



TITLE:
TECHNICAL SPECIFICATION FOR CIVIL
WORKS FOR
2x660 MW KORADI TPP UNIT #11 & #12

SPECIFICATION NO. PE-TS-527-600-C001

VOLUME - II B

REV.NO. 0 DATE 13/06/2025

MAHAGENCO STATE POWER GENERATION LTD.

2X660MW MW KORADI TPP UNIT #11 & #12

TECHNICAL SPECIFICATIONS
FOR
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

DOCUMENT NO: PE-TS-527-600-C001



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

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PREAMBLE This document/specification consists of the following sections: Section C: This section indicates the technical requirements specific to the contract not covered in section-D. Section D: This section comprises of general technical specification. Note: 1. Specifications relevant to the scope work is applicable. 2. In case of any conflict between the contents of BOQ and Section –C, BOQ will prevail over section –C. In case of any conflict between Section –C and section –D, Section-C will prevail over Section -D		



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SECTION - C
SPECIFIC TECHNICAL REQUIREMENTS

	TITLE: TECHNICAL SPECIFICATION FOR CIVIL WORKS FOR 2x660 MW KORADI TPP UNIT #11 & #12	SPECIFICATION NO. PE-TS-527-600-C001 VOLUME - II B REV.NO. 0 DATE 13/06/2025
SECTION – C comprises of sub-sections as mentioned below: • LEAD TECHNICAL SPECIFICATION • DETAILED TECHNICAL SPECIFICATION-CIVIL • ANNEXURES 1. PLOT PLAN 2. TERMS & CONDITIONS OF THE CONTRACT – SITE WORKS 3. ADDITIONAL CONDITIONS OF THE CONTRACT– CIVIL 4. TOPOGRAPHY SURVEY REPORT AND DRAWING 5. PAINTING REQUIREMENTS • CLARIFICATIONS, ADDENDUM, AMENDMENTS		



MAHARASHTRA STATE POWER GENERATION CO. LTD.

**KORADI THERMAL POWER STATION
2X660MW UNITS - 11 & 12 PROJECT**

**BID DOCUMENT
FOR
EPC CONTRACT (MAIN PLANT PACKAGE)**

RFx No. 3000046202 (BTG Package)

**VOLUME - II
SECTION - 2
LEAD TECHNICAL SPECIFICATION**

STEAG Energy Services India Pvt. Ltd.
(A wholly owned subsidiary of STEAG Group, Germany)
A-29, Sector-16, NOIDA - 201301, India

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - II
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LEAD TECHNICAL SPECIFICATION

PREPARED BY



(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

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FEBRUARY, 2024

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1.00.00 INTENT OF SPECIFICATION

- 1.01.00 Maharashtra State Power Generation Corporation Limited (MSPGCL /MAHAGENCO) has decided to install two 660MW pulverised coal fired units, based on state of the art supercritical technology at Koradi Thermal Power Station, near Koradi village, which is situated at about 11km from Nagpur city, in Maharashtra state, India.
- 1.02.00 Mahagenco intends to install the plant through Engineering, Procurement and Construction (EPC) route through two turnkey contractors; one for Main Plant (BTG) package and the other for Balance of Plant (BoP) package.
- 1.03.00 This set of bid specification documents (hereinafter referred to as 'bid specification' or just 'specification'), including all its associated volumes, annexure, attachments, clarifications and amendments, is intended for the execution of Main Plant (BTG) package (hereinafter referred to as 'package' or 'plant').
- 1.04.00 Mahagenco now intends to appoint a contractor for the design, engineering, manufacture/procurement, assembly, inspection and testing at manufacturer's works, packaging into properly sized units and shipping, transport, delivery to site, receipt, unloading, handling, storage, preservation, construction of civil and architectural works, structural fabrication, erection, painting, testing, commissioning, putting into operation; doing performance, reliability (trial operation) and guarantee testing and handing over of the completed main plant (BTG) package, comprising all items as mentioned in the scope of works and services; including specified mandatory spares, tools and tackles, 3 year O&M spares and defect liability, for the proposed 2x660MW units – 11 & 12 project of Koradi Thermal Power Station.
- 1.05.00 The EPC turnkey contractor (hereinafter referred to as "Bidder" in the bid specifications) would be responsible for all major aspects of installation; from detailed engineering, scheduling, procurement, project management, site management, construction, erection, supervision and quality control, performance testing and handing over of the plant as per the requirements of the bid specification. After award of the contract to the "Successful Bidder"; all references to "Bidder" in the bid specifications shall be read and interpreted as "Contractor" i.e. the EPC turnkey contractor who shall be completely responsible for execution of the comprehensive contract for the package. Owner/Employer/Engineer/Client refers to MAHAGENCO/MSPGCL. 'Owner's Engineer' refers to Owner's Engineering Consultant.
- 1.06.00 The bidder will control the work of all his subcontractors and will be responsible for all their work.
- 1.07.00 This technical specification is intended to specify the minimum requirement for the main plant (BTG) package. However the bidder can offer better configuration or technology to improve the plant performance or optimise the overall project cost (including capital or working/O&M cost). But any deviation has to be brought during the pre-bid stage and it has to be approved by the owner and owner's consultant by issue of relevant clarifications / amendment to the specification. No deviations will be allowed at a later stage.

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1.08.00 This section also covers the general scope of supply and services, terminal points, general plant design and layout requirements, general quality and testing requirements, erection requirements, performance requirements, painting requirements, etc. Detailed technical requirements are indicated in other respective parts/sections of the specification.

1.09.00 The intent of the specification is to ensure that the plant & equipment under this package shall conform in all aspects, to high standards of engineering, design and workmanship and meet the intended performance of the plant, even if all details of design and construction are not specifically mentioned herein. It is the owner's intent that the specifications describe a functionally complete project/plant to be constructed in accordance with this specification. However, literal adherence to elements of this specification shall not relieve the bidder of ultimate responsibility for accomplishing the intent of the specification.

1.10.00 The intent of this specification is also to relieve the owner from any responsibility for completion of the package in all aspects, as per the requirements specified herein, except the works to be performed by the owner, which is specifically mentioned as owner's responsibilities.

2.00.00 BROAD SCOPE OF SUPPLY AND SERVICES

2.01.00 The scope of supply and services covered under this bid specification include all activities within the specified battery limits/terminal/tie-in points for completion of the main plant (BTG) package as specified herein, right from site preparation to takeover of the entire package by the owner; unless any item is specifically excluded from the scope of this specification. The plant/package shall be deemed complete, only when it has been taken over by the owner, without any further conditions; till then the complete plant is bidder's responsibility. And the owner will not delay the takeover, without valid reason.

2.02.00 Although all efforts are made to make the scope as clear as possible, it may not be possible to specify each and every item herein. Bidder's scope & responsibility for this package shall comprise every equipment, material, items, structures and necessary auxiliaries and systems as a whole, including complete mechanical, electrical C&I and civil works.

2.03.00 The information in this specification is not intended to be a complete, exhaustive listing, but is provided for convenience of the package bidder in developing an understanding of the overall scope.

2.04.00 Bidder's responsibility under this specification shall include everything which is required and necessary to complete the package. The bidder's scope under this package shall be deemed to include all such items which although may not be specifically mentioned in this specification, but are needed to make the system complete in all aspects, in accordance with good engineering practice, for safe, reliable, efficient, trouble free operation and coordinated operation of the plant.

2.05.00 The bidder will provide all necessary fixtures, components, accessories, electrical and C&I accessories and appurtenances for efficient and reliable erection, operation and maintenance whether mentioned in this specification or not.

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- 2.06.00 The extent of work under this contract includes all items shown in the appropriate sketches and drawings notwithstanding the fact that such items may have been omitted from the specifications or schedules. Similarly, the extent of work also includes all items mentioned in the specification and/or schedule, notwithstanding the fact that such items may have been omitted in the sketches and drawings.
- 2.07.00 The bidder shall provide all the relevant inputs, drawings and data in proper format to other package bidders, which is required for their detail engineering, to complete the project.
- 2.08.00 All necessary coordination and interfacing with sub-contractors shall be done by the bidder. The bidder will be responsible for all acts and omissions of any subcontractor and the owner will communicate only with the bidder regarding all matters pertaining to the contract.
- 2.09.00 All necessary coordination regarding interfacing with other package contractors shall be done by the bidder during detail engineering; with the approval of owner and owner's consultant.
- 2.10.00 Before preparation of the bids, the bidder may visit the project site and make himself familiar with the site/location conditions and understand all circumstances affecting the execution of the contract, including the extent and of work to be completed by him under this specification, means of transportation and access to site, facilities for accommodation of staff and labour (including those of sub-contractor's), storage and fabrication facilities available, availability of manpower, availability of construction material, labour and political issues, climatic conditions etc. Ignorance of site conditions shall not be accepted as basis for any claim for any type of compensation or extension of time.
- 2.11.00 The successful bidder upon signing of the Contract shall establish his office at the work site and in addition to a Project Co-ordinator/Manager stationed at his head quarters, nominate another responsible officer as his resident representative/Site in-charge, suitably designated for the purpose of overall responsibility and co-ordination of the works to be performed at Site. Such person shall function from the site office to be established by the bidder and in close coordination with the Engineer.
- 2.12.00 The scope of supply and services shall include but not be limited to the following:**
- 2.12.01 Basic & detailed design and engineering of the complete the package, including all systems, equipment and items.
- 2.12.02 Preparing and submitting engineering drawings and documents for owner's and owner's consultant's approval in agreed format and getting it approved after incorporating necessary changes. Submission of supporting drawings/documents/information sought by owner/owner's consultant, for this purpose.
- 2.12.03 Carrying out site investigation studies including, geo-technical investigation, topographic survey, area drainage study, water quality analysis etc for optimum design of the plant.

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- 2.12.04 Procurement, fabrication, manufacturing, assembly, shop painting, marking, inspection and testing at manufacturer's works, packaging into properly sized units and forwarding, insurance, shipping/transport, customs/port clearance, delivery to site of each and every item required to complete the package.
- 2.12.05 Receipt of all materials/equipment at site, unloading from carriers, handling for intermediate site storage, inspection at site for any shortage or damage and taking corrective action with the knowledge of owner / site in-charge, storage at site or other designated area near the site till the item is required for erection, security, protection and preservation at storage, handling from intermediate storage, transportation from storage area to location of erection.
- 2.12.06 Construction of civil and architectural works, structural fabrication, pre-assembly, erection, painting, pre-commissioning, testing, commissioning, putting into operation, performance, reliability (trial operation) and guarantee testing and handing over of the completed main plant (BTG) package, comprising all items as per the requirements of this specification.
- 2.12.07 All associated site services as mentioned elsewhere in the specification and as required to complete the plant.
- 2.12.08 Arranging and channelling all resources required to complete the package, as per the specification.
- 2.12.09 Deployment of additional resources as required to make-up for any delay in the project.
- 2.12.10 Installing latest and established ambient air quality monitoring system at strategic locations of the plant to monitor and comply with pollution norms as specified by statutory authorities.
- 2.12.11 Maintaining the complete project area clean and organised.
- 2.12.12 Obtaining necessary clearances/permits/licenses from statutory authorities for the completion of the project, as mentioned in Volume-I (Commercial).
- 2.12.13 Assisting owner and furnishing all relevant technical data for obtaining statutory clearances in owner's scope.
- 2.12.14 Preparation and submission of commissioning procedures and check lists for all equipment and systems.
- 2.12.15 All specialised equipment/services necessary for the package and all calibrated instruments and services required for performance testing of all items of the plant shall be made available for the purpose, by the bidder.
- 2.12.16 Provision for preservation of individual equipment after initial operation and commissioning, for example nitrogen blanketing etc. as necessary.
- 2.12.17 All structures which would be required by the bidder for supporting the piping and cables/cable racks. This includes complete pipe and cable racks/trenches/bridges.
- 2.12.18 All weld neck counter flanges, gaskets & fasteners shall be supplied by bidder wherever nozzle ends on any equipment such as strainer, flow nozzles etc. are flanged.

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- 2.12.19 All fixtures, embedded parts, steel embedment including fixing lugs and welding between them, foundation plates, nuts, bolts etc. for fixing all the equipments, piping on civil works.
- 2.12.20 Chemical cleaning of equipment and systems as required, after their erection.
- 2.12.21 Thermal insulation and removable metal cladding shall be provided, for all the equipments, piping and piping support frames, as required.
- 2.12.22 Complete platforms with handrails, for operation and maintenance of equipment and valves. Toe-guards should be provided for all handrails.
- 2.12.23 Complete piping (integral and interconnecting), fittings, couplings, expansion joints, valves, gates, gaskets, fasteners, instrument stubs and supports/hangers, as required for the plant.
- 2.12.24 All pumps, filters/strainers, storage/intermediate/day tanks, agitators, air receivers, specialities etc, as required.
- 2.12.25 Complete potable water and service water distribution to all buildings in the package.
- 2.12.26 Individual overhead tanks at all locations for potable and service water as required.
- 2.12.27 Complete distribution of instrument air and service air piping for the package.
- 2.12.28 All equipment complete with drive motors, coupling, coupling guard, base plates, anchor bolts, fasteners, gaskets, etc as required.
- 2.12.29 Complete electrical works for the plant including transformers, bus-ducts, switchgears, cables, motors, local control panels, LPBS, illumination, battery, DC system etc.
- 2.12.30 Complete instrumentation required for both local and remote monitoring, process control and performance evaluation for all process parameters, including instruments, cables, control stations, PLCs, DCS etc.
- 2.12.31 Complete painting of all items of the plant. cleaning, surface preparation and painting/corrosion protection including shop painting, before erection, during erection, after erection and application of final touch-up painting as required.
- 2.12.32 Complete consumables required for the plant till successful completion of trial operation, like grease, lubricating oils, chemicals, resins, filters, gases, etc.
- 2.12.33 Supply of HSD for emergency DG set till 'take over' by the owner, will be in bidder's scope.
- 2.12.34 All the erection materials and consumables like shims, welding rods, soldering and brazing alloys, insulating tapes, compounds, chemicals etc. required for the erection and commissioning work shall be included in the Bidder's scope of work.
- 2.12.35 One set of all special tools and tackles required for the maintenance of equipments/system have to be supplied by the Bidder. These tools and tackles shall be separately packed and brought to site. 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 all such special tools and tackles shall be submitted along with the offer.

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- 2.12.36 Adequate maintenance and repair tools required for inspection, testing, calibration and rectification during maintenance of equipments/system of the plant.
- 2.12.37 Complete set of spares as mentioned in the specification.
- 2.12.38 Carrying out flow model tests, as required, on models prepared by him and witnessed/reviewed by owner/owners consultant as the case may be and submitting the test reports for owners and consultants approval.
- 2.12.39 Installation and removal of temporary items for commissioning, like piping, structures, equipment and other arrangements any, with the approval of Owner/Engineer; if such item is not required for normal operation and maintenance of the plant.
- 2.12.40 Completion and rectification/modification of all items as per punch list, before final takeover by owner.
- 2.12.41 Preparation and submission of all operation and maintenance manuals for all equipment and systems for owner's approval and getting it approved after incorporating necessary changes.
- 2.12.42 Submission of adequate copies as specified, of all approved drawings and documents in desired format, for owner's record.
- 2.12.43 Final submission of all approved 'as built drawings' in desired format.
- 2.12.44 Training of owners personnel as mentioned in relevant sections of the specification.
- 2.12.45 Defect liability of each part of the plant supplied, for a period of 12 months from the date of acceptance of PG tests; unless specified otherwise. Some of the specific requirements are mentioned in the specification.
- 2.12.46 Latent defect liability for the plant equipment under the specification after expiry of defect liability.
- 2.13.00 Plant & equipment to be supplied, erected & commissioned and civil scope are as under:**
- 2.13.01 STEAM GENERATOR, ITS AUXILIARIES, FGD, SCR, & MRHS
- i) Two (2) numbers of once through, single/double pass (tower type/two pass type), single reheat, radiant furnace, dry bottom, balanced draft, outdoor type, pulverised coal fired, outdoor installation, steam generating units having supercritical steam parameters with all necessary auxiliaries, integral piping, elevators, etc.
 - ii) *Main plant and equipment shall include the following:*
 - a) Complete steam generating unit with milling and draught plant for pulverised coal firing system, along with ignition and support firing system and low NOx burners, separated over fire air (SOFA) nozzles, all control, protection and monitoring devices, refractories and insulation as required.
 - b) Complete water cooled furnace wall, headers, risers, separators, drains, drain pipelines, valves etc. up to and inclusive of flash tanks and venting arrangement suitable for super critical parameters

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- c) Steam generator structure, water circulation system, water-steam separator system (Evaporator or separator), start up re-circulation pumps with and superheating and reheating control system suitable for super critical parameters
- d) Complete superheater system including headers, connecting pipes, vents, drain, pipelines up to flash tank, nitrogen connections, required number and type of safety valves and sampling connections
- e) Complete re-heater system including headers, connecting pipes, drains, drain pipes up to flash tank and required number and type of safety valves
- f) Attemperation system for superheaters including control valves and upstream motor operated isolating valves for superheater with control station.
- g) Emergency attemperation system for reheaters including control valves and upstream motor operated isolating valves for re-heater with control station
- h) Economiser system with connecting pipes, headers, etc.
- i) Two tri-sector Regenerative Air Pre-heaters
- j) Coal Bunkers & Feeders along with measurement facilities
- k) Continuous exhaust gas emissions monitoring (CEMS) equipment
- l) Boiler Fill system for each SG
- m) Boiler preservation system with pumps
- iii) *Steam generator integral piping shall include the following:*
 - a) All drain piping from economiser headers, superheater headers, reheater headers, de-superheaters, etc. to drain collection headers
 - b) Drain collection headers and drain connections to the flash tanks
 - c) All drain piping from safety valves and drains of vent lines led to and terminated at trenches at the ground floor level
 - d) All vent pipes and safety valves escape pipes to a level above SG house roof. The vents on the headers and tanks provided with drain lines connected to a common trough and further led to and terminated at the canal at the ground level
 - e) All hangers and supports with auxiliary steel structure, including columns and beams wherever applicable; auxiliary steel for piping hangers and supports for piping in steam generator area, wherever applicable
 - f) Attemperation line to superheater and reheater attemperation headers from BFP discharge or inter stage tap off.
 - g) Steam generator fill lines from boiler fill discharge line near steam generator area. Adequate steam generator draining facility from Bottom ring Header
 - h) Piping, fittings and tappings as required; T-connections along with root valves in impulse pipes from where tappings are required to be taken for

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remote measurement in case provision does not exist for separate tapping points from the equipment for remote measurement and control

- i) Nitrogen capping pipe work including manifold with necessary valves for superheater
- j) Atomisation steam system for oil burners including pressure reduction unit with associated pipe work
- k) Feed water piping from top HP heater outlet.(Feedwater piping from downstream of feed check valve)
- l) Auxiliary steam piping from auxiliary steam header to all the equipment requiring auxiliary steam and covered in BIDDER'S scope
- m) Pressure reduction and de-superheating station, if required for further reduction of the auxiliary steam pressure & temperature required for soot blowers and for SCAPH (required during steam generator start-up) along with necessary piping, valves and fittings from auxiliary steam header
- iv) *Following valves shall be included:*
 - a) Drain, vent and sampling lines provided with one valve or two valves in tandem depending on temperature, as specified in specification for valves.
 - b) Feed check valve and isolating valve with motor drive; the feed check valve location to be ahead of isolating valve in the direction of flow
 - c) Superheater and re-heater safety valves-spring loaded
 - d) Electromatic relief valves on superheater outlet
 - e) Start-up drain and vent regulating valves with motor drives
 - f) Start-up drain and vent isolating valves with motor drives
 - g) All start-up vents, lowest set pressure spring loaded safety valves and electromatic relief valves at superheater outlet, lowest set pressure safety valves on re-heater outlet shall be provided with silencers; drains from the above safety escape pipes shall be terminated to a common trough and from trough to a common drain line to be taken to drain trench at the ground level
 - h) All instrument tapping points with one root valve or two root valves in tandem as specified
 - i) AC motor driven main steam stop valve with separate bypass line with one isolating and one regulating valve
 - j) Valves for nitrogen capping system
 - k) Valves for chemical feed connection
- v) Steam generator outer ribbed aluminium casing; aluminium sheet casing for equipment including hot air ducts, etc.
- vi) Complete air and gas duct work with necessary expansion joints, insulations wherever required, dampers and support steel work up to chimney with consideration of SCR and Wet FGD installation in the inline path of the unit.

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- vii) Fly ash hoppers for steam generator second pass like economiser, Air preheaters, SCR and electrostatic precipitators.
- viii) Steam generator roof casing, including access doors; adequate number of access and inspection doors shall be provided for furnace, air pre-heater, economiser, fans, dust collection equipment and ducts.
- ix) Roof sealing arrangement to ensure dust free pent-house (pent-house ventilation system).
- x) Complete soot blower system including drain system and entire piping and fittings including control valves, piping and valves
- xi) *Supporting and enclosing structure comprising:*
 - a) Steam generator supporting structure complete with girders, beams, guides, Buck stays, column base plates, foundation bolts, shims, etc.
 - b) Staircases of minimum 1000 mm width with handrails 100 cm high and 2 rail safety handrails of 40 mm galvanised iron (GI) pipe, on either side of steam generator and toe guards.
 - c) Access platforms, staircases and walkways for soot blowers, man holes/inspection doors, dampers/damper drives, valves of critical services, ID fans, FD fans, PA fans, air pre-heater, transmitter racks, junction boxes, etc.
 - d) Approach platforms shall also be provided to bunker outlet gate, Mill discharge valves, all dampers and drives, furnace seal trough, fans and motors, Air pre heaters, all valves, field control and instrumentation points, etc. as per best engineering practices.
 - e) Toe boards for all staircases, platforms and walkways
 - f) Firing aisle platforms with enclosure with GI sheet covering
 - g) Steam generator roof and penthouse including GI sheet roof for penthouse, penthouse cooling fans /ventilation system. The steam generator roof shall be provided with an approach ladder and all round hand railing.
 - h) Interconnecting platforms between the steam generator and station building/power house building, between the steam generator and switchgear building and SG and Mill Bunker structure at operating floor level
 - i) All walkways and platforms unless specifically indicated shall be minimum 1000 mm wide
 - j) GI sheet cladding of equipment wherever necessary for operation and maintenance
 - k) Structures for support of monorails of ID fans, FD/SA fans, PA fans, air preheaters, coal mills and ESP maintenance.
- xii) *Air and flue gas system as below:*
 - a) Two (2) axial, blade pitch controlled primary air (PA) and two (2) axial blade pitch controlled forced draught fans each with motor complete with

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coupling and coupling guard, silencer, lubrication system (2x100% pumps, coolers, filters etc.) and base plate, foundation bolts, inlet box, rain water canopy, bird/trash screen, required actuators, adequate instrumentation, bearing temperature sensors etc.

- b) Two (2) axial type blade pitch controlled ID fans each with motor, diffuser, coupling and coupling guard, lubrication system (2x100% pumps, coolers, filters etc.) and base plate, along with foundation bolts, required actuators, adequate instrumentation, bearing temperature sensors etc.
 - c) All variable speed fans shall be provided with vibration isolators along with inertial block.
 - d) Two (2) tri-sector regenerative air pre-heaters with auto seal arrangement.
 - e) The air pre-heaters shall be provided with necessary shaft drives and a standby air motor drive (with air receiver tank, piping valves etc.), the hand operation facility shall be replaced by an extra motor operation (in total two motor drives and kone air drive systems) , off load washing facility with required supply piping & valves, drainage etc. (tapped from service water system), permanent fire fighting system and fire sensing equipment, at both cold & hot ends and in both air and flue gas sides along with necessary piping , valves etc. (connected to fire fighting system), Ash collection hoppers with disposal flanges along with RF type level switches, bearing lube oil system.
 - f) Two (2) Steam coil air pre-heaters in the bypass duct to discharge duct of FD fans with associated steam supply stations and drain collection systems. If bi sector air pre heaters are supplied, then steam coil air pre heaters shall be provided in both PA fan and FD fan discharge bypass circuits.
 - g) Forced oil lubrication system for the fans and motors shall consist of 2 x 100% oil pumps each with motors, coupling and coupling guard, 2 x 100% oil coolers, 2 x 100% oil filters as per manufacturer's standard, one (1) oil tank with accessories.
 - h) Cold air, hot air and flue gas ducting.
 - i) Sealing air duct to coal mills, feeders, etc.
 - j) Turning vanes/baffle plates, duct stiffening devices, interior bracings, slide plates, expansion joints, mating flanges, access doors and brackets, supports structure and hangers as applicable.
- xiii) **Warm-up / Start-up/Support Oil Burning System**
- The common LDO system shall be as per the Bid drawing but not limited to the following:
- a) Two (2x100%) LDO transfer pumps, to transfer LDO from existing storage tanks & unloading header of unit 8, 9 & 10 of Koradi thermal power station to Storage cum Day tanks for this Unit 11 & 12. Minimum capacity should be 50m³/hr. This includes necessary modifications in the existing system, with the approval of Engineer.

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- b) Three (3x100%) LDO pressurising pumps (1 working for each unit & 1 common standby) each with motor coupling and coupling guard, two simplex suction strainer at pump inlet, base plates, drain rim / pans, burners, trip valves, nozzle valves etc.. The LDO System is common for two units.
- c) 2 nos. of Storage cum day tanks, each of min. 1000 m³ capacity.
- d) All piping, valves and fittings as required from fuel tanks to fuel burners, return lines to tanks, drains, atomising lines etc.
- e) Necessary modifications (subject to approval) for tapping from existing unloading header and existing storage tanks will be in bidder's scope, including necessary pipe racks.
- f) Instrumentation and control as required
- xiv) *Coal preparation and burning equipment*
 - a) Generally, vertical spindle medium speed Bowl Coal mills confirming to sizing criteria/ standby requirement, each with drive motor, coupling and coupling guards, dynamic classifier, wear parts, grinding elements, gear, adequate instrumentation for safe and optimum operation, shall be provided.
 - b) Mill lubrication system with 2x100% capacity oil coolers, 2x100% capacity pumps, pipes etc, for each mill.
 - c) Base plates and foundation bolts.
 - d) Rotary Drum type Gravimetric coal feeders each with variable speed, motor, coupling and coupling guard, base plate, foundation bolts, switches for sensing presence or absence of coal, coal motion monitors, micro processor based precision weighing & calibration system, strain gauges, with all the required instrumentation, complete in all respects.
 - e) Coal burners (Low NOx)
 - f) Seal air fans each with motor, coupling and coupling guards and mechanical filters on suction
 - g) Adequate numbers of coal bunker for each unit and should have 16 hrs storage capacities for 100% BMCR operation, taking 20% filling factor considering design coal as fuel.
 - h) Stainless steel raw coal piping from bunker outlet to feeders and from feeders to mills inclusive of sliding isolation gate valve for shutting of bunker and a isolating gate valve at coal feeder inlet (facility to operated it with a chain from feeder floor), remote operated shut off gate valve between coal feeder and mill, required couplings (with 410 SS liners) etc.
 - i) Pulverised coal piping from mills to burners
 - j) Complete seal air piping and hot air piping
 - k) Flanged filler piece one each between bunker outlet and feeder inlet and one carbon steel diverter chute connection piece with flanged outlet for emergency dumping of coal from the bunkers

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- l) Proven Coal mill inerting system / fire fighting system with the required detection and alarm system, piping, valves, required instrumentation
- m) All isolating, regulating valves as required and required couplings and coupling guards
- n) Pyrite hopper with each mill for collecting waste coal / other material
- o) Handling facilities for heavy mill parts.
- p) Gravimetric belt feeder
- xv) *Ducting*
 - a) Cold air ducting to FD fans suction, FD fans discharge to air pre-heaters, bypass ducts for locating SCAPH
 - b) Cold air ducting to PA fans suction, PA fans discharge to air pre-heaters, bypass ducts for locating SCAPH (in case of bi sector air pre heaters)
 - c) Hot air ducting from APHs to burner boxes and coal mills
 - d) Flue gas ducting from economiser to APHs and from APHs to ESPs, Flue gas ducting from ESPs to ID fans and from ID fans to chimney
 - e) FGD Inlet and outlet flue gas Ducting.
 - f) SCR inlet and outlet ducting including isolation dampers and hoppers, as applicable for the system.
 - g) Chimney inlet transition pieces, counter flanges, flow splitters, expansion joints, brackets, hangers, ash hoppers(if applicable), Turning vanes, baffle plates, stiffening devices, interior bracings, expansion joints, access doors supports and hangers, support structure etc.
 - h) Ash collection hoppers below economiser and APHs as required.
 - i) Any other ducting required to complete the system of air and flue gas path.
- xvi) *Ignition system*
 - a) HEA igniter for each fuel oil burner, spark rod, retract mechanism, exciter system including step up transformers, rectifier, storage capacitor and a trigger gap along with necessary special cables
 - b) Scanner and Scanner Air System
 - c) Adequate number flame scanners, necessary piping and valves
 - d) 2x100% scanner air fans (one AC and one DC motor operated)
- xvii) *Soot blowing system*
 - a) Short retractable rotary wall blowers in furnace Long retractable and rotary blowers in superheater, re-heater and economiser
 - b) Motor drive for each blower with coupling and coupling guard, base plate, frame and holding bolts
 - c) Speed reducers, cam chain drive and other auxiliaries
 - d) Emergency hand cranks for all soot blowers

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- e) Supporting structure
- f) Complete piping system with vent, drains, relief valve, etc. as required
- g) Instrumentation and control as required, control based on Heat flux on the water walls – micro processor based
- xviii) Two (2) nos. approved type furnace inspection and maintenance equipment (Similar to sky climber)
- xix) *Dampers*
 - a) Isolation dampers with electric drives on all cold air, hot air, seal air, and flue gas ducting before and after equipment on these systems with sealing as per requirement.
 - b) Electrically operated guillotine type gas tight isolators at inlet and outlet of ESP, inlet and outlet of each ID fan inlet and outlet of each RAPH for local/remote operation, inlet and outlet of FGD & bypass; along with 2x100% sealing fans arrangement for each damper.
 - c) Air registers with drives at various elevations.
 - d) Regulating dampers with pneumatic drives, as required; supporting structure for all damper drives
- xx) Selective Catalytic Reduction (SCR) De-NOx system complete with all accessories and auxiliary equipment -
 - a) Complete DeNOx system shall be provided for each Steam Generator. The scope of SCR system shall include but not limited to the following to meet the NOx level as specified in the specification.
 - 1) De-nitrification equipment
 - SCR catalyst complete modular package.
 - SCR reactor, including housing, and mixing devices (as required), module support structure, soot blowers and ash hoppers (if applicable).
 - Complete transition ductwork from steam generator economizer outlet flange to the reactor inlet and from reactor outlet to air heater inlet flange(s), including expansion joints, flow straightening devices, and supports. Bidder to provide single/ double stream configuration as per their standard and proven practice. In case of double stream each stream shall cater the requirement corresponding to 60% BMCR operation. Economizer bypass duct & bypass damper from economizer inlet to SCR reactor inlet shall be equipped to ensure appropriate gas temperature at SCR inlet at part load operation.
 - SCR duct hoppers.
 - Ammonia Injection grid including support.

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- Ammonia vaporization system complete with 2 x100 %(1W +1S) dilution air blower with motor, inlet filters, mixing chamber along with complete piping, valves & supports.
 - Alternatively Bidder may offer dilution air connection from FD fan outlet header as per their standard and proven practice.
- 2) SCR system, Unloading, Handling and other Miscellaneous Works
- Catalyst handling equipment, including monorail for loading and unloading of catalyst module from grade.
 - SCR reagent storage tank(s) complete with support saddle, access ladder, platforms, level indicators, safety valves, high and low level alarms, excess flow valves, and other accessories as required. Ammonia sensing devices & alarming devices in the tank area shall be provided.
 - One truck unloading rack with hose connections for receiving SCR reagent from the truck and for vapor return to the truck including hoses and isolation valves for lines connecting the rack to the storage tank shall be provided.
 - One SCR anhydrous ammonia vaporizer per storage tank complete with supports, electric heater, local controls, safety valves, and other accessories as required shall be provided.
 - One truck unloading system, containing two full-capacity compressors/pumps(1W +1S) complete with motors, suction and discharge piping, supports, valves, local controls, and accessories required for control, maintenance, and safe operation of the compressor and vapour recovery system.
 - Interconnecting piping from unloading station to storage tanks and from storage tanks to ammonia injection grid shall be provided.
 - Heat tracing equipment's and accessories (if required) for process temperature maintenance or freeze protection shall be provided.
 - Shop priming of exposed steel surfaces.
 - Protective lining and coatings as required for the system.
 - Ammonia leak detectors.
 - All control and instrumentation items with applicable Hazardous area classification shall be provided.
 - Associated Electrical & civil works.
 - Water spraying system in NH₃ area as a safety measure.
- 3) Control and Instrumentation
- Process control equipment's along with complete instruments and interfacing to Unit DDCMIS shall be provided as specified in relevant C&I portion of the specification. One set of additional hot redundant controller with I/O cards and complete hardware &

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Software etc. shall be provided with Unit DDCMIS for control, operation & monitoring of SCR system.

- NOx analyzer and oxygen trim at the reactor outlet, NOx analyzer at the reactor inlet with oxygen trim (if necessary), sample probes, dryers, sample conditioning units, sample pumps, solenoid valves, and other accessories as required, mounted in a cabinet, with heating, ventilation, and air conditioning (if necessary).
- Bidder shall also follow the complete requirements for control and instrumentation volume.

xxi) *Electrostatic precipitator*

- Two ESPs, complete in all respects with all components and accessories etc; one for Boiler.
- Each unit ESP with at least four/six independent streams/passes housed in independent casing, including outer shell; complete with structural steel supports, framework, interior access walkways, exterior platforms, staircases and handrails of 40 mm GI pipe, access doors, weather proof pent house etc.
- Inlet & outlet flues, transitions and expansion joints, matching flanges
- Gas distribution system complete with turning vanes/deflector plates, flow splitter, guide vanes, perforated plates and all necessary gas flow control devices in the inlet and outlet cones and duct, warranted by the results of the model tests.
- Complete duct stiffening devices, interior bracings, slide plates, hangers, sample connections etc.
- Reinforced sheet steel casing
- Fly ash collection hoppers complete with thermal insulation, heaters, level indicators & transmitters, outlet flange, jointing materials, poke holes, access door and walkway/platform beneath hoppers.
- Inspection and maintenance access doors with frames and safety locks.
- Safety devices and safety barriers, etc.
- Collecting and rapping systems complete with supporting insulators, collecting and discharge electrodes, structural supporting frames, automatic rapping controls, shaft insulators, bush insulators etc.
- High voltage transformers, rectifiers, bus sections with sectionalising and grounding switches and controls.
- Automatic voltage control system
- Weather proof enclosure for insulator compartment complete with heaters, air blowers, filters, controls, etc.
- AC electric drive motors as required
- Electrical and instrumentation and control equipment as required

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- p) Monorails and Electric hoists on the roof, for handling transformer rectifiers.
- q) Water washing system for the ESP and its hoppers along with all tanks, pumps, piping, valves and nozzles etc.
- r) Thermal insulation, lagging, cladding and refractories, as required. Thermal Insulation along with aluminium cladding, lagging, reinforcement wire-mesh, cleats and supports, shall be provided for all the equipment/surfaces having skin temperature more than 60 degree Celsius.
- s) Opacity monitors/meter, complete with all accessories at the outlet of each pass/stream of each ESP, i.e. six (6) per unit ESP.
- t) Energy management system
- u) Provision for fluidising pad /air inlet arrangement for ESP hoppers.
- v) Suitable connections shall be provided for:
 - 1) Draft gauge measuring points on each inlet and outlet of precipitator section
 - 2) Temperature measuring points on each inlet and outlet of precipitator section.
 - 3) Adequate numbers of test connections of standard size and at suitable location to permit velocity, dust loading and temperature distribution measurements at the inlet and outlet of the precipitator
- w) For assessment and design of appropriate flue gas flow distribution in the ESP(s) and the duct work connected on the upstream and downstream sides of the ESPs, the Bidder shall conduct comprehensive model testing by developing physical Scale model by fabricating a three dimensional physical model of the Electrostatic Precipitator and it's ducting with a scale not less than 1:10.
- xxii) All the miscellaneous cranes and hoists required for the equipment coming in BTG island.
- xxiii) Elevators for buildings/structures which has operation/maintenance floor (where man / machine movement access is required for regular O&M of the plant), above 10m from FFL, for each structure like boiler, ESP control building, FGD area structure/buildings and chimney for accessibility to various levels, along with the mandatory staircase / cage ladder.
- xxiv) Mill Reject Handling System
 - a) Complete Mill Reject handling system (Pyrites handling system) including Pyrite Hopper, transportation to the storage hopper and arrangement for loading the rejects to the trucks.
- xxv) Off load washing system:
 - a) 2x100% APH/ESP wash pumps of adequate capacity and head shall be provided, including all accessories and piping and isolation valves.
 - b) A tapping (with isolation valves) from this system shall be provided for ash water sump (emergency) make-up.

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- c) These pumps shall draw water from the Filter Water Storage Tank (of BoP Package) and will be located in the Filter Water Pump House (of BoP Package).

2.13.02 STEAM TURBINE AND AUXILIARIES

- i) The scope includes all equipment required for Two (2) Steam Turbine Generator units along with auxiliaries of the type specified. Each unit will include but not be limited to the following:

a) Steam Turbine

- 1) The steam turbine shall be of tandem compound construction, condensing type with minimum seven (07) numbers of extractions with extraction for the top HP heater from the HP turbine for regenerative feed heating. HP turbine shall be of double casing design. Separate HP, separate IP and separate LP casing(s) or combined HP-IP and separate LP casing(s) shall be provided. HP inner cylinder, IP cylinder and LP cylinder(s) shall be horizontally split.
- 2) Steam turbine shall be complete with casings, rotors, bearings, temperature detectors, couplings, steam gland seals, rotor turning gear preferably hydraulic type and having local/remote operation facility, hand barring gear, emergency stop and control valves and reheat stop and control valves with their servomotors, removable type steam strainers for start up and normal operation upstream of emergency stop and reheat stop valves, cross-over/cross around piping and electric motors for all its integral subsystems. Steam strainers integral with main steam emergency stop and reheat stop valves are also acceptable.
- 3) Hydraulic/pneumatic power operated quick closing non-return valves and ordinary non-return valves for each extraction line (except for heater(s) located in condenser neck) including steam lines to BFP turbine drives and for each cold reheat line one hydraulic/pneumatic power operated QCNRV shall be provided. The type of actuation i.e. hydraulic/pneumatic shall be as per the standard proven practice of the manufacturer.
- 4) Turbo generator set will be suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation.

b) Steam Turbine Auxiliary systems

- 1) Turbine gland sealing steam system shall be provided with gland steam condenser, gland steam exhausters, all associated motors, associated piping, valves and fittings, specialties, hangers and supports, necessary insulation and complete with all instrumentation and control hardware including electro hydraulic/ electro pneumatic controller, actuator, electro hydraulic / electro pneumatic converter etc. as to make the system complete in all respects.

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- 2) Cross over/ cross around piping between IP and LP casing(s) including necessary hangers and supports for piping and secondary structural steel shall be provided, if required.
- 3) Lubricating Oil System (common for one Turbine Generator Set) shall be complete with oil tanks, oil purifying system, oil pumps and jacking oil pumps with drive motors, oil coolers, strainers, vapour extractors with drive motors, all interconnecting piping, valves and fittings, hangers and supports, necessary instrumentation and control hardware to make the system complete in all respects.
- 4) Centralized oil storage and purification system shall be common for all the units including clean oil tank, dirty oil tank, transfer pumps, purifying unit with interconnecting piping, necessary instrumentation and control hardware to make the system complete in all respects
- 5) Steam turbine control fluid and its purification system along with its conditioning system shall be complete with control fluid tank, control fluid pumps with drive motors, strainers, accumulator, control fluid coolers, waste fluid tank, purification equipment including fluid circulation pumps with drive motors, associated piping, valves, fittings and specialties, hangers and supports, Instrumentation and control hardware to make the system complete in all respects for the 660 MW units.
- 6) Steam turbine governing and protection system shall be complete with electro hydraulic governor with mechanical hydraulic back-up or electro hydraulic system with 100% hot back-up, electro hydraulic converter, hydraulic converter, tracking devices, hydraulic speed governor, electrical speed sensors, speed/load adjusting gear, motor drives, remote trip solenoids, overspeed, low condenser vacuum, low lube oil pressure, high axial shift and other trip/protection devices, electrical components associated with electro hydraulic system, test devices and test panel inserts etc. and hydraulic components like accumulator, strainers etc. along with associated piping, valves, fittings and specialties, hangers and supports.
- 7) Steam turbine exhaust hood spray cooling system shall be complete with spray arrangements, associated piping, instrumentation and control devices, valves and fittings, motor/solenoid operated valves and specialties, hangers, supports and insulation etc.
- 8) Steam turbine, associated piping & equipment drain & vent system shall be complete with turbine flash tanks, piping, valves and fittings, valve motor drives, specialties, hangers and supports, insulation, instrumentation and control etc. Vents shall be led to atmosphere up to a suitable location outside the main plant building.
- 9) Turbine preservation system consisting of adequate numbers of air driers including, fans, motors, filters, heater drying wheel, connecting piping, valves, fittings etc. for preservation against corrosion of turbine during idle periods shall be provided.

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- 10) Boroscopic inspection ports in turbine for in situ inspection of turbine internals shall be provided as per bidder's standard practice.
- 11) Steam turbine aesthetic and acoustic enclosure (removable type) with necessary ventilation and lighting system
- 12) HP/LP Bypass system shall be complete with steam and spray valves, spray control station, throttling devices, fittings, desuperheaters, hydraulic power pack, solenoid valves, quick acting devices, blanking devices for steam blowing, supports, associated piping including warm up arrangements, valves, instrumentation and control hardware, electrical devices and actuators/motors etc.
- 13) Water cooled, divided water box, horizontal surface condensers for each unit shall be complete with all accessories such as hotwells, valves, drains, vents, strainers, CW line expansion joints and fittings, isolating butterfly valves with matching flanges, associated CW piping to and from the condenser, suitable handling arrangement(s) for water box & butterfly valves, steam throw off devices for HP-LP bypass system, extraction steam piping routed through the condenser to low pressure feed water heaters and heater(s) within the condenser neck and with provision for installation of low pressure feed water heater(s) in the condenser neck, shall be provided.
- 14) HP and LP flash tanks / vessels for accepting all turbine and cycle recoverable drains including those from main steam, cold reheat, hot reheat lines, HP-LP bypass lines, heater drains, complete with all associated spray system, piping, valves and fittings, specialties, hangers and supports and insulation, instrumentation and controls etc. shall be provided. In addition one atmospheric flash tank will also be provided to accept the drains from feed water heater safety valves.
- 15) Condenser air evacuation system shall be complete with 2 X 100% vacuum pumps, associated motors, all accessories, associated piping, valves & fittings, specialties, duplex filter, instrumentation and control etc.

c) **TG Integral and other miscellaneous piping**

- 1) The scope of work for TG integral and miscellaneous piping covered under this specification shall include but not be limited to the following systems:
 - Condenser air evacuation system
 - Condenser cooling water system
 - Cycle make-up system
 - Control fluid system
 - Gland steam sealing system
 - Lube Oil system

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- Seal oil system, stator water cooling, H₂/CO₂/N₂ generator gas cooling system, any other piping, valves and specialties to make the system complete.
- Central oil storage and purification system
- Exhaust hood spray system
- Gland sealing (of valves and pumps) system
- Equipment cooling water system
- Compressed air system (Service Air and Instrument Air)
- Piping shall be complete with fittings / accessories and specialties, expansion joints, valves, insulation, hangers, supports, restraints / guides, snubbers and auxiliary steel etc. The design and engineering of the piping system shall include but not be limited to pipe sizing, hanger / snubber engineering, engineering of thermal insulation etc.

d) Condenser on-load tube cleaning system (COLTS)

- 1) Sponge rubber ball type condenser on load tube cleaning system separately for each half of the condenser. Each Condenser on load tube cleaning system shall be complete with one number Ball recirculation pump, one number Ball separator, one number Ball collecting vessel, differential pressure measuring system, Ball monitoring system (comprising of ball recirculation monitor and ball oversize monitor), associated piping, valves and accessories, instrumentation and controls, all drives, power and control cables, motors and accessories, etc.

e) Condensate extraction pumps

- 1) 3 x 50% capacity motor driven condensate extraction pumps for each unit along with all accessories, drives, suction strainers, associated piping, and valves, instrumentation and control etc. including one number cannister drainage pump per station shall be provided.

f) Feed water heating plant

- 1) Complete regenerative feed heating system including full capacity drain cooler, minimum three (03) nos. of low pressure heaters, deaerator and feed storage tank, minimum three (03) nos. of high pressure heaters, all accessories, associated piping, valves, Nitrogen gas and filling arrangement, instrumentation and controls etc. shall be provided for each unit. One set of test kit for measuring oxygen content at deaerator outlet shall also be provided for the station.

g) Boiler Feed Pumps

- 1) One half capacity (1x50%) motor driven boiler feed pump for each unit complete with booster pump along with it's drives, mechanical seals, flexible couplings, hydraulic coupling, gear box, base plate(s), forced oil lubricating system (including oil pumps, oil tank, lube oil coolers, working oil coolers, duplex oil filters etc.), Automatic

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recirculation flow control valve, integral piping and valves, temporary and permanent strainers, local instrument racks/enclosures, instrumentation and control etc. shall be provided. One (1) number portable centrifuge of adequate capacity shall also be provided.

- 2) Two half capacity (2x50%) steam turbine driven boiler feed pumps for each unit complete with booster pump, step down gear box, flexible couplings, mechanical seals, foundation base plates, Automatic low load recirculation flow control valve, integral piping and valves, local gauge boards, instrumentation and control etc. shall be provided.
- 3) Two (2) steam turbine drives for the turbine driven boiler feed pump per unit complete with ESV, control valves, non return valves for single admission drives, permanent & temporary steam strainers, preferably hydraulic turning gear, hand barring device, atmospheric relief diaphragm and it's vent piping, all inter connecting piping, foundation base plates, integral gland seal system, complete lube oil and control oil system including oil tank, oil coolers, duplex oil filters, vapour exhausters, 100% capacity centrifuge for each steam turbine driven pump, jacking oil system,
- 4) Electro-hydraulic governing system, Turbine Supervisory system along with all control and accessories as specified elsewhere in the specification shall be provided.
- 5) Boiler feed pump sets shall be suitable for installation on spring supported Reinforced Cement Concrete (RCC) foundation.
- 6) Feed regulating station (FRS) for feed water flow control.

h) **Make-up System**

- 1) Normal and emergency cycle make-up to condenser hot well for each unit consisting of piping, valves, flow elements with flow transmitter and indicators, hot well makeup control station (normal and emergency) including control valves, drain, vents, condensate spill pipe line consisting of piping, valves, control station. Condensate storage tank and emergency make up pumps.

i) **High pressure/power cycle piping shall include**

- 1) High pressure piping covering complete main steam, hot reheat and cold reheat piping between boiler and turbine nozzles, HP - LP bypass piping;
- 2) Complete auxiliary PRDS and auxiliary steam piping system;
- 3) All extraction steam piping;
- 4) Complete feed water piping including booster pumps suction, inter connection between booster pumps and main pumps, boiler feed discharge piping up to economiser, recirculation, BFP warm up and leak off and BFP turbine exhaust piping to condenser;

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- 5) Spray piping system for reheater/superheater attenuation, HP - LP bypass system and auxiliary PRDS system;
- 6) Condensate piping system;
- 7) Condenser make up water system;
- 8) Heater drains and vents piping including necessary flash tanks;
- 9) Steam drains including necessary flash tanks;
- 10) Valve gland sealing piping system;
- 11) Miscellaneous line drains and vents including necessary flash tanks;
- 12) Complete safety valve exhaust piping for safety valves on steam generator, HP piping, Auxiliary PRDS, heaters and deaerator etc.;
- 13) Startup vents, safety valves, pneumatic relief valves (PRVs), flash tanks and all vents from the respective equipment and pipes up to a level of one meter above the boiler house/ TG building roof. Silencers shall be provided for startup vents, lowest safety valve and PRVs. All drains from respective equipment and pipelines shall be connected to the drain manifold of the flash tanks;
- 14) Complete chemical dosing system piping;
- 15) Any other piping system to make the power cycle piping complete; and
- 16) Complete steam blowing of piping including target plates and chemical cleaning of piping including provision of temporary piping as required. Piping systems shall be complete with fittings/accessories, specialities, blow-down valves, vent valves, drain valves and safety valves along with their escape piping, drain piping and steam traps, expansion joints, insulation, hangers, supports, restraints/guides, snubbers and auxiliary steel etc. The drain system shall be complete along with drain pipes, unit flash tank, drain valves, root valves, relief/safety valves, control valves, motorised valves, gate/ globe valves, non-return valves, break-down orifices, steam traps etc.

j) Power cycle control valves shall include

- 1) Desuperheating spray water control valves for superheater, reheater and auxiliary steam supply;
- 2) HP heaters normal and emergency level control valves;
- 3) LP heaters normal and emergency level control valves (For LP1 heater, the arrangement shall be as per manufacturer's standard practice);
- 4) BFP recirculation control valves;
- 5) Deaerator level control valves;
- 6) Deaerator pressure control valves;
- 7) Condensate recirculation flow control valves;

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- 8) Condenser normal make up control valves;
- 9) Condenser emergency make up control valves;
- 10) Feed water control valves;
- 11) Condensate recirculation control valve;
- 12) Excess condensate dump control valve;
- 13) Deaerator overflow control valve;
- 14) The power cycle control valves shall be complete along with suitable type of bypass valves. Each control valve shall be provided with arrangement of upstream and downstream isolation valves (hand/ pneumatically/ electrically operated). All other control valves not specifically included above but required for completeness of the system shall also be in the scope of the bidder.

k) Chemical dosing system

- 1) All volatile Treatment (AVT) system complete unloading, storage, handling, measuring, dilution and metering systems for feed water chemical dosing including but not limited to unloading stations, day tanks, capacity measuring tanks, capacity preparation / dosing tanks, metering pumps, dosing pumps complete with strainers, piping, valves, fittings, manifolds, hand pumps, safety showers, eye wash, instrumentation and control panel, including oxygen cylinders with dosing skids.

l) Condensate polishing unit (CPU)

- 1) 3X50% Condensate polishing unit (2working + 1 Standby) Complete Condensate Polishing Plant including filters, mixed bed unit, regeneration unit, piping, valves, and instrumentation. The CPU shall be provided with associated chemical feed system for storing, preparing, measuring and dosing the required chemicals and with its external regeneration system, DM regeneration water tank, Effluent disposal system, PLC for control and monitoring.

m) Steam and Water Sampling system (SWAS)

- 1) Complete steam and water sampling system including sampling racks, sample coolers, pressure reducing devices, piping, valves and required instruments.

n) Industrial Gas Cylinders

- 1) Adequate nos. of gas cylinders along with manifold station for various industrial gases (hydrogen, carbon dioxide, nitrogen) shall be supplied.

o) Miscellaneous

- 1) Chemical cleaning of all equipment and systems after their erection shall be in Bidder's scope.
- 2) Thermal insulation and removable metal cladding shall be provided for all the equipments, piping and piping support frames as required.

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- 3) Necessary blanking arrangements required to protect the valves and turbine internals and other auxiliaries during steam blowing shall be provided.
- 4) All oils, chemicals etc. to waste shall be routed to a common collection tank (to be supplied by the Bidder) individually identified by the Employer for oil or any such obnoxious material which cannot be put into the plant drainage.
- 5) Suitable HOT/Electric Monorail hoist cranes alongwith runway/monorails beams and approach ladders and/ or platform of adequate capacity to meet the need for erection, operation and maintenance.
- 6) Operating platform around the deaerator, GSC, flash tanks, lube oil/ control oil tanks, HP/LP bypass valves, Emergency Stop Valves / Intercept valves, local platforms for various inaccessible valves and equipments etc. shall be in bidder's scope.

2.13.03 FLUE GAS DESULPHURISATION SYSTEM

- i) Complete flue gas desulphurisation system as mentioned in the specification, Including –
 - a) Ducting
 - b) Duct supports
 - c) Gates and Dampers
 - d) Thermal Insulation and Cladding
 - e) Absorbers
 - f) Slurry Recirculation Pumps
 - g) Mist Eliminators
 - h) Absorber Recirculation Tank
 - i) Absorber Oxidation Systems
 - j) Auxiliary Absorbent Tank
 - k) Gypsum Bleed pumps
 - l) Emergency Spray Systems
 - m) Gravimetric Feeders (Lime)
 - n) Wet Ball Mills (Lime)
 - o) Limestone Slurry Preparation/Storage Tanks
 - p) Limestone Slurry Supply Pumps & Piping
 - q) Gypsum Dewatering System, including -
 - 1) Primary Hydro-cyclones
 - 2) Secondary Hydro-cyclones
 - 3) Vacuum Belt Filters

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- 4) Vacuum System
- 5) Filtrate System
- 6) Waste Water System
- r) Process and Clear Water Tanks & Pumps
- s) Gypsum Handling System
- t) Tanks and Agitators
- u) Sump Pumps
- v) Twin Flue Chimney

2.13.04 LIME HANDLING SYSTEM

- i) Totally covered Lime Unloading Facility (from Trucks), including -
 - a) Unloading Hoppers
 - b) Platform for Dumpers, Rod gates, Rack & Pinion gates and Vibrating feeders, separate dedicated DE system for unloading facility
- ii) One no. electronic weigh bridge (60T) shall be provided.
- iii) Limestone Conveying system shall consists of high angle belt conveyors, belt conveyors, belt feeders, reversible belt feeders, Belt weighers, Metal detectors, ILMS / CBMS, Tramp iron chutes (to discharge tramp iron to ground), Flap gates (for diverting and interconnection), interconnecting chutes, Dust extraction (DE) system for conveying system
- iv) Lime stone crushing system, including Grizzly deck vibrating screens and Crushers, interconnecting chutes and DE system in Crusher house.
- v) Limestone Storage system including, limestone storage silos, Rod gates, Rack & pinion Gates, Vibrating feeders, belt feeders, weigh feeders, interconnecting belt feeders, interconnecting chutes and DE system.
- vi) Sump pumps
- vii) Suitable Dust suppression system for limestone unloading shed. Dust suppression system shall be completed with tanks, pumps, compressors, piping, valves and nozzles etc.
- viii) Suitable Dust extraction system in limestone storage shed, limestone silos and limestone bunkers
- ix) All Chute works for transfer of limestone with liner on all wearing surface with all sides welded and provided with countersunk bolt of hexagonal head (Allen key removable). The size of the liner shall be maximum 500X500 mm.
- x) Necessary lifting equipments (Chain pulley blocks, manual/electrical hoist, cranes) of adequate capacity and type for maintenance of the equipments wherever required.

2.13.05 CIRCULATING WATER SYSTEM

- i) Common CW Channel, Forebay and CW Pump House. Space shall be provided in the CWPH for IDCT (2 nos.) control room.

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- ii) 2x50% Circulating Water Pumps for each unit And 1x50% common standby for both units, along with drive motors, discharge piping, valves, hydraulic packs, rubber expansion joints, etc.
- iii) 1 no. Start-up ACW pump (common for both units) of adequate capacity & head.
- iv) Stop log gates and Screens as required for the pumps.
- v) Gantry/semi gantry cranes for handling the stop log gates and screens.
- vi) 3x50% Auxiliary Cooling Water (Booster) Pumps for each unit, along with drive motors, discharge piping, valves, electric actuators, REJs etc.
- vii) 2x50% Automatic self-cleaning filters, for each unit, in the ACW circuit.
- viii) Complete CW & ACW system piping
- ix) Debris filters at a suitable location
- x) Vibration monitoring system.
- xi) Ultrasonic flow measurement for CW and ACW.
- xii) Thrust blocks
- xiii) CW model studies
- xiv) CW transient analysis
- xv) CW treatment systems shall include the following:
 - a) One (1) no. HDPE hose station with two (2) nos. unloading hose and 2x100% unloading/transfer pumps.
 - b) Three (3) nos. bulk acid (98% sulphuric acid) storage tanks for minimum 15 days storage capacity.
 - c) Two (2) nos. acid day tanks.
 - d) 3x50% acid dosing pumps
 - e) Two (2) nos. scale & corrosion inhibitor tanks with agitator & 2x100% its injection/dosing pumps.
 - f) One (1) or Two (2) nos. bio-dispersant tank with agitator & 2x100% its injection/dosing pumps.
 - g) 1x100% biocide tank and 2x100% biocide injection pumps. Gravity can also be used for dosing biocide.
- xvi) Provision for tapping with isolation valves shall be provided for ozonisation shall be provided.
- xvii) 1 no. CW Blow-down tank (min. 1 hr. Capacity); & 2x100% FGD process water (booster) supply pumps (if required).
- xviii) All integral and interconnecting piping including pipe fittings, valves, stubs for instrumentation, pipe supports, specialities etc.

2.13.06 COMPRESSED AIR SYSTEM

- i) *Compressors*

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- a) 2x50% for each unit And 1x50% common standby for both units, skid mounted, oil free, water cooled, rotary screw compressors of adequate capacity and discharge pressure to meet instrument air (IA) requirements of the complete 2x660 MW power plant, except CHP & AHP.
- b) 1x100% for each unit And 1x100% common standby for both units, skid mounted oil free, water cooled, rotary screw compressors of adequate capacity and discharge pressure to meet service air (SA) requirements of the complete 2x660 MW power plant, except CHP & AHP.
- c) Any other compressors with associated dryers (as required), receivers and piping system, required to meet plant compressed air requirements, at any of the areas associated with the plant and if its requirement cannot be met by the main compressed air system. These compressors (2x100%) may be selected to meet the system requirements.
- d) Compressors shall include the following minimum accessories:
 - 1) Air intake filters
 - 2) Silencer
 - 3) Inter cooler for multi-stage compressor complete with trap station with bypass arrangement.
 - 4) After cooler complete with trap station with bypass arrangement.
 - 5) Sound proof enclosure
- ii) *Air Drying Plant*
 - a) 2x50% for each unit And 1x50% common standby for both units, Heat of Compression (HOC) Rotary drum type or conventional twin tower type air-dryers (with specified margin), to match instrument air compressor capacity, along with all accessories including control panel, flow meter, online digital dew point meter at the outlet of each dryer, etc. 'Open through (Blower reactivated)' type ADP is also acceptable.
 - b) A dew point analyzer shall be installed at the discharge of each air dryer to monitor the quality of instrument air delivered from the system.
 - c) Air drying plants will be interconnected with operation of selection valves from PLC
- iii) *Air Receivers*
 - a) Air receivers of minimum 10m³ capacity to hold air and minimize pressure fluctuations for each compressor near compressor house.
 - b) Additional air receivers of similar/adequate capacity shall be provided different locations shall be provided based on layout, process requirements and as specified.
 - c) Instrument air and service air receivers shall be provided along with all accessories such as pressure gauges, safety relief valves, electronic type auto drain traps, manual isolation / blow off auto drain valves, bypass control valve, fittings, temperature indicators, transmitters, etc.

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- d) Air receivers shall also be interconnected with operation of selection valves from PLC

iv) *Miscellaneous*

- a) Complete piping (integral and interconnecting), fittings, couplings, expansion joints, valves, gates and supports/hangers, required for the plant compressed air system including distribution network and unit wise ring header.
- b) Isolation valves for individual equipments
- c) Cooling water system
- d) All filters/strainers, intermediate and terminal air receivers, etc.
- e) Under-slung EOT cranes to handle all equipments in the system.
- f) Complete instrumentation required for both local and remote monitoring, process control and performance evaluation for all process parameters.

2.13.07 AIR CONDITIONING AND VENTILATION SYSTEM

i) *Air Conditioning for Main Plant and Control Building*

- a) 1x100% Vapour absorption machine (working) and 1 x 100% Screw chilling machine (standby) complete with all accessories as described here in after.
- b) 1 no. of PRDS for regulating the steam parameter as per VAM operating requirement.
- c) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Condenser Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- d) Two (2) Nos. Back pull out or Horizontal Split Casing Centrifugal Chilled Water Pump Sets (1W + 1SB) each complete with all accessories as described here in after. These pumps shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- e) Two (2) Nos. Fibre glass reinforced plastic (FRP) construction Cooling Towers ('N'W + 1SB) each complete with all accessories i.e. fan, motor, FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer, ladder and supporting structure etc. The capacity of the cooling tower shall be equal to the condenser cooling capacity. These cooling towers shall be common for 1 x 100% VAM working and 1 x 100% standby screw chilling machine.
- f) PLC / DCS based control, common for AC Plant.
- g) Air Handling Unit (AHU) / Fan Coil Units (FCU) as below:
 - 1) Three (3) nos. (2W and 1S) sheet metal cabinet type (double skin) air handing units of sectionalized construction each complete with all accessories, to match the AC load of Central Control Room, Control

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Equipment Room, Computer Room etc at operating level of TG Building.

- 2) Two (2) nos. (1W and 1S) sheet metal cabinet type (double skin) air handling units of sectionalized construction each complete with all accessories, to match the AC load of 24V DC Charger & DCDB and UPS etc.
- 3) Three (3) nos. (3 no working) FCU, to match the AC load of Dry Room etc at 0.0 M level of TG Building.
- h) Pan type humidifier in each AHU room and Electric Strip heater shall be provided in common supply air ducting from AHU's for monsoon reheating or winter heating purpose.
- i) One Lot of Pre-filters (inside the pre-filter section of the AHUs)
- j) One Lot of Fine filters (shall be provided in Common discharge of AHUs).
- k) Condenser Water Piping
 - 1) One Lot of condenser water piping interconnecting condensers, cooling tower, pumps etc. complete with strainers, valves, fittings etc. Black steel pipe conforming to IS-1239, Part I, heavy grade or IS-3589 (6mm thk) depending upon pipe size shall be used.
 - 2) The piping up to 100 mm dia shall be galvanized steel and those above 100 mm black steel.
- l) *Chilled Water Piping*
 - 1) One Lot of chilled water piping with insulation and cladding, interconnecting chiller, air-handling units and pumps sets complete with valves and fittings etc. Black steel pipe MS ERW conforming to IS-1239, part I, heavy grade or IS-3589 (min. 6mm thk) depending upon pipe size shall be used. The piping up to 100 mm dia shall be galvanized steel and those above 100 mm-black steel.
 - 2) One No. MS / FRP chilled water expansion tank (of minimum 1m³ capacity) complete with valve, Level Gauge, Level Switches, Make-up connection, overflow and drain etc. The tank shall provide with level gauge glass and shall be completely insulated.
- m) One Lot of Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanized as per IS:4736, from various equipments like chillers, pumps, AHUs, cooling tower area etc. up to the nearest drain point. (Within the room & for Cooling tower up to nearest drain point or rain water pipe on the roof) with Thermal insulation.
- n) One No. Make up water tank made of MS / FRP complete with valves, level gauge, level switches, make up connection, over flow and drain etc.
- o) Two nos. Storage water tank (8m³ capacity each) made of MS complete with valves, level gauge, level switch, make up connection, over flow and

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drain etc. This tank will supply make-up water to cooling towers, expansion tank and humidifier.

- p) Fire Dampers - The supply and return air ducts shall be provided with motor operated fire damper at locations where duct pass through walls & floors for ease of isolation, maintenance fire protection purpose & should also be possible to operate manually and as well as for emergency operation. The operation of these automatic dampers shall be interlocked the fire alarm system.
- q) One Lot of GSS Ducting (as per IS-277) with 200 g/m² or better of zinc coating sheet metal work including thermal insulation on complete supply air duct & return air duct (as applicable) and acoustic insulation for initial length of 6m from the AHU outlet.
- r) 2x100% Water Softening Plant complete with all accessories with pump, valves, piping, fitting etc.
- s) 1x100% Duty fresh air fan with pre-filter & fine filter in all AHU Rooms.
- ii) ***Air Cooled Precision Package Air-Conditioning Plant***
 - a) 3x50% or 2x100% Air Cooled Inverter Package AC will be used for each area; as mentioned the technical specifications.
 - b) 1 Lot of Fine filters (shall be provided in common discharge of each Precision AC).
 - c) 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.
 - d) 1 Lot of PVC type Drain piping
 - e) 1 Lot of GSS Ducting with 200 g/sqm or better of zinc coating sheet metal work including thermal insulation on complete supply air duct and acoustic insulation for initial length of 5m from the indoor outlet.
 - f) Thermostat and dampers for each office room/zone.
 - g) 1x100% Duty fresh air fan with pre-filter & fine filter in all Precision AC Rooms
- iii) ***Ducted Split Air-Conditioning Plant***
 - a) Ducted Inverter Split AC will be used for each area; as mentioned the technical specifications.
 - b) 1 Lot-Fine filters
 - c) 1 Lot of Copper piping with insulation for interconnecting indoors unit, outdoors units etc.
 - d) 1 Lot of PVC type Drain piping
 - e) 1 Lot of GSS Ducting with 200 g/sqm or better of zinc coating sheet metal work including thermal insulation on complete supply air duct and acoustic insulation for initial length of 5m from the indoor outlet.
 - f) Thermostat and dampers for each office room/zone.

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iv) *Split type Air-Conditioners*

- a) Split type air conditioners (air cooled) are provided to cater to the air conditioning requirements with 3 x 50% or 2 x 100% or ('N'W + 1S) duty configuration; for all PLC and UPS areas, I/O panel rooms, SWAS Rooms, rooms associated with labs, stores etc. of the power plant, all control rooms in auxiliary plant areas; as mentioned in the technical specifications; where 'N' is the no. of working units.
- b) For office cabin rooms, no standby unit is envisaged.

v) Any other areas if requires air conditioned environment, shall be provided with suitable AC plant.

vi) *Evaporative Type Ventilation System*

- a) Adequate no. of Evaporative type ventilation system of adequate capacity, complete, with all accessories shall be provided for TG building.
- b) Filtered and Cooled air from each air washer unit shall be distributed to various areas through diffusers.
- c) The TG building shall be provided with adequate number of roof extractors of adequate capacity.
- d) Air Washer system will include Fans, pumps, spray nozzles, moisture drift eliminators, distribution plates, Filters, louvers, associated piping, valves, fittings etc.

vii) *Unitary Air Filtration Ventilation System*

- a) Adequate no. of Unitary Air Filtration (UAF) system of adequate capacity, complete, including all accessories like fans, pumps, spray nozzles, louvers, moisture eliminators etc, using water repellent type nylon filters shall be provided for ESP/FGD buildings as applicable.

viii) *Pressurised Ventilation System*

- a) Centrifugal fans/ axial supply fans for various areas of the power plant, as mentioned elsewhere in this specification & the same shall be finalized based on the actual requirement during detail engineering.

ix) *Non-Pressurised (i.e. Negative) Ventilation System*

- a) Axial type exhaust fans for various areas of the power plant, as mentioned elsewhere in this specification & the same shall be finalized based on the actual requirement during detail engineering.

2.13.08 FIRE PROTECTION SYSTEM

i) *Hydrant System*

- a) One lot of underground/ over ground piping work for stand posts and risers duly painted and complete with fittings & supports, above ground isolation valves
- b) One lot of hydrant valves for outdoors and indoors complete with all accessories.

