.1768	-.1450	-.1142	-.0952
-.0763	-.0606	-.0486	-.0485	-.0467	-.0323
-.0049	.0191	.0383	.0559	.0744	.0946
.1057	.1079	.1110	.1280	.1441	.1461
.1355	.1234	.1191	.1220	.1234	.1250
.1305	.1315	.1199	.1021	.0834	.0592
.0314	.0115	-.0064	-.0213	-.0344	-.0433
-.0489	-.0583	-.0675	-.0710	-.0659	-.0657
-.0751	-.0880	-.1024	-.1170	-.1261	-.1291
-.1242	-.1207	-.1166	-.1140	-.1097	-.1050
-.1041	-.1051	-.1026	-.0917	-.0807	-.0654
-.0484	-.0309	-.0168	-.0062	.0025	.0094
.0143	.0223	.0332	.0415	.0514	.0693
.0930	.1104	.1142	.1157	.1195	.1239
.1247	.1195	.1123	.1107	.1139	.1161
.1176	.1191	.1241	.1272	.1279	.1203
.1058	.0892	.0774	.0737	.0750	.0785
.0806	.0798	.0814	.0781	.0625	.0432
.0279	.0200	.0112	.0049	-.0024	-.0112
-.0226	-.0359	-.0458	-.0494	-.0489	-.0514
-.0557	-.0554	-.0496	-.0458	-.0506	-.0554
-.0503	-.0389	-.0313	-.0253	-.0167	-.0056
.0088	.0213	.0278	.0314	.0388	.0463
.0528	.0542	.0536	.0559	.0637	.0719
.0751	.0761	.0805	.0877	.0931	.0970
.0982	.0999	.1011	.0999	.0973	.0934
.0855	.0773	.0694	.0644	.0580	.0503
.0439	.0371	.0314	.0249	.0205	.0169
.0137	.0123	.0122	.0127	.0075	-.0019
-.0111	-.0216	-.0342	-.0452	-.0494	-.0489
-.0468	-.0464	-.0440	-.0403	-.0355	-.0313
-.0279	-.0268	-.0269	-.0261	-.0253	-.0222
-.0157	-.0066	-.0016	-.0014	-.0029	-.0020
-.0015	-.0024	-.0027	-.0005	.0028	.0063
.0080	.0087	.0103	.0126	.0167	.0247
.0367	.0448				

VOLUME: II B

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of Paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painter’s bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not be yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well-known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pre-treated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477 (Part-1) ‘Code of practice for painting of ferrous metals in building’ and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc. and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1-part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers, the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conforming to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a

hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painting concrete, masonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e. Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS: 226 - Structural steel (Standard Quality)

IS: 800 - Code of Practice for general construction in steel.

IS: 806 - Code of practice for use of steel tubes in general building construction.

IS: 808 - Rolled steel beams, channels, and angle sections

IS: 813 - Scheme of symbols for welding

IS: 814 - Covered electrodes for metal arc welding of structural steel

IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

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 metal arc welders

IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS: 822 - Code of practice for inspection of welds

IS: 919 - Recommendations for limits and fits for Engineering

IS: 961 - Structural Steel (High Tensile)

IS: 1148 - Rivet bars for structural purposes

IS: 1149 - High tensile rivet bars for structural purposes

IS: 1161 - Steel Tubes for structural purposes

IS: 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS: 1239 - Mild Steel Tubes

IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm)

IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (Dia, range 6 to 39 mm)

IS: 1367 - Technical supply conditions for threaded fasteners

IS: 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS: 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS: 1731 - Dimensions for steel flats for structural and general engineering purposes

IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS: 1977 - Structural steel (ordinary quality) St-42-0

IS: 2062 - Steel for General Structural Purposes

IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS: 2595 - Code of Practice for Radiographic Testing

IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS: 3757 - High strength structural bolts

IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS: 7205 - Safety Code for Erection of Structural Steelwork

IS: 7215 - Tolerances for fabrication of steel structures

IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and

amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural steel High Tensile

c) IS: 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS: 1148 - Rivet Bars for structural purpose

b) IS: 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS: 814 - Covered electrodes for metal arc welding of structural steel

b) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural Steel (High Tensile Quality)

c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS: 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready Mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have been conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt. l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to

the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

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

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

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

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

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

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	**%**	**Remarks**
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulphur	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly, the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also require adjustment in the size of each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store

will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory

results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the

beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information

necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under

expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as

specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular

section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate

precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively, diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken

not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

   i) 10% at random on fillet-joints.

   ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor’s shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces'/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidder’s rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces'/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidder's rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However, deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted

from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work:

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times Dia or 200 mm	Bolt length exceeding 8 times Dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge

holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance

with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable

and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the “Strength Test” as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.