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- c) One lot of Water Monitors (where applicable) complete with isolation gate valves.
- d) One lot of 15m long hoses with male and female instantaneous couplings for external hydrants.
- e) One lot of 7.5m long hoses with male and female instantaneous couplings for internal hydrants.
- f) One lot of branch pipes and spray nozzles.
- g) One lot of fog type nozzles.
- h) One lot of M.S. painted Hose boxes complete with all accessories as per National Fire Protection Association (NFPA).
- i) One lot Fire hose reel set complete with valves, piping and pipe coupling.
- j) One lot of Air Release valves, drain valves, restriction, orifices
- k) One lot of nozzle with coupling
- ii) *Spray System*
 - a) One lot of underground / over ground piping work duly painted and complete with valves, fittings & supports.
 - b) One lot of Deluge valves complete with trims, alarm motor and gong and piping.
 - c) One lot of High velocity Spray Nozzles.
 - d) One lot of Medium velocity Spray Nozzles.
 - e) One lot of Quartzoid bulb detector
- iii) *Foam Protection System*
 - a) One number 100% capacities Aqueous Film forming Foam (AFFF) foam tanks complete with first fill of foam, foam inductors, valves, piping and other accessories.
 - b) One lot of foam makers complete with orifice plate, breather, foam pourer.
 - c) One lot of deluge valves complete with all trims, alarm motor and gong
 - d) One number Deluge valve local control panel.
- iv) *Inert Gas System*
 - a) Complete Inert gas system including storage containers, distribution network, discharge nozzles, pilot cylinders, gas releasing devices, control panels etc
- v) *Fire Detection and Alarm System*
 - a) Complete fire detection and alarm system including automatic fire alarm system devices like Multisensor type detectors, photoelectric smoke detectors, rate of rise heat detectors, probe type heat detectors, Notification devices like electronic hooters, siren, hooter cum strobe, control and repeater panels, UPS etc

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vi) *Portable and Mobile Extinguishers*

- a) One lot of self Pressurized with cartridge operated water type water fire extinguishers of 9-liter capacity conforming International code.
- b) One lot Carbon dioxide type fire extinguishers of 4.5 kg capacity conforming to relevant International code.
- c) One lot of Carbon dioxide type fire extinguishers of 9 kg capacity conforming to relevant International code.
- d) One lot of Mobile carbon dioxide type fire extinguishers of 22.5 kg. Capacity conforming to relevant International code.
- e) One lot of Dry chemical powder store pressurized with cartridge operated type fire extinguishers 6 kg. Conforming to relevant International code.
- f) One lot of Dry chemical powder ABC type fire extinguishers of 2 kg capacity conforming to relevant International code.
- g) One lot of Dry chemical powder store pressurized with cartridge operated type fire extinguishers 9 kg. Conforming to relevant International code
- h) One lot of Dry chemical powder type fire extinguishers of 50 kg capacity (as per relevant International code)
- i) One lot of Foam type self Pressurized with cartridge operated fire extinguishers of 9-liter capacity conforming to relevant International code.
- j) One number. Mobile foam type fire extinguishers of 50-liter capacity conforming to relevant International code.

2.13.09 HANDLING EQUIPMENT

i) *Electric Overhead Travelling (EOT) Cranes*

- a) Two (2) nos. Double Girder (DG) EOT cranes of adequate capacity for TG Hall
- b) Two (2) nos. DG EOT cranes of adequate capacity, one for BFPs of each unit (Depending on Layout)
- c) One (1) no. DG EOT crane for CW Pump House
- d) One (1) no. Single Girder (SG) Under Slung (US) EOT crane for each of following areas:
 - 1) Emergency DG set building
 - 2) Air compressor Building
 - 3) ACW pump house {one (1) no. for each unit}.
- e) 1 no. Semi-Gantry or Gantry crane for CW Pump house for handling screens and gates
- f) Any other cranes required as per layout and system requirement
- g) EOT cranes (including gantry/semi gantry cranes) shall be complete with all accessories like:

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- 1) Complete crane structure
- 2) All drive motors and driving gears.
- 3) Runway rails for bridge and trolley including all clamps, anchors, bolts, nuts, shims, inserts, end stops and other fixtures.
- 4) Operator's cabin
- 5) Portable carbon dioxide fire extinguishers are to be provided in the operator's cabin.
- 6) Runway conductors (D.S.L.) and power collectors complete with all supports, insulators, brackets, fixtures etc.
- 7) Complete Electrical works including main disconnect switch, all controls and interlocks including all supplies with necessary wiring, grounding, protective panels etc.
- 8) Limit switches for crane
- 9) Illumination
- 10) Suitable air conditioner Unit as well as Fan in operator's cabin
- 11) Spring / rubber buffers for end trucks.
- 12) Lifting lug, eye bolts etc. for handling the crane parts.
- 13) Protection guard as specified
- 14) Foot operated siren
- 15) Repair cage
- 16) All platforms, handrails and ladders as specified and as required.
- 17) Lifting hook block assembly.
- 18) Cranes electrical grounding system

ii) *Electric/Motor Hoists with Trolleys*

- a) One lot of Electric Hoists, of adequate capacities, lift & travel; complete with trolleys, runway rails and all accessories; for all equipment, of the power plant, which are not covered/handled by any crane; and as required.
- b) Electric hoist has to be provided to handle all plant equipment (which is not covered by any crane) and which is One (1) ton and above OR if the height to which any equipment is to be handled is 10m and above.

iii) *Chain Pulley Blocks*

- a) One lot of Chain Pulley blocks, complete all accessories; minimum requirement is as follows:

Quantity (nos.)	Capacity (Ton)	Lift (m)

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3	1	6
3	1	8
3	2	6
3	2	8

iv) *Electric Powered and Diesel Powered Forklifts*

- a) 2 Nos. 2T Electric Forklifts
- b) 2 Nos. 5T Diesel Forklifts

v) *Miscellaneous handling Equipments*

- a) One lot of miscellaneous handling equipment; minimum requirement is as follows:

Item	Quantity (nos.)	Capacity (Ton)
Hand Pallet Trucks	5	2
Battery Operated Pallet Trucks	2	4
Platform Trolleys	2	1
Platform Truck	2	2
Drum Trolley	3	0.3

2.13.10 ELEVATORS

i) *Passenger elevators as below:*

- a) Two (2) nos. Passenger Elevators, each suitable to carry thirteen (13) persons at a time, for Power House Building
- b) One (1) no. Passenger Elevator, each suitable to carry thirteen (13) persons at a time, for Service Building
- c) Two (2) nos. Passenger Elevators for ESP Control Building (one no. for each building), each suitable to carry eight (8) persons at a time,
- d) One (1) no. Passenger Elevator for FGD Control Building, each suitable to carry eight (8) persons at a time.
- e) Passenger Elevator, suitable to carry eight (8) persons at a time, shall be provided for other buildings which has more than Ground plus two (2) floors or if floors are above 10m height (above ground floor level / FFL). If a passenger cum goods elevator is provided for that building, then separate passenger elevator is not required there.

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ii) *Passenger cum goods elevator as below:*

- a) Two (2) nos., passenger cum goods elevators, suitable to carry minimum 3000 kg at a time; one for each boiler.
- b) One (1) no., passenger cum goods elevator, suitable to carry minimum 1088 kg at a time; one for each building/structure in FGD area, if height of operating floor/platforms (where personnel /goods approach is required for O&M) is more than 10m from ground floor/FFL.

iii) *One (1) no. Rack and pinion type elevator for each structure, as below for:*

- a) Chimney

iv) Other elevators as mentioned in the technical specifications and as required.

2.13.11 ELECTRICAL

- i) The below are the major electrical equipment's/components considered under electrical system scope of work, however it is not limited to the below, any other electrical equipment and components required for successful supply, erection, commissioning and operation of the BTG part shall also be considered under the scope. Also please refer the detailed electrical systems scope of work as specified in Volume III – Part B electrical part.
- ii) **Generator** – Generators and its accessories (seal oil system, gas system, cooling system, excitation system, automatic voltage regulator), auto synchronizers, generator control / metering and protection panels.
- iii) **Isolated Phase Bus Duct** - Isolated Phase Bus Ducts including pressurization system (along with required seal off bushing at A row wall, wall frame assembly at floor crossings) between Generators and Generator Transformers, delta connection of single phase GTs, tap-off to UTs and excitation transformer (static excitation system), LAVT cubicle and CTs for generator phase-side, neutral side and on tap off to UTs, generator neutral formation earthing cubicle (NGT & NGR).
- iv) **Power Transformers** – Generator Transformers (GTs), Station transformers (STs), Unit Transformers (UTs) complete with remote OLTC Control Cabinet/OCTC (as applicable), all fittings and accessories. During transportation Bidder shall supply impact recorders on returnable basis for each power transformer. The recorder shall be taken back only after obtaining written permission from owner's Site Incharge. All the transformers control, metering and protection panels shall also be supplied under the scope of BTG bidder.
- v) Bidder has to consider necessary loads on TG building 'A' row for stringing the overhead conductors from 400KV switchyard to 2 numbers of GT.
- vi) **Auxiliary Power Transformers** – 11/3.45kV transformers for feeding supply to auxiliary loads of BTG complete with all fittings and accessories.
- vii) **Service Transformer (LV Transformer)** -11/0.433 kV transformers for feeding supply to LV auxiliary loads for the complete BTG plant. Transformers shall be Dry type (AN) for indoor locations.

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- viii) *Neutral Earthing equipment* – Earthing resistors for 11 kV & 3.3 kV system neutrals to limit the earth fault current to 300 A (maximum) for short duration.
- ix) *HV Switchgear (11 kV and 3.3 kV)* - complete with breakers, bus bars, Instrument Transformers, Relays, Meters, terminal blocks, Dummy Panels, Bus Trunking & accessories for unit & station including FGD, CW pump house, & Compressors; and any other system/packages considered in mechanical scope of work. In 11kV Unit switchboard fast bus transfer scheme shall be provided for restoration of supply from 11kV station Switchboard in case of supply failure from the respective unit transformer. Manual/Auto live changeover with check synchronization as well as automatic Slow Changeover facility shall be provided as a backup. 11kV station Switchboard shall have Auto/Manual live changeover provision. All 3.3 kV Switchgears to be provided with Manual/Auto closing of bus coupler and Manual/Auto live changeover with check synchronizing and other synchronizing equipments. Owner's feeders for Colony, Intake Pump House and any other feeder requirement shall be provided, as indicated in the Key SLD. The check synchronizing relay shall be housed in the respective switchboards or the relay shall be part of ECP (i.e. common for 11kV, 3.3 kV & 415V systems.). The numerical relays used for protections of incomers shall not be used for synchronisation / paralleling. Separate check synchronisation relay with its hard ware based logics and interlocks for auto changeover of the systems shall be provided. All the 11KV motor feeders and power supply feeders required for BOP & station loads shall also be considered under BTG scope of work. Provision of two trip coils with individual trip circuit for all HT switchgear breakers shall be considered. Necessary inputs from BOP shall be obtained by the bidder for design of 11KV and 3.3KV unit & station switchgear. Any other feeder requirement for BOP bidder during detail engineering from HT unit & station boards which are in BTG scope of work shall also be considered under BTG bidder scope.
- x) *LV Switchgear (415V)* complete with breakers / contactors, bus bars, Instrument Transformers, Relays, meters, terminal blocks, Dummy Panels, Bus Trunking (subject to Owner's approval) & accessories for catering the loads of complete BTG package including FGD, SCR, CW pump house, Compressors, Mill reject system, Elevators, Cranes, HVAC, Fire protection system, Fuel Oil transfer & pressurising; and any other systems/packages considered in the mechanical scope of work. All 415 V PCC/PMCC/MCC to be provided with Manual/Auto closing of bus coupler and Auto/Manual live changeover with check synchronizing. A marshalling module shall be provided on each bus of LV Switchgear for interfacing with DCS. Control of incomers and bus-coupler breakers of LV switchgear shall be possible from the ECP/DCS in Main Plant Area. The check synchronizing relay shall be housed in the respective switchboards except for the Turbine PMCC & Boiler PMCC (For these two panels the relay shall be part of ECP). Dummy panels shall be integral part of the LV Switchgear and of same size. Bidder to provide feeders for owner's use as per Key SLD. Bidder shall provide necessary feeders for the complete BTG unit and station HVAC loads under the scope of BTG. Bidder shall also provide necessary feeders for BOP area from emergency switchgear/PMCC as per BOP requirement during detail engineering; necessary design, space requirement and layout/cut outs for all the LT switchgears/panels and any other equipments under BOP scope of work to be located in the BTG building/area shall also be

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considered under BTG scope of work. Necessary switchboards required for Fuel oil forwarding/pressurisation systems shall also be considered under the scope of bidder.

- xi) *Segregated Bus Ducts* – Segregated Phase Bus Duct (SPBD) between UTs & 11 kV Unit Switchgear, between ST and 11 kV station switchgear, ties between station and unit switchgear and between Auxiliary Power Transformers & 3.3 kV Switchgear with required bends, supporting structures with related civil work. Phase Cross over, if required in 11kV/3.3kV shall be accommodated at the switchgear end in the rear dummy panel. Segregated Bus Ducts will be of aluminium alloy conductor in aluminium alloy enclosure. The conductor shall be of high conductivity aluminium / aluminium alloy sized for the same rating as associated PCC/PMCC bus. For rating above 2000A conductor shall be copper.
- xii) *Non-Segregated Bus Ducts* – Non-segregated Bus Duct (NSPBD) between 415 V Service Transformer to LV service PCC/PMCC for the plant with required bends, supporting structures with related civil work. Phase Cross over, if required in 415V systems shall be accommodated at the switchgear end in the rear dummy panel.
- xiii) *Local Control Panel/JB/PBs*- Local Control panels for BTG auxiliaries like EOT & underslung EOT crane and Hoist electrics, trolley lines and power supply arrangement, Electrics for ventilation, air-conditioning, JBs as required for all systems and local stop PB stations for all unidirectional motors and bidirectional drive motors (except for MOV), DC starter panels etc. including Fuel oil transfer, forwarding/pressurisation systems, FGD, SCR, CW systems, Compressors, Fire Protection System, HVAC etc.
- xiv) *Motors* - Drive motors (AC & DC) for all rotating mechanical equipment of the plant as required. Motors with VFD where ever required as per Technological requirement shall be supplied.
- xv) *Actuators* - All motor driven actuators of the plant shall be integral type.
- xvi) *VVFD* – HT & LT Variable Voltage Frequency drives as per the system requirement. VFD shall be considered for CEP, ID fans, Aux. CW pumps and conveyor belt motors, as applicable.
- xvii) *Cable & Cable Carrier System* - HV/MV/LV Power, control, fire survival and special cables along with cable raceway system with necessary fire barriers, fire proof sealing and coating systems, Cable supporting structures, cable trenches (only in Switchgear rooms & locally (maximum 5.0 metres) near the equipment), cable racks, cable trays, conduits, cable laying and cable termination, termination kits. Necessary layout/cut-outs/openings and space requirement in the cable tray for laying cables under BOP scope of work inside BTG area and for laying the cables from 11KV Unit/Station Switchgears to the terminal points specified for cable trays of BOP areas (incomer cables for CHP, WTP, CT, and AHP) shall also be considered in the scope of BTG. Necessary design inputs from BOP shall be obtained by BTG vendor for further design of cable & cable carrier system. When equipment at both ends are in BTG Bidder's scope, supply & erection of power, control and instrumentation cables including special cable will be in BTG Bidder's scope. Cable trenches shall be avoided in main BTG area switchgear and control buildings, cable cellar shall be considered.

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- xviii) *DC System*- 220 V DC systems complete with Batteries (Plante type), Float and float-cum-boost chargers, Battery racks, Battery MCBs with BMS system, Distribution Board for the complete BTG unit loads and station loads including FGD & SCR, CW system and other BoP considered in this package.
- xix) *Diesel Engine Alternator (DG system)* – Three (3) numbers of DG sets complete with all accessories including AMF panels, DG set panels, Emergency board/MCC for the complete plant shall be covered under the scope of BTG including any BOP emergency loads especially emergency lighting..
- xx) *Earthing and Lightning protection*- For the plant area complete with earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. Lightning protection complete with vertical air termination rods, horizontal roof conductors, down comers, test links and pipe electrodes for the complete plant area/buildings including chimney, FGD, SCR, ESP, CW, FO, Transformer yard , Boiler and TG building. Treated earth pits are to be provided for transformer neutral earthing, electronic earthing, LA & CVTs. Required number of risers shall be provided at each location/elevation near the BOP equipments/components/switchgears which are to be located in plant area shall be covered under the scope of work. The plant earthing shall be interconnected with the BOP earthing at minimum of four locations. Required number of test pits/earth pits for the same shall be under the scope of the BTG package.
- xxi) *Illumination system* - shall include lighting transformers, MLDB, ELDB and DCLDB, ACN/ACE/DC lighting panels, Lighting masts, poles, lighting fixtures, lamps, internal street/road lights for the roads which are under the BTG package as marked terminal points in the plot plan, Power sockets, etc. for the entire systems covered under this package.
- xxii) *Telephone system* – complete with EPABX & its accessories required for the complete power project including all BOP areas shall be under the scope of BTG.
- xxiii) Welding sockets in the unit, including welding transformers & Welding PCC and power supply network within BTG area.
- xxiv) Electrics (cables, earthing & power supply arrangement) associated with Hoisting & handling system for the entire BTG area.
- xxv) Electrics (cables, earthing & power supply arrangement) associated with elevator, EOT cranes and underslung EOT cranes under BTG package.
- xxvi) Waste water & oily waste- from soak of GT, ST, UT & UAT of each unit shall be collected in burnt oil pit. Similarly burnt oil pit shall also be provided in Bunker/mill area if required.
- xxvii) Two Nos. portable pumps shall be supplied to transfer oily waste to common oily pit (TPI separator) located in ETP area for further treatment.
- xxviii) In drives, whenever bigger size Multi run Power cables are envisaged, power JB's for terminating the power cables shall be used. Unarmoured copper flexible cable shall be used between power JB and the motor terminal box. This flexible

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copper cable shall be routed in GI conduit or suitable mechanical protection shall be provided.

- xxix) Rail tracks for movement of GTs, STs UTs & UATs in the transformer yard for taking the transformers to maintenance bay / till the periphery road located in the Power Plant building. Common fencing has to be provided for GT & UT and separate fencing has to be provided for ST & UAT in the transformer yard for each unit.
- xxx) Complete civil works like transformer foundations with soak pits, fire protection walls for all Transformers.
- xxxi) Complete civil works like cable trenches with cover, pavements, drainage arrangement to a Burnt Oil pit for each unit to be provided within the transformer yard for GTs, STs, UTs & UATs.
- xxxii) Construction power supply distribution
- xxxiii) ELECTRICAL ERECTION AND TESTING – Installation, testing and commissioning of all the electrical equipments covered under BTG scope of work but not limited to Generator, IPBD, GT, ST, UT, UAT, Neutral Earthing equipment, SPBD, NSPBD, DC System, Switchgear (HV and LV), Motors (HV, MV and LV), Service transformers (LV Transformers), DG sets, Auxiliary steam boiler, Fuel forwarding/pressurising systems, communication system etc. with all the equipments are in the scope of Bidder.
- xxxiv) Mandatory spares as given in elsewhere.
- xxxv) Any other electrical equipment required to complete a functional, reliable operating plant.
- xxxvi) Electrical equipment & systems integral with mechanical equipment, systems and subsystems, even if not specifically referred to shall also be provided as per relevant sections of mechanical specifications and shall be included in the scope of BTG bidder. In the absence of any stipulation in the mechanical specifications, such equipment and systems shall be supplied as per applicable clauses of the electrical specifications, proven engineering practice and applicable codes and standards.

2.13.12 CONTROL AND INSTRUMENTATION

- i) The scope of work for the equipment, material and system to be furnished in accordance with this specification shall include pre FAT, FAT, pre-shipment testing at manufacturer's works, installation, interconnection with related plant and equipment, calibration, testing, commissioning and putting the Control and Instrumentation System together with all accessories, auxiliaries and associated equipment as specified hereinafter in a fully operational condition and in the manner acceptable to the Owner.
- ii) Unless explicitly stated to be common for all the unit(s), the bidder shall provide all system/equipment described in this specification for each of the unit(s).
- iii) The complete control & instrumentation system shall be furnished, erected and commissioned and all other services shall be performed by the bidder as covered under this specification including SAT and this work shall be fully in

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compliance with the requirements stated herein in the specification for following equipments/systems/subsystems and shall not be limited to the following:-

- a) Integrated Distributed control System (DCS) with PDB panels, marshalling cabinets, printers with operating stations and engineering stations, Servers etc for closed loop control, open loop control, operation, monitoring, controls, interlocks & protection, sequence control and bulk data acquisition system, analysis, report, for complete BTG control & instrumentation system, steam generator & its auxiliaries, turbine generator & its auxiliaries, station C&I, electrical distribution system, flue gas desulphurisation system, SCR and other auxiliary systems with work stations, Large video screens (LVS), hardwired visual alarm/annunciation system and any other proprietary control system are under bidder scope.
- b) DCS system including hardware and software, data bus system, interconnecting cables and devices, sequence of event recording, master and slave clock system, historical storage & retrieval system, alarm management system, engineering & diagnostic system, smart transmitter maintenance system, OPC servers, firewall, performance calculations & optimization package, interface relays for signal exchange with electrical system, barriers, printers, and gateways and links for interface with third party systems etc are under bidder scope as specified in relevant section of the specification. The separate earth system for DCS to be provided with copper bus. Bidder shall also consider DCS Configuration drawing as given in Volume III of the Specifications.
- c) Boiler & Auxiliaries related control & instrumentation system such as BMS, boiler protection system, Soot blower system, Feeder controls, bunker level & CO gas monitoring, Electromagnetic safety valve, Furnace temperature probe, furnace flame monitoring/ scanning and analysis system, Automatic steam leak Detection System, Acoustic furnace Temperature Measurement system, emission (equipments/system) control system, start up fuel oil system, dosing system, Metal Temperature measurement, fuel oil control system, other mechanical & auxiliaries systems, etc are under bidder scope as specified in relevant section of the specification.
- d) TURBINE Generator & Auxiliaries related control & instrumentation system such as Turbine protection System, Turbine Governing System, over speed protection system, bypass control system, Automatic Turbine Run-up System, Automatic turbine tester, lube oil system, jacking oil system, Turbine stress evaluator, EH oil system, Turbine Supervisory system with analysis package and turbine Generator integral instruments, turning gear, gland sealing system, auxiliary PRDS control, air cool condenser system, regenerative system, other mechanical & auxiliaries systems, etc as are under bidder scope specified in relevant section of the specification.
- e) The above system(s) shall include their respective measurement system for signal acquisition, conditioning and signal distribution of various types of inputs/outputs, meeting specification requirements including respective Hardware requirements as stipulated in -DCS, refer Vol-III Part-C of Technical Specification.

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- f) Bidder shall be responsible for engineering, selection and connection of all components and sub-systems to form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or the purpose of this specification to specify all individual system components since the Bidder has full responsibility for engineering and furnishing of a complete system.
- g) Large Video Screen min (80") with controller, GPS Master Clock, CCTV Monitoring Systems is under bidder scope as described in various sections of the specification are under bidder scope.
- h) Plant view & Management Information System server for MIS function, Computerized Maintenance Management System (CMMS) server for plant asset management, plant-wide network with user terminals etc are under bidder scope.
- i) All measuring Instruments, field instruments viz. smart transmitters (HART protocol), diaphragm pressure gauges, pressure transmitters, temperature transmitters, thermocouple, RTD, metal temperature measurement, process switches, gauges, flow / level indicators, sensors, converters, analyzers, skid mounted instruments, Local field instruments etc. along with all accessories, sensors, flow elements, radar type level transmitter, ultrasonic type level transmitter etc. with all accessories and platforms.
- j) All primary flow elements with branch pipes, along, root valves, flanges, nuts, bolts, gaskets and accessories, magnetic flow meters, mass flow meters with totalizer, Vortex flow meters, venture tube, ultrasonic flow-meter, annular, aerofoil, Rota-meter etc.
- k) Final control elements, control valves with actuators, damper with actuators, motorized/pneumatic/hydraulic actuators, on/off valves with actuators, power cylinders. All pneumatic control valves and dampers along with actuators, smart pneumatic positioners, limit switches, handwheels, solenoid valves, position transmitters and accessories
- l) Impulse pipes, (IBR & non IBR, plastic coated/ without coating SS 316 /Copper tubing), stub, tubing, pneumatic tubes along with required fittings and isolating valves, fittings, Junction boxes, instruments valves manifolds, isolating and drain valves, air supply pipes/ tubes, gauge valves, condensate pot, fittings, stands, brackets, Local instrument enclosure, local instrument rack etc.
- m) Supply, Cabling, Wiring & Termination of instrument & control cables, Thermocouple extension cables, Instrumentation pair & control cable, power cable, optical fiber cable, special cables, pre-fabricated cable, junction boxes, cable trays, sub-trays/perforated tray, tray covers, raceway, supports, cable glands, Lugs, ferrules, conduits, tray covers, inspection covers, pull boxes, bends, elbows, mounting brackets, clamps, nuts and bolts, connectors, markers, sub-tray supports, rigid conduits, tie wraps etc (irrespective of the one end or both end in their scope) for the total package.

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- n) All special & optical fiber cable for data acquisition from third party control systems and electrical control system including gateway and links.
- o) Supply of all consumables, tools and tackles, all start up and commissioning spares, instruments etc and obtaining all statutory clearances.
- p) Panel mounted instruments like indicators, ammeters, voltmeters, push buttons etc required for total package.
- q) All control room panels, operator's terminals, control panel/desk, work station consoles, marshalling/termination panels, Interposing relay panels, system panels cabinets, power distribution panel, local push button stations, local control panel, furniture etc required for total package.
- r) Complete Steam and Water Analysis System (SWAS) with dry and wet panel, stainless steel sampling line or better, sample conditioning system, analyzers, indicators, recorders, grab sampling system, annunciator, water analyzer etc. as required for total package.
- s) Complete flue gas analyzers including continuous emission monitoring system / instrument, suspended Particulate Matter (SPM) / dust analyzer, in-situ zirconium type oxygen analyzers, extraction/hotwet extraction CO,CO₂ analyzer, Sox analyzer, Nox analyzer and any other analyzer as per latest CPCB / GPCB for their on line pollution monitoring guideline.
- t) Complete CCTV and plant surveillance system as mentioned in detailed technical specification.
- u) Complete Ambient Air Quality Monitoring System (AAQMS) (minimum at four locations), climatic & meteorological monitoring system.
- v) All Gauge Boards, local Panels, local instrument encloser for Boiler side, local instrument rack for turbine side (both enclose and rack type shop manufactured), stanchions, brackets, canopy etc.
- w) All erection hardware including junction boxes, pull boxes, canopies, structural steel items viz steel angles, channels, flats.
- x) Complete cable accessories inclusive of all flexible conduits, sub-trays/perforated tray, tray covers, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts, glands, lugs, ferrules, connectors, markers, rigid conduits, tie wraps, panel/cabinet frame supports, air purging system, optical fibre cable terminators, taps, optical fibre distribution box, patch cord / pigtail, light interface unit, heavy duty conduit etc.
- y) Vibration / Machine condition monitoring and analysis system for Turbine Generator, monitoring of critical drive like ID fan, FD fan, PA fan, CEP, BFP etc and all HT drive & driven equipment including all monitors, servers with on line decision support and analysis system and required cabinets, cable including optic fiber /special cable & accessories.
- z) Parallel Redundant Uninterruptible Power Supply (UPS) System including redundant batteries for powering Instrumentation and Control System including DCS. Distribution and conversion of Power supply to all

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instruments, panels, consoles, MCB/MCCB, ACDB, DCDB, fuse, isolation transformer, voltage conversion and power distribution system are under bidder scope. The battery and battery charger shall be in the scope of the supply.

- aa) Bidder shall supply & set up Instrument workshop with all necessary maintenance testing, calibrating equipments & C&I lab /workshop instruments etc.
- bb) Special maintenance, calibration, commissioning, site testing and troubleshooting equipment required for the Distributed Control System & other bidder supplied system.
- cc) Supply of all start-up, commissioning and recommended mandatory spares
- dd) Complete grounding and electronic earthing system.
- ee) Rating plates, Nameplates and Labels for all I & C items.
- ff) Supply of all performance test instruments and analyzers.
- gg) Performance Test, Trial Operation and Guarantee Test.
- hh) Engineering documentation, Engineering Drawings, documents, Software's licensed and development tools, data, instructions, operation and maintenance manual etc. for Owner's review/approval/record.
- ii) Training of Owner's Personnel.
- jj) Bidder shall be responsible for software licensing, design, development, debugging, system engineering, customizing, installation, site modification, tuning, adjustments, commissioning and furnishing manuals, documentation etc.
- kk) Any other item/ instruments / equipment not mentioned and covered herein but required for successful installation and commissioning of complete functional I&C system shall be included by the bidder in their scope.
- ll) It is not the intent or purpose of this specification to specify all individual system/components since the bidder has full responsibility for engineering and furnishing of total system.

2.13.13 CIVIL

- i) The scope of work covered herein include all planning, collection of all site related data, conducting site investigations, development of loading and all the necessary required drawings, design and detailed engineering, preparation of all construction and fabrication drawings, supply of all labours and materials, construction, fabrication, erection and testing where necessary, of all structures required for housing all equipment and civil works for all services required for the plant defined in the bid specification. The civil works shall include all those items under BTG package, required for installation, commissioning, testing, operation and maintenance of the proposed plant.
- ii) Entire civil work including design, supply and construction for all buildings, structures, technological structures and facilities for all production, auxiliary units, foundations for all buildings, structures and equipment, roads, ramps, paving, parking areas, storm water drainage and sewers and all other miscellaneous civil

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engineering work as will be necessary for completing this package on a turnkey basis within the plant.

- iii) Site related investigations: Topographical survey and detailed Geo technical Investigations. Area drainage study to be done if required. No extra claim will be allowed because of any change with respect to soil investigation or any other input shared by Owner and that of actual investigations during detailed engineering and execution.
- iv) Site development works: Site clearance, site grading, roads, drainage and cross drainage works, including temporary roads/drains, if required.
- v) Excavation in soil and rock (if any, with or without blasting as per the site conditions), dewatering, dressing to required profile, sheet piling or shoring/strutting, backfilling with CNS (Cohesive Non-Swelling) soil and compaction as per IS code wherever required around completed structures and plinth filling, piling, plinth protection, import soil from barrow pits, disposal of surplus earth and rock as directed by Engineer, concreting including providing reinforcement and formwork, fabrication, erection & painting of all structural steel and miscellaneous steel (i.e. steel stair case, cable/duct/pipe supports, pipe racks, ladders, walkways, hand railings, chequered plate/grating floor, inserts, anchor bolts, etc.), masonry work, vibration isolation system for machine foundations if required, plastering, painting, floor finish, doors, windows, & ventilators roofing including permanent steel decking, flooring, acid and alkali resistant lining, fire proof doors, electrically/mechanically operated rolling shutters, under deck insulation, false ceiling, roof water proofing, , paving, gravel filling, precast covers, trestles, cable/pipe trenches/duct, expansion & construction joints, rain water pipes, water supply, toilet/washroom fittings, lift-well, sewerage, roof insulation, damp proofing, water proofing of underground structures, anti-termite treatment, cutting of existing roads and making good, drainage, roads, rail track, fencing, final grading including micro grading and site clearance before handing over and other auxiliary items of work, setting up of material testing laboratory to carry out relevant tests at site, safety, security, testing and commissioning etc. complete.
- vi) Dismantling of buried/semi-buried structures, if any, encountered within the plant limits.
- vii) The scope shall also included for dismantling of existing substructure wherever required, which is in the proposed BTG plant area and disposed off for the debris out of plant boundary. Quantity of concrete/below ground structures or items to be dismantled for existing structure for evaluation purpose is 5000 m³. This is indicative quantity only for evaluation. The Bidder shall visit the site, collect the data and asses the volume of work before preparation of bid; if the quantity varies, there will be no extra cost to the Owner.
- viii) All debris from the plant site, including material removed during site cutting/grading and dismantled buried/semi-buried structures etc, shall be disposed off by the bidder at his own cost, including transportation and arrangement of site for disposal. Proposal for this disposal shall be approved by owner/engineer.

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- ix) Earthwork for buildings and equipment foundations, trenches, pits, sewers and other construction work.
- x) Back filling, soling and sub-grade work for all foundation, grouting, flooring, trenches, pits and other underground structures.
- xi) Encasing structural steel column bases as well as wall beams with RCC at the locations of sun shade sills and other locations as required.
- xii) Concrete and reinforced concrete work in sumps, pits, trenches and other underground structures.
- xiii) All masonry work in sub structure and super structure including plastering as required.
- xiv) All finishing work to flooring, walling, ceiling, false flooring and false ceiling as required.
- xv) All finishing and painting work to masonry, concrete structures, steel works and wood works.
- xvi) All fencing and gates as required.
- xvii) Doors, windows, ventilators, rolling shutters, fire check doors, gates shutters etc.
- xviii) All necessary technological and equipment supporting structures.
- xix) Hand railing, inserts, kerb angles, bolts etc.
- xx) Separate ladies and gents toilets in all buildings.
- xxi) Pantry and dining space with wash basin shall be provided in all buildings.
- xxii) The scope shall cover but not limited to complete civil, structural and architectural works for the following items/buildings/structure/systems/facilities and foundations and all associated equipments/structures of these.
 - a) Construction enabling works
 - b) Steam Turbine Generator building
 - c) Control room / Electrical bay structures
 - d) Foundations for Steam generator / ESP / Duct supporting structures as well as foundations for all equipment in this area.
 - e) Fan foundations (PA, FD, SA and ID)
 - f) CEP foundations
 - g) TDBFP and MDBFP foundations
 - h) Foundations and Supporting structures for FGD and SCR systems.
 - i) Mill and Bunker building including bunkers and Mill foundations.
 - j) Mill reject system
 - k) Steam Generator elevator supporting structure
 - l) ESP & FGD Control / Switch gear rooms
 - m) Twin flue RCC Chimney (Wet stack) of 140 m height

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- n) Steam generator & ESP area paving
- o) Transformer foundations and structures, fire wall, fencing, tracking foundations, burnt oil pit, trenches and bus duct supports
- p) Condenser cooling water system including CW pump house, fore-bay, CW channels, switchgear room, CW pipe encasement and thrust blocks.
- q) Necessary Civil works for Concrete volute for CW pumps
- r) ACW Pump house
- s) Air Washer Building
- t) Compressor house
- u) Diesel generator house
- v) AC/Ventilation plant
- w) Service building
- x) CPU system foundation and structures
- y) Pipe and cable racks/pedestals/trenches (Pipe & cable racks shall also be suitably designed to accommodate BoP package/system pipes & cable trays, wherever required).
- z) Tank foundations
- aa) Foundations for Absorber, Aux. Absorber, etc.
- bb) Duct supporting structures and foundations for FGD system
- cc) Slurry recirculation pump house
- dd) Oxidation blower house
- ee) Sumps / pits for FGD system
- ff) CEMS room
- gg) Gypsum dewatering building
- hh) Lime storage silo
- ii) Mill building
- jj) Lime unloading area and storage shed
- kk) Lime handling system
- ll) Gypsum storage shed and loading area
- mm) Ammonia unloading area and shed.
- nn) Emergency mud pond for gypsum.
- oo) Fuel oil day tanks & storage tanks, including dyke wall and pump house
- pp) Miscellaneous tanks including Condensate storage tank
- qq) All civil works required for sewage system within the BTG area.

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- rr) All civil and structural works required for fire detection and protection system, including fire water storage tank, fire water pump house and pipe network.
- ss) Slope stabilisation, including RCC retaining walls, wherever required.
- tt) Supply of grout and grouting below all equipment / structures.
- uu) Cable trenches, racks, duct banks, manhole and pipe trenches.
- vv) Plant roads including access for each building / facilities from main road.
- ww) Surface drains and storm water drainage system of the plant area.
- xx) Supporting structures and platforms with access for utility pipelines, ventilation ducts and Bus ducts.
- yy) Stairs and exits for all buildings meeting TAC norms.
- zz) All water supply, plumbing and sanitary works including all fixtures for storm water drainage and Septic tanks wherever required, are covered under the scope of the contract.
- aaa) All necessary waterproofing, damp proofing and anticorrosive treatment to buildings, structures and foundations, including underground construction.
- bbb) Thrust/anchor blocks for pipe lines wherever required.
- ccc) All underground concrete surfaces which are contact with soil or ground water shall be applied two coats of bituminous paint.
- ddd) Pipe encasement wherever required, especially at crossings. CW pipes shall be encased throughout, along the power house building, up to CW pit.
- eee) All necessary civil works for crossing pipes/cables below for roadways and other services inside the BTG area.
- fff) All temporary facilities, building, offices, porta cabins, labour colonies, staff quarters, roads and services for construction for this package.
- ggg) Removal of debris, site clearance and micro levelling of the complete site, all-round buildings and premises within the scope of contract prior to completion of work.
- hhh) All necessary civil work required for road lighting within the plant area under BTG package scope.
- xxiii) It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant are deemed to be included in the scope of the bidder.

2.14.00 Site Services

2.14.01 Safety is to be given utmost priority. Safety is one of the most important philosophy to followed while execution of this project. All precautions shall be

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taken by the bidder to avoid any unsafe incidents including injury to personnel involved in installation of this project, material damage and environmental damage. Bidder will be completely responsible for any consequential damage arising out of such unsafe acts/incidents by the bidder or bidder's sub-contractor.

- 2.14.02 Fire protection during construction, especially where hot work is being done; till completion is bidder's responsibility.
- 2.14.03 Medical facilities, including facility for bidder's direct and indirect staff and labour involved in the project.
- 2.14.04 Telecommunication facilities as required by the bidder to compete the scope of work including adequate telephone & internet connections and walkie-talkie radios. The bidder shall obtain necessary permission, from the appropriate authorities to use such radio facilities at site. The bidder shall ensure that the radio communication systems do not cause interference to other radio users and control, instrumentation and communication systems installed in the power plant.
- 2.14.05 Bidder shall mobilise adequate number of all machinery required for handling, fabrication, transportation, construction, erection etc, including excavators, graders, compactor, backhoe loaders, cranes, trailers, tipper trucks, tractor trolleys, water tankers etc, of various capacities as required to complete the plant.
- 2.14.06 Bidder shall mobilise all resources required to complete the plant.
- 2.14.07 Bidder shall arrange for conveyance, boarding & lodging and other social facilities etc for all staff and labour involved in installation of this plant.
- 2.14.08 Bidder may arrange canteen/mess facilities as required for his and sub-contractor's staff and labour.
- 2.14.09 Bidder shall arrange adequate temporary and mobile toilets at various locations at site and ensure that all staff and labour use them and ensure the same are strictly used by his and sub-contractor's personnel.
- 2.14.10 Bidder shall ensure sewage collection and disposal from all site facilities during construction period.
- 2.14.11 Bidder shall setup required number of batching plants with adequate capacity to meet the concrete requirements for the package.
- 2.14.12 As mentioned in other sub-sections and sections, the plant will be established mainly at the land retrieved by demolishing the existing structures of retired units of 4X120MW units and its auxiliaries. The power block/main plant area of the proposed plant has to be constructed after demolishing the auxiliary structures like cooling towers. Most of the above ground structures at the proposed project site will be removed by the owner. All below/underground foundations, structures, pipeline, cables etc has to be excavated and removed by the bidder. Tentative quantity of below ground structures/items to be removed is 5000m³ for evaluation purpose. The quantity specified is only for bid evaluation purpose; however, the bidder shall visit the site and make his own estimation before bidding. No, extra claim on this account will be allowed after award of contract.

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- 2.14.13 Taking into consideration that Unit#6 of Koradi thermal power station are still in operation and some of its facilities like cooling water system are adjacent to the proposed site, care shall be taken that these facilities shall not be disturbed.
- 2.14.14 Site preparation including excavation and demolition of all underground structures, removal of all unwanted debris and transportation, procurement and transportation of suitable backfill material, backfilling, compaction, levelling, grading etc.
- 2.14.15 The unwanted debris shall be suitably disposed off by the bidder, subject to owner's approval.
- 2.14.16 Although the owner will try to demolish all above ground structures, any left out minor structures shall be removed by the bidder for site preparation.
- 2.14.17 Preparation of lay down area and all approach roads from main roads and preparation of internal roads within the battery limits.
- 2.14.18 Construction of storage sheds and fencing for storage area.
- 2.14.19 Storage area including open storage space shall be so developed that all materials can be stored, preserved and retrieved easily and there is no chance of any damage to material, even due to rain or associated slush. All materials in open storage yard shall be stored on sleepers to avoid direct contact with open soil/mud/slush.
- 2.14.20 Boundary/fencing as required for the storage area of Bidders construction stores, for security purpose shall be in the scope of bidder. The bidder shall be responsible for any loss of plant item till completion and shall arrange for its timely repair/replacement in case of damage or pilferage.
- 2.14.21 Watch and ward for security and safety of bidder's offices, including that of sub-contractors' and all materials for the plant till completion and handover.
- 2.14.22 Erection of temporary structures/sheds as required during the course of execution of project, and relocation of these structures for making construction/erection fronts available for works, as directed by engineer.
- 2.14.23 Construction of bidder's site office and associated office spaces including canteen, parking, air-conditioned stores etc.
- 2.14.24 Distribution of construction power to various locations and installation of additional transformers, underground cables or overhead lines, electric posts, distribution boards etc. Arrangement of electric supply to all points of job. Additional DG sets and portable battery or generator based lighting and power supply arrangements at remote locations where it is difficult to arrange/extend construction power.
- 2.14.25 Distribution of construction and potable water to various locations of the site as required for the package.
- 2.14.26 Bidder shall deploy 1 no. rack & pinion construction lift for each boiler.
- 2.14.27 All dewatering as required for construction of the plant.
- 2.14.28 All efforts shall be made to finish all below ground activities before monsoon. However in case of unavoidable circumstances, adequate no. of dewatering

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pumps shall be mobilised so that progress of work is not affected due to. All precautions shall be taken so that work is not hampered due to heavy rains.

- 2.14.29 The site shall be kept neat and tidy all the time and all construction wastes shall be segregated and disposed properly. Sets of waste drums/bins shall be kept at various locations at the site, and these shall be segregated and marked for different types of waste. All these construction waste shall be cleaned periodically. Disposal from site shall be subject to owner's approval.
- 2.14.30 Bidder shall ensure that all oil and oily wastes are safely collected without any ground contamination and disposed from site without any fire hazard.
- 2.14.31 All scraps shall be segregated, organised and stored at designated places.
- 2.14.32 All packaging material, containers, drums, wooden or other crates, gunny bags and other scraps shall be property of owner, but segregation and storage will be Bidder's responsibility till the site is handed over to owner.
- 2.14.33 The Bidder shall make good, any damage made by them to roads, drains, foot/path ways, paved areas, boundary walls and fences etc. during execution and clean all fouled roads, paving etc. whether public or existing at site, caused by or in any way attributable to the handling / transport of plant or materials by the Bidder or his sub-Contractors and indemnify the Owner against loss, damage or claims by the Local Authority or others for damage to or fouling of roads, pavings, etc., by reason of unusual traffic or other causes.
- 2.14.34 The Bidder shall at all times ensure that the public roads, giving access to site, are kept clean of any materials deposited by traffic from the Bidder or his sub-Contractors.
- 2.14.35 The Bidder shall also ensure dust suppression at site, especially at site roads periodically, as required, to avoid dust nuisance.
- 2.14.36 Maintaining proper documentation of all the site activities undertaken by the Bidder as per the proforma mutually agreed with the Owner
- 2.14.37 The site shall be handed over back to the owner in a well organised and neat & tidy condition.
- All balance touch-up paintings and final coats shall be completed.
 - All finishing works shall be completed.
 - All roads and drains shall be interconnected smoothly at the terminal points.
 - All drains shall be cleaned and covered before handover.
 - All fencing and gates shall be completed.
 - Rain water harvesting shall be completed.
 - All punch list points shall be closed or reconciled between the bidder and engineer.
 - All construction wastes shall be properly disposed off and all scraps shall be sorted, segregated and stored properly as directed by engineer.
 - All temporary works constructed by bidder for establishing the project shall be removed, if directed by engineer.

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- x) All areas shall be cleaned and paint markings shall be provided for demarcations, wherever required and as instructed by the engineer.

3.00.00 BATTERY LIMITS AND EXCLUSIONS

3.01.00 The battery limits or terminal points (TP) and exclusions for the package are as below. In case of any ambiguity, owner's interpretation shall be final.

3.02.00 Battery Limits/Terminal Points

3.02.01 MECHANICAL

Sl. No.	Description	Terminal Point	Remarks
1.	Coal	Bunker inlet	Inserts for, travelling tripper rails or plough structure supports, will be in BTG vendor scope.
2.	Fuel oil (LDO)	Outlet flanges of existing fuel oil (LDO) storage tanks of Unit 8, 9 & 10 and Tapping from Existing LDO Unloading header.	
3.	Limestone	Unloading area of limestone storage shed	
4.	Ammonia handling	Ammonia unloading area	
5.	Bottom Ash	Furnace Bottom Throat / Bottom Header Seal Plate	Seal plate shall be in bidder's scope
6.	Fly ash	ESP hopper outlet flange	
7.	ECO, DUCT & SCR, APH hopper ash	Hopper outlet flange	
8.	Mill reject	At the outlet of sector Gate of Mill Reject silos	
9.	Flue gas	Outlet of chimney	
10.	CW/CT make-up	CWPH forebay	
11.	Cooling water pipes	10 m away from cooling towers	
12.	DM water	Inlet flange of CSTs	
13.	Instrument air	1 point near power house building	Within 3 m from A-row, 1 st column of power house building (PHB)

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Sl. No.	Description	Terminal Point	Remarks
14.	Service air	1 point near power house building	Within 3 m from A-row, 1 st column of power house building (PHB)
15.	Service water	1 point near power house building	Within 3 m from A-row, 1 st column of power house building (PHB)
16.	Potable water	1 point near power house building	Within 3 m from A-row, 1 st column of power house building (PHB)
17.	Lube oil	Outlet flange of lube oil transporting tanker/vehicle	
18.	Chemicals	To outlet flange of transporting tanker/vehicle or the container	Or chemical unloading and storage area
19.	Chemical dosing system	Inlet of solution preparation tanks	
20.	Hydrogen		At the manifold inclusive of cylinders.
21.	Oxygen, CO ₂ and Nitrogen		At the manifold inclusive of cylinders.
22.	Regeneration reject from CPU	Central Monitoring Basin inlet	N Pit will be in BTG contract scope
23.	Boiler area effluents	Common effluent collection tank.	Common effluent collection tank shall be BoP contract scope
24.	TG area effluents	Common effluent collection tank	Common effluent collection tank shall be BoP contract scope
25.	FGD area effluents (Waste Water)	HCSD System (Pump House) / Ash Dyke	
26.	Other effluent if any	Common effluent collection tank	Common effluent collection tank shall be BoP contract scope
27.	CW/CT blow down	CT blow-down tank & FGD Process water tank	CT blow down tank shall in BTG contract scope Nozzles (with blinds) to be provided for 2x100% Ash Water Supply pumps
28.	Coal bunker emptying system	Outlet of chute	Suitable to directly unload from bunkers to trucks.

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Sl. No.	Description	Terminal Point	Remarks
29.	Auxiliary steam interconnection with existing units 8, 9 & 10	Nearest suitable location in Unit 8,9 & 10 premises	
30.	Gypsum	Gypsum storage shed	
31.	Fire protection system	Within 3 m from A-row, 1st column of power house building (PHB)	
32.	Clear water for FGD	Suction nozzle of Filter Water Storage Tank & Foundation in Filter Water Pump House	Pump shall be controlled based on levels of source and destination tanks.
33.	APH/ESP Water Wash Pumps	Suction nozzle of Filter Water Storage Tank & Foundation in Filter Water Pump House	One (1) tapping, with isolation valves shall be terminated at ASH water Tank of BoP Package.
34.	Transformer yard effluent	Common effluent collection tank	Common effluent collection tank shall be BoP contract scope
35.	FO area effluent	Common effluent collection tank	Common effluent collection tank shall be BoP contract scope

Note: Wherever applicable, terminal points shall start/end with counter flange, fixing bolts and nuts, gaskets etc.

3.02.02 ELECTRICAL

Sl. No.	Description	Terminal Point	Remarks
1.	Interconnection with existing 400kV & 220 kV switchyard	HV side bushings termination of GT & ST	LA and VT located in transformer yard, termination clamps including fasteners at bushings will be in BTG contract Scope.
2.	BoP power supply (for HT & LT)	Outgoing feeders of 11 & 3.3 KV station switchgears	Refer Pt. 6 for cables.
3.	BoP Power supply for Ozonisation	Outgoing feeder from 415V CW (CWPH) PMCC	Refer Pt. 6 for cables.

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4.	Earthing & lightning protection		Complete Earthing (electrical and electronic) and lightning protection, within plant under this BTG contract scope. Interconnection (at min. 4 points) of BoP and BTG earthing systems shall be in BTG contract scope.
5.	Lighting/illumination		Complete Lighting / illumination within plant under this BTG contract scope.
6.	Cables (Power & Control)		Supply, engineering, design, Erection, Laying and termination for all cables shall be in BTG vendor scope including preparation of cable schedule, wherever both side ends are in BTG bidder's scope. However, Supply, engineering, design, Erection, Laying and termination, including preparation of cable schedule, for all cables between switchyard and BTG shall be in BTG contract scope.
7.	Cable Trays		Cable tray terminal points shall be set at the following points for BOP scope. a) At power house C row end towards east side (facing CHP side) for CHP area cabling. b) At CW Pump House for CT area cabling. c) At FO area for WTP area cabling. d). Tapping from ESP/FGD cable tray for AHP building cabling. The cable trays beyond the above points shall be in BOP scope.

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3.02.03 CIVIL

Sl. No.	Description	Terminal Point	Remarks
1.	Roads	All approach roads interconnecting all facilities under BTG package and their connections to the Main plant roads at suitable locations.	Also, refer plot plan
2.	Drains	All garland drains/ local drains for effective drainage of rain water at all facilities and roads under BTG package and their connections to the Main storm water drainage network at suitable locations.	Also, refer plot plan
3.	CW channels	15 m away from cooling towers	
4.	Sewage	Sewage collection sump at STP area	Sewage pipeline up to collection sump at STP area is in bidder's scope.

3.02.04 CONTROL AND INSTRUMENTATION

- i) Interfacing of BTG DCS with BoP DCS/PLC/microprocessor based control system etc. All the interfacing hardware such as converters / modem / servers, firewalls, power supply unit, software, cables etc shall be supplied by BTG bidder at their end in central control room. BoP end interfacing hardware, software shall be in BOP (off-plant system) contractor scope.
- ii) Complete Communication armoured FO cables, special cables, signal cables and control cables between BoP DCS/PLC/Microprocessor based control systems etc to BTG DCS shall be in BTG bidder's scope. Making fully functional and operational third party soft link is under BTG bidder scope. However, technical inputs required by BTG vender for third party interface shall be given by respective BoP (off-plant system) package contractor.
- iii) For Time Synchronization Signals from BTG master clock system to BoP DCS/PLC/Microprocessor based control system/Electrical System etc, all the interfacing hardware such as signal conditioner cards/converters/modem/power supply unit, software etc shall be supplied by BTG bidder at their end in Unit control room. BoP end hardware, software shall be in BoP contractor's scope.
- iv) Complete supply, engineering, design, erection, laying, routing, termination of special cables, instrumentation cables, cable trays or GI conduit pipes/HDPE protection pipes and Optical fibre cables required for Time Synchronization Signals from master clock system to BoP contractor's each DCS/PLC & Microprocessor based control system etc shall be in BTG bidder scope.
- v) Supply, engineering, design, Erection, Laying and termination for all cables (instrumentation and signal cable, fibre-optic and other communication cables)

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shall be in BTG vendor scope including preparation of cable schedule, wherever both side ends are in BTG bidder's scope.

3.03.00 Exclusions

3.03.01 MECHANICAL

- i) Railway siding and marshalling yard
- ii) Balance of plant systems like
 - a) Coal handling system up to coal bunker inlet,
 - b) Ash handling system, including Bottom ash and Fly ash evacuation and disposal system,
 - c) Cooling Towers,
 - d) Plant water system, including intake, pre-treatment, demineralisation and effluent treatment system
 - e) Ozonisation system

3.03.02 ELECTRICAL

- i) 220 kV & 400kV Switchyards & interconnection from GTs and STs
- ii) BOP package – HT & LT switchgears
- iii) BOP package area Earthing & lightning protection except BOP equipments within BTG area.
- iv) BOP package area illumination except BTG area and its internal road lighting.

3.03.03 CONTROL AND INSTRUMENTATION

- i) BoP contractor's DCS/PLC/microprocessor based control system
- ii) BoP contractor's hardware interface and software

3.03.04 CIVIL

- i) Roads – Roads beyond BTG battery limit. Main plant roads except approach roads inter-connecting all facilities under BTG package and their connections to the Main plant roads at suitable locations.
- ii) Drains - Storm water drains beyond BTG battery limit.
- iii) Sewage – BoP area sewage system and sewage treatment plant.
- iv) Staff colony/township for owner's staff

4.00.00 BASIC PLANT TECHNICAL AND DESIGN REQUIREMENTS

- 4.01.00 All items for the plant shall be brand new and any refurbished or used item should not be used for any of the equipment or systems of the project.
- 4.02.00 Components of same function and similar duties shall be of same make and interchangeable as far as possible.
- 4.03.00 Components shall be standardised as far as possible to reduce spares inventory.

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- 4.04.00 All items, equipment and systems of the package shall be designed for a life span of minimum 40 years. All civil structures shall be designed for a life span of minimum 50 years. The plant shall be designed for a trouble free operation over entire life of the plant.
- 4.05.00 The design of all equipments shall conform to the best and current engineering practice. It shall ensure reliability, simplicity and provide long continuous service with high economy and low maintenance.
- 4.06.00 Material of construction (MOC) all parts/components/assemblies of equipment shall be so selected that its physical and chemical properties are optimum for the intended service.
- 4.07.00 Treated sewage water will be used for all applications in the plant except for potable/drinking water; MOC of all associated equipments should be selected accordingly.
- 4.08.00 All components of the plant shall be suitable for full range of ambient and other environmental conditions prevailing at the site.
- 4.09.00 All items, equipment and systems of the package shall be designed to ensure high level of reliability & availability.
- 4.10.00 The plant shall be designed such that efficiency of individual equipment and the system as a whole should be optimum.
- 4.11.00 Safety is to be given at most importance in design of equipment and whole system. The plant has to be designed to avoid any injury to plant personnel, loss of equipment/material, loss of generation/operation or damage to the environment due to design fault.
- 4.12.00 Ease of maintenance and operation of each and every item of the plant shall be equally important design philosophy for the plant.
- 4.13.00 Suitable handling arrangement and approach shall be provided for all items of the plant. Electric hoist or crane shall be provided for handling all items above 1 ton.
- 4.14.00 The metric system of Weights and Measures shall be exclusively used in this project.
- 4.15.00 KKS tagging philosophy shall be followed uniformly for all mechanical, electrical and instrumentation equipment, components, systems.
- 4.16.00 All software packages to be used for design of the plant shall proven and have proper validation report.
- 4.17.00 Although detailed technical requirements are mentioned in other respective sections of the specification, they are deemed to be applicable to all similar equipment/systems.
- 4.18.00 The plant shall comply with all applicable statutory stipulations of Ministry of Environment and Forest & Climate Change (MoEFCC), Central Pollution Control Board (CPCB), State Pollution Control Board (SPCB) and other statutory authorities.
- 4.19.00 The oil system and its facilities will be designed as per Petroleum Rules/Explosion Acts/Fire Rules of Govt. of India.

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- 4.20.00 Design of the plant shall be such that all components and equipment are suitable to withstand occurrences of periodic abnormal operating conditions.
- 4.21.00 The complete plant shall be designed with adequate redundancy. As a rule 100% redundancy shall be followed for all critical/important equipment unless specified otherwise.
- 4.22.00 All stand-by auxiliaries shall be designed for auto start up, on failure of running auxiliaries with minimum time delay and without runback on unit load.
- 4.23.00 All auxiliary equipment and drive motors shall be capable of delivering satisfactorily their rated outputs continuously for a voltage variation and frequency as mentioned elsewhere in the specification.
- 4.24.00 Pressure wherever mentioned in the specification is gauge pressure unless specifically mentioned as absolute pressure.
- 4.25.00 Design pressure shall be 1.5 times maximum working pressure for all items unless specified otherwise.
- 4.26.00 For all low-pressure piping & accessories, ASME 150# class and for high pressure piping & accessories ASME 300-900# class will be applicable
- 4.27.00 All process tanks should be provided with high and low level controls and alarms.
- 4.28.00 A minimum of 300mm free board shall be provided for all tanks in general. For bigger tanks, higher freeboard may be provided.
- 4.29.00 Advantage of gravity shall be utilised for flow wherever possible.
- 4.30.00 All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.
- 4.31.00 The equipment, components, piping and associated supporting structures shall be designed considering the effect of Earthquake as specified.
- 4.32.00 The design power output of each unit at 100% TMCR condition shall not be less than 660MW.
- 4.33.00 Plant, especially the structures shall be designed taking into consideration the good aesthetics.
- 4.34.00 Basic technical requirements of various systems are mentioned herein.
- 4.35.00 The owner will interpret the meaning of drawings and specifications and shall be entitled to reject any material or work, which according to him is not in accordance with what, is specified or required.
- 4.36.00 Steam Generator and Auxiliaries**
- 4.36.01 Super Critical Pressure ("SCP") power plant is envisaged with a view to capture better plant efficiency; minimizing basic fuel coal consumption; and most important criteria being the drastic reduction of emission quantities of SO_x, NO_x, CO₂ and particulate matters etc.
- 4.36.02 Boiler furnace can be either two pass type or tower type.

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- 4.36.03 Spiral (plain/bare tube) wall type design is preferred. However, vertical (rifled/ribbed tube) wall type furnace can also be considered.
- 4.36.04 The mass flow in the furnace-wall tubes must be sufficiently high to avoid overheating or departure from nucleate boiling (DNB) while generating steam at sub-critical pressures and to avoid excessive metal temperatures and uneven steam outlet temperatures when operating at super critical pressure at higher boiler loads.
- 4.36.05 Boiler shall be variable pressure once through boiler.
- 4.36.06 Applicable materials shall be selected considering the combination of applied temperature and pressure levels.
- 4.36.07 The SO_x emissions shall be less than 70mg/Nm³, with installation of FGD.
- 4.36.08 The NO_x emissions shall be less than 70mg/Nm³, with installation of SCR.
- 4.36.09 Particulate emission shall be less than 27mg/Nm³, with high efficiency ESP.
- 4.36.10 DRAFT SYSTEM
- The draft system comprises of two (2) sets of FD fans each set rated for 60% of BMCR capacity. The FD fans will be axial type, blade pitch control arrangement offering an optimum efficiency for regulation purpose.
 - Two (2) Induced Draft (ID) Fans each rated at 60% of BMCR flow will be blade pitch control type. The equipment will be complete with lube oil system, hydraulic regulations and all other accessories required for continuous operation and all equipment would be suitable for outdoor installation.
 - Primary air (PA) system shall be cold type. Fans shall be 2x60% capacity blade pitch controlled type.
 - Interconnection of secondary air duct before Air Pre-heater (APH) should be provided. Similarly, interconnection of cold primary air header should be provided.
- 4.36.11 PULVERISERS
- For firing high ash content abrasive coal pulverisers of slow speed large capacity bowl mills or ball and race mills will be provided having low auxiliary power consumption; and relatively high life expectancy of grinding parts and armour plating.
 - The mills size and numbers will be selected such that on an average two mill remains on standby and one of the mills is under maintenance (i.e. N+3, configuration), while firing design coal. N=7 is the number of mills in operation running at 90% of their MCR. Total 10 nos. of coal mill out of which 7 no of mills in operation running at 90% of their MCR, 2 no standby and 1 mill under maintenance.
 - Considering the grinding fineness required, it is suggested equipping the mill with rotating classifiers having speed adjustment to control grinding fineness.
- 4.36.12 The firing system will employ latest the 'state-of-the-art' burners and permit load variation from 35 to 100% BMCR without use of support fuel. The ratio of fuel and air flow will be controlled. Due to sufficient burner wall distance and the

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burner swirl direction, operation with low excess air shall be possible without the risk of wall damage.

4.36.13 START-UP FUEL SYSTEM

- i) The fuel oil system will be provided for boiler start up; and for flame stabilization during low load operation with or without coal firing. Fuel oils will be used for:
 - a) Light Diesel Oil (LDO) oil for boiler start up (up to 10% of BMCR) and (thereafter mill shall be taken so that start-up is done in combination firing to optimize start-up cost.)
 - b) Light Diesel Oil (LDO) for low load operation and flame stabilization, as necessary. System shall be designed for a capacity of 30% BMCR as a single fuel which is equivalent to 35% TMCR load. 35% TMCR load and above, there will be no oil firing.

4.36.14 SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM

- i) SCR system shall be installed for both the units and this SCR system will be installed at downstream of economizer.
- ii) The design and layout of steam generator and its auxiliaries will be suitable for installation of SCR system.
- iii) For SCR system it is envisaged to pass the flue gases containing NO_x and after completion of chemical reaction feeding the denitrified flue gases to APH.
- iv) SCR shall be provided with plate type catalysts in maximum 3 layers with a gap of about 2000 mm in between two consecutive layers and design shall take care the concentration of NO_x at inlet to top layer after reduction by low NO_x burners and separated over fire air system.
- v) NO_x removal efficiency to restrict NO_x less than 70mg/Nm³ (at 6% O₂ dry basis).

4.36.15 ELECTROSTATIC PRECIPITATORS

- i) High efficiency electrostatic precipitators having an efficiency that will limit the outlet emission to 27 mg/Nm³ while the boiler is operating at its BMCR, firing worst coal having maximum ash content shall be installed.
- ii) The electrostatic precipitators will have four (4) or more parallel gas streams, isolated from each other on the electrical as well as gas side and will be provided with gas tight dampers at inlets and outlets of each stream, so as to allow maintenance to be carried out safely on the faulty stream, while the unit is working.
- iii) Particulate emission from ESP shall not be more than 27mg/Nm³ with one field out of service in each pass.
- iv) Electrostatic precipitator will be provided with microprocessor based programmable type rapper control system and ESP management system to ensure the safe and optimum operation of ESP.
- v) Each field should have its dedicated TR set. Electrode spacing shall be 400mm with minimum SCA of 180 m²/m³/s.
- vi) ESP transformer rectifier sets will use high fire point oil as the cooling medium.

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- vii) The dust collection hoppers at all strategic locations will have a minimum storage capacity of eight (8) hours; and shall be provided with min. 3 mm SS liner.
- viii) The hoppers will have heating arrangements to prevent ash sticking to the sloping sides and down pipes.
- ix) Level indicators will be provided to indicate and trip the ESP in case of high ash levels in the ash hoppers, which will jeopardize the safety of ESP otherwise.

4.36.16 FLUE GAS DE-SULPHURISATION (FGD) SYSTEM

- i) The design and layout of steam generator and its auxiliaries will be suitable for in line installation of wet flue gas desulphurisation system in flue gas path.
- ii) For FGD system it is envisaged to take suction from duct after ID fan and feeding the desulphurised flue gases back to the chimney with provision for bypassing the FGD system.
- iii) The wet limestone based FGD system adopts limestone slurry for the removal of the SO_x present in the flue gas and water vapour in the flue gas after treatment will be saturated.
- iv) SO_x removal efficiency to restrict SO_x less than 70mg/Nm³ (at 6% O₂ dry basis).
- v) The arrangement of flue gas system shall allow complete isolation of the absorber from gas side, with the unit in operation. For this purpose, Motorized Guillotine type gates shall be provided at gas inlet, gas outlet of the flue gas and in FGD bypass duct.
- vi) ESP and FGD control and switchgear buildings shall be common.

4.37.00 Steam Turbine and Auxiliaries

- 4.37.01 The turbine component and its auxiliaries will be designed and selected to meet the stringent requirements in respect of superior thermal performance, excellent product reliability and operational flexibility.
- 4.37.02 The proposed turbine will have one HP, one IP and **one/two** double-flow low-pressure casings.
- 4.37.03 All components will be selected based on long-proven records and standardized modules.
- 4.37.04 The turbines will be of the tandem compound design. The individual shafts of the cylinders and the generator rotor shaft will be coupled rigidly together and all the shafts will be machined from single forgings.
- 4.37.05 The turbo-generator set would be designed for a maximum throttle steam flow at turbine Valve Wide Open (VWO) condition of 105% of Turbine Maximum Continuous Rating (MCR) flow.
- 4.37.06 The HP turbine will be designed with single flow. This will have a double-shell casing consisting of inner casing carrier and barrel-type outer casing.
- 4.37.07 Main steam to the HP turbine will be supplied through two combined stop and control valves and one overload control valve for main steam admission. The exhaust branch will be located below the turbine.

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- 4.37.08 The IP-turbine will be designed with double flow. This will have a double-shelled casing with horizontally split inner and outer casing.
- 4.37.09 Reheat steam will be admitted through two combined stop and control valves of the turbine. The valves will be arranged on either side of IP casing. The exhaust branches will be on the top of the casing. The steam flows to the LP Turbine through a crossover pipe.
- 4.37.10 The LP-turbine will comprise horizontally split multi shell casing. The outer casing will consists of two end walls, a bracing system, the top half and the sidewalls. The inner casing will be double shell axially split supported by support arms that are bolted to it and that rests on the bracket supports of the bearing pedestals. The bearing pedestals will be mounted on the foundation. They will carry the shaft seal casings, which shall be joined to the outer casing by means of expansion joints.
- 4.37.11 Each combined valve consists of a stop valve and a control valve that will be mounted on a common body. Every stop valve and control valve will be equipped with an electro-hydraulic-actuator. The main steam valves will be directly mounted on the HP-turbine.
- 4.37.12 A quick acting HP and IP bypass station would be provided as a part of the turbine package.
- 4.37.13 A fully automatic gland sealing steam supply system will be provided for the TG Set and the turbine drives of BFPs. HP & IP turbine shaft glands will be sealed to prevent escape of steam into the atmosphere and the LP turbine glands will be sealed for preventing leakage of atmospheric air into the turbine. Steam will be used for sealing these spring backed labyrinth glands.
- 4.37.14 During start-up and low loads (say 35% TMCR load), seal steam will be supplied to the turbine glands from the auxiliary steam header or cold reheat line through a seal steam-regulating valve. During normal operation (above 35% TMCR load), the HP and IP turbines will be of self-sealing type and under that condition the auxiliary/CRH steam source will be cut off and the leak-off steam from HP and IP glands will be used for sealing the LP glands. The excess leak-off steam shall be led to the condenser. A gland steam condenser will be provided to condense and return to the cycle, all gland leaks off steam including that from BFP turbines. A desuper-heating type bypass will be provided during outage of gland steam condenser. 2x100% capacity vapour exhausters will be provided to remove non-condensable gases from the gland steam condenser. The exhaust gases will be led over the TG hall roof level.
- 4.37.15 **LUBE OIL SYSTEM**
- The oil system will supply oil for lubrication and cooling of turbine and generator bearings, and to the hydraulic (in case of hydraulic turning gear) shaft turning gear during start-up and shutdown. This system will be provided with AC & DC powered oil pumps.
 - A separate, self-contained high-pressure fluid system with dedicated pumps will be provided for valve actuation. The system will specifically include the following:

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- a) The main oil pump will be centrifugal/gear type. The turbine shaft will directly drive it. It will have sufficient capacity to handle lube oil requirement of the bearings and emergency seal oil requirements.
 - b) 2 x 100% AC Auxiliary oil pumps for start-up, slowdown of TG unit and as standby to MOP for automatic operation. These pumps will be in service during start up till the main oil pump takes over the supply.
 - c) 1 x 100% DC emergency oil pump for meeting lube oil requirements of bearings during emergency with automatic starting on low lube oil pressure preset value.
 - d) One (1x100%) each AC & DC motor jacking oil pumps will be provided to lift the rotor at the bearing during turning gear operation.
 - iii) Each unit will be provided with an oil tank of sufficient capacity for oil changes. 2x100% duty vapour extraction fans. 2x100% capacity oil coolers will be provided for oil cooling with DM water.
 - iv) A suitably sized centrifuge type turbine oil purification plant will be provided as an auxiliary of the proposed turbo-generator set to condition the turbine oil continuously to remove the water and other impurities. In addition, a common turbine oil storage unit comprising one clean oil tank, one dirty oil tank, one purifier unit with necessary pumps, vent fans etc. will be kept. This would also receive the refill of turbine oil from outside. The purification plant will be complete with oil purifiers, storage tanks, filters, and necessary pumping sets and vent fans.
 - v) A lube oil purification unit will be permanently installed for each unit for the total oil charge on a continuous basis.
- 4.37.16 CONTROL FLUID SYSTEM**
- i) For the governing and control system of the turbine a complete self- contained control fluid system will be provided. Fire resistant fluid will be employed to eliminate fire hazards. The system will comprise:
 - a) A control fluid reservoir of adequate capacity to ensure fluid supply.
 - b) 2 x 100% AC motor driven pumps to pump the fire resistant fluid from the reservoir.
 - c) 2 x 100% capacity control fluid coolers designed for service with DM water.
 - ii) A control fluid purifying unit will be provided for the turbo-set for purifying at least 2% of the total fluid charge in the system per hour on a continuous bypass basis. 2 x 100% capacity AC motor driven purification pumps to circulate oil through purification system will be provided. Necessary filters, strainers, piping, fittings, valves and instruments shall be provided.
- 4.37.17** The turbine will have throttle or nozzle controlled type governing. The steam turbine generator unit will be equipped with an electro-hydraulic governing system backed up by 100% mechanical-hydraulic or electro-hydraulic control system. Governing system shall comply with FGMO/RGMO as per 5.2(f) of CERC (Indian Electricity Grid Code) regulation, 2010 & subsequent amendments if any. The governing system will be highly reliable and operationally safe and it

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will be capable of controlling with stability, the speed of the turbine at all power outputs between zero and the specified maximum power output when the unit is operating isolated, or the energy input to the steam turbine when the unit is operating in parallel with other units in the grid. The turbine governing system will be designed for high accuracy, speed and sensitivity or response.

4.37.18 A 60% (BMCR) HP and LP Turbine bypass station will be provided to act not only as a protection to the turbine during pressure rise resulting from sudden load throw-off but also to enable operation of the unit at loads lower than the control load. Further HP/LP bypass will permit quick, repeated hot starts of the unit on its tripping.

4.37.19 The LP bypass station will be connected to the hot reheat line and discharges the steam into the condenser. The hot reheat steam will be de-superheated by means of condensate injection. The bypass system shall be in operation when the steam turbine is not able to receive the entire steam quantity, e.g. during start-up or in case of a load rejection. The HP and LP bypass stations will be capable of meeting the following requirements:

- i) Quick start up of the steam generator from cold, warm & hot conditions.
- ii) Parallel operation of the bypass with turbine under large load throw-off.
- iii) House load operation followed by large load throw-off.
- iv) To keep the steam generator in operation so as to avoid a trip out the steam generator following full load rejection.

4.37.20 CONDENSING SYSTEM

- i) The function of the condenser is to condense the steam exhausted from the LP cylinders and to produce and maintain as high a vacuum as possible in order to increase the enthalpy drop, which can be utilised in the turbine.
- ii) The condenser unit would be transverse mounted and would condense exhaust steam by circulation of cooling water (inlet temperature 33 °C max.) in a re-circulating cooling water system using wet type cooling tower. Condenser outlet water temperature may be maintained within 42 °C.
- iii) The condenser would be designed as per HEI code or equivalent.
- iv) The heat load of the condenser will correspond to the turbine operating condition with VWO having 105% MCR steam flow, 1% make-up, 90% tube cleanliness factor and a maximum cooling water inlet temperature of 33 °C to maintain rated condenser pressure of 76 mm of Hg (absolute).
- v) The condenser should also be capable of accepting full HP-LP bypass steam flow safely without undue pressure rise, vibration, noise or other detrimental effects. Quality of LP bypass steam (pressure, enthalpy and velocity) shall be in line with HEI recommendation.
- vi) Oxygen content of condensate leaving condenser hot well will not exceed 0.015 cc per litre over the entire load range.
- vii) Clarified treated sewage water would be the cooling medium in the condenser and other auxiliary coolers.

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- viii) Stainless steel heat exchanger tubes, with rolled steel tube sheet, baffle plates, etc. are envisaged to ensure all steel construction. Cathodic protection with Zn or Al sacrificial anode would be provided, if required.
- ix) The condenser will be a single/double-flow box-type surface condenser with water boxes on each end. The steam space will be of rectangular cross-section to achieve optimum utilization of the enclosed volume for the necessary condensing surface. The condenser will be located below the LP turbine and form an integral part of it.
- x) The condenser would be spring mounted with rigid connection to the turbine exhaust. Alternatively, condenser may be on solid footing with corrosion resistant flexible metallic bellow connection with the turbine exhaust.
- xi) The double-flow LP turbine outer casing will be connected to the condenser through the steam dome. The steam dome will be welded to the exhaust casing of the turbine with the result that the LP turbine cylinder and the condenser form a unit.
- xii) The direction of circulation water flow will be at right angle with the turbine axis and in one/two pass. The condenser tube bundles, on which the exhaust steam from the turbine condenses, will consist of straight tubes with smooth surfaces and running right angle with the turbine axis in the steam space of the condenser. The condenser tubes rest in tube support plates at regular intervals along their length to prevent impermissible tube vibration when the condenser is in service. Tube sheets on the circulating water inlet and outlet sides will act as partitions separating the steam space from the cooling water side. Both ends of the tubes, through which circulating water flows, are roller-expanded into the tube sheets. On the cooling waterside the water boxes will be provided with a coating to prevent contact corrosion.
- xiii) The condenser tubes will be divided into tube bundles designed to promote uniform flow. The following general aspects of possible improvements will be considered:
 - a) Lowest possible condenser inlet pressure influenced by the pressure drop between the LP-turbine diffuser and condenser tubes, the heat transfer coefficient of the tubes and the activation of the entire heat-exchange surface.
 - b) Smallest possible condenser heat losses.
 - c) Minimized oxygen content in the condensate.
- xiv) The unit will comprise of 2x100% (1 working +1 standby) vacuum pumps for each shell along with all accessories and instrumentation for condenser air evacuation. The vacuum pumps and accessories will be used to create vacuum by removing air and non-condensable gases from steam condenser during plant operation. Vacuum pumps will be of single/two- stage liquid ring type with both stages (if two-stage pump is selected) mounted on a common shaft. Vacuum pumps will be sized as per latest HEI requirements.
- xv) Each unit will have 3 x 50% capacity (two operating and one standby) motor driven condensate extraction pumps with VVVF control. The condensate pumps will be vertical canister type, multistage centrifugal diffuser design with a double

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suction first stage designed for condensate extraction service having low suction head requirement. Connection between condenser and each pump will be through a block valve and removable strainer. The pumps & motors will be accessible to turbine house EOT crane for erection and maintenance. The pump will have adequate margins on capacity and head to cater for most adverse conditions of operation such as:

- a) HP & LP bypass in operation.
 - b) HP heaters out of service and unit operating at its maximum load during an under frequency operation.
- xvi) Connection for condensate supply to the following major services will be tapped off from this condensate discharge header:
- a) LP bypass de-superheating spray,
 - b) Turbine exhaust hood spray,
 - c) Gland sealing system de-superheating.
- xvii) Condensate will then pass in series through the gland steam condenser and drain cooler before being passed through the low pressure feed water heaters.

4.37.21 REGENERATIVE FEED HEATING SYSTEM

- i) Regenerative feed heating plant will be designed for all operating conditions including transients like sudden load throw-off, HP-LP bypass in operation, all heaters going out of service etc. The condensate from the condenser will be pumped by the condensate extraction pumps through the train of LP heaters to the deaerator. In deaerator, the condensate will be heated to saturation temperature and fed to the boiler feed pump, which increases the feed water pressure to suit the steam generator requirements. Finally the feed water is fed to the boiler through a feed regulating station.
- ii) Feed water will be heated by uncontrolled turbine extraction steam from turbine inter-stage tap-offs and cold reheat line. The deaerator will normally be operated under variable pressure on extraction steam from IP-Turbine. Each feed water heater will be capable of handling the drains from the preceding heater under operating conditions of the unit.
- iii) The equipment will be designed in accordance with latest applicable standard/codes of Heat Exchanger Institute. ASME, IBR etc. The HP heaters will also have de-superheating zone.
- iv) Horizontal spray cum tray type deaerator with a storage tank will be provided. The deaerator will be capable of de-aerating the dissolved oxygen and carbon dioxide in condensate & HP Heater drains. The minimum capacity of the deaerator will be 6 minutes between normal operating level and low level with a filling factor of 0.66. The deaerator will be normally operating by taking extraction steam from IP turbine except during low load operation and start up when the steam is drawn from the auxiliary steam header.
- v) The unit will comprise of 2 x 50% of BMCR turbine driven and 1x50% of BMCR motor driven boiler feed pump per unit with the booster pumps mounted on the common shaft. Each pump will be designed to give parameters to suit the steam

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generator requirements, such that motor driven feed pump will be used for start-up of unit and will also act as standby BFP. Turbine driven boiler feed pumps will be located at operating floor level and the motor driven pump will be located on mezzanine floor and both types will be accessible to turbine house EOT crane for erection and maintenance.

- vi) The boiler feed pumps will be of horizontal, centrifugal type with single shaft design. The boiler feed pumps outer casing will be of barrel type with end removal. The inner pump assembly comprising of shaft, impellers, stage casings will be capable of being removed and replaced as a unit without disturbing the feed piping. Each feed pump will be provided with automatic type re-circulation control valve to protect the pump under low flow condition. The boiler feed water system will be designed to operate in automatic mode over the entire range of system design loads. The arrangement will provide automatic start-up one of the standby motor driven feed pump under conditions like tripping of the running TDBFP's and/or discharge header pressure low etc.
- vii) Throttling the drive turbine steam inlet control valve in case of turbine driven pumps whereas hydraulic coupling will be utilised to achieve speed control of motor driven pumps for control of the feed flow. Provisions will be made for warm up to standby pump, if required.
- viii) Dedicated lube oil system shall be provided for each BFP.

4.38.00 General Mechanical Requirements

4.38.01 HORIZONTAL AND VERTICAL PUMP

- i) The maximum efficiency of pumps shall be preferably within +10% of the rated design flow.
- ii) The head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off without any zone of instability and with a minimum shut-off head of 15% more than design head.
- iii) Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division.
- iv) The head vs capacity and BHP vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical shall be interchangeable.
- v) Pumps shall run smoothly over the entire range of NPSH conditions without undue cavitation, noise & vibration. Peak to peak vibration limits shall be restricted to the following values during operation.

Speed	Antifriction bearing	Sleeve Bearing
1500 rpm & below	75.0 microns	75.0 microns
3000 rpm	50.0 microns	65.0 microns

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- vi) The noise level shall not exceed 85dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1m from the equipment surface.
- vii) The pumps shall be capable of starting with discharge valves open & close condition.
- viii) Selection of pumps shall be such that the design point shall be met even with negative manufacturing tolerance.
- ix) The pump shall be of stiff shaft design. The maximum internal clearances should be sufficiently more than the maximum static deflection of the shaft. Shaft size selected must take into consideration the critical speed as specified in API-610.
- x) Following codes shall be referred to:
 - a) IS 1520
 - b) IS 5120
 - c) API 610
 - d) IS 5639
 - e) IS 5659
 - f) HIS
 - g) IS 1710
 - h) And as specified.
- xi) *Horizontal Pumps*
 - a) Pump casing shall have radially/axially split type construction. The casing shall be designed to withstand maximum shut-off pressure developed by the pump at the pumping temperature.
 - b) The pumps may be single or multistage.
 - c) Pump casing shall be provided with a vent connection and piping with fittings & valves, casing drain as required shall be provided complete with drain valves, piping & plugs. It shall be provided with a connection for suction & discharge pressure gauge as standard feature.
 - d) Impeller – Impeller shall be closed or semi-closed as specified and designed in conformance with the detailed analysis of the liquid being handled.
 - e) Impeller/casing wear rings – Replaceable type wear rings shall be provided at suitable locations with suitable method of locking.
 - f) Shaft – The critical speed of shaft shall be well away from the operating speed and in no case less than 130% of the rated speed.
 - g) Shaft sleeves – Shaft sleeves shall be fastened to the shaft to prevent any leakage or loosening and shaft sleeve assembly should ensure concentric rotation.
 - h) Bearings

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- 1) Heavy duty bearings, adequately designed for the type of service specified and for long trouble free operation.
 - 2) The bearings offered shall be capable of taking both radial and axial thrust coming into play during operation. In case, sleeve bearing are offered, additional thrust bearings shall be provided
 - 3) Bearing life shall be minimum 40,000 hrs (L-10) of continuous operation at rated load and speed.
 - 4) Proper lubricating arrangement for the bearings shall be provided such that lubricating element does not contaminate the fluid pumped. Where there is possibility of liquid entering the bearings, suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.
 - 5) Bearings shall be easily accessible without distributing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.
- i) Stuffing Boxes – Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standard. If external gland sealing is required, it shall be done from the pump connection. Gland packing shall be non-asbestos type.
 - j) Mechanical seals – Wherever specified in pump data sheet, mechanical seals shall be provided. The sealing face shall be highly lapped surfaces of material known for their low frictional co-efficient and resistance to corrosion against the liquid being pumped.
 - k) Pump shaft-motor shaft coupling – The pump and motor shaft shall be connected with a adequately sized flexible coupling of proved design with a spacer to facilitate dismantling of the pump without disturbing the motor.
 - l) Base plate
 - 1) A common base plate mounting, both for the pump and motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, suitably ribbed and reinforced.
 - 2) Assembly and dismantling of each pump with drive motor shall be possible without dismantling the grouting base plate or alignment.
 - xii) *Vertical Pumps (Turbine type, mixed/axial flow)*
 - a) Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories, as applicable.
 - b) Bowl assembly
 - 1) Shall be either single stage or multi stage vertical turbine type, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of the handling fluid.
 - 2) Pumps shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing

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(where separate thrust bearing for the pump is provided). The adjustment mechanism must take into consideration the extension of line shaft due to hydraulic down thrust, weight of the shaft and impeller.

c) Discharge head

- 1) Pumps shall have either above floor or below floor discharge type, as specified.
- 2) In case expansion joint has to be used at the pump discharge, pump base plate shall either be adequately designed to take the unbalanced forces and moments from the use of such expansion joint, or a separate thrust block at the pump discharge head shall be provided to transmit these forces to the external supporting structure. Calculation of thrust load shall be done considering the highest pressure expected by the pump and internal diameter of the arch of the expansion bellow.

d) Column pipe

- 1) Column pipe shall be flanged and of bolted connection. Column pipes shall be designed for full internal vacuum.
- 2) In case of multi-piece column pipe and shaft assembly, the design shall permit raising/lowering of the pump assembly piece by piece without any difficulty. Fixtures, clamps and other tools and tackles, required for the same shall be part of the pump supply.

e) Impeller shaft, line shaft & head shaft

- 1) Shaft size shall be selected based on the maximum torque to be handled by the pump shaft.
- 2) Critical speed of the shaft shall be sufficiently away for the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.
- 3) Impeller shaft shall be guided by bearings provided in each bowl or above or below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall be chamfered at the edges.
- 4) Line shaft may be of single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the manufacturer's standard practice.
- 5) For screwed coupling, screw directions shall permit tightening of the joint during pump operation.
- 6) Replaceable shaft sleeves shall be furnished at applicable locations, particularly under stuffing box and at other locations, as considered necessary.

- f) Shaft enclosing tube – Shaft enclosing tube shall be required, unless self-lubricating (and cooled) type of shaft bearings are asked for. Length of the shaft enclosing tube shall be in conformity with the shaft piece lengths.

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- g) Seal rings – Replaceable seal/wear rings both on impeller and on casing shall be provided, if asked for.
- h) Shaft Bearings
- 1) Adequate numbers of properly selected/designed bearings shall be provided for smooth operation of the pump. Number of bearings shall be considered based on the number of shaft pieces used and critical speed of the shaft.
 - 2) Bearings may be either lubricated by external clear water/oil/grease or self-lubricated as specified.
 - 3) Complete lubrication arrangement shall be furnished with the pump. If pre-lubrication is required, then the associated pre-lubrication tanks and accessories shall be provided with the pump.
- i) Thrust bearing
- 1) Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and the dead load of the rotating components.
 - 2) Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load.
 - 3) Thrust bearings shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of tripping.
 - 4) Pre-lubrication system if required, shall be provided.
 - 5) Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external water, depending on the fluid handled.
 - 6) Location of the thrust bearing may be at the pump body or at the driver, or at both, depending on the requirement.
- j) Reverse rotation – If specified, the pump impeller and other rotating components shall be designed for reverse rotation, when subjected to reverse flow at rated pump discharge head.
- k) Other requirements may be similar to those of horizontal pumps.
- xiii) *Drive motor*
- a) The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified.
 - b) In case of parallel operation of the pumps is specified, the actual motor rating is to be selected considering overloading of the pump in the event of tripping of operating pump.
 - c) Continuous motor rating (at 50°C ambient temperature) for the pump shall be at least 10% above the maximum load demand of the pump in the complete range or 15% over the duty point, whichever is higher.

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xiv) *Submersible pumps*

- a) Pumps shall be submersible wet type, as per IS 8034 & IS 5120, or as specified.
- b) The pump shall be of single stage mono-block type with non-clog design.
- c) Pumps shall be portable type and capable of using in any sump as and when required.
- d) Pumps shall be provided with required stool and flexible hose chain connection, for easy installation and removal. Length of chain and flexible discharge pipes shall be suitable for lowering the pump into the deepest sumps.
- e) Pumps shall be able to handle solids up to 100mm and capable of handling waste water which may contain sludge, plastic, solids etc.
- f) Coupling device shall ensure leak proof joint between the pump and discharge elbow. This shall also enable the pump to be removed from the sumps without the necessity of dismantling any fasteners.
- g) In case of open impeller, the pump shall be designed to take care of the additional thrust produced.

4.38.02 MISCELLANEOUS TANKS

- i) Tanks shall be suitable constructed for continuous safe storage of liquid intended.
- ii) The connections, accessories and fittings to be furnished with each tank shall be as specified and as required. All nozzles and piping material required both inside and outside, up to the flanged terminal shall be furnished with the tank.
- iii) All tank connections shall be provided with suitable counter-flanges with necessary gaskets and fasteners.
- iv) Flange faces of all nozzles shall be machined and square with the vessel centrelines.
- v) Reinforcement pads in tank connections shall be provided as applicable and reinforced connection shall be completely preassembled into a shell plate. The complete assembly including the connection shall be thermally stress-relieved as per API 620.
- vi) The tank shall be complete with supporting structure, legs, pedestals, base plate, anchor bolts, nuts, sleeves etc., as applicable and required.
- vii) Special fittings like vents, drains, flame arrestors, breathers etc, as applicable & as required shall be furnished with the tank.
- viii) Design of tank, including, preparation of detailed design, fabrication drawings, bill of material, tag, piece numbers, welding procedure, etc. Stiffeners and other structural framing for supporting the tank shall be part of the tank design.
- ix) Except where specified, if stiffening of the shell and/or roof is required, it shall be stiffened from outside.

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- x) All welding shall be done as per IS 816, 817, 822 & 9595, as applicable. Welding sequence shall be so adopted to minimise distortion due to welding shrinkage.
- xi) Welding sequence shall be indicated in the drawings and shall be approved by the engineer.
- xii) The designer and manufacturer of the storage tanks shall comply with and obtain approval of applicable statutory regulations and safety codes.
- xiii) Due consideration for wind load and/or earthquake effect shall be given by the Bidder in the design of tanks. Maximum allowable stresses for design loadings combined with wind and/or earthquake shall not exceed 133% of stress permitted for the design loading condition, but in case shall exceed 80% of specified yield strength
- xiv) The material, minimum thickness, size and other details shall be as per system requirement and codes.
- xv) Following codes shall be referred to:
 - a) IS 803
 - b) IS 804
 - c) IS 805
 - d) IS 816
 - e) IS 9595
 - f) BS EN 12285 – 1 & 2
 - g) IS 10987
 - h) API 650
- xvi) Design of all vertical atmospheric tanks to store water, LDO, acid, alkali and other chemicals shall confirm to IS 803 & API 650.
- xvii) Design of all horizontal atmospheric storage tanks to store water, acid, alkali and other chemicals shall confirm to IS 2825 as regards to fabrication and general construction taking care of combined bending, shear & hoop stresses developed due to supporting arrangement.
- xviii) Design temperature of vessels shall be 10°C higher than the maximum temperature that any part of the vessel is likely to attain during the course of operation.
- xix) Tank shall be made from mild steel plates to IS 2062 Gr. B (or equivalent).
- xx) The joint efficiency factors shall be as specified in design codes.
- xxi) Tanks shall be provided with suitable supporting joints. All vessels shall be provided with lifting lugs, eye bolts etc, for effective handling during erection.
- xxii) The material for flanges shall be ASTM A 105 / IS 2062 Gr. B, as specified for the application.
- xxiii) For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several passes for true curvature.

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- xxiv) Vessels shall be so positioned that they do not pass through vessel connections. For cylindrical vessel consisting of two sections longitudinal seams shall be offset.
- xxv) Where possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.
- xxvi) Tanks shall be provided with float operated level indicators / level gauges / level switches and level transmitters as specified, with complete assembly. Suitable flanged pads for level switches mounting shall also be provided. Level indicator may be top or side mounted. For smaller tanks, reflex type gauge glass shall be provided.
- xxvii) SMART (HART) type DP level transmitters shall be provided for continuous level measurement as well as for alarm/interlock, as per system requirement.
- xxviii) In addition to inlet and outlet nozzles, the tank shall be provided with vents overflow, drain nozzles complete for various connections on tanks. Overflow lines from tanks to be routed to the nearest surface drains.
- xxix) Manhole size shall be minimum 600mm.
- xxx) For tanks containing DM water, alkaline water or power cycle water, the vent to atmosphere shall be through a carbon dioxide absorber, suitable mounted on the vessel. CO₂ absorber vessels shall be provided with initial fill of chemicals.
- xxxi) Similarly for equipment cooling water overhead tank, the overflow & drain from tank shall be combined together and shall be led to nearest drain (at ground level) via a seal-trough so as not to come directly in contact with atmosphere.
- xxxii) Tanks shall have suitable stairs/ladders, platforms/walkways, railings, manholes etc as required and suitable located. Ladder with cage shall be provided when tank height exceeds 2m.
- xxxiii) Stairs shall be provided for all fuel storage tanks.
- xxxiv) BS EN 12285-1 & 2 shall be followed in general for installation of tanks.
- xxxv) The finished tank grade for cylindrical tank shall be crowned from the outer periphery to the centre with a slope. The sloping factor shall be taken as 1:35 unless specified.
- xxxvi) Tank design and fabrication drawings shall be approved by the engineer.
- xxxvii) Corrosion protection
- A corrosion allowance, applicable to surface in contact with corrosive media, when required, shall be taken into consideration.
 - Each tanks shall be provided with drilled cleats welded to the tank for electrical grounding. Material of cleats shall be same as that of the shell.
 - Inside surface of all tanks shall be protected by anti-corrosive paints as required.
 - Tanks shall be blast cleaned using non-siliceous abrasive material after usual wire brushing.

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- e) Epoxy coating shall be provided on the outside and inside of vessel with one primer coat and two coats finish coats, resulting in total thickness of not less than 150 DFT.

4.39.00 Electrical Systems

- 4.39.01 Power from the proposed power station will be evacuated through existing switchyard, by Mahatransco, at 400kV level.
- 4.39.02 Station transformer will be connected to existing 220kV switchyard.
- 4.39.03 Each generator will be directly coupled to the respective steam turbine and will have a nominal rating of 660 MW at 0.85 (lag).
- 4.39.04 Generation voltage will be as per the manufacturer's standard with variation in frequency of +3% (51.5 Hz) and -5% (47.5 Hz), 3 Phase.
- 4.39.05 The generator will be connected to the 400 kV switchyard bus through a 825 MVA, 420 kV/(as per generation voltage) generator transformer (GT), comprising 3 single phase unit each having 275 MVA capacity.
- 4.39.06 Three voltage levels viz. 11000 V, 3300 V and 415 V have been envisaged to supply power to unit and common auxiliaries.
- 4.39.07 During normal operating condition of generators, the power supply to unit auxiliaries will be fed from the generator terminal through unit transformer (UT).
- 4.39.08 If any UT is not available, unit auxiliary will be fed from Station Transformer.
- 4.39.09 UT will be directly connected to generator bus duct and will be rated for 50 MVA (min.), (*as per generation voltage)/11.5 kV and with ONAN/ ONAF cooling. In order to take care of grid voltage variation, the transformer will be provided with On-Load tap changer.
- 4.39.10 UT will supply power to unit auxiliaries like ID fan, FD fan, PA fan etc., through required number of 11 kV breakers, 11 kV/3.3 kV, & 11 kV/433 V transformers, 415 V power and motor control centres.
- 4.39.11 **GENERATOR**
- The generator will be a two-pole, three-phase unit rated for 660 MW at 0.85 p.f. lag, 50 Hz. The nominal voltage rating will be as per manufacturers' standard.
 - The Generator shall be capable of continuous safe operation at rated output and power factor under any of the following conditions:
 - Terminal voltage variation of $\pm 5\%$ of the rated value.
 - Frequency variation within 47.5 to 51.5 Hz.
 - Absolute sum of combined voltage and frequency variation of 5%.
 - The generator neutral will be grounded through a distribution transformer having a secondary loading resistor limiting the ground fault current to 5-10 amps.
 - The stator winding shall be cooled by demineralised water flowing inside the hollow conductors of the winding. The rotor winding shall be directly cooled by hydrogen. The stator core shall be cooled by hydrogen flowing through radial/axial ventilating ducts. For cooling of hydrogen the heat exchangers located inside the generator frame shall be supplied with demineralised water.

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- v) Excitation system shall be of state-of-the-art microprocessor based system of latest version. There shall be two automatic and two manual channels in the AVR. The generator excitation system will be selected to provide the following basic requirements:

- Maintain the generator terminal voltage constant within 0.5% of the pre-set value over the entire load range of the machine.
- The response time must be short so that the automatic voltage regulator (AVR) can control the generator during system disturbances or transients in which rapid changes in excitation are required to maintain system stability margins both in steady state and transient condition.

- vi) The excitation system will be of static microprocessor based type of latest version. The ultimate aim of the excitation system selection will be to achieve an ideal condition in respect of rate of response, simplicity, reliability, accuracy and sensibility.

4.39.12 TRANSFORMER

i) *Generator Transformer (GT)*

- The generated voltage as per manufacturer's standard will be stepped-up and fed to 400 kV switchyard by a step-up two-winding generator transformer (GT) connected to the generator through isolated phase bus duct.
- GT will be a bank of three single-phase units each rated for 275 MVA; the total capacity of GT will thus be 825 MVA.
- One spare 275 MVA, single phase unit will be provided for 2 generating units. This spare unit will be located in the transformer yard and will be kept charged at no load from 11 kV feeder of station switchgear with protection.
- The transformer will have OFAF type of cooling with 'Off-circuit' tap change system having range of tap of $\pm 2 \times 2.5\%$.
- Vector group will be YNd11.
- The high voltage terminals of the transformer will be connected to the 400 kV outdoor switchyard by 400 kV over head ACSR conductor (not in bidder's scope).
- Lightning arresters will be provided near HV terminals of the transformer to protect it from atmospheric disturbances on each phase and Bus Post Insulators (BPI) on each phase, if required.

ii) *Unit Transformer (UT)*

- During normal operating condition of generator under unit concept, the power supply to unit auxiliaries will be given through the unit transformer (UT).
- UT will be directly connected to the generator bus-duct.
- The unit transformer will be rated 50 MVA (minimum), Generation voltage/11.5 kV, ONAN/ONAF cooled, 3-phase, 50 Hz, provided with On

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load tap change system on the high voltage side to take care of voltage variation to the extent of $\pm 10\%$ @ 1.25% per tap.

- d) HV side will be ungrounded and LV side will be grounded through resistor limiting fault current limited to about 300 Amps.
- e) The capacity of the unit transformer has been selected on the basis of the unit auxiliary load with due consideration to the starting of the largest motor, available breaker capacity and voltage regulation requirement.

iii) *Station Transformer (ST)*

- a) The station transformer will be of three phase, three winding 220/11.5/11.5 kV, outdoor oil-filled with ONAN/ONAF cooling.
- b) The station transformer will be rated 120 MVA (minimum). The station transformers supply the 11 kV Station Switchgear.
- c) The transformers will be provided with On-Load tap changer with $\pm 10\%$ @ 1.25% per tap on HV side.
- d) Two (2) Station Transformers of 120 MVA each are envisaged for 2x660 MW, units 11 & 12 of Koradi Thermal Power Station.
- e) Downstream 11 kV distribution systems will be designed in such a manner that power supply to all 11 kV switchgear is maintained in the event of the outage of any of the station transformer or bus fault on any one section of 11 kV station switchgears.
- f) The station transformer will be Star/Star/Star (Ynynyn) connected. HV side will be solidly grounded and LV sides will be grounded through resistor limiting fault current limited to about 300 Amps.
- g) The high voltage terminals of the transformer will be connected to the 220 kV outdoor switchyard by 220 kV XLPE cable.

4.39.13 **BUS DUCT**

i) *Isolated Phase Bus Duct (IPBD)*

- a) The generator will be connected with the generator transformer and unit transformer through bus duct. The bus duct will be of isolated phase, continuous type with aluminium conductor in aluminium enclosure.
- b) Lightning arrestors and surge protection cubicle of proper rating will be provided at a location as close as practicable to the generator terminals.
- c) The main section of bus from generator to generator transformer will be suitable for 26,000 Amp.
- d) The tap-off connection to unit transformers will be suitable for 2000 Amp.
- e) The maximum temperature of the bus conductor will be limited to 105 °C for silver plated joints and 90 °C for other joints and that of enclosure will be limited to 70 °C.
- f) The bus duct will be of isolated phase, continuous type with aluminium alloy conductor in aluminium alloy enclosure.

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g) Fibreglass insulator to be provided between IPBD enclosure and support structure.

ii) **Segregated Phase Bus Duct (SPBD)**

a) The 11 kV side of Unit Transformer (UT), Station Transformer (ST) & 3.3 kV side of Unit Auxiliary Transformer (UAT), Station Auxiliary Transformer (SAT) will be connected with the associated switchgears through segregated phase bus duct respectively.

b) The maximum temperature of bus conductor will be limited to 105 °C for silver plated joints and 90 °C for other (plain or tinned) joints. In case of enclosure the maximum temperature will be limited to 70 °C.

c) The minimum rating of bus duct for connection of unit transformer/ station transformer with 11 kV switchgears is envisaged as 3500 Amp / 3500 Amp respectively.

4.39.14 POWER SUPPLY ARRANGEMENT TO UNIT AND COMMON AUXILIARIES

i) As mentioned earlier, the power supply to unit auxiliaries will be from the 11 kV & 3.3 kV Unit Switchgears fed by the unit transformer (UT) & Unit Auxiliary Transformer (UAT). UT will be directly connected to the generator bus duct.

ii) The capacity of the unit transformer (UT) & Unit Auxiliary Transformer (UAT) have been selected on the basis that the unit auxiliary load and common auxiliaries corresponding to the maximum continuous rating of the unit with due consideration to the starting of the largest motor, system fault level, available breaker capacity and voltage regulation requirement.

iii) The station auxiliary loads will be fed from the 11 kV/3.3 kV station switchgears located in powerhouse.

iv) Separate 11 kV, 3.3 kV and 415 V switchgears will feed the loads for Coal Handling Plant, Ash Handling Plant, WT Plant, FGD etc., located in the respective plants as required.

v) Motors rated 200 kW and below will be supplied from 415 Volts system. For this purpose, 11 kV/433 Volts, 3 phase, 50 Hz, dry-type LV auxiliary transformers rated 2.5 MVA, 2 MVA, 1.6 MVA and 1 MVA will be used as required. These transformers will receive power from the 11 kV, 3.3 kV/433 Volts or 3.3 kV buses. Motors rated 1500 kW and below will be supplied from 3.3 kV system.

vi) The LV side of these transformers will be connected to the respective LV Switchgear/Power Control Centre (PCC)/Power-cum-Motor Control Centre (PMCC) through non-segregated phase bus duct. These transformers will be provided with off-circuit tap changing device in five (5) equal steps to take care of voltage variation to the extent of $\pm 5\%$ in steps of 2.5% per tap.

vii) Additionally, power to the water plant outside power plant would be provided from 11 kV bus.

4.39.15 SWITCHGEAR

i) The drives for auxiliary equipment, having capacity above 200 kW and upto 1500 KW will be fed from 3.3 kV and above 1500 KW will be fed or from 11 kV system

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and those with capacity 200 kW and lower will be fed from 415V, 3-phase, 4-wire system.

- ii) Suitable HV and LV switchgears, as described below, will be provided for operation of these motors.
- iii) The metering shall be as per latest CEA regulations.
- iv) **11 KV & 3.3 KV Switchgears**
 - a) Power received at 11 kV from unit transformer will be fed to the respective 11 kV switchgear through circuit breakers for further distribution to high voltage motors and also to transformers intended to step down this voltage to 3.3 kV & 415 volts. These feeders will be controlled by VCB type circuit breakers.
 - b) The 11 kV & 3.3 kV systems will be designed for 50 kA and 40 kA fault level respectively. The interrupting capacity of 11 kV & 3.3 kV breakers has been selected as 50 kA and 40 kA respectively, considering the maximum possible fault contribution from the system and also the motors under the most severe fault condition.
 - c) Motors rated 1500 kW and above shall be connected to 11 kV & Motors rated above 200 kW and below 1500 kW shall be connected to 3.3 kV switchgear.
 - d) Short-circuit withstand capability of 11 kV & 3.3 kV equipment shall be 3 seconds.
 - e) Inter-changeability will be possible with breakers having identical rating. Duplicate feed will be provided for 11 kV & 3.3 kV switchgears where considered necessary.
 - f) Auto fast Bus transfer scheme shall be provided for transfer from station to station, station to unit and vice versa.
- v) **415 V Switchgears**
 - a) 415 volts supply from LV auxiliary transformers will be fed to the respective 415 V switchgear bus through air circuit breaker to facilitate distribution for different motors and other electrical loads at the downstream.
 - b) LT Motors of rating 90 kW and up to 200 kW will be controlled by 415 V air circuit breakers.
 - c) The rupturing capacity of all 415 V circuit breakers will be 50 kA.
 - d) Short-circuit withstand capability of 415 V equipment shall be 1 second.
 - e) Duplicate feed will be provided for 415 V switchgears where necessary.
 - f) The metering shall be as per latest CEA regulations.
 - g) Motor control centres (MCCs) will be provided for the control of LV motors up to 200 kW.
 - h) For Motors rated 90 KW and above, numerical motor protection relay shall be provided.

4.39.16 CONTROL OF ELECTRICAL SYSTEM

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- i) One common Central Control Room (CCR) or main control room has been envisaged for unit nos. 11 & 12, which will be housed in the power house building or an adjacent control building.
- ii) Generator synchronisation and its control will be done from powerhouse/control building main Control Room (CCR). However, bus selection for generator transformer breaker and outgoing 400 kV feeders control; Operation of 400 kV disconnecting switches shall be done from switchyard control room (not in bidder's scope).
- iii) Control and metering of generator, generator transformer, station transformer and unit transformers will be from Central Operating Console located in Central Control Room.
- iv) Back-up panels (Electrical control panel) will be considered for control, indication, metering and monitoring of the electrical auxiliary power distribution system comprising of 11 kV and 3.3 kV circuit breakers (except those for motor feeders), LT transformers, 415 V switchgear breakers for incomers and bus couplers, DG system.
- v) Same shall also be achieved from operator's consoles through DCS. For details relevant section of C&I shall be referred.
- vi) Control panels for service system like ESP, FGD etc. will be located in the respective control room. In addition, some local panels will be provided near respective system/equipment such as boiler feed pump, hydrogen seal oil system, Lube oil system, etc.

4.39.17 PROTECTIVE SYSTEM

- i) For protection of equipment against abnormal system conditions, adequate protective devices will be installed in the respective switchgears and/or control and relay panels.
- ii) A group of such protective devices will be necessary to protect the equipment under different abnormal conditions arising in the system.
- iii) Numerical relays with 100% redundancy through different algorithm also will be used for protection of equipment like Generator, GT, ST, UT etc.
- iv) Numerical relay shall also be used for HT and LT switchgears.
- v) Transformer WTI / OTI / OIL LEVEL/ Pressure Relief / OLTC Surge Protection / Tap Changer Trouble etc. shall be provided through binary input of numerical relay distributed properly considering outage of one group.
- vi) The protection philosophy indicated above is for general guidance and represents the minimum requirement only. Additionally protection of electrical equipment shall also meet the requirement of CBIP publication no.274, CEA guideline.
- vii) In all cases, proper discrimination would be achieved so as to isolate the faulty elements only, keeping the healthy part of the system in service.

4.39.18 POWER AND CONTROL CABLES

- i) Main factors which are considered for selection of sizes for power cables are as follows:

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- a) System short circuit current and allowable withstand time
- b) Derating factors due to higher ambient temperature and grouping of cables
- c) Continuous current rating
- d) Voltage-drop during starting and under continuous operation
- e) Standardisation of the cable sizes
- ii) 11 kV & 3.3 kV cables will be of stranded aluminium conductor, 11000/11000 V & 3300 V grade 90 °C continuous rating under normal condition and 250 °C rating under short circuit condition heavy duty XLPE power cable suitable for use in 11000/3300 V non-effectively earthed system conforming to IS-7098 Part II, IS-8130, IS-5831. Galvanized single round steel mine armour for twin and multi-core cables non-magnetic hand drawn aluminium single round wire conforming to H4 of IS-8130 for single core cable.
- iii) LT power cables will be 1100V grade with stranded aluminium conductor. 90 °C continuous rating under normal condition and 250 °C under short circuit condition rating, XLPE heavy duty, power cable conforming to IS-7098 Part I, IS-8130, IS-5831, IS-3975. Galvanized single round wire armour for twin and multi-core cables. Non-magnetic hard drawn aluminium single round wire conforming to H4 of IS-8130 for single core cables.
- iv) Control cables will be multi-core 1100V grade HRPVC insulated, HRPVC inner sheathed 85 °C continuous rating under normal condition and 160 °C under short circuit condition, galvanised round steel wire armoured and with FRLS HRPVC outer sheath having 2.5 sq. mm stranded copper conductors conforming to IS:1554, IS-8130, IS:5831, IS:3975. Fire survival (FS) power & control cables will be used for system, which are necessary for protection and safe shutdown of plant in case of fire.
- v) Fire Survival Cables shall be used for important auxiliaries / area as recommended by Standard Technical Specification by CEA as below but not limited to the following:
 - a) DC emergency lube oil pump
 - b) DC hydrogen seal pump
 - c) Turbine lube oil pump/barring gear
 - d) DC emergency lighting for main building and service building
 - e) DC cables for battery to charger & DC distribution boards
 - f) Jacking oil pump
 - g) Emergency turbine trip in control room
 - h) Boiler Turbine Generator inter trip which include the interconnection between-
 - 1) Boiler master fuel trip and turbine trip relays
 - 2) Generator trip relays & turbine trip relays
 - 3) Generator trip relays & generator breaker

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- 4) Generator trip relays & field breaker
- 5) Generator trip relays & unit auxiliary transformer breaker
- 6) Incomer cables for DG board, emergency board, DC lighting board etc.
- 7) Scanner air fan & fire/smoke detector system
- 8) Complete 220V DC 24V DC & UPS control, protection & supply of cables downstream of DCDB/ACDB shall be with minimum cables size of 2CX6 mm² Cu.

4.39.19 PLANT DC SYSTEM

- i) A reliable DC power source would be provided to supply those loads, which are required to function for security, protection and safe shutdown of plant in the event of failure of normal AC power supply.
- ii) Redundant 220V DC Charger/battery system is provided for emergency electrical drives (DC) and electrical system cabinets. Each unit will have two (2) set of DC system including 220 V battery sets and chargers of adequate capacity.
- iii) Station loads will have two (2) set of DC system including 220 V battery sets and chargers of adequate capacity.
- iv) All power supply systems shall be sized for 2 hours (Min.) battery back-up to take up the entire load in case of total power blackout and with 25 % spare capacity for additional load augmentation in future. All charger feeders shall be DG backed supply.
- v) A dual redundant single phase IGBT based Uninterrupted Power Supply System (UPS) with 240V $\pm$ 1% AC supply having redundant 2 x 100% inverters and separate chargers with Two(2) Nos. battery bank is envisaged for powering of the AC consumers in the C&I System and plant communication system etc.
- vi) The instrumentation system DCS Panels shall be largely powered from a 2 x 100% redundant 24V DC power supply and charger system extending two feeders to each electronic panel sections and electrical drives/systems respectively.
- vii) DC power supply system for each unit comprises:
 - a) 220 Volt DC battery
 - b) Battery charger (float and float –cum-boost charger)
 - c) DC distribution and sub-distribution boards
 - d) Battery Cell Monitoring System
- viii) Basis of selection of the above items will be as follows:
 - a) Normal requirement of the battery is to supply power for the following:
 - 1) Control and monitoring of the plant

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2) Alarm and annunciation of plant condition under emergency. During the first one minute after occurrence of emergency the battery will be called on to supply the following loads:

- Tripping power for all major circuit breakers simultaneously
- Starting of emergency drives to protect the machines from damage
- Plant emergency DC illumination system
- Other miscellaneous loads

- b) Battery would be Plante-Ni-Cd type and the capacity of each of the 220 V battery sets would be such that it will meet the above requirement of one unit and the requirement of common services.
- c) Battery chargers of suitable capacity will be provided with quick boost and trickle charging facility for each of the aforesaid battery sets. Completely automatic and self-regulating type of battery charger will comprise 2 nos. float and float-cum-boost charger for each of the battery set.
- d) The float charger will be capable of floating the battery at 2.25 volts for Plante' or 1.42 volts for Ni-Cd per cell and at the same time supplying the normal DC load.
- e) The boost charger will be capable of quick charging the battery at 2.7 volts (max.) for Plante' or 1.54 — 1.7 volts for Ni-Cd per cell and will have the capacity to restore a fully discharged battery to a state of fully charged condition in 10 hours for Plante or in 5 hours for Ni-Cd battery.
- f) One main DC distribution board with bus coupler unit will be provided with DC sub-distribution boards as required.
- g) The main unit DC distribution board will have two incomers and one bus coupler having switch-fuse/MCCB units and required number of outgoing switch-fuse / MCCB units which will be selected to have a continuous current rating of not less that 125% of the nominal load current.
- h) DC distribution boards will be used to give DC power supply as required to plant auxiliary systems like CW system and various pump houses.
- i) Separate battery with charger will be used to give DC power supply to equipment located in auxiliary buildings for FGD, CWWPH, etc.

4.39.20 EMERGENCY POWER BACK-UP/DIESEL GENERATOR (DG) SYSTEM

- i) The emergency power system provides power to essential auxiliary loads required, to permit a safe shut down of the unit in the event of a plant blackout. In addition, power is provided for auxiliaries and services required for personnel safety and equipment safety during the blackout.
- ii) The bearing cooling pumps, seal oil pumps, barring gear, emergency lighting for the station, etc. would be fed from the emergency power supply system.
- iii) In order to meet the above requirement minimum three (3) nos. 1750 kVA (min.) diesel generator set with one diesel generator set as standby will be installed meeting the requirement of emergency load for the units.

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4.39.21 GROUNDING AND LIGHTING PROTECTION

- i) Comprehensive grounding system will be provided in the power plant.
- ii) A ground mat will be laid below ground level in powerhouse extended up to stack.
- iii) The mat will be laid up to the fence and 1.5 meter beyond it on all sides.
- iv) Suitable ground electrodes shall be provided at intervals. All metallic part of powerhouse and other electrical equipment shall be connected to this ground mat by means of suitable risers.
- v) In other areas the type of grounding may be mesh type.
- vi) Power house ground grid including transformer yard and existing switchyard ground grid shall be connected by means of ground rods at least in four points.
- vii) The grounding requirement of a power station complex could be divided into the following two main categories:
 - a) System Grounding
 - b) Equipment Body Grounding
- viii) The system grounding is adopted to facilitate ground fault relaying and to reduce the magnitude of transient over voltage. The system grounding involves primarily the grounding of the generator and transformer neutrals. The generator neutral will be high resistance grounded through distribution transformer and secondary loading resistor.
- ix) For 11 kV & 3.3 kV system of the proposed 660 MW units high resistance grounding will be provided to limit the fault current to the order of 300 Amp.
- x) 415 V power supply system will be solidly grounded. DC system will be ungrounded.
- xi) Necessary annunciation will be provided for detection of first earth-fault on positive or negative pole.
- xii) The equipment body grounding will be provided to protect personnel from potential hazard caused by ground faults and lightning discharges by providing a low resistance, conducting path to the ground.
- xiii) A suitable ground grid will be provided for grounding of equipment and structures maintaining the step and touch potentials within safe limits.
- xiv) The earth mat as provided will be buried at a suitable depth below the ground and provided with ground electrodes at suitable intervals.
- xv) All metallic parts of equipment supposed to be at earth potential will be connected to the ground mat including structures, buildings, plant rail-road tracks, the perimeter fencing etc.
- xvi) For lightning protection, lightning mast/shield wires would be provided powerhouse, transformer yard, boiler area chimney etc. Besides, this lightning arrester at required locations will be provided to protect the outdoor equipment from lightning and switching surges.

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- xvii) Lightning protection system will be installed for protecting the buildings/structures against lightning discharge. This would be achieved by providing lightning masts on stacks, cooling towers, powerhouse building, floodlight towers etc. and connecting them with the ground grid.

4.39.22 ILLUMINATION SYSTEM

- i) Wherever possible, natural lighting should be used as far as possible.
- ii) A comprehensive LED based illumination system shall be provided in the entire BTG areas covered under the scope of work.
- iii) It is necessary to facilitate normal operation and maintenance activities and to ensure safety of working personnel.
- iv) This would be achieved by artificial lighting. Required illumination levels in different areas as per standards/code of practice would be provided.
- v) For outdoor yard illumination, floodlights would be installed at suitable locations to provide requisite level of illumination. Pole-mounted fixtures will be used for approach and work roads.
- vi) The LED fixtures will be used for indoor illumination, turbine hall and boiler platforms/galleries, etc.
- vii) For hazardous location appropriate type of fittings would be used.
- viii) The lighting system design would ensure uniform illumination at working levels. Illumination levels as per standard will be followed for illumination system design.
- ix) Energy efficient lighting fixtures shall be used with LED lamps powerhouse in auxiliary buildings, outdoor area.
- x) Control room, Engineer's room and control equipment room shall be provided with recessed lighting fixture with diffusion lenses to ensure uniform semi-direct illumination and prevent glare on the LED screens.
- xi) The illumination level in the control room and control equipment room shall be designed for around 350 Lux.
- xii) Power for the illumination system would be supplied from 415V switchboard through lighting distribution boards and lighting panels. Lighting distribution boards would be located in various buildings as per the requirements.
- xiii) Suitable number of lighting panels will be located in each area, power to which will be supplied from lighting distribution boards. The lighting panels will be installed at convenient locations for ease of operation.
- xiv) In addition to normal illumination scheme, emergency AC and DC lighting scheme would be provided in the powerhouse complex.
- xv) Emergency AC lighting would be supplied from AC emergency lighting boards, which would be connected to the AC emergency MCC. The AC emergency MCC would be energised from diesel generator during emergencies.
- xvi) The station emergency DC lighting will be provided in critical and safety related areas and would be fed from station 220 Volt DC distribution systems during extreme emergencies. On failure of the AC supply, these lights will glow from DC system.

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- xvii) For isolated buildings in remote areas where station 220 V DC is not available, DC lighting will be derived from self-contained battery with charger units, energised upon loss of normal AC supply in such isolated areas.

4.39.23 COMMUNICATION SYSTEM

- i) An intercommunication system will be provided to facilitate plant operations by establishing quick communication among the operating personnel at various location of the plant.
- ii) Telephone system will be provided for quick and reliable communication between different personnel located at various plants, offices, departments, etc. as well as with outside parties.
- iii) A microprocessor based Digital Electronic Private Automatic Branch Exchange (EPABX), located in the administrative area is envisaged for the telephone communication system. It will have number of outgoing trunk lines.

4.40.00 Control and Instrumentation

4.40.01 The plant Control & Instrumentation (C&I) system for control and monitoring of Steam Generator, Turbo-Generator, Power Cycle, Auxiliaries, FGD & Offsite Plants, and electrical system, as the case may be, from a Central Control Room (CCR), which is proposed to be made common for two units.

4.40.02 The Control & Instrumentation system shall support complete remote operation of the plant from CCR with high degree of automation and shall provide monitoring feature of all major systems, equipment and related subsystems, including status of all offsite/balance of plant facilities, so that all salient parameters of the plant are made available to the operator/s at the Central Control Room.

4.40.03 The requisite provision of field instruments and sensors shall be provided for the purpose. All routine operations including hot/warm/cold start-up, loading, run-up, run-down, run-back, administrative & emergency shutdown etc., can be performed remotely from the CCR without any local operation or intervention.

4.40.04 The design philosophy shall aim at automatic self-checking & diagnostic features and failsafe operation resulting in reduction of maintenance manpower.

4.40.05 High level of supervisory automation and computation algorithm shall provide guidance towards most safe and efficient unit operation.

4.40.06 Facility shall be provided to monitor all critical manually operated valves, gates and dampers as well for information to the operator in the CCR.

4.40.07 Facility shall be provided to monitor all important parameters of offsite/balance of plant facilities for information to the operator in the CCR.

4.40.08 The C&I System shall be based on the state of the art smart Instrumentation and Distributed Control System (DCS) with functional and part geographical distribution of Inputs and Outputs at different locations of the plant to optimize the use of direct cabling from sensors.

4.40.09 The DCS shall be built around Open Architecture configuration offering high system availability and reliability, with appropriate redundancies at various levels.

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- 4.40.10 The system design shall be aimed at safe, efficient and trouble-free remote operation of the plant under various regimes of plant operation.
- 4.40.11 The system and component MTBF is expected to be very high.
- 4.40.12 The Control Philosophy for plant operation shall be as below:
- i) Design objectives of the Instrumentation and Control System shall be as follows:
 - a) Ease of Operation and Maintenance
 - b) High degree of reliability and availability
 - c) Plant and personnel safety & avoidance of Emergency
 - d) Optimum performance
 - e) Continuous self-checking & monitoring and easy fault diagnostic
 - f) Achieving of data and information retrieval
 - g) Continuous surveillance of the unit
 - h) Use of proven instruments & technology
 - i) Uniformity of hardware, software and instruments in similar application and homogeneity
 - ii) Following redundancies shall be created in the system to enhance system availability:
 - a) All critical field inputs, protection, interlock and critical controls, (both binary and analogue), shall be three fold redundant (2 out of 3).
 - b) For all other control and trip applications, field inputs shall be 1 out of 2 redundant.
 - c) For critical controls, controllers shall be three fold redundant.
 - d) For all other applications, controllers shall be dual redundant.
 - e) Redundant controllers shall be located at different sub-racks, preferably in different panels.
 - f) Where power supply units are mounted on sub-racks, same shall be dual redundant.
 - g) Each electronic panel shall receive power from redundant uninterrupted power supply. Dual stream UPS shall have dual stream of batteries and chargers.
 - h) Redundant and standby equipment shall not be assigned to the same controller pair.
 - i) Redundant 24 Volt DC system is required for C&I power supply and 240 V AC UPS supply is required for DCS panels & MMI system.
 - j) All network switches shall be dual redundant.
 - k) Controllers and HMIs each shall have dual active network connections
 - l) All servers and historical storages shall be dual redundant as separate units or by disc imaging.

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- iii) 2 out of 3 redundancies for critical control loops as mentioned in detailed specification, refer Vol.-III, Part-C shall be followed as minimum.
- iv) Triple redundant binary outputs have been envisaged only for critical trip signals related to TMR systems.
- v) Triple redundant binary outputs have been envisaged only for critical trip signals related to BPS systems.
- vi) All switches and Sensors for tripping of Boiler and Turbine auxiliary equipment (like BFP), which in turn cause Boiler and/or Turbine Trip, shall be implemented on 2 out of 3 philosophy.
- vii) Following safety features shall be provided:
 - a) All field inputs shall be optically/galvanically isolated and shall meet the Surge Withstand Capacity criterion.
 - b) All trip conditions will precede alarm condition to enable the plant operator to take remedial measure.
 - c) All power supplies extended to the field devices shall be separately fused.
 - d) Interface with external devices shall be through suitable firewall.
- viii) Following margins and spare capacity shall be built into the system:
 - a) Controllers shall be uniformly loaded to not more than 60% of the duty cycle under worst-case data loading condition.
 - b) Loops are assigned logically to the controllers so that peer-to-peer active data transactions are kept at minimum.
 - c) There remains a clear assignment between plant equipment/system and its corresponding controller (hardware-wise) for ease of maintenance.
 - d) Not more than twenty (20) analogue control loops shall be assigned to one controller (redundant pair). However, OLCS & CLCS can be combined in a controller.
 - e) There shall be hot-on-rail spare I/Os of not less than 10% in any category in any individual panel and 20% on overall count.
 - f) There shall be 20% spare rack slots on an average for future expansion and ventilation.
- ix) The system shall fulfil following performance and Response criteria:
 - a) The system shall conform to the performance criteria outlined in various international codes and standards including IBR, ASME, ASTM, ISA, PTC, and DIN etc.
 - b) Controller Cycle Time shall be adjustable meeting the requirement of the control. And will typically be set at 250 m sec (adjustable) for CLCS and 100 m sec for OLCS for critical loops and 500 m sec for non-critical loops.
 - c) All analogue inputs to CLCS & OLCS will be acquired and database updated within an interval of 250 m sec (adjustable).

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- d) Analog inputs solely used for data acquisition will be scanned and updated within 500 m sec (adjustable). For temperature measurement not related to control, the measured values may be scanned at an interval of 1 second.
 - e) Keyboard command will be executed in less than 1 second under worst loading conditions.
 - f) Updating of dynamic data on screen will take 1 second (maximum) under worst data loading condition.
 - g) The response for Operator request display (time between pressing of last key and appearance of last character on screen) will be two (2) seconds maximum under worst loading conditions.
 - h) Total number of controller shall be decided based on the conformance of the above criteria.
 - x) The control system shall be designed for combined variable pressure throttling operation in coordinated mode. The procedure shall be of fixed pressure (low) start-up assisted by HP & LP bypass followed by variable pressure operation based on turbine governing valve position during ramping and part load operation and fixed pressure (high) during and near about rated operating point.
 - xi) Run backs shall automatically limit the capability of the unit in case of failure of a major auxiliary like a fan or a pump.
 - xii) Turbine shell stress computation will decide the safe ramp-up and ramp-down rate band of the unit.
- 4.40.13 DISTRIBUTED CONTROL SYSTEM**
- i) The DCS will be the only operation and monitoring interface for the units. The main functions to be performed by DCS shall the following:
 - a) Automatic sequencing of the start-up and shutdown of equipment and auxiliaries including group/unit level start-up/shut down for auto plant start-up and shut-down, as mentioned in detailed specification.
 - b) Automatic regulation of various valves, drives and dampers to achieve optimum performance of various controlled variables and to achieve most fuel-efficient operating regime.
 - c) Control and monitoring of plant mechanical and electrical system.
 - d) Create interface for electrically operated drives.
 - e) Create a high-speed network within the system for fast data exchange between all elements in the network without bottlenecking even under worst-case data flow.
 - f) Interface with GPS master clock system for uniform and authentic time stamping.
 - g) Acquisition, display (in the form of trends, mimics, histograms etc) and archiving of plant data and maintain historical records.
 - h) Generation of alarms of various levels, sequence of event recording.
 - i) Generation of time and event based logs and reports.

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- j) Create a plant-wide high integrity data network for interfacing with auxiliary and off-site plants having their own proprietary control systems & existing plant units to make the data accessible to plant operator. Maintain fidelity of the network through suitable firewalls.
- k) Create a Management Information System network based on the real time data to appraise the supervisory, administrative and management personnel of salient plant information to aid decision-making.
- l) Create a preventive and predictive maintenance schedule based on plant data.
- m) Create a spares' inventory management database.
- n) Run the performance calculation programs in real-time to compute efficiencies and other performance related factors to monitor health of various equipment.
- o) Energy Management and audit of the plant and equipment by measuring consumption of power of all major equipment in the plant, measurement of Fuel, Steam and all other relevant parameters.
- ii) An integrated system synthesized from one general family of identical interchangeable multifunction hardware and networked together has been envisaged for the plant
- iii) The DCS shall broadly comprise the following sub-systems:
 - a) Input/output (I/O) signal processing
 - 1) Input/output process interface sub-system shall directly acquire process data from transmitters, thermocouples, resistance temperature detectors and other sensors.
 - 2) Input/output (I/O) modules shall be intelligent having the following features as minimum:
 - Every channel shall be addressable during routine periodic diagnostic check.
 - Any failure in the module, loss of signal (both analog & digital) or any signal input crossing the permissible range shall be immediately detected and displayed.
 - Such failures shall lead to failsafe situations.
 - b) Closed loop and open loop control subsystem (CLCS/OLCS)
 - 1) Multi-loop multi-function controllers shall be dual hot redundant and shall be capable of handling both Close and Open Loop Controls. Controllers shall connect to dual redundant network with a minimum bus speed of 100 Mb/Sec.
 - 2) The CLCS will perform modulating controls with optional auto-tuning facility that will act on valves, dampers or other regulating devices to achieve stable control with permissible variation in parameters.

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- 3) Parameters assigned to controller pairs shall be grouped logically and not on a random mix-and-match basis. Controller pairs can be directly correlated to major equipment for the ease of maintenance. Irrespective of the power of the processors, the total number of pairs of controllers for the unit shall not be less than 16. To avoid cross communication to the extent possible, parameters related to a drive group shall be connected to one controller pair. An extensive library of standard control and sequencing subroutines shall be resident in the controller to be strung together to realize the desired algorithm for control.
- 4) Multi-loop controllers shall interface with their associated I/O cards.
- c) Data acquisition subsystem
 - 1) Bulk non-control-related data shall be acquired in similar multi-loop controllers and shall be processed and stored for monitoring purpose.
 - 2) The data collected will be used for point display, overview alarm, graphics, trends, logging, historical storage and performance calculation alongside control-related parameters.
- d) Historical storage sub-system
 - 1) The Historical Storage Unit (HSU) will augment the Global Memory database in the system and will archive data and parameters for logs and historical records including trends, alarms and events. These will be used for analysis and performance calculation.
 - 2) Historical Storage Facility shall be redundant so that any single failure of the storage medium or electronics will not lead to loss of historical data.
 - 3) Assignment between globally distributed memory and the historical storage will be judiciously determined during system engineering stage for optimal response and use of storage space.
- e) Performance calculation and optimisation subsystem
 - 1) Plant performance calculations and other complex computations will be performed periodically and automatically by retrieving plant data and some manually inputted information. Efficiency, heat balance, and other calculations as per ASME PTC and other relevant standard will be performed in the subsystem. The findings shall be presented to the plant engineer in an easy to comprehend guidance mode to enable the plant operators to operate the plant in an optimum regime.
 - 2) Plant Optimization calculation shall combine thermodynamic models of the plant components with economic parameters like revenues from electricity sales, variable and fixed cost. The thermo-economic optimization shall take account of all important constraints of operation and shall be able to update on current equipment performance.
- f) Engineering and configuration station

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- 1) Engineering and Configuration Stations per unit shall be provided for engineering, program development, customizing, configuring & modification.
- 2) The stations can be kept on line to access plant data directly.
- 3) It should also be possible to access the programs and database within the controllers and operator's station for modification.
- 4) Normally, this station will hold the back-up programs resident within all active elements in the network so that in case of a loss or catastrophic failure, the replacement unit can reboot automatically from the station.
- 5) Engineering station shall be located in the computer room and shall be used to perform configuration of the entire system, modification of programs and algorithm for performance calculations etc.

g) Operator's station

- 1) Latest range of processor based PC or workstation with 24" full HD colour LED monitors, keyboard, cursor control device like trackball etc. shall be envisaged for human-machine interface units.
- 2) The system shall have the capability to operate and monitoring of any plant section from any one of the Operator's station. For HMI hardware details and BoM refer respective portion of the detailed technical specification.
- 3) Over and above the Operator's consoles one terminal each shall be provided for the maintenance Management and Plant Performance Calculation.
- 4) For Shift In-Charge Engineer, one operator console shall be provided if control systems for station C&I, TG and SG are on the same platform, otherwise one operator console for each platform.
- 5) There will be also 80" Large Video Screen systems for monitoring of the entire plant. These shall be independent stations on the network and shall display subsystems etc, on real time, independently.
- 6) Furnace flame image monitor for each unit is to be provided in the control room.
- 7) One (1) colour Video Copier (supported from an engineering station) and necessary number of Printers shall be provided for printing logs and alarms.
- 8) One (1) DVD writer shall be included to store historical data.
- 9) Provisionally, MIS Terminal, (Plant inside network) as soft clients, with limited and selective data access, are foreseen at different plant locations viz. C&I Maintenance Engineer's room, administrative offices, stores etc. to present plant related data in real time

h) Data Network and Gateways for interfacing with proprietary systems

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- 1) The DCS shall be based on Open System Architecture system having globally distributed database and connectivity with third party systems following standard protocol.
 - 2) Redundant Fast Ethernet switches shall be utilised for connecting and routing of data. All active items on the network shall be identified by unique address as their location in the network.
 - 3) All Controllers and HMI units shall be resident on a common redundant high-speed data highway for global distribution and access of data. Any data will be available at any point of the network as and when required unless protected or masked.
 - 4) The network shall be modular, expandable and flexible so that expansion is possible by adding extra stations on the data highway modularly and assigning the required network address, without disrupting the operation of rest of the system.
 - 5) Comprehensive automatic and periodic self-diagnostic features shall be provided to facilitate easy fault location and detection of failure. On-line testing facility, while the unit is in operation, shall be provided with suitable indication for easy identification of faulty module up to channel level. Extensive error checking (CRC-16/12) or error correcting codes shall be used to improve the reliability of communication.
 - 6) It is the intent to have the DCS to cover the entire main plant area with uniform range of hardware and software. However, if the main equipment suppliers would prefer to supply proprietary control units from their guarantee standpoint, for instance for the electro-hydraulic governing system for the main and BFP drive turbines or Automatic Voltage regulator etc, suitable interfaces shall be created between such systems and the DCS. In general, MODBUS/RS-485 or such low speed interfaces may be used for passive data exchange for reporting and archiving only and shall not be utilized for the exchange of control related parameters
 - 7) Active parameters shall be connected directly through hardware links or through fast Ethernet or similar high speed connections.
- i) Sequence of event monitoring system (SOE)
- 1) A high resolution Sequence of Event Monitoring System shall be an integral part of Distributed Control System.
 - 2) All SOE inputs shall be sourced directly from the primary switches and primary relay/contactors for “real time-stamping” based on GPS master clock following any tripping of major equipment, sub-systems and the plant as a whole.
 - 3) The system shall be capable to discriminate inputs with a resolution of one millisecond. All SER points entering from normal state into the alarm state or returning from the alarm state to normal state shall be reported and time tagged.

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- 4) One number of OWS / server for SOE monitoring system shall be provided at CCR.

j) System software

- 1) The rugged Application Software shall be truly user friendly with graphic interface, based preferably on latest multi-user platform with a relational database management system overlay.
- 2) The system software will follow open architecture protocols.
- 3) For networking, TCP-IP and ISO-OSI model will be used.
- 4) The system shall utilize a readily up-gradable, public domain software platform proven for real-time operation environment at the control and monitoring level.
- 5) The operating system shall be suitable for truly real-time operation both at process as well as HMI end.
- 6) The system shall be truly modular.
- 7) The software shall meet the following general requirements:
 - Simple, easy-to-learn editing language for editing and on-line operation.
 - Wide range of standard and non-standard peripheral support capability.
 - Effective task scheduling and support of multiple priority structure including event based interrupt etc.
 - Effective debugging.
 - Provision for on-line editing and program development without interrupting on-line functions.
 - Self-diagnostic routines.
 - Efficient memory management and effective utilization of system time.
 - Quick start-up and loading.
 - Support of multiprogramming and multi-user operation.

iv) *Display and reports*

- a) A few typical displays and logs are given below as general guideline:
- 1) Real Time Parameter / Status Display (default screen)
 - 2) Real Time Trend / Historical Trend Graph Display
 - 3) Alarm Summary Display with alarm limits Printout (on demand)
 - 4) Alarm Summary Display with alarm limits Printout (Shift Log)
 - 5) Boiler Start-up Log / Printout (event actuated)
 - 6) Turbine Start-up Log / Printout (event actuated)

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- 7) Synchronization / Loading Log / Printout (event actuated)
- 8) Shift Log / Daily Log / Printout (on demand)
- 9) Generator Trip Log / Printout (event actuated)
- 10) Turbine Trip Log / Printout (event actuated)
- 11) Boiler Trip Log / Printout (event actuated)
- 12) Operator Control Screens
- 13) Group Display Screens
- 14) Individual Display Screens
- 15) Flow Chart / Logic Screens
- 16) Operator's Guidance Message Screen
- 17) Process Subsystem Display Screens
- 18) Pre Trip and Post Trip Log

v) *DCS panels and cabinet footprints*

- a) Unitized central control has been envisaged from the Central Control Room.
- b) Major geographical distribution is not foreseen for the DCS. The electronic cabinets and marshalling cabinets shall be located in the air conditioned areas of the Control Equipment Room adjacent to CCR with an approximate area of 300 square meters (per unit), the Central Control Room housing the HMIs shall approximately be 250 square meters (per unit) and the Engineer's room area shall approximately be 50 square meters (per unit).
- c) The controls related to the CW & ACW pumps and miscellaneous pumps, which are remote I/O units of the DCS, shall be located at the pump house annex rooms respectively.
- d) The environmental rating of the indoor electronic panels shall be as mentioned in the Environmental Conditions of the detailed technical specification.

4.40.14 BURNER MANAGEMENT SYSTEM

- i) The steam generator integral controls – BMS will include the binary controls related to purging, starting and tripping of the boiler, sequential start/stop operation of burners, milling system, draft system and all relevant safety protection of furnace and boiler as a whole.
- ii) The hardware including the cabinets assigned to BMS shall be exclusive and shall not be shared with any other system.
- iii) Burner Management System shall be either DCS based and the associated engineering station shall be utilized for configuring the BMS.
- iv) Monitoring and control of BMS shall be carried out from Central Control Panel.

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- v) Functionally the entire system shall be divided into various sub-groups within the following groups:
 - a) Mill group/coal elevations
 - b) Oil elevations & igniters
 - c) ID and FD Fan draft group and air & flue path
 - d) Boiler/Common Group
- vi) Functional sub-groups shall be assigned to redundant control processors connected to common redundant system bus to interact with the dedicated Human Machine Interface unit for BMS for monitoring and operation through various graphics, displays, sequence flow diagrams etc. on screen to guide the operator towards optimal safe and efficient operation.
- vii) Safety tripping of the boiler shall be implemented in three-out-of-three or Triple Modular Redundant/certified SIL3 system. The system will consist of three completely independent protection channels with respect to modules for-
 - a) Binary Inputs/Outputs,
 - b) Analog Inputs and Outputs,
 - c) Signal processing and
 - d) Signal transfer.
- viii) *Other boiler integral controls*
 - a) The secondary air damper control will be carried out in the DCS.
 - b) Smart Soot blower controls shall also be implemented in DCS.
 - c) Acoustic tube leakage detector shall be an independent system comprising the detectors, amplifiers etc. and separate PC/ OWS is envisaged for each purpose.
 - d) Coordinated Master Control (CMC) to be implemented for smother operation.

4.40.15 HP & LP BYPASS CONTROL SYSTEM

- i) HP & LP Bypass Control Systems shall permit faster start up of the BTG unit, establish Reheater flow during starting and low load operation and also will act as a pressure relief device in case of sudden load throw off or turbine trip by bypassing the active steam to condenser via Reheater.
- ii) HP & LP Bypass Control Systems shall be implemented in DCS with adaptive set point generation algorithm based on the BTG parameters and combined variable pressure-throttling mode of operation.

4.40.16 TURBINE CONTROL SYSTEM

- i) *Electro-Hydraulic Governing (EHG) Control System*
 - a) The Electro-Hydraulic Governing (EHG) for the main TG shall be implemented in two-out-of-three or Triple Modular Redundant system. If, however, proprietary system is offered, TUV approved TMR/SIL3 system shall be provided, which will interact with the DCS for operation from (by

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hardwiring) and monitoring (through high speed link) at the Operator's console.

- b) The EHG shall be a part of coordinated control of the BTG.
- c) Unit shall be capable to run on FGMO / RGMO mode as per requirement of CERC.

ii) *Automatic turbine start-up and shutdown system*

- a) The steam turbine shall be started up under cold, warm or hot condition with a single Operator's command, shall speed up, cross the critical speed/s, synchronize and load the initial sustainable block load automatically conforming to the stress limits set by metal and steam conditions.
- b) The operations shall include pulling of vacuum, sealing of glands, starting the lube and jacking oil system, turning operation, opening of drains, steam admission etc in sequence.
- c) Such sub-system areas of control will form functional sub-groups which shall be activated in order.
- d) Similarly, during emergency or administrative shut down similar routines shall be followed to bring the turbine down to barring gear without Operator's intervention.
- e) The Automatic Turbine Start-up and Shut-down System shall be implemented in DCS with dual redundant control processors.

iii) *On-load testing system*

- a) The Trip devices shall be stroked and tested for readiness under simulated situation even with the turbine in operating condition
- b) This sub-system shall be implemented in DCS and shall be activated under operator's command.

iv) *Turbine Protection System*

- a) The Turbine Protection System for emergency tripping of the steam turbine shall be implemented in DCS in three-out-of-three mode
- b) There will be three (3) independent channels each having its own processing unit, input modules and output modules.
- c) All primary sensors related to protection shall consist of three (3) different sensors each connected to the three processors.

4.40.17 **TURBINE SUPERVISORY INSTRUMENT SYSTEM (TSI)**

- i) Turbine Supervisory Instruments shall continuously monitor the behaviour of mechanical parameters related to the rotation of BFP drive turbines, main turbine and generator under various operating conditions.
- ii) The system will provide adequate information on the operational aspect of the rotating machines, generate alarms and trip the machines in the event of excursion beyond allowable limits of operation.

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- iii) The system shall generate adequate information for dynamic balancing of the machines.
- iv) The measurements shall include shaft vibrations at both X- and Y-axes and seismic vibration at all salient bearings as well as a key phasor per equipment.
- v) Other measurements like case and differential expansion, axial movement etc shall follow equipment manufacturer's recommendation.
- vi) The supervisory system shall be complete including sensors, transmitters etc., with required accessories viz., Special Cables, Junction Box, for all measurements.
- vii) The monitors shall be micro-processor based and shall have flexibility for easy configuration. The system shall have facility to suppress false alarm and tripping due to defective transducer, power supply, etc.
- viii) *Vibration Monitoring of Auxiliaries*
 - a) Bearings of all high speed HT motor-driven equipment shall be monitored for vibration both at driving and non-driving end of the drives as well as the driven equipment in the same fashion as the turbine bearings.
 - b) Each such equipment will have X-Y axes probes on each bearing and a key phasor probe.
 - c) Vibration monitoring of auxiliaries shall be provided from the same family of hardware as the Turbine Supervisory System for system integration. This shall encompass ID, FD, PA fans, coal mills, feed pumps and condensate extraction pumps, CW & ACW pumps etc., as the case may be along with their motors.

4.40.18 MAINTENANCE MANAGEMENT AND STORES MANAGEMENT

- i) A computerized and proven Maintenance Management and Stores Management System covering various equipment, components and parts of the unit have been envisaged.
- ii) The system will support a Local Area Network with sufficient number of PCs to be located at various offices in the plant like maintenance team offices etc., and will integrate with the DCS to utilise the real time to retrieve data like running hours and conditions of various machines to provide various menu for implementation of preventive and predictive maintenance as per equipment manufacturer's recommendation and practice established in the plant.

4.40.19 ROTARY EQUIPMENT MONITORING SYSTEM

- i) Important rotary equipment shall be continuously monitored for their mechanical health. The entire machinery monitoring system will integrate into a common "Machine Condition Monitoring Package" to acquire all related information, process and analyze them to produce data related to bearing wear, lubrication and stability margins etc. with its own special diagnostic software and a terminal providing machinery diagnostic data for monitoring and balancing.
- ii) The machinery diagnostic data shall be presented in an easily comprehensible form for high level of fault finding and Operator's guidance.
- iii) High speed link shall be established with DCS for data transfer and archiving.

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- iv) The system shall encompass turbines and electrically operated drives.
- 4.40.20 AUXILIARIES AND OFFSITE PLANT CONTROL SYSTEM
- i) The basic design philosophy being one of centralized monitoring of data, various stand-alone control units shall be connected to the main plant DCS for data exchange and control, where specified.
- ii) The general guideline for interface with the Plant Auxiliary Systems and Off Site Plants through OPC connectivity shall be as follows.
- a) Plant Auxiliaries System (within this package) shall include the following plants:
- 1) Condensate Transfer (CT) pump, Hotwell Make-up pumps & DM make-up Water (DMW) pumps
 - 2) Mill Reject Handling System
 - 3) Fuel Oil Pressurizing & Heating System
 - 4) Miscellaneous pumps
 - 5) Condenser On-load Tube Cleaning System
 - 6) Automatic Self-cleaning Strainer Control
 - 7) Condensate Polishing Unit
 - 8) CW & ACW pumps
 - 9) CW treatment system
 - 10) HP/LP Chemical Dosing system
 - 11) Flue Gas De-Sulphurization (FGD) System (including Lime & Gypsum handling)
 - 12) Compressed Air System
- b) In addition to the above, there shall also be following *Off Site Plants* (which is not considered in bidder's scope and will come under BoP package contractor's scope or others) for which input data acquisition have been envisaged at central control room DCS.
- 1) Raw Water and Pre-treatment Plant
 - 2) Demineralization Plant
 - 3) Ash Handling Plant
 - 4) Coal Handling Plant
 - 5) Cooling Tower
 - 6) Fire Water Pump House Equipment
 - 7) Effluent & Sewage Treatment system
 - 8) Fire detection & Alarm System (other package)
- iii) While some of the plant areas will have their own control system (Extended DCS, PLCs / other micro processor based system) operated from their

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respective local control rooms, functioning independently; other plant areas, which directly relate to generation will be directly controlled from DCS via remote I/O units.

- iv) Some of the auxiliaries will have operational facility from central control room as well as from local panels.
- v) The control system for each of the plant auxiliaries, Off Site Plant and their Human machine interface requirement and DCS interfaces in the Central Control Room are furnished in Volume – III, Part C, and Technical Specification for Control & Instrumentation.
- vi) Data acquired from Plant auxiliaries/Off Site Plants shall seamlessly integrate with DCS database and shall be treated at par with all other variables so far as the computation and presentation of the data is concerned.

4.40.21 ELECTRICAL SYSTEM INTERFACE

i) *Electrical System Controls*

- a) All electrical controls and monitoring related to the “Unit Auxiliary System”, “Station Auxiliary System” and “Bus Transfer System” shall be performed from DCS. One Operator’s station shall be assigned for the purpose.
- b) The necessary protection relays, like synchro-check, bus under voltage relays etc. will be connected to DCS to ensure the safety of the operation.
- c) A separate synchronization panel shall be provided at the auxiliary console.
- d) All Electrical panels housing protection relays etc. related to Unit Auxiliary Control, Station Auxiliary Control and Bus Transfer System will be located in the Electronic Equipment Room.

ii) *Electrical Parameter Monitoring*

- a) Electrical parameters such as voltage, current, frequency, power, power factor, consumption of electrical energy etc. as per the electrical system SLD will be monitored at the DCS for the display of complete status of the electrical system in the form of electrical system mimic.
- b) Necessary transducers with dual 4-20 mA output shall be housed in the respective electrical switchgear.

iii) *Electrical Drive Interface*

- a) Electrically operated drives of the unit; HT & LT unidirectional and bi-directional or DC drives, shall be operated from DCS.
- b) Necessary interposing relays for the purpose shall be located within the respective Starter, MCC or switchgear Units.
- c) HT motors, important LT AC and DC drives shall be monitored for current through transducers.
- d) All drive related interlocks, permissive, trips, auto starts etc will be implemented in DCS in drive groups and in sequential mode to reduce Operator’s intervention during routine operation.

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- e) HT motors shall be monitored for hot spot formation with embedded RTDs in each stator winding. Bearings of forced lubricated drives shall be monitored for over-temperature. Vibration shall be monitored with Vibration Monitoring System.

4.40.22 UNINTERRUPTED POWER SUPPLY (UPS) SYSTEM

- i) Two (2) sets of uninterruptible power supply (UPS) systems of continuous duty have been envisaged to supply regulated, filtered and uninterrupted 240 V, 50 Hz, single phase power within acceptable tolerances to critical AC loads like computerised data acquisition system, microprocessor based control and instrumentation system, analog control system, burner management system, annunciation system, indicators/ recorders mounted on unit control boards and other critical loads of such nature.
- ii) The system would comprise static inverters, static transfer switches, UPS system battery (Plante type), float and float-cum-boost chargers for the battery, step down transformer, voltage stabilizer, DC distribution board, AC distribution boards, battery health monitoring system etc. Both automatic and manual mode of operation will be provided.
- iii) Separate UPS systems to be provided for all auxiliary control panel rooms.

4.40.23 FLUE GAS ANALYSIS

- i) The chemical composition of flue gas, being an index of combustion, shall be precisely monitored for components.
- ii) *Combustion Gas Analysers*
 - a) To monitor the efficiency of combustion, Oxygen shall be measured in flue gas at each pass in a total of three points after the boiler radiant zone with zirconium oxide cells and the resulting signal shall be utilised in the combustion control loop in two-out-of-three mode to regulate the secondary air flow.
 - b) Carbon monoxide shall also be measured at an appropriate location with infrared analyzer to serve as a guide signal for potential oxygen starvation.
 - c) Oxygen shall also be measured after each pass of the air pre-heater to detect air ingress by leakage.
- iii) *Continuous Emission Monitoring System*
 - a) In conformity with the local and state pollution control norm, Continuous Emission Monitoring System shall be installed in the chimney to analyze the constituents of the combustion products.
 - b) The system will comprise of isokinetic sampler/s to draw representative samples, coarse and fine filter, line heater, manifolds etc for drawing the sample from specified elevation recommended by EPA.
 - c) An analyzer shelter, located near chimney, shall house the SO_x, NO_x, CO₂, Mercury and Oxygen analyzers, span and reference gas bottles, sample processing system, calibration manifold and an Operator's console for display and report generation.

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- d) Particulate analyzer, measuring dust content in mg/m³, shall be located at specific chimney elevation for across the stack measurement.
- e) Opacity monitor shall be installed at the outlet of ESP on each pass.
- f) Link shall be established to send CEMS data to DCS and MPCB/CPCB servers for data reporting and central monitoring.
- g) Wherever necessary the instruments will comply with MPCB, MoE&F, AERB or any other statutory requirements and guidelines.

4.40.24 STEAM WATER ANALYSIS SYSTEM (SWAS)

- i) Considering the criticality of the water chemistry of the supercritical unit, a centralized Steam and Water Analysis System (SWAS) has been envisaged for measurement of pH, Conductivity, Dissolved Oxygen, Sodium, Silica etc. and contents in feed water, steam and condensate at various sections of the process.
- ii) Measured values and health of the Analyzers will also be monitored in plant DCS through hardwiring and will interface with the dosing system to control the dosing pumps.
- iii) SWAS will consist of a Wet Section and a Dry Section.
- iv) Wet Section shall condition the sample to bring the sample to reference temperature by cooling at the primary cooler/s with DMCW and at the secondary cooler by cooling with chilled water and also bring the sample to a pressure level acceptable to the analyzers.
- v) Dry Section shall house the Analyzers and the sensors.
- vi) All samples shall be conditioned at 20 °C temperature before entering any sensor assembly of the Analyzer under worst ambient condition.

4.40.25 COAL AND ASH ANALYSIS

- i) The chemical composition of coal and ash and total coal consumption, shall be precisely monitored.
- ii) Full Elemental Analysis Coal and Ash Analyzer shall be required.
- iii) Wherever necessary the instruments will comply with MPCB, MoE&F, AERB or any other statutory requirements and guidelines.

4.40.26 FIELD INSTRUMENTS AND DEVICES

- i) This section provides general guideline for the field instrument and sensor to be used in the plant for the measurement and control of the process parameters.
- ii) Instrumentation shall be adequate for remote operation of the plant under various conditions without any local operation under normal circumstances. However, adequate number of local instruments shall be provided for local monitoring, maintenance, fault finding and trial operation.
- iii) Pressure gauges shall be provided at each major pump output and at the inlet/outlet of heat exchangers, at various points of distribution of instrument and service air etc.

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- iv) Transmitters shall be normally used for switching application as well by setting limit values in DCS. Direct acting switches shall be used only if recommended by equipment manufacturers.
- v) Temperature sensors viz. thermocouples and resistance temperature detectors shall be directly connected to DCS without any intermediate conversion.
- vi) Temperature switches shall be avoided altogether.
- vii) All field transmitters are envisaged to be of smart type with 4-20 mA DC signal output with superimposed digital device bus signal conforming to Field Bus Foundation or any other internationally accepted protocol. The calibrated range shall be so selected that the normal parameter shall generally be between 50 to 75 % of the range, depending on expected excursion.
- viii) All temperature elements shall be duplex type. All Thermocouples will be mineral insulated.
- ix) Field devices shall have an ingress protection class of IP54 or better.
- x) Instruments shall be grouped together in closed (outdoor areas) or open (indoor areas) type racks.
- xi) General specification for the field instruments shall be as given below:
 - a) Flow Element
 - 1) Significant flow measurements like bypass steam flow, auxiliary steam flow, feed water flow, condensate flow etc. for line sizes more than 4" shall be carried out with long radius flow nozzles with radius tap.
 - 2) Flow measurements for indication purpose and in smaller line sizes shall be carried out with square edge concentric orifice plates with carrier rings and flange taps.
 - 3) Fuel oil flow measurement shall be implemented with mass flow meters.
 - 4) The material of construction of flow elements shall be SS 316 for temperature up to 450 °C.
 - 5) Air flow (primary & secondary) measurement shall be by Aerofoil or galvanized Venturi tube in the duct.
 - 6) CW flow measurement shall be by Annubar.
 - b) Flow Control Element
 - 1) The final regulating control elements envisaged shall be Electro-pneumatic type with single or double acting power cylinders for dampers and pneumatic diaphragm or cylinder actuators for the control valves, unless the process demands the use of electro-hydraulic actuators due to stroke time limitation.
 - 2) HP & LP Bypass valves shall, however, be hydraulically operated.
 - 3) Trip valves shall be pneumatically actuated solenoid operated type with quick open characteristics.

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- 4) Inching duty (remote-manually operated) and On-Off duty valves and dampers will be motor operated with non-integral starter.
- 5) All valves shall be suitably sized so that under normal conditions the maximum design flow shall be able to pass through the valves with not more than 80% opening. The absolute maximum flow foreseen, even under unusual conditions should be handled by the valves with not more than 90% opening. The characteristics of the valve trim shall be so selected that the installed characteristics offer good control resolution. Equal percentage or modified parabolic characteristics shall generally be used. Heater drain valves shall have linear characteristics.
- 6) Suitable noise abatement techniques shall be adapted preferably by source treatment so that the aerodynamic/hydrodynamic noise caused by the valves is restricted within the limits specified by OSHA or any other internationally acknowledged standard and in no case exceed 85db at a distance of 1 meter from the valve.
- 7) Special attention shall be paid to the design of severe duty valves like reheat spray control valve, start-up feed water flow control valve, auxiliary PRDS valves, BFP recirculation valves, soot blower etc to avoid excessive erosion, flashing or cavitation. Multistage-Multipath, cage guided, anti-cavitation or noise abatement type trims shall be provided for such areas to avoid long-term deterioration. Especially for all such critical applications, the valves shall be of proven track record for similar applications.
- 8) All metal-to-metal seated regulating control valves shall be with a leakage Class-IV, as minimum. For critical applications like BFP recirculation control valve, temperature control spray line control valves shall be with of leakage Class-V.
- 9) Electro-pneumatic converters shall be smart type. Regulating pneumatic devices shall have airlock relays with automatic release to maintain their position in case of air supply failure. All actuators shall be brought to the fail-safe condition under following conditions:
 - Loss of Control Signal
 - Wire Breakage
 - Loss of Power Supply

4.40.27 INSTRUMENTATION CABLES AND CABLING ACCESSORIES

- i) Instrumentation cables shall be stranded, electrolytic grade tinned copper conductor, screened, armoured, insulated and sheathed with HRPVC FRLS insulation.
- ii) Junction boxes shall be provided within transmitter racks and other locations to group sensor and transmitter signal cables.
- iii) Signal cables from Individual Instruments/sensors to field junction box, wherever applicable, shall be with conductor size of 1.5 mm².

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- iv) From the junction boxes multi-core overall screened signal cables shall be used for extending binary signals, multi-pair twisted cable shall be used for analogue signals and multi-triads shall be used for extending RTDs to the control room area.
- v) Multi-core/ multi-pair/multi-triad cables from field junction box or transmitter rack to control room shall be of conductor size of 0.5 mm².
- vi) For cable runs beyond 500 meters and where recommended by instrument manufacturer, as in case of vibration measuring equipment, 1.5 mm² or 2.5 mm² conductor size shall be used.
- vii) Extension cables shall be used to connect thermocouples. Similarly, thermocouples shall also be brought to junction boxes to facilitate the use of multi-pair cables. K-type thermocouples shall be used up to a maximum temperature of 600 °C. Beyond this temperature noble metal thermocouples shall be used. Single or Multi Pair, solid conductor, 20 AWG, overall screened & armoured extension cables will be provided for carrying millivolt signals.
- viii) Cables shall run on horizontal ladder trays on main arterial routes, except in the pulveriser area where vertical trays shall be used. Branch trays leading to instruments or junction boxes shall be galvanized perforated type. Cables shall be laid in multi-layer formation, shall be tagged at regular intervals and strapped to the trays.
- ix) Electronic earth system shall be separate from the plant earth mat, which shall be used for grounding the body of instruments and panels as safety ground.
- x) For grounding the electronic system, a separate salt pit earth shall be created with separate riser to control room area where all the electronic earth points shall be brought and connected as System Grounding (<1 ohm).
- xi) The safety ground riser will be brought to the control room and control equipment room and various termination points will be created by running a bus bar of bare Copper conductor below false flooring. All panel and cabinet frames will be connected to the safety ground.
- xii) Frames of field junction boxes, local cabinets, stands, cable trays shall be grounded locally at the local ground mat/structure.
- xiii) For the electronic system, each circuit that requires grounding shall be individually and directly connected to the system ground bus, insulated from the cabinet enclosure. The system ground shall be distributed below the false flooring by means of insulated conductors.
- xiv) Cable screens shall be grounded at electronic earth at the control room end only.
- xv) Cables shall be glanded at each point of entry with watertight glands.
- xvi) For long parallel runs, separation of 300 mm will be maintained between low level signal cables and LT power/control cables. The separation of 600 mm shall be maintained with HT cable.
- xvii) Junction boxes shall be IP-65 enclosures with knock-out holes and cage-clamp type terminals.

4.40.28 CENTRAL CONTROL ROOM LAYOUT CONFIGURATION

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- i) The functional area of the Unit Control Room shall house desk-top Operator's Stations in an open type table-top version, Large Video Screen Displays forming the wall panel overlooking the operator's stations, auxiliary consoles, if any and some large numerical LED displays like master clock, generated megawatts, frequency, mega VAR, Load demand etc for ready reckoning.
 - ii) A glass-partitioned sub-enclosure adjacent to the CCR will house network printers & copiers, Engineer's Stations; GPS master clock console, history server/s, network switches and racks for documentation.
 - iii) The fire alarm panel shall preferably standing type at a clearly visible location.
 - iv) The non-operational area of the control room i.e. Control Equipment Room, shall house System Cubicles for the DCS, Interposing Relay Cabinets, Generator relay cabinets, Uninterruptible Power Supply system power distribution cabinets, Plant Communication cabinets, fire detection panel and DC power distribution boards.
 - v) The functional area of the control room shall have recessed false flooring and false ceiling for ease of marshalling field and interconnecting cable.
 - vi) All panels/control desks/cabinets/enclosures shall have uniform final painting shades at both interior and exterior surfaces.
- 4.40.29 An instrument maintenance laboratory shall be set up within the unit to attend running maintenance needs. All necessary instruments, special tools, jigs, benches, calibration units shall be included for the purpose.
- 4.40.30 **CLOSE CIRCUIT CAMERA SYSTEM**
- i) For continuous monitoring and vigilance of major equipment and process, plant rooms & main buildings including that of auxiliary plants and non plant buildings, main gate, access roads, internal roads and peripheral surveillance etc. closed circuit camera system shall be provided with facilities for night vision.
 - ii) The cameras will be thermal or PTZ type with IP connectivity and facility for remote Pan, Tilt & Zoom. The operator's control unit shall be located at the control room.
- 4.40.31 Provision to integrate with balance of plant CCTV system with the main plant CCTV system shall be provided, so that the whole plant can be monitored from the CCR, security and administrative buildings by senior plant officials.
- 4.41.00 Civil, Structural and Architectural**
- 4.41.01 All civil structures shall be designed for a life span of minimum 50 years.
- 4.41.02 All buildings in the project shall be in RCC construction with brick walls if not mentioned specifically elsewhere in the specification.
- 4.41.03 As per the contour plan of the plot available, a single grade level namely 304.75 m above MSL (As per old units 1 to 5) for main plant with auxiliaries including off-site plant.
- 5.00.00 CODES AND STANDARDS**
- 5.01.00 All equipment, systems and works covered under these specifications shall be in accordance with all the latest applicable statutes, regulations, codes and

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standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Bidders may familiarize themselves with all such requirements before preparation of bids. Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the requirements of the latest versions of Indian Boiler Regulations (IBR), Indian Standards / ASME codes.

- 5.02.00 The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with latest version of relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes. A non- exhaustive list of reputed international standards is given below:

American National Standards Institute (ANSI)
 American Petroleum Institute (API)
 American Society of Mechanical Engineers (ASME)
 American Society of Testing and Materials (ASTM)
 American Water Works Association (AWWA)
 American Welding Society (AWS)
 British Standards (BS)
 Cooling Technology Institute (CTI)
 Deutsches Institute for Normung (DIN), Germany
 Gosstandart of Russia (GOST) standards
 Heat Exchange Institute (HEI), USA
 Hydraulic Institute Standards (HIS), USA
 International Electro-technical Commission (IEC)
 Institute of Electrical and Electronics Engineers (IEEE)
 International Organisation for Standardisation (ISO)
 Japanese Industrial Standards (JIS)
 National Electric Code (NEC), USA
 National Electrical Manufacturers Association (NEMA), USA
 National Fire Protection Association (NFPA), USA
 Occupational Safety & Health Administration (OSHA)
 Tubular Exchanger Manufacturers Association (TEMA), USA
 VDE association for Electrical, Electronic and Information Technologies (VDE), Germany

- 5.03.00 Other international Standards, equivalent or superior to the above Standards can also be adopted. However, in the event of any conflict between the requirements of the international standards or codes and the requirements of the BIS standards or codes, the latter shall prevail. In the event of any conflict between

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the requirements of equivalent codes and standards, and the requirements of IBR, the latter shall govern unless specified elsewhere in the specifications. In other cases the more stringent of the two shall prevail.

- 5.04.00 The plants and associated systems shall also be designed to comply with the requirements stipulated in:-
- 5.04.01 Central Electricity Authority (Construction of Electrical Plants & Electric Lines) Notification of 20th August 2010
- 5.04.02 Central Electricity Authority (Installation and Operation of Meters) Regulations.
- 5.04.03 Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations
- 5.04.04 Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.
- 5.04.05 Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.
- 5.04.06 Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.
- 5.04.07 Central Electricity Authority (Technical standards for Construction of Electrical Power Plants and Electric Lines) Regulations 2010
- 5.04.08 Indian Boiler Act, 1923, and Rules and Regulations specified thereunder.
- 5.04.09 Indian Electricity Act, 2003 and Rules and Regulations specified thereunder.
- 5.04.10 Indian Explosive Act and Rules and Regulations made thereunder
- 5.04.11 Indian Factory Act and Rules and Regulations made thereunder
- 5.04.12 Indian Petroleum Act and Rules and Regulations made thereunder
- 5.04.13 Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and
- 5.04.14 Applicable State Grid Code issued by appropriate Regulatory Commission
- 5.04.15 National Building Code (NBC)
- 5.04.16 Tariff Advisory Committee (TAC)
- 5.04.17 Chief inspectorate of factories in Maharashtra
- 5.04.18 Chief electrical inspectorate in Maharashtra
- 5.04.19 Maharashtra state pollution control board
- 5.04.20 Any other codes/standard published by Government of India / other agencies and institution have a bearing over the performance of the contract.
- 5.05.00 In all instances, the finally accepted applicable code or standard shall be the version last published.
- 5.06.00 All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances

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of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards

- 5.07.00 The design of Steam Generator shall meet or exceed all the requirements of latest editions of Indian Boiler Regulations (IBR). Any other standard acceptable to IBR can also be considered, provided that the requirements of that standard are equivalent or more stringent than the IBR requirements.
- 5.08.00 The turbine generator shall comply with general requirements and standards of latest versions of IEC-45 and 46, IEEE-122, IEC-34-1, IEC-34-3 or their approved equivalents
- 5.09.00 It shall be the responsibility of the Bidder to take all approvals required and get the boiler registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the owner and owner's consultant at the time of detailed engineering..
- 5.10.00 Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power project, the Bidder shall carry out the design, manufacture, supply and installation on the basis of good engineering practice with Owner's and owner's consultant's approval.
- 5.11.00 During the period of Contract execution, if any standards change, the Bidder shall be responsible to notify the owner and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard. Upon mutual agreement, the amended standard can then be followed.
- 5.12.00 Bidder shall furnish English translations of standards, if specifically requested to which the equipment and systems offered are conforming to.
- 5.13.00 Further requirements about applicable standards and codes are specified in the detailed technical specifications.

6.00.00 PLANT OPERATING CAPABILITY AND UNIT OPERATION PHILOSOPHY

6.01.00 Operating Capability of the plant

- 6.01.01 The plant, its unit (s) and its all auxiliaries equipment/systems shall be designed to operate with all the specified margins for continuous operation without any limitations under any of the conditions indicated in the Technical Specification.
- 6.01.02 The major operating capabilities for the unit(s)/plant shall be as follows:
- Operate continuously with turbine under VWO condition with rated steam parameters, design condenser pressure and 1% cycle make up.
 - Sliding Pressure Operation from rated pressure down to 40% of rated pressure with as well as without any throttle reserve. For modified sliding pressure condition, at any operating load, the throttle reserve shall be sufficient so as to achieve an instantaneous increase in turbine output by 5% of the corresponding load, by opening turbine control valves wide open. However, the output after

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instantaneous increase shall be limited to 105% of TMCR Load. The throttle reserve shall be 0% for pure sliding pressure mode of operation.

- iii) Operate continuously with HP heaters out of service with maximum specified cooling water temperature, 1% cycle make up and normal auxiliary steam requirement being tapped from cold reheat line, to generate maximum output without over stressing turbine components. The power output of the unit under this operating condition shall not be less than 660 MW or output corresponding to design BMCR heat duty, whichever is lower.
- iv) Automatic run back capability of the unit load on loss of critical auxiliary equipments, ensuring smooth and stable runback of the Steam Generator and Steam Turbine Generator equipments and systems.
- v) Continuous TG output of 660 MW under rated steam conditions, specified worst condenser pressure, 1% cycle make-up and 47.5 Hz grid frequency.
- vi) The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz.
- vii) Unit shall be capable of increasing the load through condensate flow regulation in order to meet the load cycling requirement. Necessary measurements and logics shall be provided for implementation of the same. During condensate flow regulation hotwell level may be maintained through excess condensate dump line to condensate storage tank.
- viii) Turbine shall be capable of operation on variable pressure mode during part load & start-up operation.
- ix) TG set shall be capable of operating on house load during sudden total export load throw off using HP-LP bypass system. Unit shall not trip on over-speed in the event of total export load throw-off. TG output for house load operation may be considered 40 MW at least for 1 hour.
- x) In case of sudden reduction in demand (load throw off), the unit should get safely unloaded and stabilized for operation at house load with HP-LP bypass open to full capacity. All the components including valve body of HP and LP Bypass valves shall be designed for boiler highest safety valve set pressure due to sudden load throw off under transient conditions.
- xi) HP-LP Bypass should be capable of operation in parallel with turbine with all feed water heaters in service.
- xii) Bidder shall furnish Pure sliding pressure & Modified sliding pressure operation curves.
- xiii) Plant shall be designed to give life of not less than 25 years. Further, expected numbers of Steam Turbine Generator start ups during design life are as follows:

Type of Start	Number of Starts
Hot Start	4000
Warm Start	1000
Cold Start	150

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- 6.01.03 All the systems/equipments/auxiliaries under Bidder's scope shall be designed to cater to the above operating conditions envisaged for the unit(s)/plant by the Owner. Unless specified otherwise in the Technical Specification the design should cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.
- 6.01.04 The plant shall be suitable for load cycling which implies that it should be designed to operate continuously under two shift mode (daily start stop with one shift off) and load follow mode as specified. The design would cover adequate provision for quick start-up and loading of the units to full load at a fast rate. The unit shall have minimum rate of loading or unloading of 3% per minute above the control load (i.e. 50% MCR). Plant shall be capable of minimum N1 number of daily load cycles (N1 shall not be less than 2), load variation from 100% to 50 % (and vice versa) of MCR with a minimum ramp rate of 3% per minute without affecting the design life of boiler and turbine-Generator systems. In addition, the plant shall also be capable of minimum N2 number of daily load cycles (N2 shall not be less than 1) from 50% to boiler minimum once through load (and vice versa) with a minimum ramp rate of 1% per minute without affecting the design life of boiler and turbine-Generator systems.
- 6.01.05 The design of the plant equipments and control system would permit participation of the plant in automatic load frequency control.
- 6.01.06 Bidder shall design Turbine-Generator system meeting the load cycling conditions as indicated above. In no case the design life of Turbine-Generator system shall be affected due to -
- i) 'Fatigue Damage', resulting from
 - a) The number of Cold start up, Warm start up and Hot start up as defined elsewhere in the specification and
 - b) Load cycling during defined plant life.
 - ii) 'Creep damage'
 - iii) The combined creep fatigue damage shall lie within acceptable limits.
- 6.01.07 For the steam generator, in addition to the above requirement, specific design features incorporated and design/process improvements which are being offered for N1/N2 cycles shall be submitted along with the bid. Such design features and design/process improvements over and above conventional design shall be clearly brought out by the bidder in its bid. The Bidder shall provide references for earlier supplied steam generators which meet the specified cyclic duty requirements.
- 6.01.08 The analysis and design/process improvements for cyclic operation suitability shall include all critical boiler components like headers (final Super heater outlet, economizer outlet, final reheater outlet etc.), membrane wall construction elements (tubing attachments, tension bars etc.), wind-box elements, boiler recirculation pump casing, superheater/reheater attachments, dissimilar weld joints etc.

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- 6.01.09 The Bidder shall provide information to the process adopted and analysis carried out for the design and operational improvements. Following shall be necessarily included:
- Header thickness reduction: the intervention may include improvement in properties of materials or materials, increase in number of headers etc.
 - Use of full penetration welds for header/stub welds and header ligament design improvements
 - Design improvement in the mechanical design of water walls
 - Design improvements to prevent economizer steaming
 - Stress concentration improvements: identification of critical zones, fatigue analysis, operational feedback of regular de-signs; analysis/redesign of water-walls tube/fin system, SH/RH attachments, BRP (boiler recirculation pumps) casing design etc.
 - Water chemistry improvements
 - Vent/drain/spray system sizing improvements
 - Expansion joints design improvements and fatigue tests
 - Refractory improvements
- 6.01.10 Analysis of designs shall include CFD and FEM investigations. The bid proposal may be developed by the bidder based on earlier studies/investigations. CFD studies and FEM investigation shall be specifically carried out for the equipment/component selected/designed for the subject project/package. Necessary reports for the analysis (CFD and FEM) shall be furnished to the employer. The performance data required for the analysis shall be developed using dynamic modelling for the steam generator.
- 6.01.11 Visual/NDE protocols additionalities for critical components/equipment, analysis of fatigue damage and load cycling consideration as per the BS-EN 12952-3 or other equivalent code or other equivalent code etc.
- 6.01.12 Results of design analysis which are required to be submitted as part of the EIFS (Engineering information flow system) shall be tied up with the Contractor. The Contractor shall be required to establish the design additionalities (changes in design, dimensions etc.) for making the steam generator suitable for load cycling as part of the bid proposal.
- 6.01.13 The same shall be submitted as a separate document which shall be identified under EIFS. The document shall comprehensively cover each of the above-mentioned areas/components and others identified by the bidder. The process of analysis and results shall include in the document along with conceptual designs. The Contractor shall be required to help employer's engineer run through the complete analysis (as many areas shall not form part of the submitted document).
- 6.01.14 Periodic inspection shall be carried out by the Bidder during the warranty period of all pre-identified areas with stress concentration. The specifications include thermo-couples and other instruments to collect necessary data for the field test which shall be collected to enable further confirmation of the offered design

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and/or trouble-shooting. Bidder shall recommend additional instrumentation that may be required for the purpose.

- i) Provision for life consumption/Equivalent Operating Hours (EOH) of critical components due to Creep & Fatigue shall be made available online (display in CCR) for operating personnel. Also program/measures shall be made available online (display in CCR) to guide the operating personnel for maintenance planning.
- ii) Resulting Damage Factor due to Creep-Fatigue interaction shall be made available online (display in CCR) for Operating personnel.

6.02.00 Unit Control Philosophy

6.02.01 BOILER WET- DRY STATE CHANGEOVER

- i) At around 30% TMCR load, water separator level eventually disappears. The boiler now operates in once through mode and boiler recirculation pump will shut down at approx. 35% TMCR load.

6.02.02 HP-LP BYPASS CONTROL PHILOSOPHY

- i) *HP Bypass*
 - a) HP bypass control valves are opened to minimum position of 15% (To be adjusted during commissioning) with fire on in order to establish the flow through boiler.
 - b) Maintain the HP bypass at minimum position until MS Pressure attains around 10 Kg/cm² (To be adjusted by bidder) value. Once this pressure value achieved HP Bypass valve shall open to certain predetermined value at same pressure and thereafter pressure shall be built up at same valve position till rolling pressure is achieved.
 - c) The rate of pressure rise shall be determined by OEM with respect to various start ups.
 - d) Then HP bypass will be put in fixed pressure mode at rolling pressure.
 - e) Further when required temperature parameter is achieved by increasing the firing rate, HP Turbine valve starts to open and steam is admitted to the turbine.
 - f) The bypass valve continues to maintain the fixed pressure till synchronisation.
 - g) As the turbine starts accepting steam, bypass will start to close until turbine consumes all the steam.
 - h) Once the HPBP valve is closed fully, the pressure set point shall track the actual pressure plus a threshold "dp" as per standard practise of OEM.
 - i) Spray to HPBP shall be operated to control the downstream enthalpy.
- ii) *LP Bypass*
 - a) LP bypass are opened after establishing sufficient condenser vacuum and water supply for de-superheating.

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- b) LP bypass valve are closed until a minimum pressure of 2 kg/cm² (To be determined by OEM) is measured on HRH and the controller begins to control the HRH steam pressure by operating LPBP valves.
- c) The LPBP valve is allowed to open to some predetermined value while maintaining the HRH pressure of 2 kg/cm² (To be determined by OEM). Thereafter the set point for LPBP starts to increase with gradient determined by OEM for different modes of start-ups.
- d) The rolling pressure & temperature is built up in HRH at predetermined position of LPBP valve after which the rolling pressure is maintained during rolling of turbine by LPBP valve operation.
- e) As the turbine starts accepting steam, bypass will start to close until turbine consumes all the steam.
- f) Once the LPBP valve is closed fully, the pressure set point shall track the actual pressure plus a threshold "dp" as per standard practise of OEM.
- g) Spray to LPBP shall be operated to control the downstream enthalpy.

6.02.03 AUXILIARY STEAM LINE FROM EXISTING PLANT -

- i) Auxiliary steam from existing plant (Unit 8, 9 & 10) will be the dedicated source established in the plant for the auxiliary steam system.
- ii) Auxiliary steam system during the start-up of first boiler in the plant will be supplied from the above mentioned source. This source will be common for all the units. The tapping from the existing auxiliary steam source is connected to station header.
- iii) Isolation valve is to be provided in the tapping line to isolate the auxiliary steam source from system.

6.02.04 AUXILIARY STEAM SYSTEM OPERATION

- i) During Start-Up operation auxiliary steam will be supplied from existing plant. The auxiliary steam supply from this source will be in service up to around 30% load.
- ii) With the increase of main-steam parameters steam will also be supplied from main-steam line through H CPRDS at Approx. 10% Boiler Load. With the increase of load, parameters of CRH will increase and the auxiliary steam source will be shifted from main-steam to CRH at approx. 40% Load. When this line is operated, the steam pressure is maintained by throttling, but the temperature will vary between 280°C to 320°C.
- iii) If the low capacity PRDS is unable to maintain the header pressure, the high capacity PRDS will come in service to meet the requirements of auxiliary steam.

6.02.05 HOTWELL LEVEL

- i) Normal level in Condenser is maintained by adding make-up water through normal makeup control valve (up to 3% makeup).
- ii) If the make-up demand is not met through normal make-up and level falls below pre-determined level (adjustable), emergency makeup shall be supplied through Emergency makeup valve.

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- iii) In case the level rises above predetermined high level, the high level controller shall become operative at the high level and maintain the level by opening control valve on the excess condensate dump line. Alarm shall be provided in control room for hotwell level high and low.
- iv) Motorised regulating valves are provided in bypass lines to control valves of Normal/Emergency make-up line which can be put into operation remote manually, in case of mal-operation of main control valve.

6.02.06 CEP MINIMUM RECIRCULATION

- i) Individual minimum condensate recirculation lines have been envisaged for 3x50% capacity condensate pumps at the upstream of the discharge check valves.
- ii) Minimum recirculation flow control valves are provided in the recirculation lines from condensate pumps to hotwell to ensure minimum flow requirement of condensate pumps especially during start up and low load conditions.
- iii) The control valve modulates when measured flow is varying between 0 T/hr to speed dependent set point of minimum recirculation flow and it closes fully when measured flow exceeds this speed dependent set point.

6.02.07 DEAERATOR OPERATION

- i) Normally deaerator is supplied with steam from IP turbine extraction
- ii) Deaerator pressure varies as per extraction pressure at varying loads.
- iii) De-aerator pegging pressure for cold, warm, hot start up and during HP-LP bypass operation, shall be as optimized by the bidder and shall be suitable to ensure required deaeration and water quality required for boiler. The optimized pressure should be same during warm, hot start up conditions and during HP-LP bypass operation. Steam is supplied from aux. steam header through pressure control valve.
- iv) With the increase of parameters of CRH steam, Extraction to deaerator shall be shift to CRH. Steam source to deaerator will shift to IP extraction when sufficient pressure will be available.

6.02.08 DEAERATOR LEVEL CONTROL

- i) During initial start-up & up to about 30% load, single element condensate control system using deaerator level signal is used for regulating condensate flow. During this operation low load control valve is in service.
- ii) The deaerator level measured signal is compared with deaerator level set point. The error signal from the single element controller positions the low load control valve. When low load control valve is fully open (>85%), and the condensate discharge header pressure is more than 20 kg/cm² (g) (adjustable), the full load motorized regulating valve is opened automatically.
- iii) After ensuring that the full load motorized regulating valve is fully opened, control shall be transferred from single element to three-element control. Low load control valve gets a closing command. The Pump speed shall be modulated based on the signal from three-element control.

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- iv) When the unit load is reducing and falls to about 30% and/or condensate discharge header pressure reduces below than 20 kg/cm² (g) (adjustable), then the full load valve will get a closing command and the low load control valve shall open automatically. All controls shall be transferred to low load control valve.
- v) The Normal level in the deaerator is maintained with three element control circuit by regulating speed of the CEP through variable frequency drive (VFD).
- vi) Three element of control system are:
 - a) Feed water flow.
 - b) Condensate flow.
 - c) Deaerator level.
- vii) The error signal produced between measured deaerator level and deaerator level set point is added to the feed water flow signal to form the condensate demand signal i.e. set point for condensate flow. This is compared with the condensate flow. Deviation if any will change the condensate controller output which provides the desired speed signal for VFD of individual condensate extraction pumps. Variation in pump speed will contribute to change the condensate flow required by the three element control system.
- viii) CEP Discharge Header pressure shall be maintained above 20kg/cm² (g) (adjustable), under all operating condition. If the discharge pressure goes below 20kg/cm²(g) (adjustable), an alarm is given in the control room and control valve shall come into service and the motorised valve shall close and the control shall transfer from three element control to single element control. The Pump speed shall be modulated such that the Header pressure does not fall below 20 kg/cm² (g) (adjustable).

6.02.09 BOILER FEED PUMP

- i) *Changeover Philosophy*
 - a) 1x 50% Motor Driven Boiler Feed water Pump is used during initial clean-up & plant start-up.
 - b) At low load feed water flow is controlled by 1x30% control valve. MDBFP speed will be varied to maintain DP (5 Kg/cm²) across FCV to maintain the water separator level. Above 30% load, 1x100%/2X50% MOV is opened and water flow is controlled by varying the BFP (boiler feed water pump) speed.
 - c) 1st TDBFP will come in service at around 20% load when required steam parameters as required for TDBFP is available.
 - d) After 1st TDBFP comes in service MDBFP scoop position will come down to minimum position & will come in hot standby mode and running TDBFP will maintain water separator level.
 - e) Stop command to MDBFP will be issue by the operator based on running status of TDBFP.
 - f) 2nd TDBFP will be come in service at approx. 50 % Load.

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- g) In case one TDBFP is tripped, then one TDBFP and one MDBFP can operate to cater feed water flow at BMCR.
- h) During the shutdown, 1st TDBFP is shut down at 50% load and MDBFP comes in service below 20% Load and simultaneously 2nd TDBFP is shut down below 20% load.
- ii) **Run Back Operation**
 - a) In case when both the TDBFP's are running, MDBFP shall be kept in Hot standby mode.
 - b) In case when one TDBFP trips, runback shall be initiated to 75% Load. Simultaneously MDBFP On command shall be issued. If MDBFP on feedback is not received within 5 sec (adjustable) then runback set point shall be changed to 60% Load. In this case one TDBFP will cater the demand. If MDBFP will come in service then run back command will be stopped and one MDBFP & one TDBFP will cater the load demand of 100%.
 - c) If One TDBFP is in operation and MDBFP is in recirculation mode and if suddenly running TDBFP trips then load shall be maintained at 50%. If MDBFP will not contribute in system in 15 sec (adjustable) then MFT shall be initiated.
 - d) If One TDBFP is in operation and MDBFP is in standby mode (i.e. Motor off condition) then if suddenly running TDBFP trips then immediately MDBFP will be started. If MDBFP 'ON' feedback is not received within 5 sec (adjustable), then MFT will be initiated on all BFP trip.
 - e) However, if MDBFP 'ON' feedback is received within 5 sec (adjustable), then MFT will be defeated and within next 10 sec (adjustable), if MDBFP is not able to contribute the feed water in system then MFT will be initiated again.
 - f) No BFP trip will be initiated on Separator level high-high, BFP shall be run in recirculation.
- iii) **BFP Minimum Recirculation Control**
 - a) Individual minimum feed water recirculation lines have been envisaged at the upstream of the discharge check valves.
 - b) Control valves are provided in the recirculation lines from the boiler feed pumps to deaerator to ensure minimum flow requirement of BFP's especially during start-up & low load conditions.
 - c) Flow transmitters provided for individual BFP flow measurement shall measure the flow and initiate pump recirculation by opening the minimum recirculation control valve as per speed dependent set point of recirculation flow.
 - d) The minimum recirculation valve gets automatically closed, whenever the flow exceeds flow dependant set point with adjustable margin.

6.02.10 LEVEL CONTROL OF HP/LP HEATERS

i) **HP Heaters**

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- a) The basic need of level control in heater is to maintain NWL (Normal water level) for the safe and smooth working of turbine. The normal levels in HP heaters are maintained by normal level controller by cascading the drain to next lower heater through control valve.
- b) In case level reaches low level set point, an alarm is initiated in the control room.
- c) If the level reaches high-level set point due heater tube leakage or due to some malfunction, an alarm is initiated in the control room.
- d) The level is controlled by taking drain directly to condenser through emergency level control valve. When the high level control comes into operation to open emergency drain to condenser, the normal drain control valve will also remain open.
- e) If the level reaches high high-level set point, complete heater stream isolation starts and command shall be given simultaneously for the following actions.
 - 1) Close command to Extraction steam motorised isolating valves for all heaters in the corresponding stream.
 - 2) Command will be given to open the feed water bypass line to bypass the complete stream of heaters. This will occur based on the arrangement as provided by the Bidders.
 - 3) Alternate drain Control valve of affected HPH to open fully.
 - 4) An Alarm will be initiated in control room.
 - 5) Requirement of closure of higher HP heater drain to affected heater

ii) *LP Heaters*

- a) The basic need of level control in heater is to maintain NWL (Normal water level) for the safe and smooth working of turbine.
- b) The normal level in LP heater is maintained by normal level controller by cascading the drain to lower heaters through control valve.
- c) In case level reaches low level set point, an alarm is initiated in the control room.
- d) If the level reaches high-level set point due to minor heater tube leakage or due to some other malfunction, an alarm is initiated in the control room.
- e) The level is controlled by taking drain directly to condenser through emergency level control valve. When the high level control comes into operation to open emergency drain to condenser, the normal drain control valve will also remain open.
- f) If the level reaches high high-level set point, heater isolation starts and command is given simultaneously for the following interlock actions.
 - 1) Close command to Extraction steam motorised isolating valve for affected heater
 - 2) Alternate drain Control valve of affected heater to open fully.

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3) Forced closure of power assisted NRV in extraction line through ATRS.

4) An Alarm will be initiated in control room.

5) To open motorised condensate bypass valve of affected heater and once the bypass valve starts opening (not closed status sensed by limit switch), closing signal shall be given to motorised condensate isolating valves at inlet and outlet of affected heater.

6) Close command to Normal drain control valve from higher LP heater.

6.02.11 OVERALL UNIT OPERATION:

- i) It is envisaged to start up the complete unit including offsite auxiliaries through single click/pushbutton operator action.

7.00.00 QUALITY ASSURANCE AND CONTROL

7.01.00 All materials, components, structures and equipments covered under this specification shall be tested/checked at all stages of procurement, manufacturing, construction, erection, commissioning as per a comprehensive quality assurance programme.

7.02.00 The bidder including his suppliers and sub-contractors shall prepare their quality plans in line with the requirements of the specification and standard practices and implement it after approval by the owner and owner's consultant. This will include both Manufacturer's Quality Plans (MQPs) and Field Quality Plans (FQPs). MQPs and FQPs shall be submitted well in advance so that the same can be reviewed and approved by owner/owner's consultant well in advance before start of works.

7.03.00 Manufacturing quality plan shall detail out, for all the components, equipments & items various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by bidder's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

7.04.00 Field quality plans shall be submitted and shall detail out for all the items, the quality practices and procedure etc. to be followed by the bidder's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, fabrication, construction, erection, pre-commissioning and commissioning. The bidder shall provide all necessary means for execution of inspection and testing, according to the requirements including specialised instruments if any.

7.05.00 The bidder has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted.

7.06.00 It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organizations and that the bidder monitors the performance of these by the attendance at tests of experienced

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inspectors employed by the bidder. The bidder shall, at the appropriate time, prove that his material and/or equipment comply with all the requirements of this specification, such proof being the successful completion of tests and inspections.

- 7.07.00 Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.
- 7.08.00 All materials, components and equipment supplied under the contract shall be subject to inspection by the owner, his authorised representative or any statutory authority like IBR inspector, should they so require during manufacture, construction, erection and after completion.
- 7.09.00 No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by the owner/owner's authorized representatives, or such pre-dispatch final inspection is waived by the Owner and dispatch is authorized after review of test reports.
- 7.10.00 All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports and dispatch clearance duly approved by the Owner. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.
- 7.11.00 All material used for equipment construction including castings and forgings etc. shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 7.12.00 All the sub-vendors proposed by the bidder for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment - (list of which shall be drawn up by the bidder and finalized with the owner) shall be subject to owner's approval.
- 7.13.00 All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner for approval prior to carrying out qualification test in the presence of Owner's representative.
- 7.14.00 All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.
- 7.15.00 Test results of qualification tests and specimen testing shall be furnished to the Owner/owner's authorized representative for approval. However, wherever required by the Owner, tests shall be conducted in presence of Owner's/owner's authorized representative.
- 7.16.00 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

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- 7.17.00 The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the owner/owner's representative, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.
- 7.18.00 Wherever owner's/owner's representative's (inspector) witness is required as per approved quality plans or inspection categorisation plans, the owner and owner's representative shall be notified (inspection call) along with all required details including details of item to be inspected, approved MQPs, address/place of inspection, inspection date etc, at least 21 days in advance, prior to the planned inspection date at manufacturer's works. All test reports and supporting documents shall be made available to owner's inspector at the time of inspection; irrespective of whether it has been furnished earlier.
- 7.19.00 All site inspections as per approved FQP shall be notified along with all details including details of item to be inspected, location, inspection protocols etc., at least 5 working days in advance.
- 7.20.00 The owner/owner's representative, within fifteen days from the date of receipt of such notice/inspection call, shall intimate the bidder, the probable date of visit for the inspection. All efforts shall be taken by the owner to ensure that such date shall not be later than eight days from the date of inspection as intimated by the bidder.
- 7.21.00 If the owner or his representative does not attend on the notified date or in the event the owner grants waiver for such inspection, the test may be proceed as per approved quality plan, unless an alternative date has been requested by the Owner.
- 7.22.00 Participation by owner/owner's representative in or their absence from or failure to participate in any Tests (other than the Performance Tests) shall not relieve or absolve the Bidder from any Guarantee or Warranty or obligations of services under or in pursuance of the contract.
- 7.23.00 In the event, the inspector could not witness the inspection on the scheduled date for the reasons attributable to the bidder/subcontractor; all the costs of deputing the inspector shall be borne by the bidder.
- 7.24.00 With respect to site inspections, the bidder shall, wherever required, give due notice to the owner/owner's representative whenever work is ready before covering up or putting out of view. The inspector shall then either carry out the inspection, examination, measurement or testing or notify the bidder that it is waived.
- 7.25.00 If the inspector is not satisfied with any test and requires a re-test, the tests shall be repeated under the same terms and conditions. If such retesting demonstrate that the work, equipment or material being so tested conforms to the requirements of Contract, then the owner shall bear the cost of such additional Test and the cost of any required uncovering and covering the goods and shall grant the extension of time for completion, if necessary. If however such retesting confirms inspector's conclusion and cause the owner to incur additional costs, such costs shall be recoverable from the bidder.

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- 7.26.00 If, as a result of inspection, examination or testing, the inspector decides that any equipment, system, materials, design or workmanship has failed in such inspection, examination or tests or is defective or otherwise not in accordance with the contract, the inspector may reject such equipment, system, materials, design or workmanship and shall notify the bidder promptly, stating his reasons. The bidder shall then promptly correct or replace, such item or portion so as to pass retesting and otherwise meet and conform to such requirements. No changes to project schedule or increase in the price shall be granted with respect to such additional testing. Bidder shall bear any cost resulting due to such rejections.
- 7.27.00 Notwithstanding anything contained hereinabove, the pressure parts of the boiler coming under the ambit of statutory inspection (IBR), shall be carried out by the owner's personnel only.
- 7.28.00 Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equal or superior in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner.
- 7.29.00 The bidder shall include in its proposal a comprehensive Quality Assurance Programme containing the overall quality management and procedures which it proposes to follow in the performance of the works to maintain the quality of product during various phases.
- 7.30.00 At the time of award of Contract, the detailed Quality Assurance Programme to be followed for the execution of the Contract will be mutually discussed and agreed to and such agreed programme should form a part of the Contract.
- 7.31.00 Test Certificate and Documentation**
- 7.31.01 The results of all tests shall be certified by the manufacturer, bidder or independent agency as appropriate.
- 7.31.02 On completion of the inspection/tests, the bidder shall furnish the inspection report and test certificates as per the approved quality plans to the owner for approval and despatch clearance. The test reports shall invariably indicate identification data, including Model No., Sr. No., Billing Break-up reference etc. of the equipment, method of application and duration of test along with test results.
- 7.31.03 Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.
- 7.31.04 Four copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner prior to commissioning.
- 7.31.05 Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and

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reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

7.31.06 Soft copies of above shall also be submitted.

8.00.00 PROJECT MANAGEMENT

8.01.00 The bidder shall be responsible for the overall management of the project.

8.02.00 The bidder shall submit a project management plan, within 30 days from the date of award.

8.02.01 The main objective of the document is to indicate how the various elements of the project like engineering, procurement; sub-contracting, transportation, site execution, quality control, commissioning and performance testing are planned and integrated.

8.02.02 The plan shall be in line with the project milestone schedule.

8.02.03 This plan shall contain the following:

- i) *Project Management Organisation Structure* – Indicating the responsibility centres at both home office and site office, for engineering, procurement, sub-contracting and transportation. System/area wise and discipline wise responsibilities.
- ii) *Site Organisation Structure* – Indicating system/area wise and discipline wise responsibilities, for site management, planning, site execution, administration, quality control, safety, commissioning and performance testing including material management and Billing.
- iii) *Transportation Logistics* – Planning logistics and identification of ODC consignments and its transportation strategy.
- iv) *Construction Methodology, Erection Strategy and Deployment of T&P and resources* – A detailed erection strategy showing delivery plans, sequential erection activities supported by T&P and manpower deployment plan, indicating quantities and time period. This shall also indicate time schedule for finalisation of erection agencies/sub-contractors. Considering time gap between the units, unit wise deployment program shall also be indicated.
- v) Any other information reasonably requested by owner.

8.02.04 Curricula Vitae of key personnel, who will be part of project during various stages, shall be submitted to the owner and make suitable changes if suggested by owner. Any change of the key personnel or organisation structure shall promptly be communicated to the owner.

8.02.05 This plan shall be mutually agreed between the owner and the bidder.

8.03.00 Project Schedule, Planning and Monitoring

8.03.01 The Bidder shall prepare a Master Network Schedule in the form of PERT network. The network shall be prepared on a Work Breakdown Structure.

8.03.02 The master network shall identify milestones of key events of each system in the areas of engineering, procurement, manufacture and despatch, erection and commissioning. The master network shall represent the Level I (L1) Schedule

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and will form the basis for development of detailed second and third tier execution plans i.e. L2 and L3 network schedules.

- 8.03.03 The master network shall be submitted along with the bid and shall be mutually discussed and finalised before the award of Contract. The master network shall identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie up. Scheduled dates for providing such inputs shall also be indicated and the same will be mutually discussed and finalised.
- 8.03.04 The Bidder shall not change the Master network without the prior approval of the Owner in accordance with the Conditions of Contract. In the event that the Owner approves a revision to the Master Network in accordance with the Conditions of Contract, the Bidder shall submit a revised Master Network within two weeks thereafter. This programme shall fully comply with the requirements of the specification and where necessary, reflect changes to the sequence or progress of the Works as indicated by the Owner or as proposed by the Bidder and accepted by the Owner. Such an agreed revised programme shall become the overall schedule for the outstanding works.
- 8.03.05 The Bidder, within 30 days after the date of award of contract shall submit to the Owner the detailed L2 schedule and within 90 days from the date of award of contract shall submit the detailed L3 schedule for the package, which shall be consistent with the Project Schedule given above.
- 8.03.06 The schedule shall show the sequence, timing and duration of the Work and the planned commencement and completion dates of all separable portions of the Work, including each Milestone, in form, content and level of detail satisfactory to Owner. The Bidder shall fix the major milestones to check / review progress on the life cycle curves so that the time gap between 2 milestones should not be more than 10% of the total time duration.
- 8.03.07 Along with the L2, detailed sequential supply schedule shall also be submitted and shall be mutually agreed between the Bidder and Owner. All supplies shall be purely sequential based on its requirement at site.
- 8.03.08 The Bidder shall at all times perform the scope of supply in accordance with Project Schedule and the programme.
- 8.03.09 No material alteration to the Programme shall be made without the approval of the Engineer. However, Bidder may make minor alterations to the Programme without the prior approval of the Engineer being required where such alterations are consistent with the key milestone dates set out in the Project Schedule.
- 8.03.10 The Bidder shall submit the coding procedure being adopted for computerisation along with the logic and the Work Breakdown Schedule with their respective weightages used for generating the life cycle curves and shall submit the Work Intensity Chart based on weightages conforming to their overall schedule.
- 8.03.11 If the progress of the Scope of Supply or any other part of the Works does not conform to the Programme, the Owner may instruct the Bidder to revise the programme.
- 8.03.12 If for any reason which does not entitle the Bidder to an extension of time the rate of progress of the Scope of Supply or part thereof is at any time in the

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reasonable opinion of the Owner or the Engineer too slow to secure completion of the works within the Time for Completion or any extended date the Employer may so notify the Bidder in writing and the Bidder shall thereupon take such steps as are necessary and the Employer may approve an order to accelerate (whether by re-programming the order or sequence of work or by increasing the personnel or other resources of the Bidder or its sub-contractors employed on the Scope of Supply) the progress of the Scope of Supply or part thereof so as to achieve completion of each section by the Time for Completion as may be extended. The Bidder shall not be entitled to any additional payment or extension of time for taking such steps.

8.03.13 During the performance of the Work, Bidder shall submit monthly updates comparing the Work completed against the milestone schedule or if Bidder's performance is not in compliance therewith, more frequently as requested by Owner. If Bidder's performance of the work is not in compliance with the Milestone Schedule, without restricting any other rights or remedies of Owner hereunder, Bidder shall

- i) Submit its plan for schedule recovery and
- ii) Specify in writing the steps to be taken to achieve ongoing compliance with such revised schedule.
- iii) Bidder shall submit the overall life cycle curve for progress curve. The Bidder shall adopt a milestone approach and shall identify several milestones to be achieved so that they could be measured physically. Computation of progress of the Bidder shall use weighted value concept and submit detailed computerised linked bar chart. Bidder shall submit work breakdown structure in detail along with the weightage and the milestone to be achieved every week preferably in a graphical / tabular format.

8.03.14 Bidder shall comply with the Schedule and to attend and participate in progress, site co-ordination or special purpose meetings. Progress, site and co-ordination meeting will be held at Bidder's engineering office or the Site on a weekly basis, unless otherwise requested by Owner. Bidder shall have in attendance at any such meeting the Project Manager and other management workers authorised to commit additional manpower to the Work and shall for any progress meeting bring a forecast showing the last period's progress versus the last period's scheduled work plan and the work plan for the next one month period. Unless otherwise stated in writing by Owner the forecast shall describe the Work by task, by site location, by area or building and by bay for a one month period. The commencement and completion of each task to be performed shall be clearly designated. If requested by Employer, representatives of Vendors of major materials shall be present at each such meeting. Employer may on reasonable notice to Bidder call a special purpose meeting whether at Bidder's engineering office or the site to review any portion of the Work, the performance of which is of substantial concern to Employer.

8.03.15 The Bidder shall use the latest version of a project management software preferably like MS project/Primavera to generate and submit the following (both hard copies and soft copies) to the Owner to facilitate monitoring the project progress:

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- i) Overall Schedule (on Monthly basis) hard copy and soft copies.
- ii) Performance / Forecast look ahead schedule i.e., three weeks work ahead and previous week's performance. This shall be submitted and monitored every week.
- iii) Milestone slippage report, if any.

9.00.00 SITE AND LAYOUT REQUIREMENTS

9.01.00 Plant Area

9.01.01 SITE AND SOIL PROFILE

- i) A preliminary soil investigation and topographical survey has been carried out by owner. The details are furnished in Annexure 5 and 6 of Volume – V.
- ii) The detailed geotechnical investigation, topography and setting out survey for the area covered under this package will be performed by the bidder, and will be the basis for the detailed engineering for the project. The geotechnical report shall contain recommendations for foundation design during detailed engineering.

9.01.02 LAYOUT OF SITE

- i) A suggestive plot plan indicating available area is enclosed as Dwg. No ETG061-COM-GEN-PP-001 considering the existing plant facility, fuel receipt and electrical system hook-up. However, the bidder shall further elaborate and prepare a detailed layout arrangement which will be subjected to approval of the owner.
- ii) In developing the site layout, a systematic approach shall be adopted with a view to ensure that all the subsystems comprising the package are optimally laid out both from the view point of capital cost as well as running/operating costs.
- iii) Ease of operation and maintenance of the plant will be the most important aspect to be considered while developing the layout.
- iv) The detailed layout shall be prepared by the bidder taking into consideration the most economical option, considering the requirements of the specification, functional requirements, optimum space utilisation and transportation/storage/construction/erection strategies.
- v) While preparing the detailed layout, planning the facilities in the bidder's scope and deciding upon the functional requirements, transportation and construction/erection strategies,
- vi) Bidder should take into consideration the aspects like economical layout of the plant and ease of integration of systems with existing units and considering the ease of construction, operation and maintenance.
- vii) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the bidder within the overall area available and allocated within plant boundary. In case bidder requires additional area, he shall make his own arrangement at his own cost outside the plant boundary. Development of the same including security etc. for the intended use will also be his responsibility.

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- viii) The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.
- ix) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 15 m with respect to centre line of double lane road and 12 meter with respect to centre line of single lane road.
- x) In case of rail track minimum 3m horizontal clearance between face of adjacent structure to centre line of rail and 8.5m vertical clearance between bottom of structure to top of rail shall be maintained. Further as per the practice adopted in railways, any crossing below the rail track, minimum opening size of culvert shall be 2.0m wide X 1.8m deep. A walkway of min 600mm width shall also be made available in the culvert.
- xi) The development work consists primarily of clearing the site, grading the site to appropriate levels keeping in view the planning for storm water drainage and green belt.
- xii) Global Coordinate system shall be followed or as mutually agreed. Elevation shall be in meters.
- xiii) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.

9.01.03 SITE LEVELLING AND GRADING

- i) Finished grade level (FGL) of the site shall be RL (+) 304.75 m above MSL; which is more or less the existing grade level of the site.
- ii) Finished Floor Level (FFL) of Power House Building shall be 500 mm above FGL.
- iii) Finished Ground Floor (FFL) Level of Power House building taken as EL 0.00m.
- iv) Paved level (top) in boiler & ESP area shall be at EL (-) 0.20m.
- v) Paved level (top) in transformer yard shall be at EL (-) 0.10m.
- vi) FFL of ESP/FGD control building and other buildings in boiler/Mill bunker building/chimney area shall be EL 0.00m.
- vii) Top of road shall be 0.20mm above from ground level.
- viii) Drains shall be provided both sides of roads except patrolling road. Drain shall be provided on one side of patrolling road.
- ix) FFL of offsite buildings shall be 500mm above FGL of respective areas.
- x) Site shall be cleared as required for construction. Trees if any may be retained if it will not obstruct the plant construction.
- xi) Site shall be excavated and all underground structures and unwanted debris as mentioned in the specification shall be removed.
- xii) Earthwork in excavation including quarrying/blasting as required, identifying borrow pits, transportation of soil from borrow pits, backfilling and disposal of excavated material.
- xiii) Backfilling after removal of all debris and further compaction to maintain the FGL shall be done, as required.

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- xiv) Necessary grading/levelling required for the construction shall be done by the bidder. The area shall be suitably cut and filled to suit the layout requirement as required.

9.01.04 ROADS, BOUNDARY WALL AND FENCING

- i) Water bound macadam (WBM) roads shall be constructed after levelling and grading of the site, for easy movement of plant men and material including cranes and other construction equipments. Preferably all road crossings shall be planned, designed and completed before laying of WBM road.
- ii) Roads as required inside the plant for easy access of men and material to various locations shall be provided.
- iii) Drains shall be provided both sides of roads except patrolling road. Drain shall be provided one side of patrolling road.
- iv) Plant Main road to the power house building from the main gate shall be considering turning radius required for heavy multi axle trucks.
- v) All roads in & around the power block (BTG island) area (Area from Transformer yard to chimney & FGD area) shall be rigid pavement with RCC.
- vi) All roads around the BTG Island except the road on East side of BTG Island shall be 10m wide and 1.5m wide shoulder on both sides. Road on the East side of BTG Island road shall be 15m wide four lane road and 1.5m shoulder on both sides.
- vii) All roads inside the BTG area providing access to buildings / structures / systems requiring maintenance by vehicles shall be 7 m wide and 1.5m wide shoulder on both sides.
- viii) All other roads for access to the BoP plants shall be 7.0m wide and 1.5m wide shoulder on both sides.

9.02.00 Layout of the plant area

9.02.01 The package shall comprise mainly of power block/main plant area and other non-plant areas covered under the specification like, cooling water pump house, FGD area, fuel oil transfer system, fire system, compressor house etc. (together called as 'Plant Area', for this package).

9.02.02 The following factors shall be considered in developing the plant layout for all area:

- i) Safety of personnel and plant is the most important criteria for plant layout.
- ii) Optimisation of resources and ease of operation and maintenance are the other important criteria.
- iii) Easy and safe access to all areas shall be provided for smooth operation of the plant. Especially, adequate access shall be provided to all valves.
- iv) Similarly adequate provision shall be provided for convenient maintenance of the all items of the plant. This is very important in order to reduce the equipment/plant downtime and increase the equipment/plant availability.

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- v) The layout of this plant shall be compact so as to optimize use of land, materials and minimize system losses. Special care shall be taken to optimise the total piping and cabling lengths.
- 9.02.03 As the part of layout optimization, the Bidder shall keep the following in to consideration:
- i) Unit pitch : Shall be minimum 130 m for 3 cylinder steam turbines and 140 m for 4 cylinder steam turbine.
- 9.02.04 Due consideration shall be given for the wind direction while deciding on the relative location of Cooling tower and switchyard to minimize the moisture drift towards the switchyard.
- 9.02.05 Control Room / Control equipment room {for placing control and power system panels, including remote I/O (RIO)} for all areas shall be provided as near as possible near to their respective area MCC/Switchgear. Control Rooms / Control Equipment Rooms / RIO rooms shall be air-conditioned. Batteries for power supply systems as required shall be placed in separate suitably ventilated Battery rooms.
- 9.02.06 Ground level FFL 0.00m shall be used as cable vault. All MCC / Switchgear / control equipment / panels will be placed above the cable vault floor. Minimum floor height of the cable spreader floor shall be 3.5 m.
- 9.02.07 Adequate space shall be provided for unloading and maintenance purposes in Turbine - Generator (TG) area. Requisite lay down area shall be provided for each unit on TG floor and same shall be approachable with electric overhead travelling (EOT) crane.
- 9.02.08 Each unit shall be provided with its own laydown area on operating floor level, thus enabling simultaneous maintenance and overhauling of all units, if required. In case any special arrangement for rotor maintenance is required, the same should be provided.
- 9.02.09 The bidder shall furnish GA drawings indicating the equipment laydown area with details such as blocks indicating orientation of dismantled items, travel path etc.
- 9.02.10 The bidder shall also furnish GA drawings indicating the laydown arrangement of major assemblies (provided as spares) in the TG hall, with access from EOT crane. If the area provided inside TG building is not sufficient to accommodate these unit assemblies then a separate buildings shall be provided. The layout and arrangement shall be furnished along with the bids submitted by the bidder.
- 9.02.11 Adequate provision shall be made at all areas, in regard to space and access, in order to carry out the maintenance of various equipments. Adequate maintenance facilities & access shall be provided as required, for assembly, disassembly, handling during maintenance and alignment work of all important equipment and auxiliaries viz: dampers, actuators, field instruments, steam turbine casing (inner and outer), diaphragm glands, steam valves, journal/thrust bearings, turbine rotors, generator rotor, end rings, shaft seals, generator bearings, hydrogen coolers, condenser water box, condenser cooling water line inlet and outlet motor operate butter fly valves, vacuum pumps, CEPs and BFP cartridges, BFP drive motor, turbine oil coolers, pumps, fans, air pre heaters, boiler circulation pumps, regenerative heater, coal mill, coal feeder etc.

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- 9.02.12 Cut-outs as required and lay down space for all the equipments shall be considered and lifting and handling equipments shall be extended up to the lay down space
- 9.02.13 Adequate fire escape staircases shall be provided in power house building with fire doors at each landing.
- 9.02.14 Adequate no. of staircases and access through elevator shall be provided as required and specified for various buildings.
- 9.02.15 Adequate number of permanent stores and open paved yard shall be provided as per requirement of the Station for storage of spares and materials etc.
- 9.02.16 The safety requirements as per the Factories Act, Indian Electricity Rules and other applicable codes/standards etc. shall be observed while developing the layout.
- 9.02.17 Steel storage yard and pre-assembly yard required for storing and assembling of plant equipments during construction phase and later this space will converted into open storage/green belt during the operational phase.
- 9.02.18 Crisis Management scheme and Emergency Management scheme shall be provided. This is related to plant and personnel safety during construction and operation in relation to layout features, operational features and accidents. The details shall be discussed and finalized during engineering stage.
- 9.02.19 Sufficient clear head room of minimum 2.1m shall be provided in all plant area.
- 9.02.20 Valves shall be located in accessible positions. All piping shall be routed at a clear height of minimum 2.5 m from the nearest access level for clear man movement. Best engineering practices shall be adopted for keeping the minimum clear working space around equipment and clear headroom within main structures and cable trays etc.
- 9.02.21 Space for pipe racks and pipe pedestals shall be considered while planning the layout.
- 9.02.22 Major external functional system shall be so oriented that any maintenance work as well as subsequent construction work can be carried out without any interference and/or hindrance to the operational units.
- 9.02.23 All facilities of the units are to be laid out in close proximity to each other to the extent practicable so as to accommodate all facilities efficiently within the plant boundary.
- 9.02.24 The layout shall also facilitate communication of men and materials between the various facilities both during initial construction and also during subsequent operation and maintenance.
- 9.02.25 Cross over ladders shall be provided at all suitable places wherever pipe/cable (laid over pedestals and floor level) has to be crossed.
- 9.02.26 Hand rails of suitable height and toe guards shall be provided for all platforms/walkways/ladders.
- 9.02.27 Minimum clear gap of 1000mm shall be provided between equipment foundations/columns/pipes/cable racks/pedestals/walls/trenches etc.

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- 9.02.28 Minimum clear width of all staircases shall be 1000mm.
- 9.02.29 Easy access to shift material and equipments to and from buildings should be provided.
- 9.02.30 Easy approach for vehicles to handle the equipments near maintenance bay shall be provided.
- 9.02.31 Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC. Further minimum two number fireproof double doors shall be provided in Cable vaults and HT/LT switch gear room.
- 9.02.32 One set of washroom/toilet to be provided in the control room floor of respective buildings. Separate washrooms/toilets at suitable locations shall be provided for male, female and transgender.
- 9.02.33 Pantry with suitable ventilation, sink and power supply points and platforms for induction stove and microwave oven to be provided adjacent to control rooms in respective buildings.
- 9.02.34 Below ground basement rooms shall not be considered.
- 9.02.35 All equipment shall be installed above ground. Below ground installation will not be allowed, but if a below ground installation is unavoidable, then proper maintenance space and dewatering arrangement has to be provided. Collection of oil and dirt in that area has to be avoided and it should be easy to clean such a place.
- 9.02.36 Layout and Landscaping should be aesthetically planned for the project.
- 9.02.37 **POWER BLOCK AREA**
- i) The following building / structures & equipment shall be located within power block:
 - a) Steam Generator area
 - b) Steam Turbine Generator Hall
 - c) Control & switchgear building
 - d) Power Cycle Pipe Rack & Cable Gallery
 - e) Transformer yard area
 - ii) The suggested general arrangement concept of power blocks are shown in plot plan. Bidder shall develop an optimized layout of the power blocks to suit the configuration and equipment offered, subject to approval of Owner/Consultant.
 - iii) Clear walk ways of minimum 1.5 m width at all the levels shall be provided in the main plant building. For interconnection with service building, walk way of about 3.5 m width shall be provided along the row of main plant building. Adequate fire escape staircases shall be provided in main plant building with fire doors at each landing.
 - iv) For EOT crane maintenance, through walkway shall be provided along both rails at crane girder level. Approach to the crane through rung ladders shall be provided at least at two places.

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- v) Steam turbine, generator, Lube oil system, CEP, and other equipments located in the turbine hall shall be accessible by the EOT cranes for their handling during maintenance and overhauling. For all other equipment/ components located in the main plant building, suitable handling arrangement viz. cranes/monorail hoists etc. as required shall be provided for the maintenance and overhauling. Wherever special handling procedures are to be followed, the same shall be described in a separate document.
- vi) Floor drains shall be provided at all floors and drain discharge pipes shall be properly sized taking into account the fire water sprinkler system wherever provided.
- vii) All drains shall be routed to adequately located and sized pits and shall be provided with automatic 2x100% pit/sump pumps for disposal to effluent collection pit at various locations. Suitable access shall be provided for maintenance all pits.
- viii) Electrical bays shall be provided in power house/control building for each unit to house switchgear room, cable spreader room, battery room etc. Switchgear room shall accommodate HT switchgear, LT switchgear, and Dry type transformers etc. for the main plant electrical system. Each switchgear room shall have cable spreader room below the switchgear. Minimum floor height of the cable spreader room shall be 3.5m.
- ix) The cable vault space/cable spreader room below HT/LT switchgear rooms, control rooms, unit control equipment room, Programmer room, UPS, Charger & Battery rooms, MCC room shall have minimum 800mm wide and 2.1m high movement passage all around the cable trays in the cable vault/spreader room for easy laying and maintenance of cables. Proper, unit wise segregation/separation of cables shall be provided. Cable trenches are not allowed. False flooring to route cables is not envisaged.
- x) The minimum clearances shall be maintained, taking into consideration ventilation ducts and other structures.
- xi) The Turbine repair bay area shall be sized for minimum of 20 m x 30 m. Minimum 2 maintenance bays shall be provided.
- xii) TG maintenance room and tool room shall be provided in TG operating floor or ground floor, with space to store tools and tackles and consumables of TMD.
- xiii) Passage way between power house building 'C' row and boiler 1st row column shall be minimum 12 m wide. Clear height shall be 8m except in control building area, where the minimum head room shall be 5m.
- xiv) Minimum clear approach width between Boiler/Bunker bay and ESP shall be 12m & minimum clear height shall be 8m.
- xv) Minimum clear approach width between ESP and ID fan shall be 10m & minimum clear height shall be 8m.
- xvi) Layout of facilities and equipment shall allow removal of Generator Stator, Generator transformers, Station & Unit transformers without disturbing equipment, piping, cabling, ducts routed in the area.

9.02.38 STEAM GENERATOR AREA

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- i) The lay down area shall be provided on any one side of each SG, which would facilitate easy access for erection and maintenance. Equipments located outdoor shall be provided with covered roof /canopy.
- ii) Maintenance room for boiler, mills and fans shall be provided, with space to store tools and tackles and consumables of BMD.
- iii) Coal bunker shall be cylindrical in shape.
- iv) A clear walkway of 1200mm (min) shall be ensured between the mills / its foundation / mill reject conveyors and inner face of mill bay column. Maintenance space shall be provided on either side.
- v) Mill handling arrangement complete with crane and handling facilities along with removal space shall be provided. For each mill bay, bidder shall provide adequate maintenance area for safely handling the mill equipment/parts. Roof shall be provided above maintenance space.
- vi) Equipment operating/maintenance platforms at Mill Hoist Level, Mill Discharge Valve level, Bunker/Feeder Outlet Level, Cold and Hot air damper level, scanner approach level, oil gun approach level, approach to bottom of hopper for ash handling and for other equipment shall be provided. The platform shall be such that minimum 1.2M space is available all around the equipment for operation & maintenance. However, complete platform for mill maintenance shall be provided at one level in the mill bunker building. Further, 2.1M clear height shall also be available on all such platforms for the person to stand on the platform.
- vii) FD, ID and PA fans handling arrangement complete with crane and handling facilities along with removal space shall be provided. A continuous platform shall be provided between fan and motor end for ID/PA/FD fans in order to facilitate movement of personnel.
- viii) In the SG area, facility of crane/monorail hoist etc. shall be provided along with provision of space for maintenance/ overhauling of equipment such as handling of coils of economizer, motors etc.
- ix) Interconnecting walkways between SG and TG building shall be provided at TG various levels. Walkways at various levels shall also be provided for interconnection between steam generator and bunker bay.
- x) Approach platform shall be provided from ESP outlet to ID fan suction gate.
- xi) FGD system shall be located within the main plant block beyond ESP.
- xii) Twin flue RCC (Wet stack) Chimney 140m high shall be located beyond ESP.
- xiii) DeNOx system shall be located in boiler area, Bidder shall submit the details regarding DeNOx system and its location basis clearly in bidding documents.
- xiv) DeNox system layout shall be suitable for easy replacement of catalyst modules and repair of Ammonia injection grid.
- xv) DeNOx system layout shall be suitable for easy hook-up of SCR and ducting to the isolation dampers, in case if the SCR is taken as optional scope.
- xvi) Minimum one staircase shall be provided between two adjacent passes of ESP. These stair cases shall be equally placed between the inlet and outlet of ESP.

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9.02.39 Steam Turbine and Generator Hall/Power House Building (PHB)

- i) Adequate space for maintenance of steam turbine/generator and condenser shall be provided in the layout. Requisite lay down area shall be provided for each unit on TG floor and same shall be approachable with Electric Overhead Travelling (EOT) crane. One transverse bay with adequate space shall be provided for each Unit in TG building for unloading and maintenance purposes. TG EOT crane is required to handle the heaviest component other than the generator stator.
- ii) Generator stator shall be lifted using the strand jack method or portable crane.
- iii) The crane rails of the turbine hall shall be at sufficient elevation with adequate clearance from the crane main hook to the operating floor level. Preferably, EOT Crane access shall be made available for all STG Hall equipment. In case certain items do not have EOT Crane access, suitable permanent handling facilities shall be provided for them.
- iv) The operating floor for the STG shall be at suitable elevation level to match the top level of TG deck.
- v) The vertical CEP's, shall be located adjacent to the condenser.
- vi) Preferably Closed cooling water pumps, PHE, Vacuum pumps shall be kept in the ground floor.
- vii) TDBFPs shall be preferably placed at the operating floor, with VIS system.
- viii) Clear walkways shall be provided along 'A' and 'B' row of PHB. Minimum 1.5m wide at all levels of AB bay. And minimum 2.0m wide interconnections with boilers and service building at operating floor level and other levels as required and specified.
- ix) Interconnecting platforms with boiler shall be provided for both the units at-
 - a) Operating floor level
 - b) Mezzanine floor level
 - c) PRDS level and
 - d) Deaerator level.
- x) Facility shall be provided for handling of condenser water box to enable maintenance and withdrawal of condenser tubes. Rolling shutter(s) along with extended platform shall be provided to facilitate condenser tube withdrawal.
- xi) Adequate provision for maintenance of regenerative feed heaters shall be provided.
- xii) Corridor for transportation and lifting of Generator Stator outside "A" row column all along TG building shall be considered.
- xiii) Local pits in main plant building shall avoided. However pits/sumps which are unavoidable like CW pits, shall be provided with necessary dewatering arrangements by means of drainage pumps and piping.
- xiv) Below ground basement rooms shall not be considered.

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xv) Required provision for anchoring and load for 400kV conductor stringing from GT to switchyard shall be considered in power house building.

xvi) Debris filter shall preferably be located above ground with covered shed outside the TG building.

9.02.40 CONTROL AND SWITCHGEAR BUILDING

i) The control and switchgear building shall be either a separate building or part of power house building. A common control room for Unit#1 & 2 shall be located between the units in the control and switchgear building/tower, towards the boiler side at operating floor suitably located adjacent to the TG hall, between two boilers, considering ease of cable routing and interconnection.

ii) ACP cladding shall be provided for inside and outside (front side) of PCR building.

iii) The control room shall be designed both aesthetically and ergonomically.

iv) Besides this CCR, control equipment room (CER), programmer room, PC room, UPS/ charger room and battery room shall be provided for each unit. Symmetry to be ensured in finalizing CCR, CER, Programmer room, PC room, UPS/ Charger and battery room layouts. Bidder to ensure space to place standalone/common systems in first unit.

v) The control and switchgear building shall house the Central control room and control equipment room, electrical switchgear room, relay panel room, UPS room, cable spreader room, battery rooms and air-conditioning system room as well as certain O & M Offices.

vi) Symmetry shall be ensured in finalising CCR, CER, Programmer room, PC room, UPS charger and battery room layout.

vii) Space shall be ensured to place standalone systems.

viii) The Central control room shall house the DCS and other electrical control panels

ix) Common control room with control panels in unitized control equipment rooms, for respective units, operator's consoles etc. for all modules.

x) Computer room with programmer station and associated consoles shall be provided.

xi) Electric control panels, protection panel etc shall be suitably located.

xii) Independent cabin shall be provided for the Shift In-charge/supervisor.

xiii) Conference room and C&I engineer's room shall suitably located.

xiv) Pantry and dining facility for shift engineers & staff shall be provided at the operating floor level near CCR.

xv) 24V DC charger, UPS & Batteries on unit basis for control room may be suitably placed, preferably below CCR & CER, at mezzanine floor level.

xvi) Separate wash room for ladies and gents shall be provided near CCR.

xvii) CCR shall not have any internal column inside the room. Large span roof beams shall be adopted for CCR.

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xviii) No vertical bracings, pipes, cable shafts etc. shall be routed through control room or CER.

xix) Following minimum clearances shall be maintained for C&I DDCIMS cabinets:

Internal spacing	1200mm
Clearance from back	1000mm
Clearance from front	1000mm
Clearance from side wall	1000mm

xx) The electrical switchgear room may be located in the control and switchgear building at sufficient elevation, above the cable spreader room. Minimum floor height of the cable spreader room shall be 3.5m.

xxi) AC plant shall be preferably located at the ground floor of the control building.

9.02.41 TRANSFORMER YARD

- i) All power transformers shall be located outdoor.
- ii) Generator transformers, Unit transformer, station transformer, standby Generator transformer, Unit auxiliary transformers, station auxiliary transformer and Auxiliary Transformers shall be located in transformer yard. LT dry type transformers shall be located indoor.
- iii) Adequate distance shall be maintained between the transformers.
- iv) Layout of facilities and equipment shall allow removal of generator transformers, Unit transformer, station transformer, standby maintenance transformer, Unit auxiliary transformers and station auxiliary transformers without disturbing structure, equipment, piping, cabling, bus ducts etc. routed in the area.
- v) Suitable rail track and associated facilities like jacking pads, mooring post / anchor blocks etc. shall be provided in the transformer yard, for each transformer, to facilitate the movement of transformers to and from road.
- vi) Jacking pads shall be provided where the rail tracks changes direction.
- vii) If any pipe is routed underground below the transformer rail foundation, it shall be properly encased.
- viii) Rail track shall be provided for all outdoor transformers up to road, for each transformer of size more than or equal to 7.5MVA.
- ix) When rail track is connected to TG area rail track, rail top shall be at EL 0.00m, corresponding to PHB FFL. And Bus duct support or transformer body shall be at least 8.0 m from A-row of TG building to clear the movement of GT/Stator/UT/ST/UAT on rail line.
- x) Transformers shall be separated from the adjacent building/structure and from each other by a minimum distance, as mentioned below or by a fire wall of minimum two hours fire resistance rating of minimum height 600mm above bushing / pressure relief valve vent, whichever is higher.

Oil capacity of individual	Clear separating distance (m)

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transformer (litres)	
5,000 to 10,000	8.0
10,001 to 20,000	10.0
20,001 to 30,000	12.5
Over 30,000	15.0

- xi) As a safety requirement, fire wall shall be provided on 'A' row of PHB in front of power transformers.
 - xii) For each transformer a pit shall be provided all around the transformer at a minimum distance of 1.5m from transformer edge. A sump pit shall be provided for each pit.
 - xiii) A common oil retention pit per unit shall be provided to hold oil quantity of the largest transformer (by volume) and 10 minutes of water quantity from HVWS system for the largest transformer.
 - xiv) Sump pits from individual transformer shall be connected to the common oil retention pit of that unit.
 - xv) In case of auxiliary transformers having an aggregate oil capacity more than 2300 litres, but individual oil capacity of less than 5000 litres, the separating distance between transformers and surrounding building shall be at least 6m, unless they are separated by a fire wall or are protected by high velocity spray system.
 - xvi) The transformer fencing shall be at 1.0m (min.) distance from the pit wall. The height of fencing shall be 2.5m (min.) and fencing shall have personnel entry gate and removable type fencing/gate for removal of transformer.
 - xvii) IS 1646 / CPIB manual shall also be referred to.
- 9.02.42 **ELECTRICAL MCC & SWITCHGEAR ROOMS**
- i) Separate MCC rooms shall be provided for each unit.
 - ii) Following minimum clearances shall be maintained for HT switchboards:

	Clear distance (m)
Front clearance	
For one row of switchgear	2.0
For two rows of switchgear	2.5
Back clearance	1.5
Side clearance	0.8 + Space for additional panel

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iii) Following minimum clearances shall be maintained for LT switchboards:

	Clear distance (m)
Front clearance	
For one row of switchgear	1.5
For two rows of switchgear	1.5/1.75m depending upon room size
Back clearance	
For single front	1.0
For double front	1.5
Side clearance	0.8 + Space for additional panel

iv) HT switchboard clearances shall be maintained wherever both LT & HT switchboards are in placed in the same MCC room.

v) Height of HT/LT switchgear room

	Clear height (m)
With bus duct	4.5
Without bus duct	4.0

vi) Size and routing/layout of ventilation ducts shall also be considered while maintaining the clearances.

vii) Routing of ventilation duct over the panels shall be avoided. In case if it is unavoidable, minimum 200mm clearance shall be provided above the panel and joints should be avoided over the panels.

viii) For LT switchgear/MCC room at EL 0.00m, minimum 1.4m (wide) x 1.4m (deep) cable trench shall be provided to route the horizontal cable trays.

9.02.43 PIPING AND CABLE ROUTING

i) Minimum clear height of cable/pipe trestle, within the power block area, i.e. from transformer yard to road behind chimney, shall be 8.0m (BoS).

ii) Minimum clear height of cable/pipe trestles, at road/rail crossings shall be 8.0m (BoS).

iii) Trestle height in outlying area shall be 5.0m (BoS).

iv) Trestles/Pipe rack to be provided for routing of cables, pipes etc. shall have a clear height at road crossings so as to clear the road spaces, approach to maintenance bays of different equipment.

v) Height of trestles at approach roads to various buildings/ facilities shall be 8m. In case buildings are located in offsite area and are adjacent to each other, then as

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a good engineering practice, the height of pipe rack shall be maintained all over as 8.0m.

- vi) The pipes including fire water pipes shall be routed over ground either on pedestals or on pipe rack/trestle in the plant area. Trenches for pipes shall be avoided as far as possible.
- vii) Wherever fuel oil pipes and steam pipes are running over the trestle, fire water pipes shall avoided to be routed on the same trestle.
- viii) Headroom below cable/pipe rack in transformer yard area for movement of spare GT shall be such that the same can be moved with bushings installed. A clear gap of 500mm between top of bushing and bottom of structure (BoS) shall be ensured.
- ix) A walkway of 800mm width (minimum) with hand rails and toe guards shall be provided all along length of the trestle for maintenance of cables and pipes. Ladders for approach to these platforms shall be provided near roads, passage ways. Gratings shall be provided for all external walkways.
- x) Wherever ash pipes are routed on the trestle, it shall be routed on a separate tier and separate walkway shall be provided for the same. Clear head room of minimum 2.1m shall be provided for such walkways.
- xi) The layout of shall be developed so as to meet the requirements of the cabling philosophy of the plant.
- xii) Number of bends/change in direction shall be avoided as far as possible.
- xiii) Trestles shall not foul with other structure.
- xiv) Wherever trestles are adjacent to any building it shall not obstruct any windows, doors or other openings (other than those meant for pipes/cables) and any other connecting structures like platforms/stairs etc.
- xv) Separate cable tray for optical fibre cable / UTP cable shall be provided.
- xvi) Maximum cantilever allowed to route pipes and cables is 1.5m.
- xvii) All pipes (50NB and above) should be supported on the structure; pipes hanging from structure on U-clamps shall not be permitted.

9.02.44 OTHER PLANT AREA AND GENERAL REQUIREMENTS

- i) All control rooms, electrical switchgear rooms, pump houses and any other functionally required buildings for the package is in bidder's scope.
- ii) Independent control room along with associated MCC room, UPS room, (one number common for all units of the project) shall be provided for each off-site system.
- iii) Cable trenches are not allowed in these buildings. All panels and switchgears should be kept at 1st floor, above cable floor which will be at the ground level.
- iv) Remote I/O (RIO) rooms shall be provided as required. The exact RIO locations shall be finalised during detailed engineering.
- v) Control rooms/control equipment/RIO rooms shall be air conditioned.

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- vi) Batteries for uninterrupted power supply systems as required shall be placed in a separate ventilated room.
- vii) The CW/ACW pumps shall be suitably located considering buried cooling water conduits to and from the power blocks. CW pumps shall be located in the CW pump house & cooling water from the CT will enter the CW sump through channel and a fore bay.
- viii) ACW booster pump house shall be suitably located near the 'A' row side of the PHB to optimise piping layouts.
- ix) The emergency DG sets shall be located suitable in a separate building, preferably near to the emergency bus.
- x) The interconnection pipe work between plant utilities and power block equipment shall be routed through pipe racks/sleepers. Pipe trenches or buried pipes shall be avoided. The CW/ACW water conduits shall be laid below ground and buried.
- xi) Adequate space as required by the Owner for operator's rest room, tool room and pantries shall be included in all buildings/operating area. Separate wash rooms, for ladies and gents shall be provided in all auxiliary buildings.
- xii) All pumps shall be located in covered building. Proper ventilation shall be provided. All pumps other than the pit/sump pumps shall be located above ground, except submersible pumps.
- xiii) Fabrication yard and laydown area shall also be developed as green belt.
- xiv) All oil pits and floor wash pit shall be provided with cover slab.
- xv) All cable and pipe trenches shall be designed for easy maintenance.

9.02.45 HAZARDOUS AREAS

- i) The bidder shall take full account of any special requirements concerning the nature, handling and storage of all fuel oils, and chemicals etc., and provide plant, equipment, buildings and other services accordingly, including all facilities to ensure the safety of the operating and maintenance personnel.
- ii) The bidder shall provide drawings to define all the hazardous zones taking account of all sources of hazards under normal and abnormal operating conditions, (regardless of whether or not these areas are specifically listed in the specification). The zoning philosophy shall be subject to the approval of the Owner / Engineer.
- iii) In particular, equipment directly concerned with plant which may give rise to a hazardous situation shall be designed to requirements with electrical connection safety barriers or intrinsically safe equipment. Where required by the Owner / Engineer, certification shall be provided to confirm the suitability of the equipment and devices.
- iv) The Bidder shall be responsible for ensuring that all electrical equipment installed in any hazardous zone is designed and tested to suit the relevant zone classification and shall be to the approval of the Owner. Cables shall not be laid in trenches with fuel pipe work.

9.02.46 FIRE PROTECTION PROVISIONS

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Unless otherwise specified or agreed with the Owner, the following design principles should be observed as minimum fire prevention requirements:

- i) Pipeline insulation and the infills of cable and pipeline wall penetrations are to be of non- combustible material.
- ii) All pipelines or vessels with internal temperatures of more than 180°C shall be so arranged as to avoid any contact with flammable liquids if fuel or lube oil lines should leak. Sufficient physical separation shall be ensured.
- iii) Particular care should be taken to eliminate any risk of hot pipeline-insulating material becoming impregnated with flammable liquids in the case of fuel or lube oil line leakage. The insulation is to be covered in its entirety, with an oil resistant sheet, over which the cladding is to be fitted.
- iv) Cable and pipeline ducts must be so arranged and sealed as to avoid any risk of flooding with, lube oil or any other flammable liquid. In addition to sealing the cable and pipeline ducts, the cable basements must be completely sealed against leakage from above as well, in order to preclude the ingress of lube oil or other flammable liquids.
- v) Covered floor ducts/trenches must be easily accessible for inspection and cleaning.
- vi) All parts of plant and equipment are to be arranged so that, no corners or pits are formed, in which flammable matter could collect, and would be difficult to inspect and clean.
- vii) Fuel preheating temperatures should be limited to a margin of at least 10°K below the fuel flash point.
- viii) Lubricating oil lines in the turbine-generator lube oil system are not to be connected with compression-type joints but rather with welded or screwed-type points.
- ix) Non-combustible materials which do not release noxious or toxic fumes must be used for wall and ceiling panelling, for floor covering, and for cubicles and cabinets.

10.00.00 ERECTION, SITE TESTING, COMMISSIONING AND RELIABILITY TEST

- 10.01.00 This section generally covers the minimum requirements of installation, testing and commissioning of various equipments, to be adhered to during the execution of the mechanical, electrical & instrumentation works.
- 10.02.00 Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work.
- 10.03.00 All consumables required for the job shall be ensured by the bidder.
- 10.04.00 Electrical power for testing, commissioning, reliability test and performance guarantee test shall be provided by owner, on the terms and conditions as mentioned in the commercial portion, i.e. Volume-1.

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- 10.05.00 All necessary equipments & instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the bidder.
- 10.06.00 Field quality plans shall be submitted and shall detail out for all the equipments, the quality practices and procedure etc. to be followed by the bidder's site quality control organization during various stages of site activities including receipt of materials/equipments at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning.
- 10.07.00 All inspections and tests shall be done as per approved field quality plans and protocols.
- 10.08.00 The Bidder shall provide all necessary means for execution of inspection and testing, according to the requirements.
- 10.09.00 Erection**
- 10.09.01 Erection work shall be carried out in the manner and sequence as agreed with bidder's site in-charge/resident engineer and the Owner/Engineer.
- 10.09.02 Construction and erection shall be planned such that all below ground construction & erection shall be completed first, preferably before rainy season.
- 10.09.03 All existing structures, piping, conduits, equipment and facilities, if any, shall be protected by the Bidder against damage during erection. Any damage caused by Bidder shall be rectified at his cost to the satisfaction of the Owner.
- 10.09.04 As erection proceeds each assembled part before being boxed up with a view to erecting it finally, shall be inspected and approved by the concerned supervisor. If any defect is found out during such inspection, the bidder shall make it good as per directives from owner.
- 10.09.05 All materials such as electrodes, gaskets, bolts, nuts etc., shall be of reputed make and conforming to relevant Indian Standards. Prior approval of Owner will have to be obtained before commencement of work. Manufacturer's test certificate shall have to be provided when called for.
- 10.09.06 Bidder shall furnish all instruments, isotopes, films etc. for conducting radiography and equip himself fully. Necessary operators of all testing equipment shall be provided by the Bidder. Dark room facilities with air conditioners for storing and processing radiography films and equipment, as necessary, shall have to be arranged by the Bidder. The radiography shall be done on any weld (including welds for repair) only after final heat treatment.
- 10.09.07 The equipment shall be placed on respective support, levelled and aligned with precision measuring instruments, checked for proper clearance between moving and stationary parts wherever applicable.
- 10.09.08 The installation of motors shall be carried out along with driven equipment in accordance with manufacturer's instructions and/or as directed by the Owner.
- 10.09.09 Wherever the scope includes control panels, all connections in control panels shall be completed, checked and adjusted to ensure safety and satisfactory operation of the equipment.

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- 10.09.10 Particular attention shall be given towards removal of buckles and other forms of distortion. Holes in plate work to assist in erection should be avoided.
- 10.09.11 Misalignment in vertical joints shall not exceed 10% of plate thickness or 1.0 mm, or whichever is larger.
- 10.09.12 Misalignment in horizontal joints shall not exceed 15% of upper plate thickness with a maximum of 2 mm for plate thickness above 8 mm and a maximum of 1.0 mm for plate thickness less than 8 mm.
- 10.09.13 Welding sequence shall be adopted in such a way so as to minimise distortion due to weld shrinkage and shall be got approved from the Owner prior to commencement of work.
- 10.09.14 Welding shall not be carried out on wet surfaces and shall be protected from high winds.
- 10.09.15 **ERECTION PROGRAM AND NOTIFICATION**
- i) The Bidder shall furnish a detailed erection programme taking into consideration the constraints likely to be encountered during various phases of work including interfacing with the existing plant. This erection programme shall be strictly adhered to. The Bidder shall take appropriate steps as directed by the Owner to make up for any slippage from this erection programme and no additional compensation shall be allowed on this account.
 - ii) Before erection commences and not later than three months before start of erection, the Bidder shall submit the proposed erection test program and the commissioning test program with all proposed erection and commissioning tests and checks. Together with the test programs the proposed test procedures have to be submitted.
 - iii) The test programs should consider:
 - a) that the sequence and duration of the proposed activities are logical, realistic and in accordance with safety and permit regulations in force
 - b) that the commissioning of any item of plant would not interrupt the normal operation of the existing plant.
 - c) that allowance for training the Owner's operation personnel during this period has been made.
 - iv) The Bidder has to take care that the test programs are maintained by the erection organization during erection and commissioning.
 - v) The Bidder has to mark all stages, which are subject to the Owner's acceptance and has to notify at least one (1) week in advance when such inspection for acceptance becomes due.
- 10.09.16 **SUPERVISION DURING ERECTION**
- i) The Bidder shall provide at proper time the necessary supervisory engineers, supervisors and other supervisory personnel duly qualified and in sufficient number for transportation, handling, unloading, storage, erection, pre-commissioning and post commissioning etc., start-up, testing and trial operation of plants and equipment.

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- ii) The Bidder shall keep a competent representative, who shall be approved by owner, who will be resident Engineer-in- charge and shall remain as In-charge of Bidder's work site and also remain answerable to the Owner for all activities of the Bidder at site. Before his placement at site, the Bidder shall submit his bio-data to the Owner for his approval.
- iii) The resident Engineer-in-charge shall supervise the work of all men of the Bidder working at site. He shall work in complete harmony and co-operation with Owner.
- iv) All statutory rules and labour laws prevailing in the area must be followed by the Bidder.
- v) All the areas shall be maintained clean and organised, both during execution and handover.
- vi) All safety measures against occurrence of accidents must be taken effectively.
- vii) Resident Engineer-in-charge shall not be withdrawn without written permission of the Owner.
- viii) If any of the Bidder's personnel was found unsuitable for the job, the Bidder shall remove him forthwith and a suitable replacement shall be posted to site within a reasonable time. No compensation for withdrawing of unsuitable or unqualified person(s) from site or for posting suitable person(s) to site at any stage of the project shall be allowed by the Owner.

10.09.17 SEQUENCE OF ERECTION WORK

- i) All packing cases and packages shall be opened in presence of the Owner or his authorized representative.
- ii) Each material after stripping from boxes or received loose, shall be carefully inspected, checked with shipping list and identified with erection drawing if necessary. Any short supply and/or damaged part shall be reported forthwith to the Owner in writing. The Bidder shall be completely responsible to make all necessary arrangements, application and follow procedure to process claim on underwriters, obtain replacement repair/rectify and modify as required on all such damaged/defective/lost equipment and material at no extra cost to the Owner in order to execute the work to satisfaction of the Owner within the stipulated contract time. Once the materials are inspected, the same shall be preserved properly and adequately protected from theft and deterioration or damage by rain, storm, dust, water, tampering by casual visitors or workers. The Bidder shall prepare and maintain stores, ledgers and bin cards for all materials in his custody.
- iii) Carrying out all repairs to damages that might have suffered during transit and in subsequent storage and modifications and rectification work and replacement of all lost parts, are under the Bidder's scope.
- iv) Nails and packing strips should be pulled out with suitable appliances and kept separately in container and not thrown away at random. All timber of packing cases shall have to be sorted out and stored properly at a suitable place as directed by the Owner. From time to time packing materials, timber, nails and strips shall be delivered back to the Owner or otherwise disposed of as directed by the Owner.

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- v) All timber and packing materials shall remain the property of the Owner.

10.09.18 INSPECTION

- i) After completion of erection and/or installations and before start-up the equipment and all its appurtenances shall be thoroughly cleaned and then, inspected in the presence of the Owner for correctness, soundness and completeness of installation and acceptability for start-up.
- ii) All works to be carried out by the Bidder shall be subject to inspection by the Owner as applicable. The work shall be carried out as per applicable specifications, codes of practice, drawings and instructions of Owner. The Bidder shall provide necessary facilities, instruments, personnel etc., for carrying out the inspection as above and shall comply with the instructions given.
- iii) A check list in triplicate will be furnished for the approval of Owner wherein all items to be checked and necessary instructions will be listed. Inspection and checking shall strictly follow this check list. On completion of the joint inspection and checking two (2) copies of the check list will have to be handed over to the Owner. The check lists after checking will have to be jointly signed by the Bidder's supervisor and the Owner to ensure that all inspection and checking have been properly carried out. However, such endorsement shall not relieve the Bidder from the responsibility in ensuring proper erection and cleaning.
- iv) During inspection all clearance, alignment and important measurements and adjustments as may be directed shall be noted by the Bidder for future reference and guidance. Two (2) copies of such notes shall be delivered to the Owner.
- v) All reports of radiographic examination in a format approved by the Owner shall be submitted to the Owner for his approval and records.

10.09.19 CLEANING

- i) The Bidder shall observe strict cleanliness throughout execution of the work till handover of the plant.
- ii) Bidder shall be in possession of vacuum cleaner for cleaning the internals of machinery under installation. They shall check that all the finished surfaces are greased and covered.
- iii) Before boxing up, the Bidder shall examine carefully to ensure that no foreign material, such as welding rod ends, welding beads, metal chips, rope, working tools, etc., has been left inside any equipment.
- iv) In the case of motors, the following procedure shall be observed:
 - a) Checking and cleaning of bearings and charging/filling of lubricants, wherever necessary.
 - b) Cleaning of core and winding, drying out and cornicing the winding and measurement of air gap for motor assembled at site.
- v) Wherever the scope includes control panels, all withdrawable components shall be taken out and internals shall be cleaned with vacuum cleaner.

10.10.00 Testing and commissioning

10.10.01 GENERAL

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- i) The Bidder upon completion of installation of equipments and systems shall conduct pre-commissioning and commissioning activities, to make the facilities ready for sustained safe, reliable and efficient operation.
- ii) The pre-commissioning and commissioning activities including checks, initial operation, trial run and Guarantee tests of the equipment furnished and installed by the Bidder, shall be responsibility of the Bidder.
- iii) All pre-commissioning/commissioning activities considered essential for such readiness of the facilities, including those mutually agreed and included in the Bidder's quality assurance program, as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the Bidder.
- iv) It shall be the responsibility of the Bidder to provide all necessary temporary arrangements, connections, instrumentation and other devices required during start-up and initial operation of the equipment systems which are installed by him.
- v) The Bidder shall provide test instruments, calibrating devices, etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Bidder's workmen required for the above test shall always be present at Site during such operations.
- vi) The Bidder shall also be responsible for flushing & initial filling of all oils & lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Bidder shall be also be responsible for supplying such flushing oil and other lubricants unless specified otherwise, elsewhere in these specifications.
- vii) Bidder shall make all arrangements to conduct the commissioning and testing safely and all safety precautions shall be taken appropriately.
- viii) Wastes and effluents generated during these activities shall be suitably disposed off after neutralisation and meeting all statutory requirements, in a manner acceptable to owner and PCB.

10.10.02 TESTING & COMMISSIONING PROCEDURES

- i) Bidder shall prepare and submit equipment/system wise testing and commission procedures, for all equipment/system covered under the contract.
- ii) Commissioning and Testing procedures shall be submitted at least six (6) months prior to actual commissioning/testing; and bidder should ensure that all procedures should be approved by Owner, prior to actual commissioning/testing of the equipment/systems.
- iii) The Bidder shall furnish his recommendations regarding use of various test equipments and instruments and termination/acceptance criteria for testing & commissioning, which in any case shall meet the steam turbine-generator requirements.
- iv) Standard formats for Testing/commissioning procedure are expected to maintain consistency of presentation, content and reporting.
- v) The procedures should contain the following as a minimum:
 - a) Equipment/System details

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- b) Design data
- c) Objective
- d) Pre-requisites and readiness of associated items
- e) Proposal – Method and Sequence of Activities (SoA)
- f) Time duration of each activity
- g) Inputs & Consumables required – Quantity and quality
- h) Specification of temporary arrangements, as required
- i) Safety precautions
- j) Emergency procedures
- k) Schemes and drawings, wherever required.
- l) Completion/Acceptance criteria
- m) Reference drawings/documents
- n) OEM approval/acceptance for certain items like valves / control-valves to be included in the commissioning activities, like Steam Blowing.
- o) Activity Log and commissioning protocol.

vi) Commissioning procedures should include all pre-commissioning activities.

10.10.03 PRE-COMMISSIONING AND INITIAL TRIAL

- i) On completion of erection of equipment, each item of the equipment shall be thoroughly cleaned by Bidder and inspected jointly by the Owner/Consultant and Bidder for correctness and completeness of installation and acceptability for initial trials of the equipment by the Bidder & Owner. During the above joint walk down, the list of equipment deficiency & defects shall be prepared and for such a punch list, action shall be initiated by the bidder in agreed time frame.
- ii) The list of tests to be performed prior to initial trials shall be mutually agreed and included in the Field Quality Plan by Bidder.
- iii) The purpose of these initial trials is to ensure integrity of all individual equipment for its operation in the system for initial operation.
- iv) Following the satisfactory completion of inspection, checking and cleaning of a unit, the plant will be placed in test run. During this period, all adjustments and repairs as required shall be made by the Bidder. Protocol shall be made and signature has to be obtained from Owner/ Bidder. On completion of satisfactory test run, the plant will be placed under trial operation.
- v) Prior to initial trial of any equipment the following shall be checked:
 - a) During erection all required erection tests as well as final erection checks of the mechanical completion of the systems and part thereof have to be performed.
 - b) After successful mechanical completion Mechanical Completion Certificates will be issued.

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c) The activities necessary for mechanical completion shall include but not be limited to following testing, as applicable:

- 1) Visual inspection after unloading at site
- 2) Checking of completion of relevant systems
- 3) Proper installation of the equipment and drive where applicable (like for rotating equipment), on the foundation
- 4) Proper alignment of the equipment and drive where applicable (like for rotating equipment).
- 5) Freeness of the rotors of drive and rotating equipment.
- 6) Proper connection of supports, hangers, piping, valves, instruments and other fittings.
- 7) Healthiness of lube oil system, changing and filling as necessary.
- 8) Safety audit
- 9) Testing of site welds (non-destructive examinations)
- 10) Pressure/leak/tightness test
- 11) Pipe line and equipment flushing and cleaning
- 12) Chemical protection of piping systems
- 13) Checking of coating
- 14) Testing of cranes and hoists
- 15) Safety signs and warning signs
- 16) Completion of buildings and civil works
- 17) Test of ventilating and air-conditioning units

10.10.04 PRE-COMMISSIONING TESTING

- i) After installation of all equipment on foundation, alignment tests shall be carried out by the Bidder to check levelling, clearance, eccentricity etc. Measurements will be witnessed and acceptance will be certified by the Owner and/or owner's representative.
- ii) Preconditions for the commissioning are the issue of the Mechanical Completion Certificate and the availability of the accepted commissioning program and the bidder's commissioning procedures.
- iii) Hydro Test, Air & Gas Tightness Test and vacuum tightness test shall be conducted, as applicable, for the entire system/equipment after installation at required pressure. All necessary blanking and spool arrangements for hydro testing shall be furnished by the Bidder. All necessary test pump/temporary piping/temporary tanks etc shall be supplied by the Bidder. On completion of hydraulic test, bidder shall renew the gaskets, if instructed by the engineer.
- iv) Flushing of piping, including oil flushing of control oil system, lube oil system of all rotating equipment and oil flushing of fuel oil system.

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- v) Steam blowing & chemical cleaning, as applicable of integral piping of the turbo-generator, piping of auxiliaries like BFP, CEP, Drip pump, interconnecting piping of feed water heating system, Low pressure piping, Power cycle piping & other piping in the scope of the Bidder shall be done.
- vi) The Pre-commissioning checks cover the functional tests of the individual items and their alarm and tripping systems.
- vii) Following general tests shall be included:
 - a) Mechanical equipment
 - 1) Individual pre-commissioning runs/initial trials of all rotating equipment such as pumps, compressors, dosing equipment etc.
 - 2) Functional tests of the mechanical equipment
 - 3) Testing and adjustment of safety devices.
 - 4) Fill test of tanks.
 - 5) All tests and activities pertaining to the heater exchangers as per OEM recommendations and this specification.
 - 6) All test and activities pertaining to auxiliaries like BFP, CEP, Drip Pumps,
 - b) Hydraulic Testing of Pressure Parts – Boiler
 - 1) On completion of installation and all welding of the Steam Generator pressure parts and boiler external (non-boiler) high pressure piping, a hydraulic test according to the requirements of the Indian Boiler regulations (IBR) shall be performed by the Bidder.
 - 2) Hydraulic cap / blanking arrangement shall be employed wherever required, especially when valves/control valves supplied by others is installed on the bidder's piping system, during hydraulic testing, and otherwise it should be subject to acceptance of respective valve supplier.
 - 3) The water for hydraulic test shall be made alkaline by addition of suitable chemicals.
 - 4) After the test, the Boiler and high pressure external piping shall be suitably drained and preserved.
 - 5) Any defect noticed during the testing shall be rectified and the unit shall be retested by the Bidder, at the earliest.
 - 6) In case, the branch connection or tap-off piping, which is not in the Bidder's scope of piping, are not ready or not erected at the time of hydraulic testing of piping in Bidder's scope, then the Bidder has to supply and use necessary blanking arrangement as required at these locations.
 - 7) The hydraulic test shall be considered officially successful only on certification by the concerned inspecting authority as per the provision of the IBR and the Owner.

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- c) Hydraulic Test for STG integral piping, heat exchangers, condenser tubes & condenser, equipment cooling water system pipes and associated equipment etc. shall be done.
- d) The hydraulic test of other piping system as per statutory requirement and specified elsewhere shall also be carried out.
- e) Air and Gas Tightness Test of Furnace, Ducts etc.
- 1) After completion of the installation of the furnace tubes and/or inner skin casing wherever applicable, on ducts and air heaters and before commencement of application of insulation, a test shall be performed on the steam generator and ducts, by the Bidder to prove and establish the gas tightness of erected components.
 - 2) The gas tightness shall include all the components in the Air-Gas path, from the outlet of FD fan, through Steam Generator, ESP, FGD, up to the Stack.
 - 3) Such tests shall be established, with all mountings like soot blowers etc. installed in position.
 - 4) Normally physical leak detection method by pressurising the section under test by running FD/PA fan or temporary blower, as the case may be, can be adopted. However, Bidder may adopt any other better method of testing, with the approval of owner.
 - 5) The air & gas tightness test, can be conducted on ducts in segmented manner, as and when these segments are ready.
 - 6) Temporary blanking wherever required has to be provided by Bidder.
- f) Boiler Chemical Cleaning
- 1) Bidder shall perform thorough and efficient cleaning of all the internal parts of the Steam Generator, like economiser, water wall / evaporator, separator, feed water piping, start-up recirculation lines and associated piping covered under these specifications, except those portions, which are to be steam blown.
 - 2) The cleaning operation will include-
 - De-mineralised (DM) water flushing
 - Chemical cleaning using acids
 - DM water rinsing
 - DM water flushing
 - Nitrogen capping etc.
 - 3) The cleaning procedure shall include final flushing and draining of the boiler under a nitrogen gas cap and/or filling the boiler with inhibited water or any other proven procedure recommended by the manufacturer for the preservation of the boiler which is acceptable to the Owner.

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- 4) Dry preservation of non-drainable portion during shutdown has to be provided.
- 5) Chemical cleaning of equipment and piping systems
 - Following piping system, should be included:
 - ◆ Boiler feed pump discharge piping
 - ◆ Main condensate piping
 - ◆ Extraction steam piping
 - ◆ Other miscellaneous piping
- 6) The following equipments which form a part of the above system shall also be included in the cleaning operation.
 - Deaerator
 - Gland steam condenser
 - Drain cooler
- 7) Before introducing chemicals, all the piping systems and equipment listed above shall be water flushed. Water flushing will be followed by alkaline cleaning, acid cleaning and passivation or by EDTA (Ethylene Diamene Tetra Acid) and passivation.
- 8) Pre-cleaning procedure
 - Prior to starting any phase of cleaning operation the following procedures shall be ensured:
 - ◆ Installation of all temporary piping, valves, pumps and equipments as required for the flushing and chemical cleaning operations. Temporary piping shall be routed at floor level as far as possible and secured in place to prevent movement/vibration beyond acceptable limits.
 - ◆ Installation of the instruments as required for ensuring satisfactory monitoring and control of the cleaning process. The Bidder shall also determine and arrange locations for sampling of the cleaning solution during cleaning.
 - ◆ By passing all regulation/control valves coming in the cleaning circuit or installation of temporary spool pieces.
 - ◆ Installation of special end covers and temporary suction strainers, for boiler feed pumps and condensate pumps. pump internals shall not be installed.
 - ◆ Installation of plastic seal in the condenser neck to protect the turbine from alkaline fumes. Blocking and securing of all spring hangers in the steam lines which may be flooded during the cleaning operation.
 - ◆ Hand cleaning of the interiors of all vessels which are included in the cleaning operation.

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9) General cleaning procedures:

- Seal water lines to pump shall be flushed by the permanent arrangement provided for the same.
- Where pipeline terminate in spray headers, these headers shall be inspected after each phase of the cleaning operation and cleaned if necessary.
- All strainers shall be observed closely during the cleaning operation by reading differential pressure gauges, and shall be cleaned when the differential pressure exceeds a predetermined value.
- All high points, vents shall be opened periodically to ensure full system flow.
- Upon completion of each stage of cleaning, the waste products shall be drained and transferred to the waste treatment basins. The Bidder shall then supply and add the necessary chemicals to the basin to neutralize all waste solutions and rinses generated by the cleaning process, and arrange for its disposal to an area to be indicated by the Owner/Engineer.
- Strict safety precautions shall be exercised at all times during the chemical cleaning and during storage and handling of the chemicals. The Bidder shall ensure provision of all protective clothing, apparatus and equipment along with necessary first aid kits as required for handling the chemical and for carrying out the cleaning operation.

g) Steam blowing

- 1) Steam blowing of Boiler including, complete Superheaters, Reheaters and various external and interconnecting steam piping system shall be carried out by the Bidder, as per the agreed/approved procedure.
- 2) Steam blowing shall include engineering, supply and installation of all temporary piping, valves, fittings including quick actuating valves (for puffing purposes), supports, blanking plates, spools, target plates, instruments, controls and all other accessories and services required to complete the cleaning process as specified herein.
- 3) The detailed schemes and procedure for steam blowing operations shall be prepared and furnished by the bidder and discussed and finalized during the detailed engineering stage.
- 4) Steam blowing shall also include reinstatement of cleaned piping systems; and dismantling/removal of all temporary piping, equipment and materials from site. All temporary piping, valves, equipment and materials shall be taken back by the bidder upon satisfactory completion of cleaning, and shall be removed from the Owner's premises.

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- 5) Engineering involved regarding temporary piping shall include the following:
 - Selection of temporary piping including disturbance factor calculation.
 - Preparation of layout of temporary piping and performing stress analysis as per ANSI B 31.1.
 - Selection of temporary hangers and supports as required.
- 6) The following piping systems shall be cleaned through steam blowing operation:
 - Main steam, HRH, CRH, HP bypass & LP bypass piping
 - Auxiliary steam piping including TG gland sealing lines.
- 7) Steam blowing shall be carried out for removal of particles (rust, scales, weld splatter etc.) from various piping systems to avoid damage to turbine balding. Cleanliness of system shall be checked by means of test plates made of steel, which will be installed in the centre line of the piping system.
- 8) Cleaning shall be achieved by steam purging i.e. by blowing of steam through the piping such that the momentum of flow is greater than that of steam flow during normal operation of unit (at TMCR). The disturbance factor during steam blowing (ratio of momentum of flow during purge to that during TMCR) shall be more than 1.4.
- 9) The blow off shall be done with steam, which is exhausted through adequately sized, open-ended temporary piping. Temporary piping and motor operated valves shall be installed for steam blowing operation. Pressure shall be built up in the boiler and the piping warmed before release of steam by quick opening of motor operated valve located on temporary piping. The cycle shall be repeated until steam from the blow out pipe is determined to be clean.
- 10) OEM's acceptance for Valves/control valves which are to be kept installed in steam blowing circuit, should be furnished for owner's approval, before steam blowing; otherwise they will have to be removed during steam blowing. These acceptances should be included along with the procedure.
- 11) For equipments/components installed on high pressure external piping, such as various thermo-wells, flow meter, control valves, HP/LP Bypass valves etc., the Bidder shall comply with guidelines to be followed during steam blowing, with respect to removal / blanking / replacement of such items their internals etc. by spool pieces as given by the respective manufacturer/sub-contractor.
- 12) The actuator operated valves used for steam blowing shall have special characteristics like minimum loss of pressure, resistance to wear during severe working conditions (high velocity and carryover of water and solid particles), quick opening time, minimum effort on actuator etc.

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- 13) If the flow nozzles and control valves etc. have already been erected these shall be removed and replaced by spool pieces before steam blowing. The removed flow nozzle and control valves etc. shall be put back after steam blowing.
- 14) In the case of branch connections/ tap-off piping are not ready or not erected at the time of steam blowing operation then the Bidder to supply/use necessary blanking arrangement as required at these tap-off / branch connections.
- 15) It will be the responsibility of the Bidder to operate the Steam Generator and its accessories equipment to generate adequate steam at the parameter and quality in line with the requirements of steam blowing procedure.
- 16) The Bidder shall make adequate provisions for temporary enhancement of fuel oil firing capacity of the steam generators by changing oil gun tips etc. as may be required so as to be able to conduct complete steam blowing operation by oil firing alone.
- 17) All necessary precautions to avoid fires and cold end corrosion of Air pre-heater, during such oil firing at enhanced SG loads, shall be taken by the Bidder.
- 18) For the steam blowing operation, steam conditions like pressure, temperature etc. at the Steam Generator outlet shall be so selected that a minimum cleaning ratio/ disturbance factor of more than 1.4 is achieved.
- 19) A cycle of heating, cooling and blowing/ purging, is to be repeated to ensure thorough cleaning of the interior of the pipes/ tubes etc.
- 20) The final indication of cleanliness shall be demonstrated by purging through target plates positioned at the discharge point.
- 21) The steam blowing termination criteria shall be, achievement as under:
 - Acceptable target plate condition
 - Measured disturbance factor (DF) more than 1.4.
- 22) The required values to calculate actual DF will be measured at site. The criteria for acceptable target plate condition shall be finalised during detailed engineering.

h) **SCR System**

- 1) Complete pre-commissioning work including tests of facilities such as pressure drop test of SCR system and all other tests as mutually agreed in the Bidder test procedure and field quality assurance program as well as those identified in the specification.

i) **ESP**

- 1) Complete pre-commissioning work including tests of facilities such as air and gas tightness tests of ESP, pressure drop test of ESP, gas

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distribution test of ESPs etc. and all other tests as mutually agreed in the Bidders test procedure and field quality assurance program as well as those identified in the specification.

j) FGD

- 1) Complete pre-commissioning work including tests of facilities such as air and gas tightness tests of FGD, pressure drop test of FGD etc. and all other tests as mutually agreed in the Bidders test procedure and field quality assurance program as well as those identified in the specification.

k) Electrical equipment

- 1) All tests and activities pertaining to Generator and Excitation system and auxiliaries like Primary water system, Seal Oil system, gas system etc.
- 2) The following checks and test measurements shall be made during erection and pre-commissioning (as appropriate) in accordance with agreed standards:
 - Screwed connections for correct assembly
 - Terminals and terminal connections for correct assembly;
 - Checking of earthing connections and testing of earthing resistances
 - Measurement of insulation values
 - Fire proof partitioning
 - Marking, inscription, provision of designation plates
 - Voltage checks
 - Polarity checks in the case of D.C. voltages
 - Fuses, over current trips, short-circuit trips, time settings, relay settings
 - Transformer oil levels
 - Safety signs and warning signs
 - Setting indicators, revertive (check-back) signals to the central control room etc.
 - Checks on wiring and cabling for conformity with the constructional circuit-drawings and plans
 - High-voltage tests
 - Trip tests
 - Functional test on equipment.
 - Tests on the transformers

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- During installation - checking of complete delivery, checking of core earthing and insulation of active part from tank, H.V. sample tests of transformer oil in accordance with IEC, or equivalent Standards.
- During the Tests on Commissioning - checking of satisfactory operation.
- Tests on the generator main busbar - Checking for perfect electrical and mechanical correctness and for the air-tightness of individual main connections system.
- Tests on the earthing and lightning protection system - Acceptance tests and measurements of the earthing installations in accordance with IEC or IS standards.
- Tests on the lighting system - Proof of the minimum new value of lighting densities, checking of correct operation both electrically and mechanically.

I) Control and instrumentation equipment

- 1) Site related test for Control & Instrumentation equipment and calibration tests of instrumentation loop checking, functional testing of control equipment, interlocks, protection inputs, etc. are covered under Volume III, Part – C, Detail Technical Specification for Control & Instrumentation.

10.10.05 COMMISSIONING

- i) A precondition of the commissioning is the successful completion of the pre-commissioning checks of all items of the whole system. Commissioning basically consists of
 - a) Commissioning Tests
 - b) Initial operation and trial operation which also includes in it a Reliability Run and followed by PPA tests.
- ii) *Commissioning tests*
 - a) Commissioning tests shall be performed in accordance with the procedure contained in the commissioning program approved by the Owner for individual equipment/system and as a plant. Commissioning test shall also include redundancy and automatic fall back by simulation of fault conditions
 - b) On completion of each commissioning activity to the satisfaction of the Owner/ Owner's Engineer, the commissioning schedule shall be signed and dated by the Bidder and countersigned by the Owner and Owner's Engineer.
 - c) Commissioning test and initial operation shall prove that the plant is prepared and adjusted to ensure the correct functioning of the individual components and of the complete plant.

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- d) After successful completion of the commissioning tests and initial operation "Authorization to Trial Operation" shall be signed.
- e) The commissioning test shall cover at least demonstration and acceptance of following tests:
- 1) Test run and Operation of Pumps, Blowers, Fans, Compressors and other rotating equipment.
 - 2) Capability of all drives
 - 3) Protection tests
 - 4) Interlock tests
 - 5) Tests on Control & Instrumentation (C&I) Equipments
 - 6) Calibration tests of orifice, flow nozzles, instruments and control equipment to the extent included in these specifications
 - 7) Operation of protection devices including the following as a minimum
 - Boiler protection
 - Steam turbine protection
 - Generator protection
 - Transformer protection
 - Auxiliaries protection
 - 8) Fire protection systems operation
 - 9) Isolation procedures method of isolation of plant equipment for safe shut-down and maintenance procedures including as a minimum
 - HV station and unit supplies
 - LV supplies
 - Protection systems/settings, in accordance with agreed design and the requirements of the transmission system
 - 10) Cold Air Velocity Test (CAVT)
 - A CAVT shall be conducted on each Steam Generator during commissioning before its initial operation to establish the average cold air velocity and the velocity distribution at minimum three predetermined sections (Owner's Choice) of steam generator.
 - The data obtained from the CAVT will be used to compute the actual flue gas velocities as well as their distribution at the test sections during actual operation by correlating the CAVT data with the test/computed data from Thermal Performance Test.
 - Should the CAVT results after this correlation with TPT data indicate actual localized high flue gas velocity zones/ mal-distribution of gas flow and/or flue gas laming, suitably designed stainless steel screens at required SG cross sections shall be

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provided by the Bidder to bring the deviation of the localized gas velocity within $\pm 20\%$ of average gas velocity specified.

- Through this test the Bidder shall also demonstrate the compliance with the specification requirements regarding the maximum allowable flue gas velocities at various sections of the Steam Generator.
- The Bidder shall submit a detailed CAVT report and the computations of actual velocities after correlating CAVT data with TPT data to the Owner for approval.

- 11) Starting with stand-by auxiliaries
- 12) Operation of all auxiliaries, including chemical dosing systems.
- 13) Check run on the Pulverised Fuel (P.F.) Mills including clean air flow test.
- 14) Checks on operation of all air heaters and adjustment of seals, if necessary when each heater is up to its working temperature.
- 15) Checks on operation of all soot blowers and retraction gear and the sequences control.
- 16) Checks on correct functioning of the Burner Management System (BMS).
- 17) Start-up tests
- 18) Commissioning tests and procedures as per agreed/approved procedure for all SG & TG auxiliaries and BoP items within the Bidder's scope of work; including checks on operation of all individual control loops in the control system.
- 19) Checks on operation of all individual control loops in the turbine generator control system.
- 20) Checks on correct functioning of the Turbine Protection System (TPS), Turbine Supervisory Control System (TSCS) for main turbine, Automatic Turbine Run-up System (ATRS), Automatic Testing of Turbine (ATT).
- 21) Turbine bypass operation capability - Test for HP/LP bypass valves operation & their control system.
- 22) Test for operation of governing control system for turbines.
- 23) Condenser vacuum test, feed water heater operational tests for establishing correct cascaded flow, heater water levels etc. & checking of all parameters as per approved heat balance diagrams.
- 24) Verification of start up times and loading rates of power units and steam generators at various downtime conditions
- 25) Normal automatic start to preset load

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- 26) Staged automatic including start to synchronous speed, manual synchronizing (including synchro-check), automatic synchronizing, manual and automatic loading
- 27) Power unit(s), to test partial and full load rejection to demonstrate
- 28) Full load rejection tests to measure transient maximum speed and steady state speed at normal governor droop setting
- 29) Method of resynchronism to be demonstrated

10.10.06 INITIAL AND TRIAL OPERATION

- i) After successful completion of commissioning and Initial Trials of respective equipment and after relevant test protocols have been accepted by the Owner, the Bidder shall be allowed to prepare the Plant Units for Initial Operation.
- ii) After successful Initial Trials of all the individual equipment, all equipment shall be operated together as a system. The purpose of this Initial Operation is to ensure integrity of all the sub-systems which compose the total system. Based on the observations made during Initial Operation, necessary corrections shall be effected in the equipment/systems to ensure proper integrated operation of the system.
- iii) During Initial Operation, any adjustments/calibrations to the instruments fitted in the new system shall be done in the presence of testing staff of Owner so as to enable them to familiarise themselves with its adjustments and maintenance. The Bidder has also to ensure that he trains Owner's Engineers at site dealing with this system in proper way.
- iv) After satisfactory completion of Initial Operation for each sub-systems and systems, the complete Unit shall be considered ready for Trial Operation.
- v) During Trial Operation, the associated plant auxiliaries and Unit will be started up and loaded. During this loading operation all the controls and protections shall be finally set.
- vi) During the period of Trial Operation, all the necessary adjustments in the plant/equipment shall be made by the bidder to establish that the complete system as a whole with all sub-systems and with all standby equipment is ready for coordinated continuous operation. During these trials, all the standby equipment also shall be run alternatively to prove their performance.
- vii) After the plant is loaded to the maximum capability rating and the bidder is fully satisfied with its performance, he shall offer the unit for Reliability run by communicating the same to the Owner in writing. After receipt of such communication and if the owner/engineer is also satisfied with the initial operations, after approval from owner; the plant will be put on trial operation/reliability run.
- viii) During this period, the Bidder shall demonstrate capabilities of his supplied equipment as indicated in the specification or in subsequent discussions.
- ix) The trial operation/reliability run shall also demonstrate the following:
 - a) Performance of individual system during coordinated operation and their performance in design condition.

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b) Unit Start-up

- 1) Start-up time (up to full load), and loading capabilities for the Turbine Generator together for cold start conditions (greater than 36 hours shutdown), warm start conditions (between 8 and 36 hours shutdown) and hot start conditions (less than 8 hours shutdown) or as indicated by the Bidder in the offer and accepted by the Owner, shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam-metal temperature mismatch etc. are within design limits.
- c) Unit start-up/shutdown demonstration as per combined start-up curves for cold, warm and hot conditions
- d) Sustained capability of the plant
- e) Reliability of the equipment and auxiliaries
- f) Adequacy of the various auxiliaries, ancillaries & systems and controls.
- g) Capability of all equipment & drives of the plant to correctly perform the functions, for which it is specified/designed, shall be demonstrated.
- h) Safety requirements
- i) Standby system availability
- j) Operation of interlocks
- k) LP/HP bypass operation capabilities
 - 1) The HP & LP Bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:
 - Generator circuit breaker opening
 - HP - IP stop valves closing due to turbine tripping
 - Sudden reduction in demand to house load
 - 2) It shall also be demonstrated that, under all these conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and condenser pressure beyond the maximum permissible value indicated by the Bidder in his offer and accepted by the Owner.
- l) SH/RH spray system
- m) SADC and its control
- n) Boiler Air & Gas System interlock operation
- o) Soot blower operation
- p) TG Set Capability

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- 1) The steam turbine generator unit shall be capable of delivering at generator terminals the output as indicated by the Bidder in the heat balances submitted along with his bid, under the following condition.
- 2) Maximum continuous output at generator terminals corresponding to both strings of HP heaters out of service, under rated steam conditions, at condenser pressure of 89 mmHg(Abs) and 3% make-up & Aux. Steam requirement tapped from CRH, generating not less than the rated output OR output corresponding to design BMCR heat duty, whichever is less without overstressing turbine components.
- 3) While conducting the tests of (a) above the condenser pressure measurement shall be done at 300mm above the top row of condenser tubes .

q) Condenser

- 1) Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.
- 2) Oxygen content in condensate, at hotwell outlet, shall not exceed 0.015 CC per litre over the entire load range and shall be determined according to calorimetric Indigo - Carmine method
- 3) Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system.
- 4) When one half of the condenser is isolated, condenser shall be capable of taking at least 60% T.G. load under EMCR conditions.
- 5) The capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17 deg.C below the temperature corresponding to absolute suction pressure shall not be less than specified elsewhere. Correction curves for establishing the capacity at site conditions shall also be furnished
- 6) Condenser on load tube cleaning system shall be made ready before trial operation of the plant. Life of sponge rubber balls & Number of balls lost during 720 hours of continuous operation of COLTCS shall be demonstrated by the bidder.

r) Feed Water Heaters & Deaerator

- 1) TTD's and DCA's of feed water heaters in line with 660 MW TMCR heat balance shall be demonstrated.
- 2) Dissolved O₂ content in Deaerator effluent at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/ litre determined as per ASTM-D-5543-09 or Indigo Carmine method.
- 3) Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving deaerator.

s) Boiler Feed Pumps

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- 1) The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated as per specification requirements.
- 2) Cold start up / hot start up of the unit using TDBFP with motive steam from auxiliary steam header.
- t) Condensate Extraction Pumps
 - 1) The vibration, noise level and parallel operation of any two of the three pumps shall be demonstrated.
- u) Drip pumps (if envisaged)
 - 1) The vibration and noise level shall be demonstrated.
- v) Balance pumps, Blowers, Fans, Compressors and other rotating equipment
 - 1) The vibration, noise level and parallel operation, wherever applicable, of the pumps, blowers, fans, compressors and rotating equipment shall be demonstrated.
 - 2) Pumps, blowers, fans, compressors and rotating equipment shall be capable of delivering flow and head corresponding to design point as specified
- w) Demonstration of boiler operation, rate of change of load and sudden load change withstand capability
- x) Sudden Total Loss of External Load
 - 1) On occasions, the steam turbine generator unit may experience sudden total loss of all external load. Under these conditions, the steam turbine generator unit shall not trip but shall continue to be in operation under the control of its speed governor to supply power for the plant auxiliary load with HP-LP bypass in operation while staying within the agreed limits of steam to metal temperature mismatch, exhaust hood temperature, absolute and differential expansion, vibration and eccentricity.
 - 2) The same shall be demonstrated. Further, the provisions of relevant Parts/Sections of the specification shall also be complied with.
- y) Steam Metal Temperature Mismatch Limitation
 - 1) The steam-metal temperature differential for cold, warm and hot start up, loading / unloading and shutdown conditions shall be within the permissible limits indicated by the Bidder in the offer and accepted by the Owner.
- z) Steam Temperature Imbalance
 - 1) The Bidder shall demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10 deg C under all loads including transients.
- aa) Minimum continuous low load operation, without oil support, when firing with the coals from the range identified. The Bidder shall demonstrate that

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with any combination of mills/adjacent mills in service (to Owner's choice) the Steam Generator does not require oil firing for stable boiler operation at the agreed load.

- bb) Operating stability when operated in the full range of load conditions with load variations by increasing or decreasing the electric load
- cc) Demonstration of the capabilities of the Power Units to operate at rated voltage and frequency, at power factors and reactive conditions between 0.85 (lag) and 0.95 (lead) start-up tests of the Plant equipment, facilities and systems including checking of automatic change-over of standby facilities
- dd) Capabilities of firing of 30% imported coal & 10% Biomass
 - 1) Bidder shall demonstrate the capability of Steam generator and its auxiliaries to operate at rated parameters safely and on sustained basis at TMCR load while firing range of Indian coal(s) as specified blended with imported coal up to 30% by weight.
 - 2) Similarly, Bidder shall demonstrate the capability of Steam generator and its auxiliaries to operate at rated parameters stably, safely and on sustained basis at TMCR load while firing 10% Biomass, along with the range of Indian coals and also blended (30% imported coal) coal.
 - 3) Duration of such test, to establish the Steam Generator co-firing capability, will be mutually agreed by Bidder and Owner.
- ee) Performance characteristic of fans (PA/FD/ID fan capacity, head developed, etc
- ff) Margin on equipment, especially fans
 - 1) After completion of installation of fan drives, Fans, inlet and outlet ducting, measuring equipments etc. Bidder shall demonstrate the margin on seal air fans, primary fans, Forced draft fans and induced draft fans as specified elsewhere in Technical Specifications.
 - 2) Similarly margin on other equipment as specified shall be demonstrated.
- gg) Balancing of Coal/Primary air flow
 - 1) Bidder shall balance the primary air as well as coal flows in the pulverised fuel pipes such that the minimum PF and PA flow imbalance in the PF pipes from each coal pulveriser does not exceed 5% of average flows.
 - 2) The above balancing shall be checked by the Bidder by carrying out both clean air test and dirty air test (using dirty pitot tubes)
- hh) ESP
 - 1) Bidder shall demonstrate that ESP air in leakage shall be limited to 1% of the total gas flow under guarantee point condition.

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- 2) Bidder shall demonstrate that the maximum flue gas pressure drop across the ESP under specified guarantee point condition shall not exceed 20 mmwc.
- ii) FGD
- 1) Capabilities of all drives & equipment
- jj) Fire Protection System
- 1) Vibration and noise of fire water pumps
- 2) Parallel Operation, vibration & noise level of the fire water pumps and diesel engines.
- 3) Performance test of each of systems such as, as per the design parameters/ standards/TAC –
- Hydrant,
 - HVW Spray,
 - MVW Spray,
 - Foam Injection system,
 - Inert gas extinguishing system,
 - fire detection and alarm system,
 - Fire monitors
 - Fire extinguishers
- 4) All tests as required by the TAC.
- kk) Satisfactory operation of the Mill Reject Handling System as per the requirements of the specification.
- ll) Satisfactory operation of the Auxiliary Steam and PRDS System as per the requirements of the specification.
- mm) Verification of vibration and noise emission guarantees
- nn) Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees
- oo) Verification of active power response and voltage control response according to the requirements specified in the network connection conditions
- pp) Demonstration of proper controlling, monitoring and recording according to the requirements of the grid code
- qq) Verification of completeness of scope of supply
- rr) Verification of 24 hours uninterrupted MCR operation
- x) Owner will arrange necessary dispatch clearance (to export generated power to the grid) for initial and trial operation from Load dispatch centre / Mahatransco (MSETCL) / Mahavitran.

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- xi) Owner will ensure that all other facilities/systems which is under the scope of owner or other contractors, is ready to support the trial operations.
- xii) The Reliability run of the unit/plant shall be undertaken jointly with the Owner as a part of the trial operation and within the trial operation period. The Trial operation can be done unit wise.
- xiii) The Reliability Run of the unit/plant will be established and the Trail Operation Test shall be considered successful if, during the Trial Operation, the complete plant as an integral unit, shall be operated for minimum 720 continuous hours, on designated fuel, at prevailing ambient conditions, and achieves the following:
 - a) The unit/plant should operate continuously on for minimum Fifteen (15) days uninterrupted at a load not less than 95% of the capacity of the plant; and
 - b) The unit/plant should continuously minimum seventy two (72) hours at rated full load, in fully automatic mode i.e. with Coordinated Master Control (CMC) on fully automatic mode. No interruption is allowed during this 72 hrs period; and
 - c) During the 30 days (720 hrs) period of operation, the 660MW unit shall generate a minimum of 404 million units (kWh) i.e. 85% of maximum possible generation at 100% TMCR, as measured at generator terminals.
- xiv) During the period of trial operation, the time of operation with any load shall be counted. Minor interruptions not exceeding thirty minutes at a time, caused during the continuous operation, shall not affect the total duration of trial operation.
- xv) However, for longer interruption and any interruption due to defect in the equipment and sub-system or system, the owner may extend the duration of trial operation depending upon the period of interruption. In the event of interruptions to the reliability test run, for which the Bidder is responsible, the length of the reliability test run can be extended by a period equal to the total duration of the interruptions.
- xvi) If such an interruption due to bidder lasts more than 24 hours, the reliability test run shall be restarted, after repairing the defect. The reliability test run may be interrupted due to bidder on a maximum of three occasions only.
- xvii) A trial operation report comprising of dates and duration of trial, observations and recordings of various parameters to be measured shall be prepared by the bidder and signed jointly by the owner and the bidder. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the trial operation. If the trial operation is established to be satisfactory, except for some minor adjustments, if any, the bidder shall prepare the plant for performance guarantee test.
- xviii) However, if the Trial Operation is not satisfactory, necessary modification/repairs to the plant/ equipment based on the observations during trial operation shall be carried out by the bidder and on completion of such works the trial operation shall be repeated again.
- xix) The initial & trial operation shall be undertaken jointly with the owner.

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- xx) After the trial operation is carried out successfully, to declare it as such, a joint protocol shall be signed among the Chief Engineer (O&M), Mahagenco, the Project Manager or their authorised representatives and the Bidder.
- xxi) The fuel (primary and secondary), start-up power and auxiliary steam for initial & trial operation, test/commissioning and PG Test shall be provided by the Owner.
- xxii) Moreover, for the Purpose of commissioning, trial operation and Guarantee Tests, the Owner shall provide operating personnel for operation of the equipment. Such personnel provided by the Owner shall work under the supervision of the Bidder till the Plant is taken over by the Owner.

11.00.00 PERFORMACE GUARANTEES AND ACCEPTANCE TESTS

- 11.01.00 The term "Performance Guarantees" wherever appears in the technical specification, shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the technical specification, shall have the same meaning and shall be synonymous to "Guarantee/Acceptance Test(s)"; these terms may also have been used interchangeably.
- 11.02.00 After satisfactory completion of the trial operation, and is established, the performance test shall be conducted at site by the bidder.
- 11.03.00 The bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in the specifications. The performance guarantee figures of the equipment/system shall be proved by the bidder during the performance guarantee test.
- 11.04.00 The bidder shall provide guaranteed performance for the complete package and the values guaranteed shall be binding on him.
- 11.05.00 The bidder shall conduct performance test as described in the contract document and prove the guarantees as per mutually agreed & approved procedures.
- 11.06.00 Performance guarantee shall be provided for operation at contract specific site reference conditions as specified and the guaranteed performance parameters of the plant shall be proved by the bidder during the test. Should the results of these tests show any deficiency from the guaranteed value, the Bidder shall modify the equipment as required at no extra cost, to enable it to meet the guarantee
- 11.07.00 The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
- 11.08.00 The Bidder shall conduct performance tests and demonstrate all the guarantees covered herein during performance guarantee/acceptance test (PG test). The various tests which are to be carried out during the PG test are mentioned in the specification.
- 11.09.00 The tests shall be conducted at the specified load conditions or as near the specified conditions as practicable. The owner/bidder will apply agreed factors to

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compensate for deviation from the designed parameters. The suitable correction curves mutually agreed by the owner and the bidder shall be used.

- 11.10.00 The parameters indicated under 'Correction' shall be guaranteed by the bidder during the performance tests and if the parameters are not attained during the performance tests, bidder shall make all efforts to achieve the parameters.
- 11.11.00 These tests shall be binding on both the owner and the bidder to determine performance of the equipment/system with the performance guarantees data.
- 11.12.00 The Bidder should make the plant ready for the PG tests before start of Trial Operation.
- 11.13.00 Once the Trial Operation starts, No further shutdown is envisaged for preparation of PG test. But, in case of an unavoidable situation, owner will provide required shutdown, on mutually agreed basis.
- 11.14.00 All Category-I Performance Tests shall be conducted along with the Trial Operation; except the following:
- 11.14.01 Coal Mill Wear Parts Warranty
- 11.14.02 Auxiliary Power Consumption for Station Auxiliaries; PG test for Station Auxiliaries Power Consumption can be done along with Unit#2 Initial Operation)
- 11.14.03 PG test of AC System (especially for Auxiliary Power Consumption, under station auxiliaries) shall be carried out by the Bidder within One (1) year of successful completion of trial operation of the respective AC system during summer in the months of March to June. If Unit#2 initial operation falls in these months, then PG test of AC system can be clubbed with Unit#2 initial operation.
- 11.15.00 It shall be responsibility of owner to arrange for start-up power, primary & secondary fuel, water and load dispatch clearance (to export power) during PG tests.
- 11.16.00 The performance tests shall be performed using only the normal number of operating staff provided by the owner. Bidder, vendor or other subcontractor personnel shall only guide wherever required and collect necessary data for compiling the reports.
- 11.17.00 At all times during the performance tests the emissions and effluents from the plant shall not exceed the guaranteed emission and effluent limits.
- 11.18.00 The duration of the Performance Guarantee Test of the plant at the rated capacity shall be mutually agreed. However, a stability period of 2 hours before commencement of test and 2 hours test period followed by another 2 hours stable period shall be maintained.
- 11.19.00 All efforts shall be made for successful completion of the PG test along with Trial Operation of the unit on designated fuel or as per the time frame specified for a particular equipment/ plant/ system in the Technical specifications. Delay in conductance of the test beyond this period will not be normally permitted by the owner. In the event of owner agreeing to conductance of such tests after three months, for reasons not attributable to the owner, as assessed by the owner, no factor for ageing shall be considered for computing performance of the equipment.

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11.20.00 The guarantee tests shall be conducted by the bidder at site in presence of owner on each unit individually.

11.21.00 All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

11.22.00 Any special equipment, tools and tackles required for the successful completion of the performance tests shall be provided by the Bidder free of cost.

11.23.00 Performance Guarantee Tests on the equipments/systems not covered in this section shall be carried out as per the procedure/test codes specified in respective detailed section.

11.24.00 Measurements

11.24.01 All instruments including flow nozzles as necessary for conductance of PG tests shall be installed prior to the start of initial operation. No shutdown shall be allowed for installation of PG test instrument/ flow nozzle etc. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the Bidder, if required. However, same shall be installed before start of initial operation of unit.

11.24.02 All test instrumentation as required for the Performance Guarantee Test shall be provided by the Bidder free of cost. Special / Precision instruments required for Performance Guarantee Test shall, however, be arranged by him and shall be returned to him after successful completion of the tests. All test instrumentation shall be in accordance with the applicable code.

11.24.03 All the necessary instruments (in duplicate) required for the tests shall be furnished by the bidder so as to meet the accuracies specified in the codes.

11.24.04 Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the bidder, if required.

11.24.05 The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes.

11.24.06 Instruments for PG test and instruments for process control of similar applications are envisaged to be of same make and model having same accuracy level. However, instruments for PG tests are also acceptable as per standard and proven practice of the Bidder/OEM and in such case; instruments for process control shall be as per requirements of the specification.

11.24.07 All the instruments shall be calibrated by a certified body (an accredited independent test institute) before and after the tests Instruments need to be calibrated before and after the test to identify the drift which is to be used for applying corrections to the calibration which is estimated based on the average of the pre-test and post-test calibrations

11.24.08 All the instruments including the flow nozzle shall be calibrated by the Bidder before initial operation in a reputed international institute. All calibrations reports shall be made available prior to the start of initial operation and calibration certificates in original submitted to Employer. All calibrations shall be made

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available prior to the test and calibration certificates in original submitted to Owner at least 15 days before conductance of the test for Owner's approval.

- 11.24.09 The calibration certificates shall be considered valid for a period of not more than six (6) months from the date of its calibration or as per the guidelines of NABL accredited Calibration agency.
- 11.24.10 The instruments shall be sealed after calibration by calibrating lab. The percentage calibration error/deviation should not be more than accuracy class of the instrument. Calibration low beta ratio throat tap nozzle assembly including flow straightner, upstream and down stream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC6.
- 11.24.11 All test instruments and calibration procedures shall be duly approved by the Owner. Batch calibration shall not be accepted. Calibration before and after test and installation of the test instrumentation for the test shall be the Bidder's responsibility.
- 11.24.12 Control system loop tuning required to limit the variation of parameters during performance guarantee testing shall be completed prior to Trial Operation / PG Test.
- 11.24.13 All PG test process parameters shall be made available in DDCMIS.
- 11.24.14 The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.
- 11.24.15 Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the bidder; with all costs included in the contract price.
- 11.24.16 For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly shall be installed permanently in condensate line prior to initial operation; same shall be also used for process control.
- 11.24.17 Secondary flow devices shall be calibrated flow nozzle / orifice plate as per ASME PTC 19.5.

11.25.00 Test Documents

11.25.01 TEST PROCEDURE

- i) Bidder shall submit all PG test procedures, as per latest codes / standards, meeting the specification requirements, along with sample calculations and detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.
- ii) The test procedure shall highlight the anticipated date for the test, list of instruments and their accuracies, arrangement and form of the tests.
- iii) The procedure shall include the following for each test or group of tests:
 - a) Objective of the test
 - b) Prerequisites and system readiness checklist.
 - c) Safety and emergency precautions and preparations required; and checklist.

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- d) Various guaranteed parameters & tests as per contract.
- e) Method of conductance of test and test code.
- f) Duration of test, frequency of readings & number of test runs.
- g) Method of performance calculation and formulae.
- h) Correction calculations, curves and respective equations for graphs to be fed for the online computation.
- i) Instrument list consisting of range, accuracy, least count, and location of instruments.
- j) Scheme showing measuring points.
- k) Sample calculation
- l) Acceptance criteria.
- m) The sequence of the tests to be conducted.
- n) The time duration of each test
- o) The number of test runs
- p) A list of instruments that will be used for each test. The list shall define which instruments are:
 - 1) Special test instruments,
 - 2) Certified,
 - 3) To be calibrated before and after each test to identify the drift which is to be used for applying corrections to the calibration which is estimated based on the average of the pre-test and post-test calibrations,
 - 4) Check instruments,
 - 5) Station supply instruments
 - 6) Schematic diagram showing all test points and cross referenced to the instrument list and
 - 7) Method of data logging. Data logging thro' satellite communication is not permitted.
- q) All formulae, calculations, conversion factors, curves, correction curves etc., to be used in the conducting of the tests and the calculations of the test results. All such items shall be to a accuracy level of four decimals.
- r) Sample test reports to data sheets and all specific result sheet forms that will be used for the test.
- s) Special conditions if any.
- t) Any other information required for conducting the test and analysing the test results.

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- iv) The provisions outlined in the ASME performance test code or other International and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless specified otherwise in the specification.
- v) All tests shall be carried out and acceptance shall be according to mutually agreed procedures.

11.25.02 TEST REPORTS

- i) After the conductance of PG test, the test results shall be calculated in Bidder's PG test program/software. The correction curves shall be fed/inbuilt in the PG test program/software. Provision of manual entry of offline data, which cannot be captured online (such as Relative Humidity, Atmospheric pressure, Coal Analysis, Un-burnt carbon in fly ash and bottom ash, Bottom ash / Fly ash collection in various hoppers, Flue gas analysis (grid result) etc.) shall be provided.
- ii) The Bidder shall prepare test reports for each performance test in which the methods followed, instrument readings, graphs, observations, final results obtained etc., shall be recorded.
- iii) Evidence of the test data shall be issued by Bidder after who shall also perform the necessary calculations. The basic information and figures to be used for the tests shall be compiled by Bidder.
- iv) The details of all measuring/recording meters, test instrumentation such as class of accuracy, make etc. shall be covered in the trial operation and performance test reports.
- v) The reports shall contain a summary of any tests and certifications as well as results, recorder charts, observations and comments derived from the testing and turnover procedure as applicable.
- vi) For each of the Performance & Guarantee Tests, the Bidder shall evaluate the test figures and compile the Test Report containing a complete analysis of the test results.
- vii) Bidder shall examine and sign the reports and certificates of all tests. The Owner shall review and comment on all test protocol and procedures, reports and certificates.
- viii) After the conductance of Performance test, the Bidder shall submit the detailed test evaluation report of Performance test results to Owner promptly but not later than two (2) weeks from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Six (6) hard copies and soft copies as desired by owner, of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.

11.26.00 The Bidder shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III.

11.27.00 Should the results of these tests are at adverse side from guaranteed values, the Bidder shall modify the equipment as required to bring it to meet the guarantees. In such cases, the performance tests shall be repeated within one month from the date on which the equipment is made ready again for tests. All costs of

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modifications including labour, material and the cost of additional testing to prove that equipment meets the guarantee shall be borne by the Bidder.

- 11.28.00 If, the PG test fails i.e. the Functional Guarantees are not met, either in whole or in part, the Owner may, at its sole discretion, provide the Bidder notice, setting forth particulars of such defects or failure. The Bidder shall, forthwith upon receipt of such notice, at his own cost and expense, within a reasonable period allowed by the owner, make such changes, modifications and/or additions to the Plant and Equipment or any component thereof, as may be necessary to meet the Functional Guarantees. The Bidder shall notify the Owner upon completion of the necessary replacement, changes, modifications and/or additions, shall request the Owner to facilitate the repetition of the Guarantee Tests until the Functional Guarantees have been met.
- 11.29.00 If, the PG test fails i.e. the level of tested functional/performance guarantee parameters is beyond the acceptable shortfall limits, either in the whole or in part, even after the expiry of any additional time granted by the Owner (i.e. after carrying out necessary changes, modifications, and/or additions), the Owner may, at its sole discretion, exercise anyone of the following options:
- 11.29.01 **FOR CATEGORY-I GUARANTEES – PERFORMANCE GUARANTEES UNDER LIQUIDATED DAMAGES**
- Reject the equipment/system/plant and recover from the Bidder the payments already made; Or
 - Accept the equipment/system/plant after levying liquidated damages as specified in Volume - I, The LD for shortfall in performance shall be levied separately for each unit. The penalty values and acceptable shortfall limits are applicable for per unit basis except for total auxiliary power consumption (as total auxiliary power consumption shall be guaranteed for the two units). The penalty shall be pro-rated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category-I' Guarantees
- 11.29.02 **FOR CATEGORY-II GUARANTEES – PERFORMANCE GUARANTEES UNDER REJECTION**
- Reject the equipment/system/plant and recover from the Bidder the payments already made. Conformance to the performance requirements under Category-II is mandatory.
- 11.29.03 **FOR CATEGORY-III GUARANTEES – PERFORMANCE GUARANTEES UNDER COMPULSORY CORRECTION.**
- Reject the equipment/system/plant and recover from the bidder the payments already made; Or
 - Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover amount equivalent to the damages as determined by the owner, from the contract price. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as 'Category-III' Guarantees

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11.30.00 Guarantees under Category – I (Performance Guarantees under liquidated damages) are as follows:

11.30.01 UNIT HEAT RATE AT 100% TMCR LOAD

- i) This will be the Guaranteed Heat Rate in kcal/kWhr, under rated steam conditions at 77 mmHg(abs) condenser pressure, with zero make-up, at 660 MW load (i.e. 100% of rated load).

11.30.02 UNIT HEAT RATE AT 55% TMCR LOAD

- i) This will be the Guaranteed Heat Rate in kcal/kWhr, under rated steam conditions at 77 mmHg(abs) condenser pressure, with zero make-up, at 363MW load (i.e. 55% of rated load).

11.30.03 TG OUTPUT

- i) Continuous TG output of 693 MW unit load (i.e. 105% of rated load) under rated steam conditions at 77 mm Hg (abs) condenser pressure, with zero make-up.

11.30.04 AVERAGE CONDENSER PRESSURE

- i) Average Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes with 693 MW output, 0% make up, design CW temperature and design CW flow.

Note: The condenser pressure measurement while conducting the guarantee tests from (i) to (iv) above shall be measured at 300 mm above the top row of condenser tubes.

11.30.05 STEAM GENERATING CAPACITY

- i) Steam generating capacity in Tons/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the specified range in Volume – II, Section – 1, Project Information.

11.30.06 UNIT AUXILIARY POWER CONSUMPTION

- i) Unit auxiliary power consumption comprising of all Unit Auxiliaries shall be guaranteed in line with the requirements stipulated in subsequent clauses of this sub-section.
- ii) Power consumption of all unit auxiliaries shall be taken for continuous unit operation at 660 MW (i.e. 100% rated load) under rated steam conditions and at condenser pressure of 77 mm Hg (abs) with 0% make-up with design coal.

11.30.07 AUXILIARY POWER CONSUMPTION FOR STATION AUXILIARIES

- i) Station auxiliary power consumption comprising of all station Auxiliaries (Covered under this BTG Package), required for continuous station operation at 2 x 660 MW (i.e. 100% rated load of all the units) under rated steam conditions and at condenser pressure of 77 mm Hg (abs) with 0% make-up with design coal shall be guaranteed in line with the requirements stipulated in subsequent clauses of this sub-section.
- ii) Note: Power consumption of each of the pump/fan/compressors/ Conveyors etc. wherever mentioned shall be measured with its own drive at the switchgear end.

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11.30.08 LIFE OF COAL PULVERISER WEAR PARTS

- i) Life of coal pulveriser wear parts, in hours of operation, for the entire range of coal characteristics specified.

11.30.09 LIMESTONE CONSUMPTION RATE

- i) Limestone consumption of FGD system in kg/hr under guarantee point conditions.

11.30.10 AHP LEAKAGE

- i) AHP leakage; not more than 5%.

11.30.11 FOR THE ABOVE PURPOSE, RESPECTIVE (CAT-I) PERFORMANCES / GUARANTEES WILL BE COMPUTED AND ESTABLISHED AS FOLLOWS:

- i) *Unit Heat Rates are to be computed as below:*

$$\text{UNIT HEAT RATE (@100\%)} = \frac{\text{Turbine Cycle Heat Rate (THR @100\%)}}{\text{Steam Generator Efficiency (SG\_EFF @100\%)}}$$

And

$$\text{UNIT HEAT RATE (@55\%)} = \frac{\text{Turbine Cycle Heat Rate (THR @55\%)}}{\text{Steam Generator Efficiency (SG\_EFF @55\%)}}$$

- ii) To establish the above, following tests for Turbine Cycle Heat Rate and Steam Generator Efficiency shall be conducted simultaneously but independently:

- a) Following tests for Turbine Cycle Heat Rate and Efficiency of Steam Generator shall be conducted simultaneously, but independently:

- 1) Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at 77 mmHg(abs) Condenser pressure with zero make up at 660 MW unit load (i.e. 100% of rated load).
- 2) Efficiency of the Steam Generator at 660 MW unit load (i.e. 100% of rated load) with 27 degree Celsius ambient temperature and 60% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air.
- 3) Turbine Cycle Heat rate in kcal/kWhr under turbine throttle main steam pressure of 150 Kg/cm² (abs) and turbine throttle main steam temperature / reheat steam temp. at turbine inlet of 565 deg C / 593 deg C (as selected) at 77 mmHg(abs) Condenser pressure with zero make up at 363 MW unit load (i.e. 55 % of rated load) with one TDBFP in operation.
- 4) Efficiency of the Steam Generator at 363 MW unit load (i.e. 55% of rated load) with 27 degree Celsius ambient temperature and 60%

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RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air.

iii) *Turbine Cycle Heat Rate -*

- a) Turbine cycle heat rate at respective TMCR unit loads, after subtracting excitation power and power of TG integral auxiliaries with following conditions:
 - 1) Cycle make-up : 0% makeup
 - 2) Cooling water inlet temperature of 33 °C
 - 3) TDBFP's in operation
 - 4) Generator power factor of 0.85
 - 5) Condenser pressure of 77mmHg (abs)
- b) Gross Turbine cycle heat rate at respective TMCR condition shall be calculated after accounting for pressure drop in main steam piping, Reheater system and all extraction steam piping from steam turbine to feed water heaters & deaerator
- c) Gross Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams:

$$\text{HEAT RATE} = \frac{M_1(H_1 - h_1) + M_2(H_3 - H_2) + M_{IS}(h_1 - h_{IS}) + M_{IR}(H_3 - h_{IR})}{P_G}$$

Where,

M_1 = Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr

M_2 = Quantity of steam from turbine to reheater in Kg/hr

M_{IS} = Quantity of Superheater desuperheating spray flow in Kg/hr

M_{IR} = Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr

H_1 = Enthalpy in kcal/kg of live steam

H_2 = Enthalpy in kcal/kg of steam to reheat

H_3 = Enthalpy in kcal/kg of reheated steam

h_1 = Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters

h_{IS} = Enthalpy of superheater desuperheating spray water in Kcal/Kg

h_{IR} = Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg

P_G = Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 693MW @105%, 660MW @100% and 363MW 55% TMCR unit load –

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- 1) Power taken by Excitation system (kW) including transformer losses, as applicable for various guarantee points, in case of static excitation system is offered. (The transformer losses at various points shall be based on factory test to be conducted)
- 2) Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (kW)
- 3) Power required for lubrication, if lubricating pumps are separately driven (kW)
- 4) Power required for control fluid pumps, if control fluid pumps are separately driven (kW)
- 5) Power required for hydrogen, seal oil auxiliaries, if separately driven (kW)
- 6) Power required for stator water cooling system, if cooling pumps are driven separately (kW)
- 7) Power required for Gland Steam Exhauster (GSC) if GSC Exhausters are separately driven.
- 8) Power required for motors, heaters etc. of any other auxiliary service for the turbine generator (kW)

Note: The calculation formulae shall suitably be corrected or values to be considered depending on spray water tapping location.

- d) Superheater and reheater spray component will be decided based on the desuperheating arrangement.
- iv) It may be noted that the heat balance diagrams and guarantees shall be furnished considering zero spray water quantity for superheater and reheater spray. During Performance Guarantee Testing, in case water is required for superheater and/or reheater temperature control, the bidder shall be entitled to heat rate correction as per correction curves to be submitted by him with his offer.
- v) *Applicable Corrections for Heat Rate, Output and Condenser Pressure*
 - a) Based on the cycle conditions and covering entire range of operation for Turbine, following correction curves for variation in Turbine Cycle Heat Rate i.e. @105%, @100% & @55% TMCR load and TG output to be furnished along with bid:
 - 1) Variation in main steam pressure and temperature
 - 2) Variation in reheater steam temperature
 - 3) Correction curves, if applicable, due to change in reheater spray quantities with respect to coal properties
 - 4) Variation in condenser pressure for main condenser
 - 5) Variation of power factor, frequency, generator hydrogen pressure and voltage.
 - 6) Change in system water storage.

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b) Above correction curves shall be provided for following cases:

- 1) 105% of TMCR for output guarantee
- 2) 100% of TMCR for heat rate guarantee
- 3) 55% of TMCR for heat rate guarantee

Note: In case, any of the above correction curves are not submitted along with price bid, no negative corrections shall be allowed on Turbine Heat Rate, on this account. Positive corrections, if required to be applied, then the amount shall be decided by Owner.

c) Corrections Applicable for Condenser Pressure Guarantee

- 1) Variation in Cooling Water Temperature
- 2) Variation in Cooling Water Flow
- 3) Variation in Heat Load

d) It may be noted that the Heat Balance Diagrams and Guarantees shall be furnished considering the quantities of water for reheater sprays with owner's choice of any mill combination in service. For reheater, the spray quantities used shall not exceed the limits specified elsewhere in the specification. During PG testing, in case, the spray quantity used are at variance from the values used in the heat balance diagrams, the actual values will be used for calculation of heat rate and no correction shall be allowed.

e) However, correction on account of variation in Reheater spray quantities, with respect to values used for the purpose of turbine cycle heat rate values shall be permitted only to the extent that such variations are solely attributable to the change in coal properties, with respect to those specified for the design coal. Bidders shall necessarily include the correction curves for variation in reheater spray quantities with coal properties in his bid proposal, failing which no corrections shall be permitted.

f) The above list of correction curves are conclusive and curves in addition to above shall not be applied.

vi) During the PG tests, through heat rates will be calculated for VWO condition / 105% of TMCR; but Category-I guarantees will be applicable to -

- a) Unit Heat Rate at 100% TMCR Load
- b) Unit Heat Rate at 55% TMCR Load

vii) *Steam Generator Efficiency*

a) Steam Generator efficiency by the bidder shall comply with following limiting parameters:

- 1) Firing design coal
- 2) On Gross Calorific value (GCV) basis
- 3) At 27°C DBT and 60% RH ambient air conditions
- 4) Excess air at economizer outlet - 20%

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5) Corrected flue gas temperature at air preheater outlet

- @105% TMCR - 129°C or as predicted by the Bidder whichever is higher
- @100% TMCR - 125°C or as predicted by the Bidder whichever is higher
- @55% TMCR – 120°C or as predicted by the Bidder whichever is higher

6) Unburned fuel at all guaranteed efficiency load i.e. 1.0% (max.)

- b) Bidder to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the Bidder for parameters indicated at 4), 5) & 6) above are lower than those specified above.
- c) Major requirements/methods of steam generator efficiency tests is as below -

1)	Test Code	As per PTC 4 / B S EN12952-15,2003 (by loss method)
2)	Test loads	105% TMCR (693 MW / VWO unit Load)
		100% TMCR (660 MW unit Load)
		55% TMCR (363 MW unit Load)
3)	Test conditions	Boiler operating with rated excess air, coal fineness and firing design coal.
4)	Ambient air condition	Dry bulb temperature and Relative humidity shall be as specified above. The reference air temperature for the efficiency guarantee/ testing shall be taken as the temperature of air (as the design temperature of air) entering PA and FD fans.
5)	No. of readings	Two sets of consistent readings for each of test loads. Average of the test efficiencies based on above two readings for each load shall be considered for guaranteed efficiency.
6)	Correction to tested efficiency shall be applicable for variation in following parameter only-	
	•	Ambient air temperature.
	•	Relative humidity of ambient air.
	•	Hydrogen in coal.
	•	Moisture in coal.
	•	GCV of coal.
	•	Percentage of ash in coal.
7)	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Owner's approval	
8)	The Steam Generator efficiency testing shall be carried out with any combination of mills in operation to Owner's choice, with fineness of	

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	pulverized coal not exceeding 70% through 200 mesh.
9)	The duration of the test shall be at least four hours. No Soot blowing shall be allowed during the stabilisation period, i.e. for at least four (4) hours prior to commencement of the PG test and also during the test period.
10)	Steam generator efficiency shall be with guaranteed or actual air heater leakages, whichever is higher.

d) Major requirements/methods of steam generator efficiency tests

Sl. No.	Losses to be Measured	Remarks
1)	Loss due to radiation from furnace bottom	To be calculated based on furnace bottom hopper opening and heat flux in this area.
2)	Loss due to unburned carbon	Ash samples will be collected from furnace bottom hopper, Air heater, Economiser and ESP hoppers, duct/SCR hoppers (if applicable). The ash collection rate for computation of losses shall be 20%, 3%, 5% in the furnace bottom hopper, air heater, economiser, duct/SCR hoppers (if applicable) and balance in ESP hoppers. The unburned carbon loss for Steam Generator Efficiency at each load shall be taken as 1.0%
3)	Loss due to sensible heat in ash	To be calculated based on the ash collection rates indicated above and ash temperature of furnace bottom ash as 1040 °C in case of wet bottom ash system and 300 °C or actual, whichever is higher, in case of dry bottom ash system, with heat recovery. Temperature of Duct / economiser ash, SCR hopper ash, Air heater hopper ash, ESP ash shall be considered same as that of flue gas in these areas.
4)	Loss due to Mill Rejects	The total mill rejects throughout of the test (minimum four hours) from all mills shall be considered as one gross which will be weighed to measure the reject rate and then reduce by halving and quartering to the required sample size for calorific value analysis to be used for working out loss due to mill rejects.

- e) Computation other heat losses will be as per PTC-4 / BS EN 12952-15.
- f) Inlet air moisture to be considered in the vapour phase.
- g) Bidder shall furnish the correction curve, for Owner's approval, covering the expected ranges of variations, for all parameters, for the range of coal specified.

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- h) The guaranteed steam efficiency shall be without any heat credit.
- i) For all other aspects, not spelt out here, or in the specifications, where PTC/BS code stipulates the agreement between the parties concerned, before commencement of the PG tests, the Bidder shall get these approved by the Owner. However, no correction to SG efficiency on account of variation in Turbine Cycle parameters, or vice versa, shall be allowed.
- viii) *Gross Continuous TG Power Output*
- a) Gross continuous TG power output at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:
- 1) Cycle make-up: 0% makeup
 - 2) Cooling water inlet temperature of 33 °C.
 - 3) Generator power factor of -0.85
- ix) *Steam generating capacity*
- a) Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's discretion) with the coal being fired from within the range specified at the following conditions with heaters out of service condition:
- 1) BMCR condition
 - 2) TMCR conditions
 - 3) TMCR with all HP heaters out of service condition
- x) *Auxiliary Power Consumption(APC)*
- a) The respective Auxiliary Power Consumption for Unit and Station (2x660MW BTG Package) are to be calculated in isolation to calculate the respective guaranteed power consumption as is illustrated hereunder: The guaranteed auxiliary power consumption shall be sum of the calculated Unit and Station Auxiliary Power Consumption.
- b) Unit Auxiliary Power Consumption
- 1) The unit auxiliary power consumption shall be calculated using the following relationship, with design coal-

$$P_{AU} = P_U + T_L \text{ (Unit)}$$

Where,

P_{AU} = Guaranteed Unit Auxiliary Power Consumption

P_U = Power consumed by the auxiliaries of the unit under test

T_L = Losses of the Generator transformers and Unit Transformers supplied by bidder based on works test reports. While

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guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries.

- 2) The power consumption (P_u) of entire unit auxiliaries fed from unit transformers shall be measured at the incomers of respective unit boards. Suitable correction for auxiliaries not in service at the time of this measured power consumption like MDBFP etc, shall be done on as per the technical specification. If GCB scheme is adopted, suitable corrections for station auxiliaries shall be done.
- 3) All unit auxiliaries required to be operated to continuously the plant at the rated load of 100% TMCR have to be considered. The auxiliaries to be considered shall include but not be limited to the following:
 - Unit Auxiliaries to be considered for calculating P_u
 - ◆ Turbine generator and auxiliaries
 - ◇ Turbine unit oil purifier
 - ◇ Turbine unit control oil purifier
 - ◇ Booster pumps for TDBFP (if applicable)
 - ◇ TDBFP lube. Oil pumps
 - ◇ Feed and discharge pumps of turbine oil purification system
 - ◇ Oil purifiers of TDBFP including feed and discharge pumps
 - ◇ Electric oil heater of TDBFP lube Oil (if applicable)
 - ◇ Electric oil heater for turbine lube oil tank (rated power shall be considered)
 - ◇ Vapour extractor fan motors
 - ◇ MDBFP Auxiliary Oil pump (if applicable)
 - ◇ Condensate Extraction Pumps (CEP)
 - ◇ TG control oil pumps
 - ◇ Oil pumps for HP & LP bypass system
 - ◇ Condenser air evacuation equipment (Vacuum pumps)
 - ◇ BFP drive turbine condenser air evacuation pumps (if applicable)
 - ◇ BFP drive turbine condenser extraction pumps (if applicable)
 - ◇ COLTCS
 - ◇ Drip pumps (if applicable)
 - ◇ Chemical Dosing pumps
 - ◇ Hotwell make up pumps (Duty factor - 0.2)
 - ◇ CW Pumps, including all auxiliaries

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- ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- ◆ **Steam Generator and Auxiliaries**
 - ◇ Primary Air (PA) Fans including its lube oil pumps
 - ◇ Coal Feeders
 - ◇ Seal air fans
 - ◇ Coal mills including its lube oil pumps
 - ◇ Forced Draft (FD) Fans including its lube oil pumps
 - ◇ Regenerative Air Preheater including its lube oil pumps
 - ◇ Electrostatic precipitators (ESP) - with all TR sets , all hopper heaters including wrap around heaters of adapters, if applicable & all insulator heaters/pent house fans (if applicable) of all ESP passes working and rapping system in normal operation. During the test all hopper heaters including wrap around heaters of adapters, if applicable & all insulator heaters/pent house fans (if applicable) of all ESP passes will be in ON condition and set point temperature shall be kept 5 degree Celsius above the flue gas temperature.
 - ◇ Induced Draft (ID) Fans including its lube oil pumps
 - ◇ Boiler circulation pumps
 - ◇ Scanner air fans
 - ◇ Electrical Heat Tracing (if applicable)
 - ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- ◆ **SCR system and auxiliaries**
 - ◇ Ammonia forwarding pump
 - ◇ Dilution air fan
 - ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- ◆ **FGD system**
 - ◇ Absorber recirculation slurry pumps
 - ◇ Air oxidation blowers
 - ◇ Gypsum bleed pump
 - ◇ All Process/filter water pumps

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- ◇ Gypsum dewatering system - Vacuum belt filter, vacuum pump, filtrate pump & agitator, waste water pump and agitator
- ◇ Lime stone preparation system – gravimetric feeder, grinding mill, limestone slurry pump and agitator
- ◇ Sump system – Absorber area sump pump & agitator, gypsum area sump pump & agitator, limestone area sump pump & agitator and auxiliary absorbent pump and agitator
- ◇ All agitators
- ◇ Lime handling system (0.3)
- ◇ Gypsum handling System (1.0)
- ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- ◆ Balance of plant - Unitised systems
 - ◇ Mill reject system (0.5)
 - ◇ ACW (booster) pumps of the unit
 - ◇ DMCW pumps to supply cooling water on the primary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling (Unit auxiliaries) water system.
 - ◇ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- Electrical system
 - ◆ Losses in Bus ducts (at rated load conditions)
 - ◇ Isolated phase bus duct (IPBD)
 - ◇ Segregated phase bus duct (SPBD)
 - ◆ UPS power consumption (at rated load condition)
 - ◆ DC System power consumption (at rated load condition)
 - ◆ GCB Losses of Unit : Losses and fan power for Generator Circuit Breaker (if applicable)
 - ◆ Other Unit auxiliaries (Bidder to list all other continuously/intermittently running equipment)
- 4) Transformer losses (for Unit)
 - Transformer losses (at rated capacity) shall include –
 - ◆ Iron loss
 - ◆ Copper loss
 - ◆ Cooler pump and fan loss

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- Following transformers are included:
 - ◆ Generator Transformer losses (at rated Load Condition)
 - ◆ Unit auxiliary transformer losses (at rated load conditions)
 - ◆ Station transformer losses (at Unit rated load conditions)
 - ◆ Losses in all other service/auxiliary transformers (at rated load conditions)
- 5) The bidder shall furnish a list of equipment to be covered under Unit auxiliary power consumption, which shall be subject to Owner's approval.
- 6) The bidder shall ensure that power supply to all such equipment to be covered under unit auxiliary power consumption is fed from unit board of the respective unit.
- 7) The measurement for guaranteed auxiliary power consumption shall be carried out during ESP collection efficiency test. The method for computing the power shall be as described below:-
 - Power consumption of ESP will be measured pass wise and for one pass/stream (Say ESP-A) at a time with the help of energy meter in ESP MCC.
 - Energy meter reading will be taken before starting the collection efficiency test and after completion of collection efficiency test.
 - Before starting collection efficiency test, switch off all the TR sets, all hopper heaters, all insulator heaters/pent house fans (if applicable) and rapping systems serving to one pass (ESP-A) temporally and note down energy meter readings for period t1 i.e. E1. The power consumption shall be $W1=E1/t1$.
 - During the collection efficiency test the total energy fed in to ESP MCC of one pass (say ESP-A) will be measured during entire period of collection efficiency test i.e. E2. Total time period (t2) of test shall be noted. The power consumption shall be $W2=E2/t2$. During the test all hopper heaters of all ESP passes will be in ON condition and set point temperature shall be kept 5 °C above the flue gas temperature.
 - Measured power consumption for one ESP pass (say ESP-A) = $(W2-W1)$
 - Measured Electrostatic Precipitator power of one unit = Power of (ESP-A + ESP-B + ESP-C + ESP-D + ESP-E + ESP-F)
 - Number of stream & fields shall be as per the PG test of ESP as detailed elsewhere.
- 8) Guaranteed Unit Auxiliary Power Consumption of FGD system shall be taken by considering the additional pressure drop in the FGD system during FGD SO₂ removal efficiency test at specified guarantee point conditions. For this purpose, difference of FGD

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system pressure drop during FGD SO₂ removal efficiency test and that at Unit Auxiliary Power Consumption test shall be loaded as additional Auxiliary Power Consumption.

- Generation from roof top solar during the test period shall be added to the total measured power consumption.

c) Station Auxiliary Power Consumption

- 1) The station auxiliary power consumption shall be calculated using the following relationship, with design coal-

$$P_{AS} = P_S + T_L \text{ (Station)}$$

$$\&$$

$$P_S = \text{SUM} (P_i \times D_i)$$

Where,

P_{AS} = Guaranteed Station Auxiliary Power Consumption

P_S = Total Power Consumption, while running the units at 100% design load for all auxiliaries of the (2x660MW) station, supplied by the Bidder under this Package.

P_i = Power consumed by each station auxiliary

D_i = Duty factor to be considered for each station auxiliary

T_L = In this case (Station) - Transformer Losses of the Station transformers and that of any other Transformers associated with station auxiliary power supply system (excluding those in Unit system like GT, UT, UAT, UST etc.) and shunt reactor supplied by bidder, for meeting station auxiliary power supply, based on works test reports.

- 2) Losses of transformers shall be considered based on the works test reports as per the criteria specified in subsequent clauses under the subheading Transformers.
- 3) While guaranteeing the station auxiliary power consumption the bidder shall necessarily include all the station auxiliaries running at full load with duty factors as have been defined herein.
- 4) Common auxiliaries/system for both units such as Fire Protection System, Illumination, and HVAC etc shall be apportioned for individual units during testing & calculation.
- 5) The station auxiliaries that shall be running during the guarantee test for calculating " P_S " shall include but not be limited to the following:
- Plant Instrument and Service Air Compressors & Air Drying Plant
 - ◆ Instrument Air Compressors (All Normally Running (4 Nos.)) – Duty Factor=0.6
 - ◆ Service Air Compressors (All Normally Running (2 Nos.)) – Duty Factor=0.35

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- ◆ ADP Heaters (if applicable) (All Normally Running (4 Nos.)) – Duty Factor=0.5
- ◆ ADP Heaters (if applicable) (All Normally Running (4 Nos.)) – Duty Factor=1.0
- ◆ Power consumption at rated duty point for compressors to be arrived based on shop test and power consumption at rated duty point for Air Drying plant to be arrived based on site test.
- Air Conditioning System
 - ◆ Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of Chilling machines / VAM machine, Chilled water Pumps, Condenser water Pumps, Air handling unit (AHU) fans, cooling tower fans and other auxiliaries for the Air conditioning system of main plant building, FGD control room, ESP control room of each units, AHP control room, service building, administrative building. Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air conditioning system of auxiliary plants like ESP control rooms, FGD control rooms, etc. Power consumption at motor input terminals of centrifugal fans of mechanical ventilation system.
 - ◆ Power consumption at rated duty point for water cooled chillers & air cooled condensing units shall be based on site test and for other drives like chilled water pumps, Condenser water Pumps & AHU/centrifugal fans shall be based on shop test.
- Mill Reject System
 - ◆ Mill Reject conveying system: Duty Factor – 1.0
- Auxiliary Water System Pumps (Working Pumps)
 - ◆ Service water pumps
 - ◆ Potable water pumps
 - ◆ DM water transfer pumps
 - ◆ Waste water transfer pumps
 - ◆ Any other pump/drive required for continuous operation of the plant.
- Fuel Oil System
 - ◆ LDO forwarding/pressuring pumps – Duty factor – 0.5
- Plant Illumination
 - ◆ Indoor Lighting

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- ◆ Outdoor Lighting – Duty factor – 0.4
 - DMCW / ECW system for common auxiliaries
 - ◆ ECW system for common station auxiliaries (as provided). Total power consumption of all equipments (excluding envisaged standby ones) shall be included.
 - Transformers
 - ◆ Transformer losses (TL) shall be considered as per following (as applicable)-
 - ◇ GT - 100% no load loss, 54% of Copper losses & 100% Cooler Loss.
 - ◇ ST– 100% no load loss, 8% of Copper losses & 9% Cooler Loss.
 - ◇ UT – 100% no load loss, 52% of Copper losses & 50% Cooler Loss.
 - ◇ Aux/ LT Outdoor/ LT Indoor Transformer: 100% no load loss & 25% of Copper losses
 - ◇ Reactor – losses at rated voltage
 - 6) The above list is not comprehensive and only indicative. Bidder shall furnish the comprehensive list of equipment to be covered under station auxiliary system, which is to be considered under station auxiliary power consumption. That will be subject to Owner's approval.
 - 7) Where duty factor is not indicated the same is to be considered as '1.0'.
- xi) *Condenser Pressure in mm Hg (abs)*
- a) Performance test for design condenser pressure shall be conducted in accordance with latest edition of ASME PTC-12.2. The condenser pressure shall be measured with a vacuum grid utilizing ASME basket tips. The grid shall be fitted at 300mm above top row of condenser tubes.
 - b) The tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.
 - c) The tube side fouling resistance for design condition shall be calculated as per specified cleanliness factor of 0.9. The tube side fouling resistance for actual test condition shall be measured as per methodology given in ASME PTC 12.2. Alternately, the same shall be calculated using expected actual cleanliness factor appropriately assessed considering the aspect of actual tube cleaning prior to conducting the test.
- xii) *Air pre-heater leakage*
- a) It shall be demonstrated that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed value or specified value (whichever is lower) of Technical specifications.

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- b) Above requirement needs to be complied with recirculation of flue gas from downstream of ESP.

xiii) *Life of Coal Pulveriser Wear Parts*

- a) The Bidder shall warrant the wear life of all wear parts of the coal pulveriser when grinding the specified range of coal(s). Pulveriser wear parts are defined as those parts of the pulveriser which are in contact with coal or coal dust and are likely to wear out during the operation of the pulveriser.
- b) The guarantee/warranty shall be demonstrated on each pulveriser during the Guarantee Trial Period (GTP) commencing after establishing successful operation of the pulveriser continuously for a period of not less than twenty four (24) hours, at or near its guaranteed rated capacity.
- c) The GTP for the respective wear part(s) shall be at least three years or the wear life of that wear part(s), whichever occurs later. The establishment of the warranty will be based on equivalent running hours of the pulveriser regardless of the specified coal. The average wear life (AWL) of the mill wear parts during GTP shall, however be corrected for the variation in YGP index for the coal fired during GTP.
- d) Minimum Guaranteed Life for various coal pulveriser wear parts shall be as indicated in relevant sections of the specification.
- e) The wear parts shall be considered to have passed their warranted operating life when they have successfully demonstrated their capability to meet the full load rated capacity of the pulveriser (as per requirements of relevant clause of Specification) during the guaranteed life of the wear part.
- f) No weld build-up or reversing of grinding elements will be permitted for achieving the guaranteed wear life. In case any of the wear part has worn out to such an extent that either the normal or safe operation of the pulveriser is jeopardized, if that part is not replaced/repared, or continuous use with this part may lead to exposure or wear of other parts which are not meant for the purpose of checking the shortfall in wear life, even if there is no reduction in pulveriser rated capacity, then the part shall be deemed to have outlived its wear life.
- g) If any of the wear parts fail to meet the warranted life, additional quantities of these wear parts shall be supplied on pro-rata basis as defined below. For the duration of this warranty period, the replacement wear parts shall be available to the Owner at the spare part price indicated in the Contract, adjusted as per terms and conditions of the Contract.
- h) Computation of liquidated damages for plant life of 10 years.
 - 1) On the expiry of GTP (minimum 3 years), deficiency in the life of each wear part that has not fulfilled the warranty will be worked out on an item wise basis and shortfall so established due to reduced wear life and its implications for the plant life shall be worked out.

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2) The Bidder at no extra cost to the Employer shall provide one and half times the wear parts needed to make good the shortfall in the wear life for 10 years of plant life.

- i) The shortfall part settlement (SPS) will be calculated based on the actual wear life of the parts that have worn-out in the GTP on a pulveriser-by-pulveriser basis. In this connection the procedure given below shall be followed.
- j) Pulveriser Warranty Shortfall Part Settlement (SPS) Procedure (With Example), for all wear parts of each coal pulveriser:

Sl. No.	Description	Procedure	Example
1)	Guaranteed wear life of wear part	Say, X – hours	X = 16000 hrs
2)	Total life achieved by a particular wear part during GTP	Say, X1 hours by Originally installed part(s), & X2 hours by Subsequently replaced part(s)	X1 = 13,000 hrs X2 = 14,000 hrs
3)	Average Wear Life (AWL) of failed wear part(s)	$AWL = (X1+X2)/2$	AWL = $(13000+14000)/2$ = 13500 hrs
4)	Shortfall in hours Total shortfall for wear part during GTP	$S = (X-X1)+(X-X2)$	S = $(16000-13000) + (16000-14000)$ = 5000 hrs
5)	GTP in years	$GTP = (X1+X2)/8760$	GTP = $(13000+14000)/8760$ = 3.08
6)	Shortfall Part Settlement	$SPS = (S \times 10)/(AWL \times GTP)$	SPS = $(5000 \times 10)/(13500 \times 3.08)$ = 1.202 (To be rounded off to nearest whole number) = 1.0

- k) The Bidder shall provide to Owner either the wear parts of original or better quality material in number equivalent to one and half times the quantity worked out based on the method explained in the above example so as to compensate for the shortfall in wear life for a plant life of 10 years as has been established above, or the cost of such number (i.e. one and half

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times the quantity worked out as per the above example) of wear parts based on the prices agreed for mandatory spares.

- l) The final mode of compensation for such shortfall viz. by means of additional quantities of spares worked out or by cost thereof shall be as per Owner's discretion. The total cost of such replacements shall be without any limit to the maximum amount recoverable subject to the provisions of this Specification.
- m) The credit of one and half times of shortfall in wear parts life shall also apply for already supplied mandatory spare parts under this contract based on average wear life achieved during GTP period.
- n) Average Wear Life (AWL) during GTP, to be considered for pulveriser wear part warranty shall be as arrived at from the station record for each pulveriser, and as corrected for variation in YGP index of the coal being fired during GTP. For this purpose the coal YGP shall be the average tested value during GTP. The Bidder shall collect the coal samples and get them tested for YGP index at recognized, Owner's approved test lab, periodically. (The frequency of sampling and testing shall be mutually agreed between Bidder & Owner). The YGP index testing shall be done as per the BS Standard specified. A jointly signed record shall be maintained during GTP.
- xiv) Lime stone consumption
 - a) The bidder to calculate the lime stone consumption for the guaranteed SOx generation based on the combustion calculation considering design coal specified for the project and design the wet FGD system and subsystem to maintain SO₂ emission level less than 70 mg/Nm³ (6% O₂ dry) at 100% TMCR, considering 20% excess air at economizer outlet, 15% Air heater in leakage and 2% duct and 1% ESP leakage as a minimum.
- xv) SCR Catalyst Life
 - a) Bidder shall guarantee and demonstrate minimum SCR catalyst life of 16000 hrs. The catalyst shall be deemed to have exhausted its life as and when SCR efficiency for control of NOx emission reaches to a level of 70%, with ammonia slip not exceeding 3ppm at 6% oxygen (O₂) content in flue gas on dry gas basis.
- xvi) Ammonia consumption for DeNOx /SCR system.
 - a) Guaranteed Ammonia consumption rate (in Kg/hr/unit, 99.5 wt %), at 100% TMCR, for firing worst coal, shall be demonstrated. The ammonia consumption rate shall be measured during the test for SCR efficiency for control of NOx emission.
 - b) Maximum NOx emission (thermal as well as fuel) measured as NO₂ from the Steam Generator unit shall not exceed 70 mg/Nm³ (at 6% O₂ level and dry basis) for design coal specified; at 100% TMCR continuous operation provided the minimum catalyst inlet temperature required for ammonia injection is maintained.

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11.31.00 Guarantees under Category – II (Performance Guarantees under rejection) are as follows:

11.31.01 NO_x EMISSION

- i) It shall be guaranteed that, total NO_x emission from the unit shall be less than 70 mg/Nm³ (6% O₂ dry), at 100% TMCR, with design coal.
- ii) The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load up to 50% of total load.

11.31.02 SO_x EMISSION

- i) It shall be guaranteed that total SO_x emission from the unit shall be less than 70 mg/Nm³ (6% O₂ dry), at 100% TMCR, with design coal.

11.31.03 PARTICULATE MATTER EMISSION

- i) It shall be guaranteed that, with one field out of service in each stream/pass, the particulate emission from ESP at 100% TMCR load and worst coal firing shall be less than 27 mg/Nm³. The corresponding ESP efficiency shall be worked out.

11.31.04 NOISE LEVEL

- i) All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in the technical specifications.

11.31.05 FOR THE ABOVE PURPOSE, RESPECTIVE (CAT-II) PERFORMANCES / GUARANTEES WILL BE COMPUTED AND ESTABLISHED AS FOLLOWS:

- i) Particulate Matter Emission from Electrostatic Precipitator
 - a) The performance/acceptance tests shall be carried out in accordance with method-17 of EPA (Environmental Protection Agency of USA) code. The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.
 - b) The particulate emission from ESP shall not be more than 27 mg/Nm³ under guarantee point condition at 100% TMCR load with worst coal firing. The corresponding ESP efficiency shall be worked out.
 - c) The ESP air in leakage shall not be more than 1% of total gas flow at ESP inlet at the guarantee point condition and shall be demonstrated.
 - d) The maximum pressure drop through the ESP at the guarantee point flow condition shall not exceed 25 mm WC, which shall be demonstrated.
 - e) The gas distribution in the various stream and fields shall be demonstrated.
 - f) Method of computing test efficiency of ESP
 - 1) The performance test on electrostatic precipitator will commence after a minimum period of three thousand (3000) hours of cumulative operation after completion of initial operation. During the interval between the commencement of trial operation and the commencement of performance test only routine maintenance shall be carried out. No physical or chemical cleaning of ESP shall be

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permitted during this period or immediately before the conductance of the performance tests.

- 2) The test efficiency shall be based on the overall performance of the electrostatic precipitator over a mutually agreed period of operation under the conditions given in this specification and allowing the normal operation of the unit including rapping and normal soot blowing and/or when fuel oil is being fired in the igniters and/or warm up guns.
- 3) The overall test efficiency and test temperature/inlet dust burden for one set of ESP passes (stream) serving one Steam Generator shall be worked out as follows:
 - Vm (guarantee point test flow) shall be the total of inlet gas flows to the all the gas streams at the time of test.
 - Test inlet dust burden (Di) shall be weighted mean of the inlet dust burdens for the individual streams i.e.:

$$D_i = \frac{(V_{m1} \times D_{i1}) + (V_{m2} \times D_{i2}) + (V_{m3} \times D_{i3}) + (V_{m4} \times D_{i4}) + (V_{m5} \times D_{i5}) + (V_{m6} \times D_{i6})}{(V_{m1} + V_{m2} + V_{m3} + V_{m4} + V_{m5} + V_{m6})}$$

Where suffix 1, 2, 3, 4, 5 & 6, represent the six gas streams; The formula will be revised accordingly, if the no. of streams vary.

Similarly, the test outlet dust burden (Do) will be calculated based on outlet gas flow.

- The weighted test inlet gas temperature (Ti) shall also be worked out in a similar manner i.e.

$$T_i = \frac{(V_{m1} \times T_{i1}) + (V_{m2} \times T_{i2}) + (V_{m3} \times T_{i3}) + (V_{m4} \times T_{i4}) + (V_{m5} \times T_{i5}) + (V_{m6} \times T_{i6})}{(V_{m1} + V_{m2} + V_{m3} + V_{m4} + V_{m5} + V_{m6})}$$

- The measured test efficiency shall be

$$E_m = \frac{D_i - D_o}{D_i} \times 100 (\%)$$

- The corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temp. shall be based on the above computed test values and the procedure indicated in the next para.

Note: 5th & 6th gas stream if applicable

- 4) At the time of performance testing if the inlet flue gas conditions are not consistent with the specified conditions, due to variation in coal characteristics from the design coal and boiler operating conditions the precipitator performance conforming to this specification, shall be

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determined using performance curves and correction factors accepted at the time of award of contract. However, the test efficiency shall be corrected to the guarantee point conditions in the following manner:

- $E_c = 1 - e^Z$

Where,

E_c = Corrected test efficiency to guaranteed point conditions

$$Z = C \cdot \ln(1 - E_g)$$

$$C = 1/(C_a \times C_b \times C_c \text{ etc.})$$

C_a , C_b , C_c etc. are correction factors for flue gas at temperature, ESP inlet dust loading and sulphur based on correction curves furnished by the bidder and approved by the owner.

- $E_g = 1 - e^Y$

Where,

$$Y = (V_m/V_g)^{0.5} \ln(1 - E_m)$$

E_g = Measured test efficiency corrected to the specified guaranteed point flow

V_g = Specified guaranteed point gas flow (m³/sec)

V_m = measured gas flow {m³/sec}

E_m = Measured test efficiency

$\ln$ = Logarithm, natural base

- 5) The correction curves should be realistic for expected range of operation and variation in characteristic specified.
- 6) The test efficiency shall be the average of at least three corrected test efficiencies

ii) Method of Computing Test Efficiency of FGD

- a) The performance tests shall be carried out in accordance with ASME PTC 40 (2017) code.
- b) The details of the test shall, however be mutually agreed upon between the Owner and the Bidder.

iii) Noise Levels

- a) Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of BS EN 61672-1, 2 & 3 / IS 15575.
- b) Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

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- c) A minimum of 6 points around each equipment, shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A-weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

11.32.00 Guarantees under Category – III (Performance Guarantees under compulsory correction) are as follows:

11.32.01 START-UP

- i) Start-up time (upto full load), and loading capabilities for the complete unit (boiler, turbine and generator together) for cold start, warm start and hot start conditions as agreed shall be demonstrated, ensuring that the various turbine operational parameters like vibration, absolute and differential expansion, eccentricity and steam metal temperature mismatch etc. are within design limits.

11.32.02 UNIT LOAD RAMP RATE CAPABILITY

- i) Individual unit load ramp rate capability shall be demonstrated as per the requirements of the specification, ramp-up up to 100% load and ramp down up to minimum continuous operating load; while maintaining the parameters within prescribed limits.

11.32.03 MINIMUM CONTINUOUS LOW LOAD OPERATION

- i) Minimum continuous low load operation, without oil support, when firing with the coals from the range identified. The Bidder shall demonstrate that with any combination of mills/adjacent mills in service (to Owner's choice) the Steam Generator does not require oil firing for stable boiler operation at the minimum specified load.

11.32.04 STEAM GENERATOR AND AUXILIARIES

- i) The total attemperation water flow quantity for super heater steam temperature control T/hr
- 100% TMCR condition while firing design Coal
 - 100% TMCR condition while firing Worst Coal
 - 80% TMCR condition under sliding pressure operation while firing design Coal
 - 80% TMCR condition under sliding pressure operation while firing worst Coal
- ii) The total attemperation water flow quantity for reheater steam temperature control with rated excess air
- 100% TMCR condition while firing design Coal
 - 100% TMCR condition while firing Worst Coal

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- c) 80% TMCR condition under sliding pressure operation while firing design Coal
- d) 80% TMCR condition under sliding pressure operation while firing worst Coal
- e) It shall also be demonstrated that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions (100% TMCR)
- iii) The super heater steam temperature at the high pressure (HP) turbine inlet under the following conditions(°C)
 - a) Range of Coal specified
 - b) Steam Generator load 60% TMCR to 100% BMCR under sliding pressure operation
- iv) The reheat steam temperature at the intermediate pressure (IP) turbine inlet under the following conditions (°C):
 - a) Range of coal specified
 - b) Steam Generator load 60% TMCR to 100% BMCR under sliding pressure operation
- v) Steam temperature imbalance
 - a) It shall be demonstrated at SH and RH outlets (in case of more than one outlet) that the temperature imbalance between the outlets does not exceed 10°C under all loads including transients.
- vi) Furnace exit gas temperature (FEGT)
 - a) It shall be demonstrated that maximum furnace exit gas temperature (FEGT) shall be as specified. A comprehensive thermal performance test (TPT) shall be conducted for this purpose on one unit only. FEGT shall be demonstrated through such TPT by indirect measurement, with coal pulveriser combinations of Owner's choice and all other requirement in line with Technical Specifications.
 - b) The demonstration shall be done by backward calculations method, after having measured/tested/calculated the economizer outlet gas temperature (average), excess air (average), unit heat load (based on turbine flow and reheater flow), characteristics of coal being actually fired during testing, heat absorption in different stages of heat transfer equipments (based on steam/water temperature and pressure measurements) etc.
 - c) FEGT for the specified design and worst coals shall be calculated using the measured FEGT (with test coal) as above and using computer modelling technique for necessary conversion of the results to the specified design and worst coals. The FEGT demonstration using computer modelling technique shall involve following steps:
 - 1) Development of a computer field model (FM) (backward) using above measured/computed field data. This will be used to calculate the surface effectiveness factor (SEF) for each of heat transfer banks including furnace water walls with test coal.

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- 2) The above field model shall have to be validated by various tests (loads, coal pulveriser combination etc. with test coal) to ensure SEFs for each bank are consistent (within $\pm 5\%$) for all tests.
 - 3) Using above SEFs, for each heat transfer bank Bidder's original boiler design model will be changed to make it this '2X660 MW UNITS - 11 & 12 PROJECT specific'.
 - 4) The validity of the above model shall be checked for each test by feeding the test coal both from backward direction FM and the calibrated this '2X660 MW UNITS - 11 & 12 PROJECT specific' model as per above step. The model validity is established if the results for flue gas temperature profile in the boiler, zonal assumptions etc. are identical in both the 'BACKWARD' and 'FORWARD DIRECTION'.
 - 5) The validated "2X660 MW UNITS - 11 & 12 PROJECT" model shall have "Fuel Switching" capability i.e. it shall be able to appropriately vary the furnace absorption with changes in the coal properties. Validation of the above fuel switching capability will also have to be established to the satisfaction of Mahagenco.
 - 6) Having established and demonstrated Fuel Switching capability, the contractual FEGT can be demonstrated by using the site specific calibrated model as per step-(d) and plugging in the specified coal(s).
 - 7) The detailed procedure and the correction curves for the above test shall be to Owner's approval.
- d) The Bidder through thermal performance test (TPT) as per above shall also demonstrate that the flue gas temperature (Actual/MHVT values) at the entry and exit of various boiler heating surfaces and also the variations across the cross section perpendicular to gas flow do not exceed the values indicated in the data sheets for 100% TMCR (660 MW).
- vii) Minimum stable load on the Steam Generator without oil support under the following condition (%)
- a) It shall be guaranteed that oil support for flame stabilisation shall not be required beyond 30% of BMCR load when firing the coals from the range identified.
 - b) It shall be demonstrated that with any combination of mills/adjacent mills in service (to Owner's choice), the steam generator does not require any oil firing for stable and efficient boiler operation at and above 35% TMCR loads
 - c) Minimum stable load without oil support shall be demonstrated under the following condition
 - 1) Range of coal specified
 - 2) Both Load ramp-up & ramp down
 - 3) Any combination of mills in operation

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viii) Coal consumption at 100% BMCR, and 100% TMCR for design coal and worst coal based on the following (T/h)

- a) Ambient air temperature 32°C
- b) Relative Humidity 65%

ix) *Coal mills*

- a) Performance testing shall be done on coal mills toward establishing its guaranteed capacity specified at the rated fineness, applying corrections for the variation in coal characteristics i.e., HGI (Hardgrove Grindability Index) and total moisture.
- b) Loading of each mill when steam generator operating at 100% BMCR and 100% TMCR condition while firing design coal and worst coal
- c) Coal fineness for the range of coal specified-
 - 1) Through 200 mesh screen
 - 2) Through 50 mesh screen
- d) Capacity, efficiency and power consumption of each mill while firing design coal and worst coal (TPH) at:
 - 1) New Condition
 - 2) at 50% wear life
 - 3) at worn out condition
- e) Capacity demonstration test shall be carried out for the following conditions:
 - 1) Capacity output of one coal pulveriser (of Owner's choice) of each Steam Generator shall be demonstrated for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.
 - 2) Capacity output shall also be demonstrated on four coal pulverisers (of Owner's choice) of each Steam Generator, not less than the 90% of guaranteed value of 1) above, at 100% mill loading with the originally installed grinding elements in nearly worn-out condition or at the end of guaranteed wear life of grinding elements, whichever is earlier.
- f) Capacity test as mentioned at 1) & 2) above shall be demonstrated at the following conditions occurring simultaneously during testing:

Rated pulverised coal fineness	1) not less than 70% through 200 mesh and 2) not less than 99% through 50 mesh screen
Test coal	Any available coal from the specified range

- g) In case the guaranteed capacity of coal pulverisers as stated above are successfully demonstrated, remaining coal pulverisers of corresponding steam generator will also be considered to have successfully met the

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above capacity guarantee requirement. However, in the event of any of the coal pulverisers not meeting the guarantee test, all the coal pulverisers of corresponding steam generator will have to be tested to demonstrate guaranteed capacity.

- h) During the demonstration of the pulveriser capacity output, manufacturer's operating instructions will be followed and pulveriser will be operated with the specified range of coals without any such readjustment that requires a shutdown of the pulveriser or reduction of the load and/or any replacement of any pulveriser wear parts.
- i) For the purpose of testing to demonstrate the capacity, if HGI (grindability) and total moisture vary from those given in coal characteristics, the above pulveriser measured capacity shall be corrected using the capacity correction curves furnished by the Bidder and approved by the Owner. HGI versus coal pulveriser capacity curve shall be furnished for HGI variation up to a value above which the capacity remain constant.
- x) *Primary air fans*
 - a) Capacity (m³/hr)
 - b) Head developed (mWC)
 - c) Fan efficiency (%)
 - d) Power consumption (kW)
 - e) Margins envisaged on capacity and head
- xi) *Induced draft fans*
 - a) Capacity (m³/hr)
 - b) Head developed (mWC)
 - c) Fan efficiency (%)
 - d) Power consumption (kW)
 - e) Margins envisaged on capacity and head
- xii) *Forced draft fans*
 - a) Capacity (m³/hr)
 - b) Head developed (mWC)
 - c) Fan efficiency (%)
 - d) Power consumption (kW)
 - e) Margins envisaged on capacity and head
- xiii) *Seal air fans*
 - a) Capacity (m³/hr)
 - b) Head developed (mWC)
 - c) Fan efficiency (%)
 - d) Power consumption (kW)

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- e) Margins envisaged on capacity and head
- xiv) Satisfactory operation of FD, ID and PA fans without undue noise and vibration while operating in isolation or in parallel with other fans shall be demonstrated at site.
- xv) *Fuel oil firing system*
- a) Percentage load for which High Speed Diesel/Light Diesel Oil (HSD/LDO) firing system is designed (% BMCR)
- xvi) *Run-back capabilities*
- a) The automatic runback capability of the unit (boiler-turbine-generator) on loss of critical auxiliary equipment (such as tripping of one ID/FD/PA fan/ air heater etc.) shall be demonstrated ensuring smooth and stable runback operation, as mentioned in the technical specifications
- xvii) CO emission at 100% TMCR at rated excess air for specified range of coal
- xviii) Flue gas temperature at APH outlet (maximum) while firing design coal at 100% TMCR without considering air leakage, (°C)
- xix) Unburnt carbon in bottom ash while firing design coal at 100% TMCR(%)
- xx) Unburnt carbon in fly ash while firing design coal at 100% TMCR(%)
- xxi) Total unburnt carbon loss while firing design coal at 100% TMCR (%)
- xxii) Surface temperature of thermal insulation with ambient temperature of 40°C at surface velocity of 0.25 m/s. (°C)
- xxiii) *SCR System*
- a) Ammonia consumption rate at 100% BMCR for specified coal range to maintain NO_x < 70 mg/Nm³ shall be guaranteed.
- xxiv) *FGD System*
- a) Absorber outlet gas temperature
- b) Absorber outlet gas moisture percentage.
- c) Leak-proofness of dampers and gates.
- d) Oxidation air blower performance (flow, temperature, pressure).
- e) Wet Ball Mill Capacity at rated fineness

- 1) The Bidder shall demonstrate the guaranteed capacity of each limestone pulveriser under the following conditions:

Limestone fineness	90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process)
Limestone Quality	All available quality from the specified range

- 2) Bidder shall demonstrate the above capacity with the originally installed grinding elements in nearly worn-out condition as mutually

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agreed for the purpose of ascertaining wear life of any of the wear parts.

f) Wet Ball Mill Wear Parts Guarantee

- 1) Bidder shall demonstrate the life of wet ball Mill wear parts in line with requirements stipulated in the Technical Specification. The establishment of the above guarantee shall be based on the operating records available at the Power station and will be computed for each pulveriser based on actual total hours of operation.

g) Wet Ball Mill Ball Consumption

- 1) Bidder shall guarantee ball consumption per ton of limestone throughput in line with requirements stipulated in the Technical Specification. Bidder shall furnish the minimum ball diameter below which the balls shall be replaced.

h) Pressure Drop Across FGD

- 1) The Bidder shall demonstrate that the total pressure drop in the gas path across the FGD System shall not exceed the guaranteed values for the range of coal and loads specified in the Technical Specification

i) Vacuum Belt Filter Capacity

- 1) Bidder shall demonstrate the capacity of the Vacuum Belt Filters to dewater the quantity of gypsum with the specified purity and moisture content as specified in respective Technical Specification.

j) Gypsum Purity

- 1) The Bidder shall demonstrate that the purity of the gypsum produced shall not be less than 90%, chloride content shall not be more than 100ppm and the moisture content shall not be more than 10% for the range of specified coal(s) and based on CaO content of 51% in limestone.

k) Limestone unloading stream

- 1) Capacity of all the equipment in the limestone unloading path up to the Storage silos/shed should be demonstrated.

l) Gypsum handling system

- 1) Capacity of Gypsum conveyor taking feed from gypsum dewatering unit and feeding to gypsum storage shed through travelling tripper provided on last conveyor.

- m) Guarantee tests all left out Conveyors/bucket elevators not appearing above along with all associated equipments shall also be considered.

11.32.05 STEAM TURBINE AND AUXILIARIES

- i) Gross power output (MW) at 100% TMCR and VWO condition after subtracting excitation power and TG integral auxiliaries with following conditions:

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- a) Cycle make-up : 1% make-up
- b) Cooling water inlet temperature of 33°C
- c) Generator power factor -0.85
- ii) Gross power output (MW) at 100% TMCR after subtracting excitation power and TG integral auxiliaries with following conditions:
 - a) Cycle make-up : 1% makeup
 - b) Cooling water inlet temperature of 33°C
 - c) Generator power factor -0.85
 - d) All HP heaters out of service
- iii) Gross power output (MW) at 55% TMCR after subtracting excitation power and TG integral auxiliaries with following conditions:
 - a) Cycle make-up : 1% makeup
 - b) Cooling water inlet temperature of 33°C
 - c) Generator power factor -0.85
 - d) At 47.5Hz to 51.5 Hz
- iv) Continuous TG output of 105% of rated load (i.e. 693 MW unit load) under rated steam conditions after subtracting excitation power and TG integral auxiliaries
 - a) Cycle make-up : 1% makeup
 - b) Cooling water inlet temperature of 33°C
 - c) Generator power factor -0.85
 - d) At 47.5Hz to 51.5 Hz

Note: The condenser pressure measurement while conducting the guarantee tests shall be measured at 300 mm above the top row of condenser tubes.
- v) *Turbine-generator set capability*
 - a) The steam turbine generator shall be capable of delivering at generator terminals the output as indicated in the heat balances under the following conditions:
 - 1) Continuous TG output of 100% TMCR under rated steam conditions at 89 mm Hg (a) worst condenser pressure with 1% make up.
 - 2) While conducting this test, the condenser pressure measurement shall be done at 300 mm above the top row of condenser tubes.
 - b) The automatic runback capability of the unit (boiler-turbine-generator) on loss of critical auxiliary equipment (such as tripping of one BFP/CEP etc.) shall be demonstrated ensuring smooth and stable runback operation.
- vi) Upon sudden total loss of all external loads, units will not trip on over speed but shall continue to be in operation to supply power for plant auxiliary load (house load).

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- vii) Run-Back capabilities of the SG and STG upon loss of critical auxiliary equipment, shall ensure smooth and stable run back operation.
- viii) Variable pressure operating range (% TMCR)
- ix) *Condenser*
- a) Total pressure drop in condenser tube side with design cooling water flow and temperature (mWC)
 - b) Total cooling water temperature rise (°C) in condenser with design cooling water flow and CW inlet temperature of 33 °C under the following condition:
 - 1) Unit operating at 100% TMCR condition
 - 2) Unit operating at VWO condition
 - 3) Unit operating with all HP Heaters out condition and generating 100% TMCR power output
 - 4) Unit operating under house load and HP & LP bypass operating at rated capacity
 - c) Condenser pressure
 - 1) Performance test for design condenser pressure shall be conducted in accordance with latest edition of ASME PTC-12.2
 - 2) Condenser pressure in mm Hg (abs) measured at 300 mm above the top row of condenser tubes under VWO conditions, 1% make up, design CW temperature and CW flow.
 - 3) The condenser vacuum shall be measured with a vacuum grid utilizing ASME basket tips.
 - 4) Temperature of condensate, at outlet of condenser, shall not be less than saturation temperature corresponding to the condenser pressure at all loads.
 - 5) Air leakage in the condenser under full load condition shall not exceed more than 50% of design value taken for sizing the condenser air evacuation system.
 - 6) When one half of the condenser is isolated, condenser shall be capable of taking at least 60% TG load under TMCR conditions.
 - 7) The capacity of each vacuum pump in free dry air under standard conditions at a condenser pressure of 25.4 mm Hg (abs) and sub cooled to 4.17°C below the temperature corresponding to absolute suction pressure shall not be less than 30 SCFM. Correction curves for establishing the capacity at site conditions shall also be furnished.
 - 8) The air and vapour mixture from air cooling zone of condenser shall be 4.17°C below the saturation temperature corresponding to 25.4 mm Hg (a) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

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- d) Tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.
- e) If tube side fouling resistance for actual test condition is not measured as per methodology given in PTC 12.2, the tube cleanliness factor corresponding to the same shall be appropriately assessed considering the aspect of actual tube cleaning prior to conducting the test.
- x) *Condensate extraction pump CEP)*
 - a) Rated capacity (m³/h)
 - b) Rated Total Dynamic Head (TDH) (mWC)
 - c) Pump efficiency (%)
- xi) *Booster pump of CEP) (if applicable)*
 - a) Rated capacity (m³/h)
 - b) Rated Total Dynamic Head (TDH) (mWC)
 - c) Pump efficiency (%)
- xii) *Condensate polishing unit (CPU)*
 - a) Effluent quality of outlet of each vessel at its rated design flow and design service length between two regenerations
 - b) Chemical consumption for regeneration
 - c) Pressure drop across the polisher service vessel, as specified, in clean and dirty condition of resin at rated design flow.
 - d) Condensate water quality.
- xiii) *Feed water heaters*
 - a) Pressure drop on the tube side of the individual LP heaters (Maximum) (mWC)
 - b) Pressure drop on the tube side of the individual HP heaters (maximum) (mWC)
 - c) TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.
 - d) Outlet temperature from final feed water heater(s)
- xiv) *Deaerator*
 - a) Dissolved O² content at deaerator outlet without chemical dosing at all loads, not to exceed 0.005 CC/litre determined as per ASTM-D-888 – Reference method-A or Indigo Carmine method.
 - b) Difference between saturation temperature of steam entering the deaerator and temperature of feed water leaving the deaerator shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.
 - c) Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions

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xv) *Boiler feed pump (BFP)*

- Rated capacity (m³/h)
- Rated Total Dynamic Head (TDH) (mWC)
- Pump efficiency (%)
- Noise

xvi) *Booster pump of BFP*

- Rated capacity (m³/h)
- Rated Total Dynamic Head (TDH) (mWC)
- Pump efficiency (%)

xvii) Satisfactory operation of BFPs and CEPs without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site.

xviii) *Equipment cooling water system (ECW/DMCW)*

- Capacity, head & power consumption of all the pumps with the respective job (own) motors to be demonstrated at shop. For the pumps which are included under "Unit Auxiliaries for calculation of Pu" as defined elsewhere the power consumption value (at rated duty point) during shop testing shall be considered for computation.
- Vibration, parallel operation and noise level of all the pumps at the rated duty point shall be demonstrated at site
- Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

xix) *Condenser on-load tube cleaning system (COLTCS)*

- Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation shall be as indicated by Bidder in the offer and accepted by the Owner.

xx) *HP & LP bypass system capability*

- The HP & LP bypass system should satisfy the following functional requirements under automatic interlock action. It should come into operation automatically under the following conditions:
 - Generator circuit breaker opening
 - HP & IP stop valves closing due to turbine tripping
 - Sudden reduction in demand to house load
- Under all above conditions, while passing the required steam flows as per the relevant heat balances, the condenser should be able to swallow the entire steam without increasing the exhaust hood temperature and

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condenser pressure beyond the maximum permissible values. The same shall be demonstrated.

11.32.06 POWER CYCLE PIPING

- i) Actual hanger readings under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/HP & LP bypass piping system

11.32.07 FUEL OIL SYSTEM

- i) Capacity, head and power consumption of all the pumps shall be guaranteed.
- ii) Vibration and noise level of all the pumps at the rated duty point shall be demonstrated at site
- iii) Above shall be demonstrated with individual and parallel operations.

11.32.08 MILL REJECT SYSTEM

- i) Belt conveyors TPH
- ii) Power consumption
- iii) Continuous effective removal of mill rejects without spillage in the system shall be demonstrated.

11.32.09 GENERATOR

- i) Generator Maximum Continuous Rating (MVA)
- ii) Generator Efficiency (minimum) (%)
- iii) Hydrogen Make-up per day (m³/day)
- iv) Excitation system
 - a) Capacity of excitation transformer for static excitation (kVA)
 - b) Total loss of excitation transformer (kW)
 - c) Total loss of static excitation system (kW)
 - d) Total loss of brushless excitation system (kW)

11.32.10 BALANCE OF PLANT (BOP) EQUIPMENT (BTG Package)

- i) Compressed air system
 - a) Free air delivery at site conditions per each compressor (Nm³/min)
 - b) Power consumption at site rated parameters per each compressor (kW)
 - c) Maximum capacity of each air dryer at min working pressure and max. temp at after cooler outlet (Nm³/min)
 - d) Parallel operation of air compressors shall be demonstrated at site.
 - e) Pressure drop across Air Drying Plant, Capacity and outlet dew point of each air drying plant shall be demonstrated at site.
 - f) Vibration level and noise level of each air compressor, blowers and any other rotating equipments of each air drying plant shall be demonstrated at site.

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ii) *CW Pumps*

- a) Each pump shall be tested at shop/ site (as applicable) for capacity, head, and power consumption. Current, Voltage, Motor input Power, Frequency, Speed, Bearing/ Motor winding Temperature, Vibration and noise level of pumps and drives and parallel operation (as applicable) without hunting & abnormal noise and with load sharing within 10% of each other at the rated duty point of pumps shall be demonstrated at site as a part of Performance & Guarantee test.
- b) Shop tests conducted with the actual motor shall be considered to determine the guaranteed performance parameters of Flow, Head, Efficiency and Power Consumption. During the shop test no negative tolerance in the guaranteed capacity, head and efficiency of the pump shall be allowed.
- c) Detailed requirement of CW pump tests are mentioned in CW system specification.

iii) *Pumps (For all other pumps under this BTG package)*

- a) Capacity, head, and power consumption of all the pumps at the rated duty point (to be demonstrated and proved at shop with the respective job motors) and to operate in accordance with the approved pump characteristic curves. During the shop test no negative tolerance in the guaranteed capacity, head and efficiency of the pump shall be allowed.
- b) Current, Voltage, Motor input Power, Frequency, Speed, Bearing/ Motor winding Temperature, Vibration and noise level of pumps and drives and parallel operation (as applicable) without hunting & abnormal noise and with load sharing within 10% of each other at the rated duty point of pumps shall be demonstrated at site as a part of Performance & Guarantee test.

iv) *Fire Protection System*

- a) Capacity, Head & Power consumption of fire water pumps. Shop tests will be acceptable.

v) *Elevators*

- a) Carrying capacity of Elevators (kg)
- b) Over speed test
- c) Over load test
- d) Travel and hoist Speed Checks
- e) Landing checks

vi) *Cranes and hoists in each area*

- a) EOT cranes
 - 1) Safe working load (T)
 - 2) Operating speed (meters per minute)
 - Hoisting

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- Long travel
- Cross travel
- b) Under-slung cranes
 - 1) Safe working load (T)
 - 2) Operating speed (meters per minute)
 - Hoisting
 - Long travel
 - Cross travel
- c) Electric hoists
 - 1) Safe working load (T)
 - 2) Operating speed (meters per minute)
 - Hoisting
 - Long travel
- vii) *Air conditioning system in each area*
 - a) Capacity and discharge pressure of chilled water pumps, condenser water pumps at its rated duty point. Parallel operation of pumps
 - b) Capacity and static pressure of AHU fans at its rated duty point.
 - 1) Capacity (TR) of A/C system of Main Plant Area (TG Building), A/C system of Service and A/C system of ESP/FGD control rooms.
 - c) Auxiliary power consumption
 - d) Inside room conditions during summer, for all air conditioned areas.
 - e) Vibration and noise level of equipment.
- viii) *Ventilation system in each area*
 - a) Capacity and static pressure of centrifugal fans, roof exhausters at its rated duty point of Ventilation system.
 - b) Auxiliary power consumption
 - c) Inside room conditions
 - d) Capacity and discharge pressure of pumps of air washer units and UAF units at its rated duty point of Ventilation system.
 - e) Vibration and noise level of equipment.
- ix) *CW Chemical Treatment*
 - a) The bidder shall guarantee that the program offered shall meet the performance requirements stipulated for CW System. Also, the bidder shall demonstrate the guaranteed chemical consumption proposed in the bid, during the contract period.

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- b) For the purpose of verifying the guarantees on scale, a deposit monitor/test heat exchanger/fouling monitor shall be provided by the bidder stimulating the condenser operating conditions. The deposit monitor shall be weighed in new and clean condition and then weighed again on monthly basis and after completion of the test period. Prior to commencement of treatment program and after chemical cleaning of condenser tubes, the fouling factor shall be calculated for each condenser of 2 x 660 MW units.
- c) The fouling factor shall also demonstrate the cleanliness of condenser tubes by visual examination of the same.
- d) Corrosion coupons reflecting the metallurgy of the system components shall be supplied and installed by the Bidder to measure guaranteed corrosion value and corrosion rate shall be determined based on observations on monthly basis after completion of six months.
- e) Guarantee Values of Scale, Corrosion, Fouling & Bio Fouling
 - 1) Cumulative Corrosion Rate on Mild Steel < 3 mils/year
 - 2) Cumulative Corrosion Rate on Stainless Steel < 0.1mils/year
 - 3) Cumulative Corrosion Rate on Cu/Ni < 0.3 mils/year.
 - 4) Cumulative Scaling Rate of Internal Tube Surface Area of Condenser <15mg/dm²/year
 - 5) Fouling Factor: Deterioration in Heat Transfer Coefficient shall not be more than 5% of the original value just before commencement of the treatment program.
 - 6) TVC (Total Viable Count) (Micro Biological Counts) < 1.2 x 100000 counts/ml of circulating water.
 - 7) SRB (Sulphate Reducing Bacteria) <100 organisms/100 ml of circulating water.
- f) Dosing capacity of all dosing pumps shall be demonstrated.

11.32.11 ELECTRICAL SYSTEM

- i) As applicable and/or as specified in the technical specification in electrical Section

11.32.12 CONTROL AND INSTRUMENTATION

- i) Performance guarantee tests for closed loop control system shall be carried out at site to verify the integrated performance of the total plant C&I and to verify as to whether all the important parameters remain within stipulated permissible limits under all the operating conditions. In case during this tests or otherwise it is observed that the behaviour/response of Bidder's system (drives actuators/ valves etc.) is not satisfactory/acts as a limitation/restriction in achieving the permissible limits, the bidder shall carry out all required modifications rectification etc., in his system whatsoever so that the permissible limits can be achieved. He shall also depute his experts for associating in the above tests and also for carrying out the necessary modifications, rectification etc.

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- ii) Further the Performance guarantee tests shall be as applicable and/or as specified in the technical specification in Control & Instrumentation section.

11.32.13 AUTOMATIC ON-LINE TURBINE TESTING (ATT) SYSTEM

On-load testing of turbine protective equipment without disturbing normal operation and keeping all protective functions operative during the test

11.32.14 MAKE-UP WATER

Bidder shall specify the amount of make-up water required at TMCR and the conditions being the basis for his calculation. Bidder will be required to guarantee the amount.

11.32.15 VIBRATIONS

Bidder shall guarantee that the vibration levels as stipulated elsewhere in this specification will not be exceeded under any operating condition.

11.32.16 PLANT AVAILABILITY GUARANTEE

- Bidder shall guarantee the availability of the plant as a whole to be demonstrated during the Warranty period.
- The availability shall be minimum 95%.
- Plant availability shall be calculated with reference to 100% TMCR and full 1 year operating period from the date of taking over of the plant. In case this is not achieved, such period shall be further extended to 1 year from the date of repair of the equipment.
- The availability of the plant shall be calculated as below:

$$\% \text{ Availability} = (\text{OT} + \text{IT})/8760$$

Where-

OT = Actual operating hours of the plant during the one (1) year period (8760 hours) starting from the date of Taking Over of the plant

IT = Time in hours when the plant may be idle in the one (1) year period (8760 hours) due to reasons not attributable to the Bidder.

- Preventive and forced outages as well as capacity deratings done due to plant problems shall be considered.
- Planned maintenance including statutory inspection time shall be considered as plant available period.
- Outages and deratings due to dispatch conditions will not be considered in availability calculations (i.e. it will be considered that the plant is fully available during such dispatch conditions).
- Outages and deratings due to reasons not attributable to the bidder will be considered as fully available in availability calculations.

11.32.17 CONSUMABLES

- Bidder shall specify the major consumables and their consumption. Bidder will be required to guarantee the consumption specified.

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11.32.18 OTHER GUARANTEES

- i) Any other guarantee as applicable and/or as specified in the respective sections of the technical specifications

11.32.19 Performance Guarantee on Helical Springs and Viscous Dampers for Machine Foundations

- i) The Bidder shall guarantee the performance of the Steel Helical Springs and Viscous Dampers, to be provided by him for various machine foundations as specified in detailed technical specification, for a period of 24 months from the date of commissioning of each machine.
- ii) For TG foundation, TDBFP & MDBFP & PA/FD/ID Fan foundations, in case Alternative-2 (Open Foundations) are adopted by the bidder, then bidder has to furnish extended warranty of Five Years for satisfactory Static & dynamic performance of the respective foundations.

11.32.20 Performance Guarantee on Acid / Alkali Resistant Linings & Anti-Weed Treatment

- i) The Bidder shall furnish a performance guarantee for the acid/ alkali resistant linings and anti-weed treatment, as specified in detailed technical specification, for a period of three years from the date of completion of work or date of handing over, whichever is later.

11.33.00 Bidder shall guarantee all the above items unit wise, for each unit, and for station auxiliaries, preferably while both units are in operation; unless specified otherwise. The same will be finalised in the respective approved test procedures.

11.34.00 TURBINE GENERATOR PERFORMANCE ACCEPTANCE TEST

11.34.01 Performance test for the turbine generator set will be conducted in accordance with the latest edition of ASME PTC-6. Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 693 MW (105% TMCR) MW, 660 MW (100% TMCR) & 363 MW (55% TMCR) unit outputs corresponding to the conditions stipulated in the specification.

11.34.02 Power consumed by the auxiliaries mentioned under in the Unit Heat Rate calculations, which is to be deducted from electrical power generated, shall be measured during the performance / Acceptance Test. Wherever the measurement is not possible, design values of power consumption by an auxiliary shall be considered.

11.34.03 Corrections to the test results for steam turbine shall be applied as per the correction curves listed in technical specification. All the efforts shall be made to control the unaccounted for leakage to the minimum, when the system is properly isolated for a performance test. It shall be bidder's responsibility to arrest all the cycle leakages and valves passing before start of initial operation. It will be endeavour of the bidder to keep the unaccounted for leakages below 0.1% of the design throttle flow at that load. In case the value of unaccounted for leakage, is more than 0.1% of design throttle flow at that load, the suitable correction for make-up shall be provided as per approved correction curve.

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11.34.04 If due to any unavoidable situation, PG test is delayed, Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl. No. 3.07, Sub-Section-3 of ASME-PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test, In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.

11.34.05 The tests shall be arranged in a manner that the OWNER's operation is not disrupted Duplicate test runs shall be performed at 693 MW, 660 MW and 363 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, third test shall be run at the same point. The corrected result of any one of the three test runs, which deviates from the corrected averaged result of all the runs by more than 0.25%, shall be eliminated; otherwise the results of all the three tests runs shall be accepted.

11.35.00 The applicable values of liquidated damages factors for non- fulfilments of guaranteed performances are indicated under Volume-1, Commercial conditions of Contract.

12.00.00 SITE HEALTH AND SAFETY MANAGEMENT

12.01.00 Safety is to be given utmost priority. Safety is one of the most important philosophies to be strictly followed, while execution of this project. All precautions shall be taken by the bidder to avoid any unsafe incidents, including injury to personnel involved in installation of this project, material damage and environmental damage. Bidder will be completely responsible for any consequential damage arising out of such unsafe acts/incidents by the bidder or bidder's sub-contractor.

12.02.00 Bidder should follow all the safety regulations / norms as imposed by the Law/Authority/factory inspectorate /owner.

12.03.00 Bidder shall require his employees to wear suitable personal protection equipments (PPEs) like hard hats, safety shoes/boots and safety reflective jacket at all times when they are inside the plant area. Hard hats, safety shoes and safety jackets with reflective stripes shall be mandatory for all site personnel. Safety gumboots shall be used while working in waterlogged or slushy area.

12.04.00 All workers, when going to or from place of work in the plant only the prescribed walkways, paths or cross-overs shall be used. Rail-road crossing warnings shall be followed.

12.05.00 The bidder shall be responsible for:

12.05.01 The management of safety organisation at site for implementation of health and safety at site

12.05.02 The identification of site hazards and assessment of risks and mitigating the same

12.05.03 The arrangement of emergency plans, safety inspections and audits.

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- 12.05.04 The system of notifying all employees, of the site safety plan, method statements and site safety rules.
- 12.05.05 Imparting safety induction training to all workers involved in the project, directly or indirectly under him.
- 12.05.06 Conducting safety review meetings
- 12.06.00 The bidder shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site under him. He shall observe safety rules & codes applied by the Owner at site without exception.
- 12.07.00 The bidder shall notify the Owner of his intention to bring to the site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled or prohibit the use of the same for safety reasons. Bidder shall abide by Owner's decision in such cases. No claim for compensation due to such prohibition will be entertained by the Owner.
- 12.08.00 Storage of petroleum products & explosives for construction work shall be as per rules and regulations laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Bidder.
- 12.09.00 All requisite tests and inspection of handling equipment, lifting tools & tackle shall be periodically done by the Bidder and all records shall be maintained. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 12.10.00 All combustible waste and rubbish shall be collected and removed from the work site at least once each day. Use of undercoated canvas, paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 12.11.00 The bidder shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony, etc.
- 12.12.00 Personnel trained for fire fighting shall be made available by the Bidder at site during the entire period of the contract.
- 12.13.00 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Bidder shall maintain adequate number of qualified electricians to maintain his temporary electrical installation safely.
- 12.14.00 All accidents resulting in injury shall be reported to the Owner promptly. Owner's safety rules, regulations and directives shall be followed and reports thereon shall be submitted as and when required.
- 12.15.00 Female workers shall not be allowed to work beyond 6 PM.
- 12.16.00 The Bidder shall provide necessary first aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Bidder's personnel shall be trained in administering first aid.
- 12.17.00 First aid kits shall be available at bidder's site office and other suitable locations.

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12.18.00 Bidder shall ensure that proper treatment of injuries is immediately available either as such or in the form of constantly available transportation to a source of such treatment.

12.19.00 Bidder shall ensure that stretchers are available near all areas in which their men are working and that the location of stretchers are well marked.

12.20.00 Bidder shall be solely responsible for the dissemination of all safety regulations including those written here, those promulgated by the Owner and those dictated by good practice, and shall ensure that all his employees and those of his Sub-Contractors are conversant with same.

12.21.00 Safety regulations during execution

12.21.01 Crawling on, over or under movable equipment shall generally be prohibited.

12.21.02 For overhead work, proper signs shall be placed below and shall be barricaded preferably, and, when conditions justify, a watchman shall be stationed to warn employees in the vicinity. Suitable safety nets shall also be used to avoid fall of men/material/tools.

12.21.03 Work on or about crane runways shall not be undertaken without the Owner's permission. Whenever it is necessary to do any work on or above the crane runways, the Bidder shall furnish a flag man stationed on the floor.

12.21.04 SCAFFOLDING:

i) Only scaffolds which meet the safety requirements and any governing laws shall be used in the project.

ii) All scaffoldings shall be certified by the safety inspector and shall be visibly tagged as per the status, whether it is UNSAFE or FIT for USE.

iii) Hand rails and toe guards shall be provided for all platforms unless unavoidable.

12.21.05 Work in area of electric wires and cables shall generally be avoided.

12.21.06 All burning and welding equipment shall conform to, and be used in accordance with, regulations governing such equipment. No burning or welding shall be done at any place on the site until location where such work is to be done is approved.

12.21.07 Adequate fire protection shall be made available before proceeding with such work.

12.21.08 Appropriate warning signs shall be placed at various locations and shall be observed.

12.21.09 Temporary guard rails/barricading shall be provided for all openings/pits during construction. And, safety belt, as required, depending on fall height, has to be used while working very near to such area.

12.21.10 Safety goggles shall be worn whenever there is a possibility of flying particles or splashing of corrosive fluid.

12.21.11 When working around corrosive environment workmen shall wear gloves, goggles and protective shoes.

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12.21.12 When ladders are the means of access to a platform, they shall be firmly secured top and bottom and the ladder rails shall extend at least one meter above the top landing. When a ladder cannot be secured, a man shall be stationed at the base.

12.21.13 Safety belts shall be used by men working in high places above 6 feet, when no hand rails or other guards are in place. Fall arrester shall be used wherever required and as directed by owner's safety inspectors.

12.21.14 List of suggestive safety equipments is as below:

Sr. No.	Safety equipment
1.	Safety PPEs (Industrial Safety helmet & Industrial Safety Shoes) Industrial Safety Helmet (IS: 2925-1984 marked) Industrial Safety/Electrical Shoes (IS: 15298-2002 marked) Full body Safety Harness (conforming IS: 3521)
2.	Fall Arrester 'Rope grab fall arrester' & anchorage line. Anchorage Line: 14mm -16 mm diameter, three strand twisted Polyamide rope. Rope Grab fall arrester: Openable & Guided type Fall Arrestor (on flexible line) conforming EN 353-2 & works on 14-16 mm diameter polyamide rope. material: Nickel Chrome plated Steel Connector: Karbiner conforming to EN 362 (Minimum Strength 22 KN), material: Steel
3.	Horizontal life line Stainless Steel Wire rope of 8mm diameter. Minimum six nos. of steel U-bolt clips are required for clamping each wire rope to a rigid support (03 nos. of U-bolt clips at each end).
	Safety Net (Conforming IS 11057:1984) Safety Net (Net Size: 10m x 5m, Mesh Size: 25 mm, Mesh Rope: 2mm double cord, Border/Tie Cord: 12mm diameter polypropylene rope (tested as per IS: 5175). 2M length shall be provided at all four corners.

13.00.00 SPARE PARTS

13.01.00 All the spares shall be delivered in new and unused condition.

13.02.00 All spares shall be procured from their OEMs or from equally reputed vendors.

13.03.00 Equipment and components shall be standardised as much as possible for interchange-ability and to reduce spares inventory.

13.04.00 Spares shall be inter-changeable with the parts for which they are intended to be a replacement.

13.05.00 The quality plan and the inspection requirement finalized for the main equipment will also be applicable to the corresponding spares.

13.06.00 All spares shall be properly packed and protected for long storage at site under prevailing conditions, up to expiry of guarantee period of the spares.

13.07.00 Spare part identification number shall be clearly marked for all items.

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13.08.00 Spares for the plant shall be divided into three categories as follows:

13.08.01 Commissioning and start-up spares

13.08.02 It shall be the responsibility of the bidder to maintain adequate items in sufficient number, as commissioning & start-up spares to ensure that commissioning & start-up activities and plant operation till end of Performance Guarantee Test and subsequent handover of the plant to owner, do not hamper for want of spares.

13.08.03 These used spares shall be the property of the owner. However, bidder will be allowed to take back all the left over unused erection and commissioning spares after the guarantee period is over.

13.08.04 All commissioning & start-up spares as required shall be provided by the Bidder without any additional cost to the Owner.

13.08.05 The list and details of start-up and commissioning spares shall be furnished by Bidder prior to award of Contract.

13.09.00 Mandatory spares

13.09.01 The mandatory spares required for the plant are identified and listed in Annexure-3, Volume-V of this specification. Bidder shall review the list of spares specified and finalise the same based on the equipment and system proposed by the Bidder, in consultation with Owner.

13.09.02 When a particular item of spares is indicated as 'percentage', it shall be considered as percentage of total number of that item for scope of work, unless specified otherwise. Fraction shall be rounded off to the next higher whole number. Wherever a particular item of spares is mention in 'Set' it is the set of items for one (1) equipment.

13.10.00 The Bidder shall specify the quantity in numbers/sets, unit cost and anticipated normal life of individual spares. Wherever sets are mentioned, the bidder shall furnish the item details and prices of each such sub-item.

13.11.00 Whenever the item of spares has been indicated as 'set' for the Unit or the station, the same shall include total supply of that item, as specified and where it is not specified, 'set' shall mean the supply for single equipment / system.

13.12.00 One set of spares for particular equipment shall mean the total quantities of that particular spares for the single equipment e.g., 'set' of bearings for a pump shall include the total number of bearings in a pump. The 'set' shall however, include all components required to replace the item of spares.

13.12.01 The owner reserves the right, to vary the quantity of any of the spares and /or to add/delete any item of spares, after evaluation/during award/detailed engineering stage limited to a period of six (6) months from date of award of contract, at the unit rates agreed to in the contract or to be mutually agreed at a later stage.

13.12.02 The deliveries of mandatory spares shall commence from the date of first synchronisation of the unit (first unit if more than one units awarded) and shall be completed on or before the date of taking over the unit (first unit if more than one units awarded) by the owner. However, imported spares may be supplied along with respective equipment.

13.13.00 Recommended operation and maintenance (O&M) spares

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- 13.13.01 The bidder shall provide, based on his own experience of the performance of his equipment, in the form of a schedule given in bid documents, the complete list of recommended operation and maintenance spares for three (3) years operation of the equipment covered under the proposal.
- 13.13.02 In the list of operation and maintenance spares parts, the Bidder shall identify the unit-wise population of each of items recommended and anticipated normal life of the spares.
- 13.13.03 The spare parts must be able to replace the original part completely and have the same technical specifications in quality, material, inspection and mechanical aspects.
- 13.13.04 Bidders shall supply all measurement testing data (if applicable) of any spare part supplied.
- 13.13.05 All spare parts supplied shall be packed and stored for a 5 years preservation based on the local climatic conditions. Suitable preserving coating as required shall be applied. Small spare parts shall be packed and sealed by transparent plastic bags and drying agents will be used if necessary.
- 13.13.06 Every spare parts shall have operation instructions and design marks of the factory when it is supplied.
- 13.13.07 When multiple spare parts are packed in one packing box or container, the general indication to the spare parts outside the packing boxes or containers shall include a detailed list. All packing boxes, containers, and other such tanks shall be marked properly and numbered clearly. All electrical equipment including switches, fuse connection easy melting and other similar apparatus shall be protected and insulated.
- 13.13.08 The identification of all spare parts shall be in the English language.
- 13.13.09 Deliveries of these spares (if awarded under this contract) shall commence within 6 months from the date of taking over of the respective unit by the owner and shall be completed within 12 months from the date of such taking over.
- 13.13.10 Wear and tear parts, to be replaced by the Owner at his own cost, shall be marked separately.
- 13.13.11 Bidder shall identify in the spare parts list, the items having a delivery time of more than 3 months
- 13.13.12 Bidder shall enter into a long term spare supply agreement with the OEM, and agree to transfer the same faithfully to the owner upon COD. Bidder shall commit to facilitate further negotiations on the spares with the OEMs directly by the owner.
- 14.00.00 TOOLS AND TACKLES**
- 14.01.00 All tools and tackles required for repair and maintenance of the plant by the owner, after takeover shall be supplied by the bidder.
- 14.02.00 This shall also include special tools and tackles as required for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Bidder in sufficient quantity to equip

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the shift personnel, maintenance personnel and workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit.

- 14.03.00 List of such special tools, tackles and equipment shall be submitted in the EPC bid.
- 14.04.00 The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Bidder and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.
- 14.05.00 The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner it has not been subjected to more than normal wear and is still fully suitable for its intended use.
- 14.06.00 The following tools and appliances shall be supplied under this Contract for use by the Owner:
- 14.06.01 Two sets of special tools and gauges required for the maintenance of the Plant
- 14.06.02 One set of special lifting and handling tackles / appliances required for the maintenance of the Plant.
- 14.07.00 Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel/aluminium/wooden construction, the number of boxes being determined in relation to the layout of the plant and equipment in question.
- 14.08.00 If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels.
- 14.09.00 Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended. Details of the tools/tackles and a list of items shall be maintained for each box and shall be marked on the box or a copy of list of items shall be maintained (tamper proof) in the box.
- 14.10.00 Suitable storage racks shall be provided for all portable tools and tackles supplied under this contract.
- 14.11.00 Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.
- 14.12.00 All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle.
- 14.13.00 The Bidder shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner's Engineer.
- 14.14.00 The Bidder shall provide all runway beams, trolleys (manual as well as battery operated), mobile ladders, collapsible maintenance platforms, lifting blocks, special slings etc. necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations

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14.15.00 The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner at the time of Taking Over of the complete Plant.

15.00.00 CONSUMABLES

15.01.00 Lubricants and greases

15.01.01 All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site.

15.01.02 All oils and greases shall as far as possible, be readily available in India.

15.01.03 The number of oils and greases shall be kept to a minimum. For each type and grade of lubricant recommended, the bidder shall list at least three equivalent lubricants manufactured by alternative companies.

15.01.04 In case of imported oils, lubricants and other consumables, the bidder shall indicate the indigenous equivalents to enable the Owner to arrange subsequent refills. Preference should be given to indigenous oils and lubricants during first filling itself.

15.01.05 Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.

15.01.06 The Bidder shall supply the first fill of lubricants for the Plant, and shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as specified under scope of supply.

15.02.00 Chemicals and other consumables

15.02.01 Scope includes the supply (by the Bidder) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works.

15.02.02 The Bidder shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as specified under scope of supply and services.

15.02.03 The Bidder shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

16.00.00 SURFACE PREPARATION AND PAINTING

16.01.00 This section covers the general requirements related to the cleaning protective coating and painting of equipment, components and system. Painting and protective coatings shall comply with the requirement of this section as well as Volume-V, Annexure-8 Cleaning, Protective Coating and Painting.

16.02.00 Painting system for the complete plant shall be selected for medium corrosivity category, i.e. C3 and medium durability category, i.e. 7-15 yrs, as per ISO 12944. However, a minimum requirement of the specification has to be met.

16.03.00 All paint and associated materials shall be procured from approved vendors and should be delivered to project site, in manufacturer's sealed original packaging/container. Each container shall be labelled by the manufacturer, with

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the manufacturer's name, type of paint, description of content, colour, batch number, date of manufacture, shelf life expiry date and pot life.

- 16.04.00 All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.
- 16.05.00 The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages-
- 16.05.01 Cleaning before painting and/or corrosion protection (application of prime coat)
- 16.05.02 Cleaning in workshop
- 16.05.03 Cleaning before erection and during installation.
- 16.06.00 Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.
- 16.07.00 For cleaning in workshop and before painting, mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.
- 16.08.00 Machined surfaces shall be protected during the cleaning operations.
- 16.09.00 In the event of the surfaces not being cleaned to the Owner's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.
- 16.10.00 Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned.
- 16.11.00 All weld areas shall be suitably stress relieved before chemical cleaning.
- 16.12.00 The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:
- 16.12.01 Proper storage to avoid exposure as well as extremes of temperature
- 16.12.02 Surface preparation prior to painting.
- 16.12.03 Mixing and thinning
- 16.12.04 Application of paints and the recommended limit on time intervals between coats.
- 16.12.05 Shelf life for storage.
- 16.13.00 Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.
- 16.14.00 Mechanical mixing, as recommended by manufacturer, shall be used for paint mixing operations in case of two pack systems, except that the Engineer may allow the hand mixing of small quantities at his discretion.
- 16.15.00 All the surface preparation, protective coating, painting of steel, structures; equipments shall be suitable for prevailing site condition.

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- 16.16.00 The bidder has to check all painting work to be carried out according to the specification & recommendations of the paint supplier, further to all relevant prescriptions and regulations concerning the health and safety of work.
- 16.17.00 The type and number of protective coats for any item requiring painting are to be furnished by the bidder as per the paint manufacturer's recommendation for owner's approval; if it is different from the requirements of the specification.
- 16.18.00 The paint supplier has to present data sheets including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.
- 16.19.00 Bidder shall take all safety precautions and shall follow the entire EHS requirement as agreed with the owner/engineer during execution of work.
- 16.20.00 The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation which pertains to the work.
- 16.21.00 Protection of the blast cleaner operator's eyes and respiratory system should be given prime consideration in any open blast cleaning operation. Airfed helmets, respiratory filters, air conditioned hoods etc. should be provided in sufficient number to the blast cleaning operators to avoid the harmful effect of blast cleaning abrasives. Also, an automatic shut-off device which will shut-off the air supply to the blasting machine should be installed which will prevent the dangerous whipping of an operating blast hose if an operator becomes disabled.
- 16.22.00 The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it.
- 16.23.00 Transport and erection of painted structures shall be carried out only after the drying time specified by the paint manufacturer has elapsed. Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimising handling after painting. All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction.

17.00.00 APPROVED SUB-VENDOR / MAKES

- 17.01.00 Approved sub-vendor list is provided in Annexure – 4, Volume-V.
- 17.02.00 Any change in sub-vendor/contractor for all items under this package shall be subject to owner's approval. Bidder shall submit all necessary credentials and other details as sought by owner for the approval of such sub-vendors.
- 17.03.00 Owner reserves the right to accept/reject any sub-vendor for the project.
- 17.04.00 Approval, rejection or addition of makes shall not have any cost implication to the Owner after award of contract.

18.00.00 PLANT AND EQUIPMENT IDENTIFICATION, LABELLING

18.01.00 Plant and equipment identification

- 18.01.01 The Bidder shall propose and apply a common identification system preferably KKS numbering for the whole plant equipment, facilities and systems showing

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the name and number of each item and its respective drawing number etc. to fully identify the plant.

18.01.02 The structure of the designations shall be developed in such a way that the symbols used can be handled by electronic data processing equipment. The identification system must be used by all subcontractors, vendors, etc., and shall be a proven system for power plant application.

18.01.03 Each item of plant shall be separately designed with a reference number, which shall be used consistently on the drawings, in the documents and on the catalogues as well as on the equipment items themselves.

18.02.00 Labelling

18.02.01 Name plates which are to be firmly fixed on all the equipment, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the skid or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

18.02.02 The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them.

18.02.03 Indoor installed equipments (e.g., panels, cabinets, switchgear, etc.) shall also be labelled by appropriate name plate.

18.02.04 The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Bidder and the Owner. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags.

19.00.00 DRAWINGS AND DOCUMENTS

19.01.00 General

19.01.01 The bidder shall submit all design drawings and documents like, General Arrangement drawings, Mechanical, Electrical, C&I and Civil Design Basis/Criteria, Drawings, Data Sheets, Equipment and their Capacity Selection, Test Procedure etc. and other engineering documents stipulated in the specification for approval/information of the engineer along with the design calculations and general write up wherever involved. All design documents and drawings shall be properly coordinated.

19.01.02 The Owner reserves the right to ask the Bidder to submit copies of drawings and other documents for approval to his Head Office or to the Office of his Representatives. If the Owner/consultant are satisfied with the drawing, it will be returned to the Bidder marked with an 'Approved' stamp. If the Owner/consultant are not satisfied with the drawing, it will be returned to the Bidder with comments and the drawing shall be revised and re-submitted for approval.

19.01.03 The purpose of having drawings checked and approved by the Owner is to assist the Bidder in interpreting the Technical Specification so as to eliminate mistakes in the equipment or material actually shipped to the site of the work. The formal approval given to the Bidder is to be considered as in conformity with this purpose and in no manner shall be construed so as to release the Bidder from

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any liability or responsibility for proper design, fabrication or compliance with the Contract Documents.

- 19.01.04 Equipment drawings shall clearly indicate the general arrangement of the equipment to be furnished, give principal dimensions, and show sufficient details required for a complete power station.
- 19.01.05 While submitting drawings for approval, including any prepared by a Sub-Contractor, the Bidder shall certify that he has fully examined such drawings and that they comply with the requirements of the Contract.
- 19.01.06 For the purpose of this Clause, the term "drawings or documents" shall imply all design drawings and documents associated with the project including GA drawings, P&IDs, design calculations, data sheets, equipment specifications, design basis, diagrams, schedules, performance curves etc.
- 19.01.07 Approval of a drawing by the Owner or his Representatives will imply that:
- Drawings and documents have been examined and appear to be in accordance with the basic design concept of the project and meet the requirements of the Specification.
 - Drawings and documents of components and equipment have only been examined in relation to compatibility of the items and equipment with the Specification and in respect of interconnection with other items and equipment.
 - Any approval given by the Owner or his Representatives shall in no way relieve the Bidder of his responsibility under the Contract.
- 19.01.08 The Owner will not normally require receiving copies of detailed manufacturing drawings but the Bidder shall make these available if requested to do so.
- 19.01.09 The Bidder shall ensure that drawings are submitted in due time to permit amendments to be made and the drawings re-submitted for approval without delaying the scheduled deliveries or the guaranteed competition dates according to the Contract. Execution of work shall be taken up after the drawings are cleared by the Owner.
- 19.01.10 Submission of drawings and documents for approval shall be strictly sequential, in accordance with the manufacturing and construction plan and sequence.
- 19.01.11 Master drawing list and submission sequence shall be submitted after approval of project schedule and supply schedule. Supply schedule shall include the lead time for manufacturing of all items.
- 19.01.12 It shall be noted that the tender drawings and data sheets submitted along with the specification is only for tender purpose and shows only the minimum requirements for the plant. Bidder's drawings and documents shall be more detailed and shall include all details as per the actual requirements during detailed engineering.
- 19.01.13 Requirements about the format of drawings and documents, the provision for documents and the Owner's responsibilities with regard to documentation are specified in relevant section of this volume.
- 19.01.14 Soft copies of all drawings and documents shall be submitted to owner and consultant via email and larger size files if any shall be transferred through Cloud

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Storage Servers. Sufficient soft copies as mutually agreed during the term of the contract shall be submitted in USB flash drive or CD/DVDs, especially as-built drawings and O&M manuals. Hard copies shall be submitted as per the document distribution schedule defined herein or as mutually agreed during the term of the contract.

- 19.01.15 The Bidder shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Owner and his Representatives or not.
- 19.01.16 The stipulations and requirements specified elsewhere in the specification shall also be followed with respect to preparation and submission of drawings.
- 19.01.17 All Bidder's drawings which are found to be incorrect during the construction period or which require changes owing to site constraints, shall be corrected by the Bidder to an "as built" condition to reflect any necessary changes.

19.02.00 Drawings and documents to be submitted by bidder

The drawings and documents to be submitted by the Bidder for approval shall cover the complete Scope of Contract work as defined by the Contract Specification and shall generally include, but not be limited to, the following:

19.02.01 DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID:

i) General

- a) Completely filled in technical schedules & other schedules as required to be submitted with the bid documents.
- b) Completely filled in data sheet – B
- c) Project milestone schedule
- d) Project implementation schedule (Level-2) along with required readiness dates for owner inputs and readiness of systems to be covered under Balance of Plant package.
- e) Inputs required from client, with quantities and qualities required.
- f) Sequential supply schedule of all major items, along with lead time for manufacture and delivery to site.
- g) Master Document List (MDL) for Mechanical, Electrical, Civil and C&I with sequential schedule of submission
- h) Project execution methodology
- i) Flow Diagrams and P&ID (Process and Instrumentation drawings) indicating Instruments and the destination / functionality of the signals
- j) Space requirement for construction site and equipment
- k) Layout of temporary site facilities, buildings, structures, installations
- l) Plot plan
- m) A report on foundation proposed for various structures, buildings and facilities based on the data furnished by OWNER and further data collected by the BIDDER. Allowable safe bearing capacity for open foundation,

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depth of foundation, need for pile foundations, soil improvement if any required, special precaution against aggressive soil etc., shall also be covered in the report.

- n) General arrangement drawings with sections for major building viz. Power house building, Boiler and auxiliaries, ESP & FGD control building, CW pump house, etc.
 - o) Quality Assurance plan.
 - p) Complete description of the plant offered including description of the process and the equipment
 - q) General descriptions of individual systems and control philosophy including descriptions of operation including description of start-up, shutdown and emergency shutdown procedures, Also behaviour of boiler/steam generator and, turbine, etc. under transient conditions.
 - r) Complete bill of materials of the plant with expected life of major items along with break up price
 - s) Project specific Safety Plan shall be submitted for approval of owner.
 - t) Training program and schedule for training of Owner's personnel
 - u) List of spares
 - v) List of Special tools and Tackles
 - w) Maintenance proposal (for SG and STG)
 - x) Inspection intervals (major/minor) for six years along with the spares to be replaced during the above inspections. Bidder shall provide the cost of such spares on yearly basis.
 - y) For, steam turbine, steam generator, generator and the total scope of supply maintenance and overhaul charts should be submitted with this bid. Both major and minor plant outages for inspection and/or routine maintenance should be shown on the chart, together with the nature of the work to be undertaken and the expected duration of the outage. This information should also include all the auxiliary plant to be supplied under the Contract.
 - z) Drawings and documents to be submitted with bid as mentioned elsewhere in the specification
- ii) Mechanical
- a) Heat and Mass balance diagram same for 100% TMCR condition (0% and 1.0 % makeup), VWO condition (0% and 1.0 % makeup), 60% TMCR (Constant and Sliding pressure operation), All HP heaters out condition, Auxiliary steam condition and house load operation with HP-LP bypass in operation
 - b) Start up curve for cold, warm and hot condition
- iii) Electrical
- a) Technical description of electrical system

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- b) Single line diagram of BTG package
- c) Ratings of all major equipment - load list
- d) Characteristic curves of Generator & motors
- e) Description of Generator Cooling System, Excitation System & AVR
- f) GA drawing for all the major equipment such as Generator, transformers, GCB, HT switchboards
- g) Type test certificates for Generator, Generator transformer, GCB, HT switchboard
- h) Description & Catalogues of all Electrical equipment
- i) Technical Data Sheets
- iv) Control and instrumentation
 - a) DCS / PLC architecture drawing (also indicating interconnection of different offsite C&I System) highlighting system features and capabilities
 - b) Plant Control and operational philosophy
 - c) Process description / functional write – up for all open loop and closed loop controls
 - d) GA diagram of the major equipments such control panel, control room console etc
 - e) Functional specification for Plant DCS, STG control system with technical catalogues
 - f) Write-up, scheme, technical details etc. of Continuous Emission Monitoring (CEM), Vibration monitoring and analysis system, Steam & Water Analysis System (SWAS), GPS /Master slave clock system etc
 - g) SER / Annunciation system configuration details including capacity, time stamping etc
 - h) Details on all C&I items including CCTV, AAQMS, lab Instruments, Flue gas analysers and Field Instruments
 - i) List of software (latest version) and hardware with confirmation certificate

19.02.02 DRAWINGS AND DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT:

The drawings and documents required for design, manufacture, construction, installation, operation and maintenance of the plant shall be submitted by the bidder in good time for approval/information, so as to permit the plant as a whole to be constructed in compliance with the specification and time schedule.

The below list is only indicative. The detailed list and approval category of the drawings/documents shall be submitted and agreed sufficiently in advance, so that corrections and amendments desired by the owner as well as resubmission of the documents will not result in any delay with respect to the guaranteed time table. The owner reserves the right to request from the bidder additional

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drawings and documents as may be required for proper understanding and clarity on design and engineering of the plant.

- i) Re-Submission of all the technical data furnished during pre award contract stage.
- ii) Geotechnical investigation report
- iii) General arrangement drawings / Equipment layout of all equipments/buildings etc, along with coordinates, sections indicating the approach, unloading & maintenance area.
- iv) Bill of quantities/materials
- v) Part lists
- vi) Specifications
- vii) Design basis for all the systems and major equipment
- viii) Control philosophies
- ix) Design/Sizing calculation of all major equipment
- x) P&ID (Process and Instrumentation drawings) indicating Instruments and the interlocks for all the systems
- xi) Flow diagrams
- xii) Schematic diagrams
- xiii) System architectures
- xiv) Logic diagrams
- xv) I/O lists
- xvi) HMI configurations
- xvii) Data sheets of all items
- xviii) Load lists
- xix) Feeder lists
- xx) Drive lists
- xxi) Air requirement
- xxii) Water requirement
- xxiii) Ash collection data
- xxiv) Performance data
- xxv) Valve schedules
- xxvi) Pipe schedules
- xxvii) Pipe routing
- xxviii) Cable schedules

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- xxix) Cable routing
- xxx) Cable connection diagrams
- xxxi) Settings
- xxxii) Instrument schedules
- xxxiii) Performance curves
- xxxiv) Single line diagrams
- xxxv) Key diagrams
- xxxvi) Circuit diagrams
- xxxvii) Protection schemes
- xxxviii) Load details
- xxxix) Forces, moments and movement diagrams
- xl) Design basis memorandum for all buildings, facilities, services and structures
- xli) Design calculations and drawings for foundations, substructure and superstructure of all buildings and other structures & facilities like drains, roads, crossings, tanks, sumps, trenches, ducts, sewers, tunnels etc.
- xl ii) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc
- xl iii) Design calculations and drawings for all facilities and services like roads, culverts, bridges, paving, road/rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc
- xl iv) Architectural drawings including finishing schedules and colour schemes
- xl v) Foundation plans
- xl vi) Levelling and grading plan
- xl vii) Excavation details
- xl viii) Reinforcement details
- xl ix) Architecture details including schedule of doors and windows
- I) Plot plan of the site including all buildings and installations, roads, drains, pipe and cable rack/pedestal/trench routing, sewage and fire system pipe line layout, storage and fabrication area etc with coordinates of major points and elevations/FGLs.
- li) Manufacturing quality plans for all items
- lii) Painting and surface preparation procedure
- liii) Painting schedules
- liv) Storage and preservation procedures
- lv) All field quality plans

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- Ivi) Welding procedures
- Ivii) Equipment testing procedure
- Iviii) Equipment and system wiser commissioning procedures
- lix) Monthly progress reports
- lx) Master document list
- lxi) Manufacturing and supply/delivery schedule
- lxii) L2 network schedule
- lxiii) System wise L3 schedule
- lxiv) Testing reports
- lxv) Declaration of confirmation with statutory regulations
- lxvi) Operation and maintenance manuals
- lxvii) Lubrications list and schedule for all items
- lxviii) All as built drawings
- lxix) Training program
- lxx) Complete bill of materials of the plant with expected life of major items along with break up price
- lxxi) Drawings and documents as mentioned elsewhere in the specification and as required by the owner for better understanding or other reasonable purpose, even though not specifically mentioned.

19.03.00 Document distribution schedule (of Hard copies, after placement of order)

Document	Distribution		
	Owner		Consultant
	Head Quarter	Site	
L2 schedule & monthly progress reports	4	4	0
Drawings and documents for approval	3	0	0
Drawings and documents for information	3	0	0
Approved drawings and documents	2	2	0
Testing and commissioning procedures	2	2	0
O&M Manuals	2	4	0
As built drawings	2	4	0

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Note: Only soft copies to be submitted to consultant. However, hardcopies should be submitted to consultant, whenever specifically sought.

19.04.00 Manuals

19.04.01 General

- i) The Bidder shall provide the manuals in a timely manner to enable the Owner / Engineer to review and comments and request changes as necessary.
- ii) Payments will be withheld for non-compliance or for late delivery of the drawings, procedures and manuals. In particular the Bidder shall be held responsible for consequential damage to the plant where such damage is due to late delivery of the O&M manual resulting in non-familiarity of the operating technique.
- iii) The Bidder shall also note that while all documents, procedures and manuals shall be in the English language including that of the sub vender of the bidder, it is particularly important that the O&M manuals be in clear concise English.
- iv) All manuals shall be divided by systems or sections and cross-indexed as necessary.

19.04.02 Certification Manuals

- i) This manual shall contain the approved works certification documentation for all plant equipment and services as specified in the relevant codes and standards and in this specification and the Bidders Quality Manual.
- ii) This manual shall also include all material tests certificates. Certificates and test procedures shall be specific to the plant supplied.

19.04.03 Construction Manual

- i) This manual shall include a comprehensive record of as built site construction tests and records.
- ii) The manuals shall be compiled in separate parts system wise for the complete plant offered.

19.04.04 Commissioning Manual

- i) This manual shall include all the records, certificates and test results arising from the agreed pre-commissioning and commissioning procedures carried out on site.
- ii) The performance tests and guarantee test results shall also be included. There is a particular requirement that all commissioned plant/equipment values be recorded in this manual and subsequently incorporated into the O&M manuals.

19.04.05 Operating and Maintenance (O&M) Manual

- i) The Bidder shall provide the O&M Manual properly bound, within the time required/specified, to enable the Owner's staff to become fully acquainted with the operation, adjustment and maintenance of the entire plant.
- ii) The manuals shall contain full and explicit instructions in respect of the operation of the plant under all operating conditions and the maintenance routines and requirements to be established to maintain the plant in optimum performance.

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- iii) These instructions shall be as comprehensive as possible and the form in which they are to be set out shall be agreed with the Owner / Engineer.
- iv) The instructions shall be tailored to suit the specific requirements of the Operations and Maintenance functions and personnel, taking into account the staffing philosophy for the thermal power project.
- v) The instructions for the related parts shall be accurate and easy to understand and shall contain the necessary sequence of individual activities.
- vi) The diagram and drawings associated with the instruction shall be clear and unambiguous.
- vii) It is an essential requirement that all information and plant data contained in the manual must be project specific and derived from the design, manufacturers / suppliers and commissioning data of the as-built plant.
- viii) Where the Bidder includes standard brochures the installed item of plant or equipment shall be clearly identified.
- ix) All sections shall contain an introductory description of the particular item/system including its function and operating criteria and any special features.
- x) On the basis of the commissioning and running experience of the Plant, the instructions shall be amended to a final form within three months of the end of commissioning and, for this purpose; the Bidder shall supply the required number of printed copies of all approved amendments for insertion in the bound set of instructions.
- xi) The Bidder shall prepare manuals integrating all equipments supplied by the sub vendors.
- xii) The entire O&M manuals including that of the sub vendors shall all adopt the same format paper size etc.
- xiii) Contents of the Manual (equipment or system wise)
 - a) Safety precautions
 - b) Write-up/specification of the equipment/system
 - c) Control philosophy
 - d) Installation instructions
 - e) Commissioning instructions
 - f) Operation instructions
 - g) Maintenance instructions
 - h) Data Sheets
 - i) General arrangement drawings, P&IDs, schematics, wiring diagrams, logics, functional diagrams, performance curves etc.
- xiv) Manuals may be common or separate for-
 - a) Erection/installation
 - b) Operation &

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- c) Maintenance
- xv) Operating Instructions

The instructions shall include at least the following specific procedures/items:

 - a) Pre-start-up
 - b) Start-up
 - c) Normal operation and parameters to be monitored and limiting values
 - d) Shut-down
 - e) Interlocks and protections
 - f) Operation procedures during fault conditions
 - g) Trouble shooting
 - h) Isolation procedures
 - i) Stand-by mode and preservation
 - j) Operation Logs/running records to be maintained including parameters and intervals
 - k) Items requiring special attention (if any)
- xvi) Maintenance instructions
 - a) Maintenance instructions shall include the required inputs for-
 - 1) Mechanical
 - 2) Electrical
 - 3) Control and instrumentation
 - b) The instructions shall include at least the following specific procedures/items:
 - 1) Safety instructions
 - 2) Inspection
 - 3) Handling and lifting
 - 4) Routine maintenance and intervals
 - 5) Lubrication schedules and lubricants
 - 6) Assembly and disassembly
 - 7) Part lists including part identification number and blow-up diagrams
 - 8) Drawings detailing tolerances
 - 9) Set-up and calibration
 - 10) Test-run
 - 11) Special maintenance/repair including welding (if any)
 - 12) Maintenance log and history to be maintained

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13) Items requiring special attention (if any)

19.04.06 Plant Technical Diary

- i) A plant technical diary including technical details of all plant systems and equipment shall be prepared and submitted.
- ii) The technical diary shall include following details as a minimum:
 - a) Major specifications
 - b) Location
 - c) Make
 - d) Quantities
 - e) Weight
 - f) Material of construction
 - g) Bearing details
 - h) Major dimensions
 - i) Design and working pressures
 - j) Efficiency
- iii) All major technical parameters including limiting values shall be specified therein.

19.05.00 Format

- 19.05.01 All drawings and documents shall be prepared in international 'A' series i.e. A4, A3, A2, A1 & A0
- 19.05.02 Soft copy of all documents shall be submitted in PDF format. AutoCAD or other original formats may be sought by owner/consultant in some cases like plot plan for better clarity/understanding.
- 19.05.03 Grouped documents shall be provided by size A4, with the inclusion of bigger size drawings which, however, have to be folded as Size A4.

19.06.00 Numbering and Identification of Documents

- 19.06.01 All the drawings shall be identified through a common way of numbering in accordance with the requirement of contracting.
- 19.06.02 The numbering system of drawings and documents proposed by the Bidder shall be in compliance with the plant identification system and to be agreed with the Owner.
- 19.06.03 Apart from this, some drawings may also be numbered in the way which the bidder or subcontractors are used to do. But, there shall be a common title block on all published drawings which include the following contents:
 - i) Project
 - ii) Owner
 - iii) Owner's Engineer
 - iv) Contractor

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v) Description

vi) Drawing No.

vii) Sheet No.

viii) Revision No.

19.06.04 The measuring units and dimensions marked on the project engineering drawings shall be of SI system conforming to ISO 80000-1.

19.06.05 In case dimensions are not marked in conformity with the scale of drawings and any dimension on the drawing does not conform to those dimensions and sizes measured through certain scale, the actual marked dimensions shall be applicable.

19.06.06 For revision of drawings, the revised part shall be clearly and definitely shown on the drawing.

19.07.00 Others

19.07.01 The Owner and bidder agree that the Contract will be concluded in accordance with the EPC method of building the power project.

19.07.02 It is the Bidder's duty to ensure that design standards and conditions meet the requirements and that the power project shall operate safely, reliably and with high efficiency, having the same performance as stipulated and guaranteed.

19.07.03 The Owner may examine, check and approve the drawings and documents at his discretion with the aim of ascertaining that all these drawings and documents meet the requirements specified in the contract documents. The Bidder shall have an active and cooperative working relationship with the Owner. If there is a disagreement over any issue, Owner and Bidder shall work together to reach some conclusion through mutual consultations.

19.07.04 The drawings and documents of the Bidder shall be approved or returned with observations, within fourteen working days by the owner.

19.07.05 To enable smooth review of drawings and documents in time, bidder shall strictly follow the agreed document submission schedule and dumping/bunching of documents will not be entertained.

19.07.06 The Bidder shall clarify the observations raised by the owner and shall attempt to correct the drawing or document subsequently only.

19.07.07 Generally, copies of drawings or documents containing trade secret and drawings with patented nature need not be provided. However, to know whether the Bidder has performed its obligations, the Owner/consultant will have the right to examine those drawings and may seek them if required.

20.00.00 ENVIRONMENTAL PROTECTION

20.01.00 The Bidder shall offer a plant so as to meet the pollution control requirements of statutory authorities. Emissions and discharges of solid, liquid and gaseous effluents from the plant shall fully comply with all requirements and limits specified in Environmental (Protection) Act, 1986, along with all latest amendments to all of the above requirements, stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF)

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and State Pollution Control Board (SPCB) for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement.

- 20.02.00 The discharge of pollutants in water and air as well as noise levels shall meet with the stipulations of Central Pollution Control Board (CPCB), Maharashtra Pollution Control Board (MPCB) as well as other Acts of the Government under the Ministry of Environment and Forestry (MoEF). If there should be a discrepancy between standards and this specification from the more stringent requirement will apply.
- 20.03.00 Bidder shall comply with the following clearances obtained for the project, as applicable for the scope of the package:
- 20.03.01 Environmental Clearance form MoEF
- 20.03.02 Consent to establish from MPCB
- 20.04.00 Environmental protection design for the power project will be based on the requirements of environmental impact report and relevant stipulations, and state of the art, proven technology will be adopted.
- 20.05.00 The air emissions of the plant will meet the Pollution control board norms and guidelines. The plant effluent shall also meet the stipulations laid down by Pollution control board. The general pollution control board (PCB) requirements shall be imposed. Any add-on requirements during public hearing and EC shall be imposed as amendment.
- 20.06.00 The plant should be designed to economize on water use and to set up a water management system featuring maximum reuse of effluents.
- 20.07.00 The Bidder shall take all necessary measures for noise attenuation in order to meet the specified noise levels. All equipment shall be designed to run without undue vibration and with the least amount of noise.
- 20.08.00 Environmental monitoring stations as per the requirement of the specification shall be provided by the EPC Bidder in accordance with "Environmental Protection Design Stipulation for Thermal Power Projects". It shall be provided with the instruments according to Environmental Monitoring norms to supervise and monitor the pollutants emitted during power generation so that it meets with the ambient air quality standards and also that environmental quality and trend can be known so as to provide scientific basis for pollution prevention and control. The environmental monitoring station will be designed in such a way as requiring no staff and Maharashtra Pollution Control Board should be consulted in deciding the location of the stations.
- 20.09.00 In order to meet the environmental quality requirements, the Bidder has to guarantee that at all loads and operating conditions of the Steam Generator the flue gas emission levels (Suspended Particulate Matter (SPM), Sulphur Di Oxide, and NO_x) for the range of fuel to be used in the plant, will strictly adhere to the norms and requirements of MoEF. No deviation/correction in this regard is acceptable.
- 20.10.00 The Bidder shall provide on-line automatic Continuous Stack Emission Monitoring (CEM) for monitoring the levels of SO_x, NO_x and SPM. The Bidder

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shall also provide stack monitoring kits for monitoring SO_x, NO_x and SPM at plant boundaries.

- 20.11.00 The monitoring systems should incorporate the means to record various time averaged values as required by the performance requirements. Monitoring data should be displayed in the control room, with provision of alarms to notify the operator of any deviation from the specified values. The Bidder shall furnish a list of monitoring equipment he intends to provide with their location in the plant.
- 20.12.00 Soil can become contaminated by oil and chemical spillage during Operation and Maintenance of the Plant. The entire plant shall be designed, operated and maintained in such a way to prevent any soil contamination and adequate provisions shall be made in the design.
- 20.13.00 Dust emission to the air from the site, roadway, etc. shall be controlled by providing suitable dust control systems.
- 20.14.00 Noise Control
- 20.14.01 An integrated approach shall be taken by the Bidder to control noise emission which shall include but not be limited to:
- Design and layout of building to minimise transmission of noise, segregation of particular items of plant and to avoid reverberant areas
 - Specification of permissible noise levels for bought-out items
 - Choice of materials for civil construction
 - Acoustic design of buildings
 - Use of acoustic lagging / enclosure with attenuation properties on plant components/installation of sound attenuation panels around the equipment.
- 20.14.02 Where the requirements stated above are not met within the basic design of the plant they shall be achieved by the supply under the Contract of suitable means of noise control, which shall conform to the following requirements:
- The noise control system shall, as far as possible, be designed to form an integral part of the plant
 - The abatement system shall, wherever practicable, be applied to the source of excessive noise rather than to the entire item or component
 - If above means are not adequate and enclosures are used for noise abatement, close fitting enclosures shall be provided
- 20.14.03 Noise control areas
- Control Rooms - The noise levels in control rooms must be such that intelligible speech communication is always possible and mental concentration is not hindered.
 - Other control areas - The noise levels in other control areas must be such that intelligible conversation (telephone and person-to-person) is possible and operator fatigue is minimised.
 - Station noise criterion - The criterion for environmental noise is that the design of the station and its components shall not exceed, in any continuous mode of

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operation, the level stipulated by MOEF and/or Pollution Control Board at any point on the site boundary. Presently the norm is such that the noise level shall not exceed 85 dBA at 1.5 m from equipment surface and 70 dBA at plant boundary.

iv) Noise level shall not exceed 85 dBA at 1.5 m from equipment surface, except for the following:

- a) Turbine, generator and pulveriser – 90dBA
- b) Safety valves & associated vent pipes, HP/LP bypass valve, soot blower or wall blowers, regulation drain valves – 115 dBA

20.15.00 The rain water collected from the roof of buildings shall be channelised through the rain water down comers and routed to the garland drain around the buildings. These garland drains shall be connected to the plant storm water drainage network system all around the plant. Several recharge wells shall be located at strategic locations within the plant and shall be interconnected to the storm water drain network system to ensure recharging of the ground water table.



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**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

**BID DOCUMENT
FOR
EPC CONTRACT (MAIN PLANT PACKAGE)**

RFx No. 3000046202 (BTG Package)

VOLUME - IV, PART - D

-

TECHNICAL SPECIFICATION

CIVIL

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

STEAG Energy Services India Pvt. Ltd.

(A wholly owned subsidiary of STEAG Group, Germany)

A-29, Sector-16, NOIDA - 201301, India

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TECHNICAL SPECIFICATION

CIVIL

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

PREPARED BY



(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

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A-29, Sector-16, NOIDA - 201301, India

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1.00.00 INTRODUCTION

- 1.01.00 This section covers the technical specifications for design and construction of Civil, Structural and Architectural Works for buildings, structures, systems & facilities including all materials and labours for this project. The scope of civil works for BTG package including FGD works to be carried out under the contract is as detailed here. The items, though not specifically mentioned, but are needed to make the system complete shall be treated as though included and the same shall also be furnished and erected / constructed unless otherwise specifically mentioned as excluded.
- 1.02.00 Description of various items of work under this specification and nature of work in are given hereinafter. The complete work under this scope is referred to as 'Civil Works'.
- 1.03.00 The work to be performed under this specification consists of design, detailed engineering and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.
- 1.04.00 Supply of all materials including cement, reinforcement steel and structural steel and all other materials necessary to completion of the work shall be in the scope of Bidder.
- 1.05.00 This criterion contains a general description of the facilities, a description of the structural idealization, type of foundation systems, design loading conditions & load combinations etc. as per Codes & Standards, specifications, material specifications and general Engineering practice.
- 1.06.00 The scope shall also include setting up by the Bidder of a complete testing laboratory in the field to carry out all relevant tests required for the work.
- 1.07.00 The Bidder's work shall cover complete requirements as per codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Owner / Owner's Engineer.
- 1.08.00 The Bidder shall prepare the fabrication and erection drawings and get approval from Owner/ Owner's Engineer before start the work.
- 1.09.00 The Bidder shall be solely responsible for the correctness of the layout and levels and shall provide necessary instruments, materials, access to works, etc., to the Owner/Owner's Engineer for general checking of the correctness of the civil works.
- 1.10.00 All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.
- 1.11.00 The Bidder shall inspect the site, examine and obtain all information and data required and fully appraise himself of the prevailing conditions at the proposed site, access to site, communications, transport, right of way, availability of local

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labour, materials and their rates, local working conditions, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

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

1.13.00 Project Information

1.13.01 Unless otherwise specified, the following design conditions shall be considered for the equipment offered:

- i) Seismic Zone : Zone II as per IS 1893-2002
- ii) Basic Wind speed : 44 m/s
- iii) Ambient Temperature
 - a) Maximum (daily) : 47.8°C
 - b) Minimum (daily) : 3.9°C
- iv) Relative Humidity
 - a) Monsoon season : 85%
 - b) Dry season : 61%
- v) Rain fall
 - a) Annual average rainfall : 1112.7mm
 - b) Maximum rainfall in 24 hours : 315mm/day
- vi) Altitude : +304.75m from MSL

1.14.00 Construction Water

1.14.01 The Construction water for construction activities will be provided by the Owner free of cost. It will be made available at one point and suitable number of outlets to cater to all the requirements shall be derived by the Bidder. Bidder has to provide the temporary storage (min. 7 days) facility for construction water. Claim for non availability of water will not be entertained.

1.15.00 Construction Power

1.15.01 Construction power for construction activities shall be provided by Owner without any charges. It will be made available at one point and suitable number of outlets to cater to all the requirements shall be derived by the Bidder. The quantum of construction power to be provided shall be decided depending on availability.

1.15.02 The Construction Power system by its design and nature shall be a temporary system and not part of the permanent power supply. The Bidder acknowledges that electricity sourced may be unreliable in quality and availability and its interruption or non-availability or variations in supply voltage of frequency for any reason shall not constitute a condition for claim of extra time or costs on part of

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the Bidder. Further, Bidder shall be responsible for making necessary arrangements to ensure that uninterrupted Construction Power supply (DG sets) is available.

1.15.03 Without limiting the generality of the foregoing, such temporary supplies of Construction Power shall include:

- i) Power for all construction offices, portable cabins, temporary warehouses and storage areas, and other temporary buildings used during the performance of the Work.
- ii) Power for temporary equipment put in place until such time as permanent Plant Power supply systems are installed. Such temporary equipment shall include temporary construction lighting on buildings and power to cranes and hoists.

1.15.04 Power utilized by Bidder and sub-contractor on the Site for the purposes of performance of the Work such activities to include curing, welding, forming, stress relieving and provision of power for all electrical construction equipment.

1.16.00 **Geotechnical Investigation**

1.16.01 A preliminary Geo-technical Investigation has been carried out by the Owner and report of the same is attached in Annexure – 5, Volume-V. However this report along with the recommendation given there shall be considered by the Bidder for reference only.

1.16.02 Bidder is advised to verify the content of report by taking a few bore holes at site and analyzing the same before submission of bids. Alternatively, Bidder may make his own assessment for the type of foundations envisaged based on this preliminary report at his own risk. In any case, the Bidder has to carryout detailed geo-technical investigation after the award of contract, through some reputed agency approved by Mahagenco and submits geo- technical investigation report with recommendation for Owner's review & approval. The recommendation given in approved final report becomes binding on the Bidder. The Bidder shall not be eligible for increase his price or demand any extension of time because the final report is in variance from preliminary report furnished by Owner.

1.17.00 **Topographical Data**

1.17.01 Owner has been carried out the topography survey work and the drawing is attached in Annexure– 6, Volume-V. However, the Bidder shall carry out detailed survey of the whole plant on award of contract. Before submission of bid; it is the responsibility of the bidder to verify the various features at site and required interconnection along with other areas on his own.

1.17.02 The proposed plant will be established mainly at the land retrieved by demolishing the existing structures of retired units of 4X120MW units. The power block/main plant area of the proposed plant has to be constructed after demolishing the auxiliary structures like cooling towers. Most of the above ground structures at the proposed project site will be removed by the owner. All below/underground foundations, structures, pipeline, cables etc has to be excavated and removed by the bidder wherever required. Tentative quantity of below ground structures/items to be removed is 5000m3 for evaluation purpose. The quantity specified is only for bid evaluation purpose; however, the bidder

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shall visit the site and make his own estimation before bidding. No, extra claim on this account will be allowed after award of contract.

- 1.17.03 Taking into consideration that unit 6 of Koradi thermal power station are still in operation and some of its facilities like cooling water system are adjacent to the proposed site, care shall be taken that these facilities shall not be disturbed.
- 1.17.04 Site preparation including excavation and demolition of all underground structures, removal of all unwanted debris and transportation, procurement and transportation of suitable backfill material, backfilling, compaction, levelling, grading etc, is in bidder's scope.
- 1.17.05 The unwanted debris shall be suitably disposed off by the bidder, subject to owner's approval.
- 1.17.06 Although the owner will try to demolish all above ground structures, any left out minor structures, if any, shall be removed by the bidder for site preparation.
- 1.18.00 **Statutory Requirements**
- 1.18.01 Bidder shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Tariff Advisory Committee (TAC) of IRDA India, Air and Water act for Pollution control Board, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of Central and State Pollution Control Board shall be followed. Bidder shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.
- 1.18.02 The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for green belt as indicated in "General Layout Plan". In addition to that lay-down areas and other vacant land of the plant will be used by owner for the development of green belt.
- 1.18.03 The contract or part shall not be assigned or sublet by the bidder without written permission of OWNER.
- 1.19.00 **Instructions To Bidder**
- 1.19.01 Bidder is requested to go through the bid documents carefully. In case of any contradiction/conflicts in various clauses given herein, the same shall be brought to the notice of the owner clause wise. Owner's decision shall be binding on bidder and shall have no implication to Owner.
- 1.19.02 Deviations from bid document if any shall be furnished by bidder clause wise clearly during the pre-bid stage, otherwise the same shall not be considered.
- 1.19.03 Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, sub-soil conditions, natural drainage etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.

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1.19.04	The submission of a bid by the bidder will be considered as evidence that such an examination was made and any later claims/disputes in regards to rates quoted shall not be entertained or considered by the Owner.	
1.19.05	List of equipment to be deployed by the bidder and his associates is to be furnished to the Owner along with the bid document.	
1.19.06	All materials used in the works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Owner or Owner's engineer and shall comply strictly with the tests prescribed hereinafter or, where tests are not laid down in this specification, with the requirements of the latest issue of the relevant Indian, American, British, German Standards or other Standards approved by the Engineer.	
1.19.07	Samples of all materials proposed to be used in the works shall be approved by the Owner/Engineer.	
1.19.08	The work shall be carried out by competent personnel skilled in their various trades.	
1.19.09	The bidder shall organize his own arrangement to transport his equipment, men and materials so as to match the construction schedule as and when required during construction period upto commissioned stage.	
1.19.10	Before commencing the works, the bidder shall ascertain the locations and nature of all existing underground services and shall take every possible precaution against any damage occurring to them or interference therewith, during the execution of the works.	
2.00.00	BRIEF SCOPE OF WORK	
2.01.00	The scope of civil works under this specifications include all planning, collection of all site related data, conducting site investigations, development of loading drawings design and detailed engineering, construction, fabrication, erection of complete Civil, Structural & Architectural works for the BTG area including FGD system of proposed power plant as per these specifications including supply of all materials, labour, consumables, tools & equipment, loading, unloading, fabrication, erection, execution of work & testing, commissioning etc. complete, for all buildings, structures and facilities on EPC basis.	
2.02.00	Bidder's scope shall also include excavation in soil and rock (if any, with/without blasting as per the site conditions), dewatering, dressing to required profile, sheet piling or shoring/strutting, backfilling with CNS soil with compaction as per IS code wherever required around completed structures and plinth filling, piling (if required), plinth protection, import soil from barrow pits, disposal of surplus earth and rock as directed by Engineer, concreting including providing reinforcement and formwork, fabrication, erection & painting of all structural steel and miscellaneous steel (i.e. steel stair case, cable/duct/pipe supports, pipe racks, ladders, walkways, hand railing, chequered plate/grating floor, inserts, anchor bolts, etc.), masonry work, vibration isolation system for machine foundations if required, plastering, painting, floor finish, doors, windows, & ventilators roofing including permanent steel decking, flooring, acid and alkali resistant lining, fire proof doors, electrically/mechanically operated rolling shutters, under deck	
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insulation, false ceiling, roof water proofing, , paving, gravel filling, precast covers, trestles, cable/pipe trenches/duct, expansion & construction joints, rain water pipes, water supply, toilet fittings, lift-well, sewerage, roof insulation, damp proofing, water proofing of underground structures, anti-termite treatment, cutting of existing roads and making good, drainage, roads, rail track, fencing, final grading including micro grading and site clearance before handing over and other auxiliary items of work, setting up of material testing laboratory to carry out relevant tests at site, safety, security, testing and commissioning etc. complete.

2.03.00 It is also includes preparation of architectural drawings, engineering and fabrication drawings, as built drawings, plumbing and sanitary network drawings, etc.

2.04.00 **Site related investigations-**

2.04.01 Topographical survey of the entire BTG area including FGD plant establishing bench mark and grid marking and

2.04.02 Detailed Geo-Technical Investigation works.

2.04.03 Drainage study

2.05.00 **Site development works**

2.05.01 Site clearance including diversion of existing services if any.

2.05.02 Site grading of the area as identified in the Property Plan.

2.05.03 Roads, drains and cross drainage works within the scope of area. Temporary roads/drains required for construction/pre-commissioning purpose.

2.05.04 Since the BTG area of proposed plant is located in the existing plant cooling towers area, MAHAGENCO has dismantled the superstructure of all structures including cooling towers etc. Also clear the debris from site before handing over the site to the bidder. The scope shall also be included for dismantling of existing substructure wherever required which is in the proposed BTG plant area and disposed off for the debris from plant boundary. Tentative quantity of concrete/below ground structures and items to be dismantled is 5000m3. This is indicative quantity only. The bidder shall visit the site, collect the data and asses the volume of work before quote the price. If the quantity varies, the bidder shall not be eligible for increase his price or demand any extension of time.

2.06.00 Construction enabling works

2.07.00 This specification covers entire civil engineering work including design, supply and construction for all buildings, technological structures and facilities for all production, auxiliary units, foundations for all buildings, structures and equipment, roads, ramps, paving, parking areas, storm water drainage and sewers and all other miscellaneous civil engineering work as will be necessary for completing this package on a turnkey basis within the battery limits.

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3.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED

3.01.00 Drawings and documents to be submitted with bid

- 3.01.01 Suggested plot plan locating all buildings, structures, facilities roads, temporary site office, etc., with their plan dimensions.
- 3.01.02 A detailed write-up on cooling water system along with schematic drawing showing preliminary sizing and details of channels, fore-bay and pump house, cold and hot water conduits and the method of construction.
- 3.01.03 A report on foundation proposed for various structures, buildings and facilities based on the data furnished by owner and further data collected by the bidder. Allowable safe bearing capacity for open foundation, depth of foundation, need for pile foundations, soil improvement if any required, special precaution against aggressive soil etc., shall also be covered in the report.
- 3.01.04 A write-up on dewatering system proposed at the time of construction where deep construction such as for CW fore bay and pump house etc. are to be executed.
- 3.01.05 General arrangement drawings for all major buildings and structures showing dimensions, levels, plans, sections, elevations, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc.
- 3.01.06 Detailed design criteria proposed to be adopted for each building, structures, foundations, facilities etc.
- 3.01.07 A write up on the sizing and constructional details of RCC chimney with sketch showing detail of foundations, wind shield and liner along with list of appurtenances.
- 3.01.08 List of software proposed to be used in various areas for analysis, design, drafting as well as project monitoring along with their sources and validation report for software.
- 3.01.09 List of all sub-contractors that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be employed in the job on behalf of the sub-contractor etc. shall be submitted to the OWNER. Only the Subcontractor, approved by OWNER shall be engaged by the bidder on the job.
- 3.01.10 A write up on quality plan for both design and construction along with details of quality control laboratory with a list of testing equipment shall be furnished.
- 3.01.11 Write-up on proposed sewage disposal system for the toilet in various buildings.
- 3.01.12 List of equipments/ special tools and plants deployed.
- #### **3.02.00 Drawings and documents to be submitted after bid**
- 3.02.01 The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system) and shall be made on latest versions of AUTOCAD. Software used for design shall be validated and established ones

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like STAAD Pro. Hard and soft copies to be furnished to the OWNER. The list is not exhaustive but indicative only. 3.02.02 General plant layout drawing with coordinates of roads, buildings and facilities, piping / cable trenches, pipe and cable racks, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc. 3.02.03 Drawing showing underground facilities with coordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc. 3.02.04 Soil investigation report based on additional geo-technical investigation carried out by bidder along with foundation recommendation for various buildings / structures / facilities. 3.02.05 Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement. 3.02.06 Design basis memorandum for all buildings, facilities, services and structures. 3.02.07 Drawing showing loading data at various levels for all buildings and structures. 3.02.08 Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings. For main plant building bidder shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts. 3.02.09 Design calculations and drawings for foundations/ substructure and superstructure of all buildings including pump houses and other structures. 3.02.10 Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc. 3.02.11 Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road / rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc. 3.02.12 Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling, etc. 3.02.13 Design calculations and drawings for plumbing and building drainage. 3.02.14 Design calculations and drawings for transformer yard, etc. 3.02.15 Design calculations and drawings for structures pertaining to condenser Cooling water system. 3.02.16 All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the OWNER. 3.02.17 Details of corrosion protection measures for all structures. 3.02.18 Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings. 3.02.19 All design and drawings for RCC twin flue chimney		
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3.02.20 All design calculations and drawings for foundation of Boiler and ESP area structures. 3.02.21 All design calculations and drawings for foundation of FGD structures 3.02.22 Shop drawings / fabrications of all structural steel works (only for reference) and design calculations for important joint connections. 3.02.23 Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, TG foundation and other machine foundations. 3.02.24 Write up on various statutory requirements and their compliance for various buildings and facilities. 3.02.25 Quality assurance and Quality Control procedures. 3.02.26 Copies of all reports on investigation and studies carried out by the bidder as per the scope. 3.02.27 Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER. 3.02.28 Civil drawings shall have construction drawings reference of electrical and mechanical details if any to avoid confusion of openings/sleeves/inserts/levels and dimensions 3.02.29 Wherever possible mechanical bolts shall be cast in situ with sleeve for future minor rectification instead of providing pockets this will avoid cutting of main reinforcement for provision of pockets. 4.00.00 DESCRIPTION OF BUILDING, STRUCTURES AND FACILITIES 4.01.00 Following structures / buildings / areas / facilities are to be included in the contract. The description against each building / system is indicative only and not exhaustive. Although almost all the systems are covered here but any other system (Civil, Structural and Architectural) required for successful completion of the project shall form a part of this contract and shall deemed to be included in the scope of works. 4.02.00 Site Related Investigation 4.02.01 TOPOGRAPHICAL SURVEYING i) Site survey shall be carried out by the bidder to establish the ground levels and to determine any existing structures, roads etc. The site survey shall be carried out before the commencement of the work and if required during the progress of the work. The site survey shall be carried out at a grid spacing of 5-10 meters and at every change of level of the existing ground to produce contour drawings at 0.25 meter intervals. Scale of the contour drawings shall be as directed by the Consultant. A specialized firm approved by the Consultant shall carry out the site survey. ii) .A single grid pillar will be given by the client with coordinates in plant area. Necessary grids shall be made by bidder including demarcating the structures,		
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buildings and jungle clearance including cutting, uprooting and removing of trees and dispose the same away from the site etc.

- iii) Survey points (reference points and bench marks) : The bidder shall construct adequate number of reference points and bench marks for marking the setting out lines and levels. The reference points shall consist of suitable metal plates set in 400 mm x 400 mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level. All levels of the benchmarks shall be related to the agreed datum. The exposed numbers, locations, coordinates and level of the reference points and bench marks shall be plotted on drawings and approved by the consultant prior to the commencement of the work.
- iv) Safeguard of survey points: The survey points shall not be removed from their position without the permission of the Consultant. If any of the survey points are damaged or lost due to any work carried out near their location, the bidder shall be responsible for replacing such survey points.
- v) Surveying during the progress of work: The bidder shall assist the consultant at any time when checking survey points, setting out, checking construction items and erection parts. The bidder shall provide and arrange the following:
 - a) Provision and maintenance of survey instruments and accessories
 - b) Provision of skilled personnel, supply of all material required for the survey exposing covered survey points.
 - c) Shifting of any machinery used for construction out of the sight lines.
 - d) Stopping all drilling, blasting, driving and any other works.
 - e) Causing soil vibrations and stopping during instrument observations.
 - f) Removing all obstructive accumulation of water.
 - g) Taking all necessary safety precautions.
 - h) Furnishing any marking material requested by the Consultant in connection with control surveys.
 - i) Providing additional survey points in accordance with the consultant's instruction.

4.02.02 GEO-TECHNICAL INVESTIGATION WORKS

- i) Detailed geo-technical investigation to verify the results of the preliminary investigation carried out by owner shall be carried out by the bidder on award of work. Based on the plot plan developed, the bidder shall identify proposed borehole locations and obtain the approval of owner prior to commencing the investigation. In the power block bore holes shall be provided and spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of transformer yard. For major structures boreholes shall be provided at closer intervals. In the offsite areas also it shall be ensured that the bore holes are provided near all major structures.
- ii) Following field tests shall be conducted:

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a) Bore holes b) Static Plate load tests c) Cyclic Plate load test d) Field Permeability tests e) Field Density tests f) Vane Shear tests g) Static Cone Penetration tests h) Electric resistivity tests. i) Pressure meter test j) Block vibration test iii) Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 60.0 m or 5 m continuous into hard rock whichever is earlier. iv) Standard penetration tests (SPT) and collection of undisturbed soil samples (UDS) shall be carried out alternatively at 1.0m intervals and at significant change of strata. The interval shall be increased to 1.5m below 5m depth of boring. UDS shall be replaced by SPT in cohesion less strata. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth. v) In rock strata, core recovery and Rock Quality Designation (RQD) shall be noted carefully for each run, immediately after cores are taken out of barrel. vi) During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table. vii) Following laboratory tests shall be conducted: a) Grain size analysis 1) Hydrometer analysis 2) Sieve analysis b) Field Density and Moisture Content c) Specific Gravity d) Chemical Analysis of soil and Ground water including Sulphates, Chlorides, pH value, etc. e) Chemical Analysis of 2:1, Water: Soil extract of the samples giving SO₃ content. f) Consistency Index: Liquid Limit, Plastic Limit, Plasticity Index, Shrinkage Limit and Shrinkage ratio. g) Consolidation test giving all relevant information. h) Swelling pressure and free swell index for expansive soils.		
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- i) Unconfined Compressive Strength on undisturbed soil samples
- j) Direct Shear Test
- k) Triaxial Compressive Strength Tests:
 - 1) Unconsolidated Undrained Test
 - 2) Consolidated Undrained Test
 - 3) Consolidated Drained Test
- l) Moisture-density relations for Standard Proctor and Modified Proctor tests.
- m) Crushing Strength of rock on specimens of NX size.
- n) Test for determining CBR value for design of pavements at various locations.
- viii) The soil investigation report shall necessarily include but not be limited to the following information.
 - a) Recommended types of foundation.
 - b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
 - c) Recommendations for values for modulus of sub- grade reaction for foundation design by elastic method.
 - d) Type of cement to be used for concrete substructures and in stone / brick masonry foundations with reference to the chemical nature of subsoil and ground water.
 - e) Recommendations regarding excavations (shallow & deep), embankment, Safe sides slopes for excavation and embankment, dewatering, site drainage, etc.
 - f) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.
 - g) Precautions to be taken for design of lightly loaded structures when expansive soil is encountered with respect to swelling pressure and free swell index values obtained.
 - h) Recommendation on CBR values to be adopted for design of Roads.

5.00.00 GENERAL LAYOUT PLAN

5.01.00 The preliminary layout plan proposed for the project is shown in the drawing no ETG061-COM-GN-PP-001 titled "PLOT PLAN".

5.02.00 It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope. Area identified for facilities remain same as indicated in GLP, however, minor modification of location of building may be done to optimize layout.

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5.03.00	Bidder shall prepare the detailed layout of the plant facilities which are in his scope and shall submit the same for Owner's approval.	
5.04.00	While preparing the detailed layout, planning his facilities and deciding upon the transportation and erection strategy he shall ensure the following aspects.	
5.04.01	All Statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws are met.	
5.04.02	Face of the buildings and facilities are located in such a way so as to have an offset of minimum 15 to 20m with respect to centre line of road.	
5.04.03	The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.	
5.04.04	The interface requirements with the plant construction/erection activities of other contracting agencies engaged by Owner. These agencies engaged will be working simultaneously with the Bidder within the plant premises.	
5.04.05	Available Area for laydown, preassembly and batching plant have been earmarked on the General Layout Plan.	
5.04.06	No permanent facility shall be located within the safety zone limit around the fuel Oil storage tanks etc., except those permitted by Owner.	
5.04.07	Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed.	
5.04.08	All parts of the buildings and facilities shall be approachable by fire tenders.	
5.04.09	Main roads /peripheral roads are only shown in General layout plan and road layout tender drawing. Approach made of heavy-duty paving/passage to buildings/structures/facilities in the scope of bidder from nearby plant road/peripheral road/grid road/internal access road shall be provided. Multiple numbers of accesses to different parts of any building /facility like main plant building, control room, transformer yard, service building etc. should be provided.	
5.04.10	Facilities are to be planed considering the diverted route of transmission line as shown in General Layout Plan.	
6.00.00	SITE DEVELOPMENT WORK	
6.01.00	Site Clearance	
6.01.01	Existing plants, buildings and trees on the proposed layout are cleared by the owner; however the site shall be cleared of shrubs or other vegetation, rubbish, slush etc and other objectionable matters and any roots or stumps of trees met during excavation, they shall be removed by Bidder. Where earth fill is intended, the area shall be stripped of all loose / soft patches or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / rerouted with the permission of the OWNER. Existing wells, pits, marshy areas etc shall be filled up with earth of approved quality.	
6.01.02	The bidder shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing	
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structures, underground services, general site conditions, site for disposal of surplus materials, debris etc and all other items affecting the work. Claims due to ignorance of site conditions will not be considered after submission of Bid.

6.02.00 Site Grading

6.02.01 Necessary grading to achieve the desired finished grade level shall be in Bidder's scope.

6.02.02 Fills shall normally be made up of Cohesive Non Swelling material capable of being compacted up to 95% Modified Proctor density. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the bidder himself. Earth from Swamps, marshy as well as lagoons, expansive type of clays, peats, organic material, material susceptible for combustion, material which will react with other material already used in work shall not be used as borrow material. A minimum side slope of 1 vertical: 2 horizontal shall be maintained at all slopes.

6.02.03 Slopes shall be provided with 230 thk stone pitching to prevent erosion.

6.02.04 Bidder shall dispose any extra soil within plant boundary as directed by OWNER or in case soil has to be disposed outside the Plant area the area shall be arranged by the bidder himself within a distance of 6 km from plant boundary as directed by owner.

6.03.00 Roads, Drains and Culverts

6.03.01 All roads in the power plant area of BTG island and main access road from gate shall be rigid pavement with RCC and all other roads shall be Bitumen top flexible pavement designed and constructed as per relevant IRC codes.

6.03.02 The road shall be designed to cater to the load and needs of construction and maintenance of heavy trucks carrying machinery and heavy cranes. The surrounding roads for BTG Island shall be 10m wide, except road on the east side of BTG island (between BTG island and CHP area) which shall be 15 m. All other roads providing access to buildings / structures / systems requiring maintenance by vehicles shall be 7 m wide. Peripheral/patrolling roads inside boundary wall shall be 4 m wide Water bound macadam base (WBM) without bituminous topping. 1500 mm wide road shoulder shall be provided on either side of all two lane/Four lane roads with appropriate topping.

6.03.03 On either side of the roads side drains covered with perforated precast RCC slabs, shall be provided. Drains shall be designed during detailed engineering; however minimum clear width of the drain shall be 450mm. The drains shall be designed using RCC. Drainage lines and other underground services shall be located at the edge of the shoulder. All service and utility lines crossing the roads shall be taken up through NP3 class RCC pipe designed for impact loading. Culvert shall also be generally using NP3 class pipe. In case the diameter of the pipe required is more than 600 mm, cast-in-place RCC box culverts shall be provided.

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6.04.00 **Storm Water Drainage**

6.04.01 The drainage scheme shall be based on the detailed area drainage study being carried out by the Bidder. Plant drainage system shall be based on the recommendations of the report.

6.04.02 Storm water drainage system shall be designed in two parts.

- i) Main drains
- ii) Auxiliary drains

6.04.03 Main drains shall be designed as a network covering total plant area and shall ultimately be disposed in the manner defined in the drainage studies. Auxiliary / branch drains shall cover individual graded terraces to collect discharge from plant buildings and shall connect to main drain at suitable locations.

6.04.04 In the main plant area, drainage for plant effluent and storm water shall be carried by gravity. The drains shall generally be covered type and constructed of RCC (provided with perforations). RCC pipe culverts / box culverts shall carry drainage under roads. However, in other areas, the drains need not be of covered type.

6.04.05 At places where covered drainage system is required, channels with removable cover shall be preferred to piping system, as piped system tend to get blocked. Underground storm water piping shall be restricted strictly to areas where surface drains are not desirable or practicable from functional point of view.

6.04.06 Drainage shall be provided where necessary to prevent ponding and ground erosion and to carry surface water away from building, structures and other works including roads, building or equipment foundations.

6.04.07 The storm water drainage for the contaminated area such as coal stack pile etc., shall be designed separately and the discharge shall be led separately for treatment and disposal.

6.04.08 Any existing nalla which is coming in the plant area shall be suitably diverted and connected to a permanent water course.

6.05.00 **Sewage / Waste Water Drainage**

6.05.01 For plant area sanitary sewage disposal, Effluent from the each building complex shall be connected to a common combined sewage treatment plant. The treated effluent shall conform to the requirement of Pollution Control Board.

6.05.02 Waste water generated from the plant shall be taken up to inlet of ETP/STP. Provision shall also be made for collection and disposal of solid waste. Generally salt glazed stone ware pipes shall be used to carry sewage / waste water where pipes are laid in original ground. Where pipes are to be laid on filled up soil or below roads / paved areas Cast iron pipes shall be used. They shall be encased in concrete at road crossings. Manholes shall be at junctions and change of direction. In straight stretches manhole shall be provided at a maximum spacing of 30 metres.

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6.06.00 Construction Enabling Works

6.06.01 TEMPORARY SITE BUILDING

- i) The bidder shall provide for at his cost the following building facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory Rules regarding staff welfare facilities. All these building shall have brick cladding, GI/Colour coated metal sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/c as required.

6.06.02 STORES

- i) A covered store shall be provided with brick cladding and GI/Colour coated metal sheeting to store at least one-month requirement of cement. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 10 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.
- ii) Covered storage area may also be provided to store other construction material which will be affected on exposure to wind, sun and rain.
- iii) Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.
- iv) Storage yard paved or unpaved shall be provided with in the stores complex for storage of other material.
- v) Proper fencing and security arrangement shall be provided for the stores complex.

6.06.03 TEMPORARY WORKSHOP AND GARAGE

- i) The bidder shall provide for a temporary workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities.

6.06.04 FABRICATION YARD

- i) Depending on the extent of fabrication envisaged at site, the bidder shall establish a fully fledged structural fabrication yard with adequate handling facility during and after the fabrication.
- ii) A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control.
- iii) Portion of the yard shall have covered shed with H.O.T / E.O.T/Gantry cranes so that fabrication work can proceed even during inclement weather.

6.06.05 QUALITY CONTROL LABORATORY

- i) A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc.

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- ii) This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER.

6.06.06 FUEL STORAGE AREA

- i) Bidder shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility.

6.06.07 STAFF WELFARE FACILITY

- i) Bidder shall provide adequate facility for his staff inside the plant boundary such as Toilets for both gents and ladies, Canteens, drinking water facility, rest places, etc.
- ii) Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the Bidder's responsibility.
- iii) He shall also provide for proper disposal of sewage and other wastewater to meet with the requirement of Pollution Control Board.
- iv) Bidder shall identify sufficient area outside the plant boundary to accommodate his staff and labour. Construction and maintenance of the staff and labour colony to satisfy all statutory requirements is the sole responsibility of bidder.
- v) The bidder shall be primarily responsible for all statutory deductions and contributions on account of CPF/EPF as per rules/act in force and subsequent amendments during contract period.

7.00.00 SALIENT FEATURES AND DESIGN CONCEPT

7.01.00 General

7.01.01 This section of specification covers salient features and design concepts of Civil, Structural and architectural works pertaining to Power Plant components as detailed below.

7.01.02 The following table indicates some of the building sizes. Subsequent paragraphs give the description of the buildings. It shall be noted that the building sizes shall be based on the various criteria as defined and based on the operation and maintenance requirements wherever applicable. However, the building sizes shall in no case be less than what is furnished in the table.

S. No.	Description	Size In Meters
1	Power House Building	45 X 265
2	Mill Bay	12.5 X 44
3	Service Building	40X18

7.02.00 Steam Turbine Generator Building

7.02.01 Turbine building (TG Bay) framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction.

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- 7.02.02 The Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. Number of E.O.T. Cranes will be as per Mechanical Requirement. At crane girder top flange level, a crane walkway shall be provided in line with Factory rules. Access shall be provided to crane walkway through stair case from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance required duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 100 mm thickness (over metal sheet) and the roof shall be laid to a slope of 1 in 100, constructed over permanently colour coated galvanized M.S troughed metal sheet of approved profile supported on steel purlins and trusses. Over the TG Bay roof, monitor shall be provided with Exhaust system mounted on the side wall of the monitor. Side wall at location of exhaust fan shall be of brickwork supported on the steel beam. Roof of the monitor shall be of RCC over steel beams. Side cladding and end cladding of monitor shall be of translucent sheets except in areas where fans are mounted.
- 7.02.03 Service and maintenance bays shall not have any intermediate floors. However a 1500 mm wide observation gallery with hand rails shall be given along the wall at the operating floor level to observe the TG erection operation. Intermediate floors shall be preferably as indicated in the station building general arrangement drawings. The floor shall be RCC floors over steel framing; whereas the floor at any other level as required may have chequered plate / gratings supported on structural steel frame work.
- 7.02.04 Cladding shall be of brick wall up to a height of 3000 mm above Ground floor level on gable ends as well as on the A row. Walls in front of transformers on 'A' row shall be of adequate thickness and height to satisfy the requirements as per TAC regulations. Cladding beyond the above level shall be of permanent colour coated double skin insulated weather tight metal cladding system. For Electrical rooms and control room portion the cladding will be completely of brick with single skin metal cladding on the external surface to match the exterior finish of the building. External brick wall surfaces shall be plastered with cement mortar before erection of sheets.
- 7.02.05 All windows shall be anodized aluminium side hung and generally glazed using 6 mm thick wired glass. However in areas where cladding is of sheeting fixed glazing in anodized aluminium frame work and in accessible areas sliding windows in anodized aluminium frame work using 6 mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding / cum folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.
- 7.02.06 Staircases protected on all sides with fire proof enclosure shall be provided to satisfy TAC regulations. Staircase shall be for maximum utility and safety. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying TAC regulations. Access cage ladders shall be given to T.G building roof. Panic bar shall be provided for all fire proof door.

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7.02.07	Roof shall be provided with In situ concrete supported on metal decking with elastomeric membrane type waterproofing system as per specifications.. Roof rain water pipe shall be of uPVC conforming to IS 4985:2021 shall be provided to drain off the rain water from roof for all buildings. They shall be suitably concealed from the facade. Cement concrete tiles conforming to IS 13801 over cement mortar shall be provided over complete water proofed area suitable slope in screed concrete for drainage of water towards rain water pipes through metallic snout.	
7.02.08	Thickness of structural RCC floor shall be minimum 150 mm above the steel floor beams for the intermediate floors with an additional 50 mm floor finish which shall be provided later. 25 mm concrete cover shall be provided below beam top flange level.	
7.02.09	All the intermediate floors shall be provided with proper drainage. Catch pit with C.I grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same coordinate for all floor levels. 80 NB galvanized M.S pipes conforming to IS:1239 shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided in ground floor to receive the water. Proper drainage arrangement shall be provided in the ground floor by means of RCC gravity channels with CI grating on top. The drainage shall be led to sumps from where the water shall be pumped to plant drainage arrangement. Around equipment liable to frequent drainage, concrete kerb shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator should be provided as required to isolate oil from the drainage water where the water is mixed with oil.	
7.02.10	In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.	
7.02.11	Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.	
7.02.12	Expansion joint shall be provided in the building to satisfy the requirements of IS:800 and IS:3414 unless the location of expansion joint is not specified in the GA drawings accompanying the Bid document	
7.02.13	Foundations for major equipment like Turbo generator and Boiler feed pump shall be mounted on properly designed conventional block / frame type RCC foundation. However the foundation shall be isolated from the building frame work.	
7.02.14	Rough plaster shall be applied for outer wall / concrete surfaces before erection of metal cladding.	
7.03.00	Control Room / Electrical Bay/Heater Bay Structure	
7.03.01	The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that in front of control room no cross bracing is provided.	
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7.03.02 Minimum headroom of 2200 mm shall be given in the cable vaults. In control room false ceiling level shall be kept 3500 mm above floor level. 7.03.03 All floors shall be of in-situ RCC slab provided over structural steel beams with film coated shuttering. Min thickness of structural concrete shall be 150 mm with an additional 50 mm provided for finish. Roof shall also be of in-situ concrete with permanently laid M.S sheet shuttering; but the concrete shall be given a slope of min 1 in 100 for proper drainage. No openings will be permitted on the roof of control room excepting possibly opening for A/C duct to exercise proper control on air conditioning. No openings will be permitted on the roof also, as this will interfere with effective water proofing. 7.03.04 Cladding shall be of brick walls. Windows for switch gear room and control room / electronic cubicle room will not normally be allowed on the Boiler side to avoid coal dust nuisance. However minimum two numbers of sliding windows shall be provided for switchgear rooms. Walls shall normally be supported on wall/floor beams. If wall beams cannot be avoided they shall preferably be given at the level of floor beams and shall be encased in concrete. 7.03.05 Portion of the structural steel column projecting into the room shall be encased with flame resistant material such as Gypsum board to shield it from fire hazards. 7.03.06 Cable vault shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side. 7.03.07 Switch gear room shall be provided with minimum two steel doors to satisfy statutory requirement. In addition a two leaf sliding doors of flush welded steel construction shall be provided to move the switch gears into the room making use of equipment lifting hatch provided in turbine building. 7.03.08 Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodized aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. All the doors shall be single leaf glazed aluminium doors for all cabins. For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. All partitions wall for Control room area shall be of aluminium glazed partition up to roof level, on either side of air lock. Glass partition/windows of rooms protected by inert gas shall be shatter-proof. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding all round to reduce sound nuisance. 7.03.09 Battery room shall be provided with PVC doors in PVC framing. For Air washer room steel doors shall be used which shall be air tight. No window shall be provided in Air washer room. 7.03.10 Staircase properly enclosed to satisfy TAC regulations shall be provided at either ends of each unit. All doors leading to staircase shall be automatic closing fire proof door. Staircase shall not be provided around the passenger lift. At least one staircase shall extend up to roof. Toilets shall be provided at the switch gear room level and control room level. Toilet floors shall be sunk and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.		
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7.03.11 Control room and electronic cubicle room are to be provided with false ceiling. False ceiling shall be designed aesthetically properly arranging, supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling. 7.03.12 Roof shall be given a fall of about 300 mm for proper drainage. Elastomeric membrane type Waterproofing system as per specifications shall be provided over the roof. The entire roof shall be made accessible by cement concrete tiles over the water proofing layer, set in cement mortar and pointed using neat cement mortar mixed with crude oil. 7.03.13 Floor above control room where APRDS and other pipes are located as well as floor below the de-aerator area shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room. 7.03.14 All openings in floor for switch gear and other panels shall be sealed with fire proof material after cables are connected. 7.03.15 Adequately designed RCC storm water drains shall be provided to lead the roof drainage on to the plant drainage system. These drains shall have pre-cast RCC slotted cover. Plinth protection shall be given on the side of the drain up to the brick wall. 7.03.16 ACP cladding shall be provided for walls inside and outside of PCR. 7.04.00 STG area foundations 7.04.01 The TG foundation shall comprise of RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns. These TG columns can be interconnected to the Main Power House Building frame either rigidly or connected through PTFE bearings on corbels/ brackets of the TG Columns. The general arrangement & details of springs/ viscous dampers and supporting group of columns and beams shall be based on TG Equipment detail of the Bidder. 7.04.02 TDBFP&MDBFP foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers inside Main Power House. In case the top deck is located at operating floor/mezzanine floor level, the springs/ viscous dampers shall be supported on a group of structural steel columns-beam grid which shall be rigidly integrated with the Main Power House Structural frame. 7.04.03 In case the MDBFP/TDBFP foundation is approved by owner & consultant to be located at ground floor of Main Power House, then these shall be designed as block foundations directly resting on soil / pile. Vertical facing of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/Cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round.		
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7.04.04 For the foundations of Turbo-generator, Boiler feed pumps, etc. detailed static and dynamic analysis shall be done. 7.04.05 The vibration isolation system (where ever applicable) supplied shall be of proven make and shall be in successful operation supporting machines like steam turbo-generators, BFPs, etc., 7.04.06 Wherever foundations directly supported without any helical spring and viscous dampers for TG or BFPs, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations. 7.04.07 The bidder or his consultant should have adequate prior experience in design of machine foundations for the respective alternative to be adopted by the bidder and the machines should be in successful operation for at least one year prior to the date of submission of bid. 7.05.00 Boiler area Machine foundations 7.05.01 The scope of work of the Bidder shall be design and construction of all Civil & Structural Works of Machine Foundations including supply of all materials. 7.05.02 PA/ FD/ ID Fan and Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 Kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round. 7.05.03 For the foundations of Fans (ID, FD and PA), Mills, etc. detailed static and dynamic analysis shall be done. 7.05.04 Wherever block foundation is adopted by the bidder, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations. 7.05.05 The bidder or his consultant should have adequate prior experience in design of machine foundations and the machines should be in successful operation for at least one year prior to the date of submission of bid. 7.06.00 Boiler structure 7.06.01 The Boiler supporting structure shall be structural steel framed superstructure adequately braced in vertical planes in both the orthogonal directions. The general arrangement & details of structural steel columns, beams, bracings, ceiling girders etc shall be as per the Bidders Boiler Structure design and detailed engineering scheme. 7.06.02 The bottom base plates of Boiler structure columns shall be 1.20m below the finished paving level in the Boiler area. The RCC pedestals supporting the column base plates shall be extended in order to provide RCC encasement to the structural steel columns up to at least 300mm above the top of the paving RCC slab. Steam Generator roof (pent house)/canopy/side cladding shall have single skin troughed profile permanent colour coated sheet. Cladding for Boiler		
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elevator enclosure except its machine room shall be with single skin troughed profile permanently colour coated sheet.

- 7.06.03 Bidder shall integrate the boiler supporting structure with Mill & Bunker Building Structure.
- 7.06.04 Waterless Bio Urinals with enclosure are to be provided by the Bidder on each floor elevation of each boiler. Maintenance of toilet in hygienic condition till COD of the unit shall be the responsibility of the bidder.
- 7.06.05 Boiler supporting structure shall be designed by the Bidder based on provisions of IS 800 for structural steel and IS: 456 for RCC works.
- 7.07.00 **Mill And Bunker Bay Building**
- 7.07.01 The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed the coal into coal bunker.
- 7.07.02 The bunker shall be circular in plan and each bunker shall have a holding capacity as per the requirements of the steam generator. A comprehensive flowability study shall be conducted by the bidder for the coal bunker hopper to ensure smooth flow of coal in all seasons with different moisture contents and different percentage of fines. Geometric parameter of hopper and lining material shall be decided considering the findings of flowability study. Complete hopper (sloped portions) shall be provided with lining of at least 5mm thick SS 304M grade material.
- 7.07.03 Mills are to be located on the ground floor. Mill foundations are to be designed with conventional block/frame type RCC foundation. In addition to Mill foundations provision has to be made in the Mill bay ground floor for trenches accommodating Mill reject system conveyors.
- 7.07.04 A Mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This shall be a platform with chequered plate or gratings over steel framing with hand rails all-round. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runway girders shall extend to the full length of Mill bay to enable approach to the service bay also.
- 7.07.05 Above this framing, feeder floor is provided. The extent of the feeder floor shall be decided by the bidder based on his maintenance requirements. Feeder floor shall be of RCC supported on structural steel framework. Handrails shall be provided on all the sides. A steel stair case shall be provided for access to feeder floor from ground floor.
- 7.07.06 Frame works for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper.
- 7.07.07 Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.

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7.07.08	Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel frame work.	
7.07.09	Tripper roof shall be of RCC supported on structural steel frame work. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet or steel handrail shall be provided for the tripper roof. Access stair / ladder shall be provided from tripper floor to roof in each unit.	
7.07.10	In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air cannons.	
7.07.11	Tripper floor and roof shall be given access through Boiler stair case / Elevators.	
7.07.12	Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor up to 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanized sheet cladding shall be provided. Fixed steel windows with 6 mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery.	
7.07.13	Roof slab will be sloped to one side to permit easy drainage. Screed shall be of under roof tiles.	
7.07.14	Rain water down take pipes shall be of uPVC pipe conforming to IS 4985:2021.	
7.07.15	All structural steel work shall be provided with epoxy painting as defined in relevant section. All exposed gratings and handrails shall be galvanized. Expansion joint shall be provided in the structure as required by IS: 800.	
7.08.00	Steam Generator Elevator Supporting Structure	
7.08.01	Capacity and number of the elevator shall be as shown elsewhere. The elevator supporting structure shall be of structural steel braced in both directions. Plan bracings are provided at all the landing locations. Where landing locations are far apart, plan bracings shall consider at least at every 8 m centres.	
7.08.02	Elevator shaft shall be constructed with colour coated insulated metal cladding system supported on structural steel work. Lift pit shall be of RCC construction. Ground floor entry shall be kept about 500 mm above general graded / paved level with a ramp for approach. A sump for drainage and Aluminium ladder shall be provided in the lift pit.	
7.08.03	Machine room floor shall be of RCC with 300 mm kerb wall all round. Roof also shall be of RCC construction with permanently colour coated galvanized MS trough metal sheet decking. Roof shall be sloped to one side for drainage purpose.	
7.08.04	Side cladding shall be of insulated cladding as specified for lift cage. Adequate window shall be provided for admitting natural light. Adequate / designed monorail with equipment hatch in the machine room floor shall be provided to lift heavy machinery. Steel staircase shall be given to the Machine room from last landing. Landing levels are generally governed by the floor levels in the Boiler structure. In addition landing shall be provided at feeder floor and tripper floor	
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levels. Structural steel gallery shall be provided from the elevator landing platform to these floors.

7.08.05 Windows in the machine room shall be anodized aluminium using 6 mm thick wired glass. Door shall be of flush welded hollow steel type. All structural steel work shall be provided with 2 coats of primer and a minimum of 2 coats of anticorrosive epoxy paint.

7.09.00 **ESP Structure**

7.09.01 The ESP structure shall be a structural steel superstructure with vertical bracings in the required vertical planes in both longitudinal and transverse directions, the details of which shall be as per the approved ESP equipment GA & details of the bidder.

7.09.02 The bottom of base plate for ESP structure columns shall be 300mm above the finished paving level in ESP area. The RCC pedestals supporting the column base plates shall be extended accordingly above the top of the paving RCC slab. Further, the gusset plate / base plate shall be encased in concrete up to the top of bolts. ESP roof (pent house)/canopy/side cladding shall be single skin troughed profile permanently colour coated sheet.

7.10.00 **ESP Control Room**

7.10.01 This shall be RCC framed structure. Separate building is envisaged for each unit. The ground floor shall accommodate cable vault, toilet and staircase. First floor shall accommodate switch gear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC regulations, package air conditioners for EC control room and VFD room.

7.10.02 Staircase area shall be protected from fire safety angle as per TAC regulations. Main door to switch gear room shall be steel sliding door having adequate area to admit switch gear. There shall be minimum two doors to the switch gear room, of flush welded steel type. Control room should have one swing type aluminium glazed double panel door and one single panel door. Windows shall be steel glazed for switch gear room with wired glass. For control room if window is provided the same shall be of fixed glass type with 6 mm thick sheet glass. Main entrance of the building shall be a rolling shutter with appropriate ramp approach. Aluminium false ceiling shall be provided in the Control room. Under deck insulation shall be provided above false ceiling.

7.10.03 Roof shall be given access by means of cage ladder. An equipment hatch shall be given in the first floor with lifting beam to lift the switch gear / control panel to the first floor.

7.10.04 Roof shall be given a slope of minimum 1 in 100 towards the side opposite to transformer yard. Roof shall be given Heavy duty water proofing with Bitumen felt. Adequate number of rain water down take pipe shall be provided using uPVC pipe conforming to IS 4985:2021. Garland drain as well as plinth protection shall be given around the building.

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7.10.05 Transformer yard shall be provided with 3 m high PVC coated chain link fencing with gates. In case more than one transformer is being provided, fire wall shall be given to separate the transformers. Oil soak pit shall be provided below the transformer. Burnt oil pit shall be provided connecting the soak pits with RCC pipes. The transformer area shall be provided with paving using hard stone aggregates. 7.11.00 Wet Flue Chimney 7.11.01 Provision for one twin flue reinforced concrete chimney with cladding of minimum 2mm Titanium/C-276 or Borosilicate glass block lining on mild steel liner for 2 X 660MW unit of the project. 7.11.02 The height of Chimney/ stack height shall be 140m. 7.12.00 Steam Generator Area Paving 7.12.01 Entire steam generator area up to the end of Chimney shall be provided with RCC paving over rubble soling. 7.12.02 Paving shall be carefully planned such that maintenance access roads of minimum 4 m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the Steam Generator elevator also to enable handling of equipment at higher level during maintenance. Such road ways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading. 7.12.03 The drainage of the entire Steam Generator area shall be properly planned. Network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which leads the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant drainage system. Where open drains are not permitted underground pipes may be provided in which case at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns in the area shall be provided with RCC encasing to a height of minimum 200 mm from the top of foundation pedestal with sloping (3%) with concrete at top to avoid corrosion in steel column. The maximum paved level in Steam Generator area shall be kept a minimum 150 mm below the finished ground floor level in Turbine building area. 7.13.00 Transformer Yard 7.13.01 Generator transformer, station transformer, unit auxiliary transformer and service transformer are located in front of the turbine building. Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through concrete, pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as Fire barrier wall. 7.13.02 RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3 m high chain link fencing with gates. Where rails cross the fencing, fencing shall be		
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made of removable type to facilitate transport of transformer. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.

7.14.00 Condenser Cooling Water System

7.14.01 Filtered / Clarified water shall be used for circulating water system.

7.14.02 RCC cooling water channel shall be of rectangular shape and designed as a water retaining structure. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel leading to the fore-bay of the pump house. Dimension of the channel shall be decided on the basis of the quantity of water to be carried by the channel. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above ground level with suitable galvanized M.S pipe hand railing on either side. Expansion joint shall be given at a spacing of about 30 m. Pedestrian crossover shall be given across the channel at approximately 300 m centres. The channel shall smoothly diverge and form the fore-bay in front of the pump house.

7.14.03 Depth of the forebay shall generally match with the C.W sump level, which shall be decided based on submergence requirement of the C.W pumps at the lowest water level in the sump. Forebay shall be provided with cage ladder at four corners constructed of galvanized steel. Top of the forebay shall be kept 500 mm above grade level and handrail of galvanized M.S. pipes shall be provided for the entire length on either sides. Water level indicator (float type) shall be provided in the forebay close to the pump sump on either side to observe the depth of water. Water levels shall also be marked by epoxy painting, inside the forebay at a suitably visible location.

7.14.04 Dimension of the pump sumps shall be so selected as to prevent dead water areas, reverse currents, flow separation and eddies. Recommendations of British Hydromechanics Research Association (BHRA) and Hydraulic Institute Standards shall be followed. Bidder shall conduct Hydraulic Physical Model study to demonstrate trouble free operation of the pump sump and forebay for all possible alternatives / combination of pump operation.

7.14.05 Pump sump shall be designed as water retaining structure. Each sump shall be provided with stainless steel groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Whereas number of coarse screen and fine screen shall be the same as the number of pump sumps the number of stop log shall be a minimum of two. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering and lifting of stop logs and screens. These openings shall be covered with galvanized mild steel gratings when the screens are placed in position. Provision for handling of the screens and stop logs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also

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be provided with a drain sump to empty the sump for attending to maintenance of pump.

- 7.14.06 Pumps generally have common base plate with the motor and hence the pump foundation is provided at the motor floor level. A thrust block shall be provided connecting the pump and motor floors to resist the pump thrust. Staircase shall be provided from the pump floor to motor floor.
- 7.14.07 Motor floor shall be given handrail on the two sides. Pump maintenance area shall be provided on one side at the pump floor level.
- 7.14.08 Necessary civil works for concrete volute pumps with auxiliaries shall be done.
- 7.14.09 The pump house structure shall be of R.C.C frame. Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have R.C.C grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.
- 7.14.10 An annex to the C.W pump house shall be provided in RCC framed structure to accommodate Switch gear and Control room with cable vault below, Chlorination room, Chlorine cylinder storage room and toilet block. Side cladding shall be of brickwork except in Chlorine cylinder storage area where brick wall is provided only to a height of 1 m. All floors and roofs shall be of RCC. Roof shall be given proper slope. Review for providing elastomeric compound as per roof treatment done in other major plant building.
- 7.14.11 To protect water proofing courses, a screed layer of concrete grade M20 using 10 mm downgraded aggregate, of average thickness 40 mm shall be provided. Rain water down comers shall be of uPVC pipes conforming to IS 4985:2021. Roofs shall be made accessible by MS cage ladder.
- 7.14.12 All doors shall be of flush welded steel construction. For Switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of Transformer yard shall be designed to satisfy fire rating as per TAC regulations.
- 7.14.13 An auxiliary transformer yard may be required in front of the Switch gear room. Civil work similar to the transformer yard in front of ESP control room shall be included in the scope of work.
- 7.14.14 Outside the pump house support blocks for butterfly valves and pipes along with proper handling facility shall be provided.
- 7.14.15 Cooling water conduits of adequate size shall be provided from C.W pumps to Power House Building A row column and hot water conduits from Power House Building A row column to cooling tower. These conduits shall be formed of structural steel conforming to IS: 2062 grade B laid underground with an earth cushion of 1500 mm above the pipes. The pipes shall be provided with painting lining as specified in the Mechanical Section on internal surface. In case of steel pipes wrapping as per IS: 10221 shall be provided for external surfaces. Where pipes are not encased, the pipe shall be given sand bedding up to the centre line of the pipe. At location of the bends RCC anchor blocks shall be designed and

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provided. Manholes shall be provided along the length of pipe at about 150 m centres and near locations of bend in each pipe. The pipes shall be line tested before commissioning of the system. At road / rail crossing, RCC encasement shall be provided and designed adequately to withstand the additional imposed loads.

7.14.16 Following design requirements shall be met:

- i) The design pressure shall be the highest of the following:
 - a) Pump shut off head + Static head difference between normal water level at CW sump and the lowest invert elevation of the CW conduit
 - b) Maximum pressure due to surges
- ii) The conduit shall also be designed for vacuum pressure inside and overburden pressure outside. The Vacuum pressure shall be based on the surge analysis but in no case less than 0.9 Kg/sq cm for the inlet and outlet pipes from the condenser and the delivery pipes from pump discharge up to the header and 0.5 kg /sq cm for the main inlet and discharge pipes. Suitable protection devices such as air release valves shall be provided to ensure that design vacuum pressures are not exceeded.
- iii) The conduit shall be designed for surcharge of 2t/m².
- iv) The design shall be checked for other loading combinations of surcharge, transformer load, ground water pressure etc.

7.15.00 **CW Ducts**

7.15.01 CW ducts shall be concrete encased steel lined ducts. The concrete encasement shall be of minimum 500mm thick with square shape outside. Generally, M20 grade PCC encasement shall be provided. At locations of duct crossing road, rail in transformer yard or any other facility, RCC encasement of grade M25 shall be provided. Minimum two layers of reinforcement (On both faces) of 12 mm diameter bars @ 200 mm c/c shall be provided for RCC encasement of CW Duct. Top of CW duct encasement shall be minimum 1.5 m below finished ground level.

7.15.02 The minimum thickness of steel pipes shall be as follows including corrosion tolerance of 2 mm:

- i) For pipes above 1800 mm upto and including 2300 mm dia - 12 mm
- ii) For pipes above 2300 mm upto and including 3200 mm dia - 14 mm
- iii) For pipes above 3200 mm upto and including 3750 mm dia - 16 mm
- iv) For pipes above 3750 mm upto and including 4000 mm dia - 20 mm

7.15.03 However, for ducts running below rail line in transformer yard/road, minimum thickness of CW liner shall be 20 mm.

7.15.04 Suitable tap-offs shall be provided in the duct to connect CW blow down, ACW tapping etc. Based on the transient analysis, sufficient number of stub connection shall be provided in the duct to fix air release valves.

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7.15.05	All duct installation & jointing shall be strictly in accordance with the stipulation given elsewhere in the specification for structural steel work. All the joints of liners shall be butt welded joints. The circular deformation of liner shall be less than 1% of diameter of liner while handling, transportation, erection & construction. If required, temporary bracings may be provided, during handling, transportation & concreting to reduce the deformation.	
7.15.06	The completed duct shall be tested for water tightness, for the pressure equal to twice the working pressure or 1.5 times the design pressure whichever is higher and shall be generally water tight to Engineer's satisfaction. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld. Any in flow / leakage of water from the duct shall be sealed / repaired at Bidder's cost. However, tests in part of length of duct may be permitted with prior approval only.	
7.15.07	Wherever required anchor / thrust blocks shall be provided with RCC M25 grade concrete. Suitable RCC chambers shall be provided with precast covers to install flow measurement devices and valves in the duct.	
7.15.08	Manholes of minimum 1000mm clear opening shall be provided in each CW duct at a spacing of 200M (approx.) to facilitate maintenance / dewatering of CW ducts. At least one manhole shall be provided at the deepest point for both intake & discharge duct.	
7.15.09	Following shall be considered for design of C.W. ducts:	
	i) Maximum design water pressure	
	ii) Surge or water hammer pressure of 5.0 Kg / Sq.cm.	
	iii) Expected vacuum conditions as arrived from transient analysis	
	iv) Soil overburden	
	v) Surcharge Pressure of 2T/Sq.m	
	vi) The effect of concrete encasement shall not be considered in the design of CW duct	
7.16.00	Air Washer Room	
7.16.01	This shall be a steel framed building adjoining to the Turbo generator building.	
7.16.02	Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall be given 20 mm cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided for. Doors shall be of flush welded steel and they shall be made airtight. Rolling shutter of adequate size should be provided for taking the equipment inside.	
7.17.00	Compressor House	
7.17.01	Compressor building shall be of steel framed construction. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on	
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steel beams. Side cladding shall be by brick supported on concrete encased steel beams. The roof framing shall support an under slung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Steel glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel doors shall be provided for movement of personnel. Dimension of the building indicated are tentative and shall be decided by the bidder to suit the dimension of the equipment he is supplying duly taking into account maintenance requirements.

7.18.00 Diesel Generator House

7.18.01 This shall be a single storied RCC framed structure and shall have brick cladding and provided with electric hoist. D.G set foundation shall be isolated from the floor. Side cladding shall be double wall brick cladding with cavity for noise suppression.

7.18.02 All trenches shall be of RCC. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

7.19.00 Fuel Oil Handling system

7.19.01 The civil works are to be provided for following fuel oil handling system areas as mentioned below:

- i) Fuel Oil pump house.
- ii) Foundation and dyke wall and all associated works for LDO storage tanks and day tanks.
- iii) Pedestals and foundations to support the interconnecting piping between LDO tanks to the pressurizing pumps as well as piping from tanker unloading area to the Unloading pump house and further on to the LDO tank.
- iv) Tanker unloading platform. (If applicable)
- v) Oil water separator pit.

7.19.02 FUEL OIL PUMP HOUSE

i) *Salient Features:*

- a) This building shall be a single storied framed superstructure with RCC columns, structural steel roof truss (with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise minimum 40 mm thick (above the crest of metal deck sheet) RCC slab supported on profiled metal deck sheet. Waterproofing on Roof slab shall be done as per architectural specifications. The building shall be completely covered with 230mm thick brick wall with provisions for doors, windows, rolling shutters. The building shall have separate enclosures for the control room and the switchgear room. All rainwater down comers shall be concealed with brick wall. The minimum floor area of this building shall be as per the equipment layout plan of the bidder.

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ii) *Design Concept:*

- a) The grade of concrete shall be M 25 for all columns, beams, footing and slabs. The building shall be designed as per IS: 456, IS 800, IS 1893, IS 13920 (for ductility detailing).

7.19.03 FUEL OIL STORAGE TANK FOUNDATIONS

- i) The Fuel Oil Storage Tank foundations shall be either RCC raft or RCC Ring Beam system with compacted infill. The RCC raft /RCC ring beam shall be supported on virgin soil or pile foundation depending on the load bearing capacity of the soil. The tank bottom base plate shall be supported on flexible compacted fill comprising 75mm thick Bitumen aggregate mix on top and compacted sand/ soil fill below, compacted in layers of 200mm to minimum 85% relative density as per IS:2720. The bitumen-aggregate mix shall consist of compact crushed stone, screenings, fine gravel, clean coarse sand(river sand) mixed in hot asphalt (8 to 10 percent by volume) and rolled or compacted. In the GA & detailing of foundation RCC ring wall/ beam it should be ensured that no bearing stress from tank superstructure is transmitted to the concrete surface. The top of flexible compact fill and top of RCC Circular wall shall be atleast 325mm above the surrounding ground surface for effective drainage.
- ii) The finished tank grade (Top surface of flexible compact fill) shall be crowned from its outer periphery to its centre at a slope of 1 in 100.
- iii) The Tank foundations shall be inside a RCC dyke wall enclosure. The entire area outside the tank foundations and within the surrounding RCC dyke walls shall be paved with concrete. The thickness of concrete paving shall be minimum 100mm. The single layer reinforcement in paving slab shall be min 10 Tor@200c/c. The area paving RCC slab shall be supported on 230mm thick Rubble soling with the internal voids filled with coarse sand. The height of the RCC dyke wall shall be evaluated based on the depth of Oil spillage for full oil volume of one storage Tank in addition to a free board of 300mm. Structural steel cross over ladder shall be provided (min 2 numbers) for each RCC wall dyke enclosure. Operating platforms wherever required as per functional requirement shall be provided.

7.19.04 TANKER UNLOADING PLATFORM (IF APPLICABLE)

- i) The road tanker unloading platform shall be heavy duty RCC paving minimum 250 thick RCC slab resting on elevated compacted ground surface. A minimum slope of 1:250 shall be provided (in one direction) for the slab for Oil-Water Surface run-off to the peripheral drain.
- ii) Expansion joints shall be provided in chess board fashion. RCC ramp shall be provided for approach of truck.

7.19.05 OIL WATER SEPARATOR PIT

- i) The Oil-Water Separator RCC structure (pit) shall be designed as an underground structure. The sizing of the separator shall be based on the total surface run-off from the Fuel Oil Handling area and Hydraulic design for the oil separation. Surcharge load and ground water table up to ground surface shall be

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considered in addition to other functional loads for structural design of RCC wall for the separator pit.

- ii) Drainage trenches with proper bed slopes towards the oil-water separator pit shall be provided around the tank foundation. The entire area outside tank foundation shall have slope towards the drain trenches.
- iii) Foundation for trestles and pedestal foundations, for supporting the pipes, shall be provided wherever required, at appropriate spacing. At pipe bends, necessary thrust resisting arrangement shall be provided.
- iv) The entire fuel Oil Handling area shall be fenced all round with minimum 1.50m high metal fencing with provision for gates at key locations.
- v) Seismic design shall be carried out for the Fuel Oil Storage Tank foundation, Fuel Oil
- vi) Unloading Pump House & the Oil water separator.

7.19.06 ARCHITECTURAL FEATURES OF FUEL OIL HANDLING BUILDINGS

- i) Spaces for Pump Rooms, MCC Rooms, Control Rooms etc. shall be provided as per functional requirement. One Toilet block with drinking water facility shall be provided in each building.
- ii) External finishing shall be of Premium Acrylic Smooth Paint with Silicone additives over suitable primer of water proof cement.

7.20.00 **Service Building**

7.20.01 The Service Building is a 5-storied building (min. size 40M x 18M) including ground floor. Building is located adjacent to the Power House Building as shown in the Plot Plan. The Plan area specified under specification is minimum requirement. An all-weather covered access corridor to be provided with powerhouse building at operating floor level, if the Service Building is detached one from power house building. The building size shall be suitably decided during detail engineering stage. It will house the facilities as listed below. Building should have 2 (two) nos. of passenger elevator (13 passenger) and 2 (two) staircases. Overhead water RCC tank of 10,000-litre capacity should be provided at roof of the building.

7.20.02 It is an important part of operation and maintenance of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience.

7.20.03 Facilities in different floors shall be as under:

Sr. No.	Level	Area Description
1.	Ground floor	Entrance lobby, Reception Lounge (double height), First Aid room, Telephone exchange, Civil Maintenance office & Store, Boiler Maintenance Store and staff room, Turbine Maintenance Store and staff room, Lift,

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Sr. No.	Level	Area Description
		Staircases, Toilet etc.
2.	First floor.	Boiler Maintenance J.E./A.E. room, Boiler Maintenance Dy. E.E. cabins room and E.E. room, Turbine Maintenance Dy.E.E. cabins room and E.E. room, Boiler Maintenance library/record room, Turbine Maintenance library/record room, safety office, pantry.
3.	Second floor	Electrical Maintenance store and staff room, Electrical Maintenance lab room, Electrical Maintenance J.E./A.E. room, Electrical Maintenance Dy.E.E. cabins room and E.E. room, Electrical Maintenance library/record room, POG store room, POG E.E. cabin, E.E. Efficiency cabin, Computer and Planning section, pantry.
4.	Third floor	I & C store and staff room, I & C lab room, I & C J.E./A.E room, I & C Dy.E.E. cabins room and E.E. room, Testing store and staff room, Testing J.E./A.E room, Testing Dy.E.E. cabins room and E.E. room, I & C library/record room, Simulator Room, Training Hall, pantry, testing library/Record room etc.
5.	Fourth floor	S.E. three cabins, Dy.C.E. two rooms, C.E. one room with attached toilet, Technical Section, VIP lounge, Conference room, Video Conference room, Pantry etc.
6.	Roof	Lift M/C room, Water tanks, Cooling towers for HVAC, etc

7.20.04 The Building shall be centrally air-conditioned. Drinking Water Cooler, Water filter shall be provided on all floors. Wash room shall be provided on all floors. Separate ladies toilet shall be provided on all floors. All finishing items, Layout, and other requirements should be of owner's choice. However modern design approach of an office building like- open & flexible (workstation based) layout, usage of natural light, solar control, energy efficient, etc shall be considered by the bidder. Since this is one of the most prestigious buildings, aesthetically this should achieve landmark quality. ACP cladding shall be provided for inside partitions and front side elevation works.

7.20.05 Specially designed long and spacious RCC porch shall be given in front of the main entrance for receiving cars of VIP's.

7.20.06 Special attention to be given in front of service building in landscaping the area and developing garden with flowering plants and fountains etc

7.20.07 Shaded car parking facility shall be provided as per requirement of the owner. Bidder shall have to furnish all relevant drawings and details including finishing in their offer.

7.20.08 Brief technical specifications of different items to be used for the area as follows:

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i) *Flooring*

- a) Generally, floor finish shall be Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles, of minimum size minimum 600 mm x 600 mm of approved colour & design, and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 40 mm thick including the thickness of the tiles, under bed.
- b) For Entry cum reception lounge, VIP lounge, Main meeting/ conference room: Suitable and approved combination shed of marble slab and strips shall be used. Floor pattern shall be approved by the owner before erection.
- c) For staircase and Corridors: Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey shed.
- d) For Toilet: Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado shall be 100 mm higher than lintel level starting from finish floor level.
- e) For other areas like AHU room, Generator room, Electrical room, Etc: 40 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.

ii) **WALL FINISH**

- a) Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with POP (Plaster of Paris)/White Putty (Birla White) for all area except areas like AHU room, Generator room, Electrical room, etc. which shall be of plastered surface with Acrylic Distemper paint. Front wall for elevator shaft shall have polished granite slab wall cladding (min 12 mm thick). Painting to exterior surfaces of wall shall be of weather proof exterior emulsion paint (Asian Paints). To accentuate the building façade a suitable combination of Aluminium composite panel (ACP)/textured paint like RENOVO may be used.

iii) **FALSE CEILING**

- a) It will be applicable for all areas excluding non A/C areas like AHU room, Generator room, Electrical room, Etc, pantry and toilet. It shall be of aluminium linear acoustic false ceiling with glass wool insulation on top having approved colour with stove enamel finish, integrated with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc.
- b) For pantry and toilet false ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm.

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iv) DOORS

- a) Double acting glazed aluminium door with minimum 15 micron colour anodized finish shall be used having glazing thickness 8mm of clear/tinted float glass of approved brand. The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. Glazed partition may be etched with suitable and approved designed.
- b) Wooden doors shall be of factory made solid core wooden flush door with C.P. teak veneered surfaces in wooden frame with wooden architrave.
- c) Toilet & pantry doors shall be wooden panel door.
- d) Doors for areas like AHU room, Generator room, Electrical room, Etc shall be hollow metal flush door.

v) GLAZED PANELS

- a) The glazed panels shall be made of aluminium sections having same finish that of aluminum doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling and maximum available width. Insulating glass shall consist of 2 nos. 6 mm thick clear float glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. Glazed partition may be etched with suitable and approved designed.

vi) WINDOWS, GLAZED CURTAIN WALL

- a) All windows of A/C areas shall be with heat reflecting glass/double insulated glass. Other windows shall be 15micron thick color anodized aluminium glazed window with minimum 4mm thick clear float glass. Glazed curtain wall shall be Unitised structural glazing system comprising of 30 micron colour anodized aluminium extrusions with double insulated heat reflecting glass. The system shall be able to withstand wind pressure as per relevant data given elsewhere in this specification at all heights.

vii) UTILITIES

- a) All utility lines like water supply line, Electrical wiring, telephone line etc. shall be concealed type. Fittings and fixtures for toilets should be of best quality and to be got approved by Owner prior to installation. Roof treatment, sanitary & sewerage system, roof drainage etc. shall be as per specification.

viii) STORES:

- a) Numbers of store building required shall be decided during detail engineering.

7.21.00 **Fire Water Pump House**

- 7.21.01 The scope of the Bidder shall be design and construction of Civil, Structural, Architectural, Water Supply, Plumbing and Sanitary Works of Fire Water Pump House, storage tank and Foam system including supply of all materials.

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7.21.02	The fire water Pump House shall be single storied and single bay RCC superstructure provision for a structural steel monorail. MCC /switchgear rooms, control room etc. shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding. The building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans.		
7.21.03	Steel shed with roof covering with provision for a structural steel monorail shall be provided for foam system including associated civil works for foam bladder tank foundations, grade slab, pipe pedestals etc. Control room shall have RCC framed structure with cast-in-situ RCC roof slabs with brick cladding. The shed and building shall be fully covered with external brick wall with provision for doors, windows, rolling shutters and exhaust fans. Fire water storage tank foundation shall be provided as detailed elsewhere.		
7.21.04	Fire water pipes shall be provided with either RCC trench or buried underground as per requirement.		
7.21.05	Fire water trenches shall be open RCC type trench with removable RCC cover.		
7.21.06	Interlocking concrete block paving shall be provided over the buried fire water pipes as specified elsewhere in the specification.		
7.21.07	At road/rail/ drain crossings of fire water pipes, the fire water pipes shall be provided with minimum 200mm thick PCC encasement all around the pipe.		
7.22.00	Civil Works for Fire Detection & Protection System in Ground Floor/ Paving		
7.22.01	Fire water pipes shall be provided with either RCC trench/buried underground/on pedestal.		
7.22.02	Fire water trenches shall be open RCC type trench with removable RCC cover. RCC valve pit alongside trenches and RCC fire trenches crossing drains shall also be provided as per requirement.		
7.22.03	Interlocking concrete block paving shall be provided over the buried fire water pipes as specified elsewhere in the specification.		
7.22.04	At road/ drain crossings, NP3 class hume pipe encased in RCC shall be provided as per requirement at a depth of minimum 1m from FGL for routing of fire water pipes.		
7.22.05	In case of rail crossings, NP4 class hume pipe encased in RCC shall be used instead of NP3 class hume pipe.		
7.22.06	Each of the outdoor deluge valve and accessories shall be provided with housing comprising of Brick wall and RCC roof.		
7.23.00	Pipe and Cable Racks		
7.23.01	All cable and pipe routing in outlying area shall be clubbed and shall run over ground on structural steel. Pipe / cable racks at a height not less than 3000 mm above grade level. Where the pipes cross roads / railway clear headroom shall be 8000 mm. The racks can be multi tiered. Cable shall normally be laid above the pipes.		
7.23.02	The Pipe- Cable Gallery shall be Structural Steel Superstructure with Steel Truss (Lattice Girder) having a general span of 15.0m/20.0m. The steel truss shall be		
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supported on 2 legged/ 4 legged trestles the arrangement of which shall be developed by the Bidder. Trestles for pipe and cable galleries shall also be of structural steel.

- 7.23.03 The width of the Gallery shall vary depending on the functional requirement. A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery. The walkway shall comprise 40mm thick MS grating and 1.0m high handrail made of 32NB MS pipes. For pipe /cable galleries carrying ash pipes, galvanized MS grating shall be provided over entire width of the gallery.
- 7.23.04 Plan bracings shall be provided at all chord levels of the cable gallery truss. Minimum gusset plate thickness shall be 8mm for all connections.
- 7.23.05 Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) up to the pipe/cable racks/trestles.
- 7.23.06 The racks are generally designed as a rigid frame in the transverse direction and braced in the longitudinal direction. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres. Access ladder shall be provided at suitable location. Where so required checkered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundations with bottom of base plate about 300 mm above ground level.
- 7.23.07 At the inter-connection of Pipe/Cable gallery with Plant buildings, Pipe/Cable gallery shall be terminated at a maximum distance of 1.50m from the building. The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from centre line of the plant building. Cantilever of 2.50m shall be taken from pipe-cable gallery/ trestle structure.
- 7.23.08 The pipe-cable structure shall be designed as a 3-dimensional space frame for all the relevant load cases mentioned in the design criteria chapter.
- 7.23.09 The gallery being an unclad building, wind load shall be evaluated based on the projected frontal area of the structural members and cable tray depth.
- 7.23.10 The end portals shall be designed as rigid frames hinged (pinned support) at the base plate level (on top of the trestle column). Deflection of end portal due to wind shall be evaluated at the portal column-rafter joint. The gallery vertical truss shall be designed as simply supported girders on trestles and detailing of end portals shall be done accordingly.
- 7.24.00 **FGD System**
- 7.24.01 The civil works for FGD system shall comprise of civil, structural and architectural works below and above ground level of Ball mill building, Ball mill foundations, FGD control room building, slurry re-circulating pumps & oxidation blowers building, tank foundations, absorber tower foundation, MCC building, gypsum dewatering building, transformer foundation, equipment foundations, storage shed for Gypsum, lime storage silo, Truck tippler with shed for lime unloading, wet stack, duct supporting structures, conveyor structures, limestone crusher house, miscellaneous tanks foundations, pipe & cable gallery/ trestles,

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drainage, sanitation, water supply (from terminal points to various buildings/facilities) and all other civil, structural and architectural works associated with the complete FGD system specified elsewhere in this specification. Bidder may also refer terminal points & exclusions in this regard.			
7.24.02	Buildings for FGD System: FGD System may comprise of various buildings based on the functional requirement viz. Ball Mill building, MCC/Control room building, Gypsum dewatering building, re-circulating pumps & oxidation blowers building, Gypsum storage shed etc.		
7.24.03	Control building and MCC Buildings: These shall be steel/RCC framed building with RCC roof and floor. For steel framed building roof /floor shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only) over structural beams. Cladding shall be of brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations. All air - conditioned areas, shall be provided with false ceiling system (details specified elsewhere) with under deck insulation.		
7.24.04	Limestone Grinding System building/Ball Mill building: This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification.		
7.24.05	Limestone unloading shed: It shall be an underground RCC framed and RCC walled water retaining structure and steel structure on over ground from RCC pedestal at height of 0.5m and having side and roof cladding with galvalume sheet. M.S grizzly is provided on RCC hopper top as per required size of lime stone and sump with sump pump is considered for dewatering of the pit. RCC stair case, machine hatch, monorail shall be considered for access to the pit with the prohibition of pent house.		
7.24.06	Limestone storage silo: Silo of required capacity made of structural steel as specified in mechanical portion along with roof covering overhead structural shed and access platforms/walkways shall be provided as per soil investigation.		
7.24.07	Lime stone Crusher house: Crusher house shall be constructed using Steel frame structure and RCC foundation with brick in filled wall up to 2.5m height and remaining height shall be permanently color coated galvalume sheet cladding. Floor slabs shall be of RCC over 0.8mm thick metal deck sheeting. Crushers shall be supported on RCC deck slab which in turn will rest on vibration isolation system consisting of springs & dampers.		
7.24.08	Conveyor galleries & trestles: Overhead limestone/gypsum conveyor shall be of structural steel frame with cladding and roofing. Transfer points and intermediate supporting trestles shall be made of braced steel framed structures as per mechanical general arrangement drawing layout of conveyors. The staircase shall be of external type.		
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7.24.09 Gypsum Dewatering Building: This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or brickwork/concrete block work with plastering on both sides. Roof shall be provided with roof water proofing treatment, as specified elsewhere in the Technical specification. 7.24.10 Booster Fan (if applicable) and Ball Mill foundations: Fan, Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level. The vertical faces of this block foundation shall be isolated from adjacent footings by providing minimum 100mm thick polystyrene board of type-1 conforming to IS: 4671 with density 20 kg/cum sandwiched between the vertical face of block foundation and 230 thick brick wall all round. 7.24.11 For the foundations of Fans, Mills, etc. detailed static and dynamic analysis shall be done. 7.24.12 Wherever block foundation is adopted by the bidder for mill or FAN foundations, suitable provisions to be ensured by the bidder in their General Arrangement and design to prevent transmission of vibration from these machine foundations to other nearby structures / foundations. 7.24.13 The bidder or his consultant should have adequate prior experience in design of machine foundations and the machines should be in successful operation for at least one year prior to the date of submission of bid. 7.24.14 RCC Floors, Paving & Grade Slab details: i) Passages shall be provided inside the FGD area connecting to the outer periphery road to have access to the various facilities/buildings. These passage areas shall be provided with heavy duty paving for movement of heavy vehicles. The top surface of the passages shall be finished with 50 mm thick metallic hardener topping. Heavy duty paving shall also be provided for the areas in the equipment lay down area, unloading & maintenance area, storage area with 50 mm thick metallic hardener topping. ii) Lightly loaded areas such where no heavy traffic movement is envisaged shall be provided with Normal Duty paving. However, corridors below pipe/cable trestle gallery where no traffic movement is envisaged and in the area over the buried fire water pipes shall be provided with interlocking concrete blocks of minimum M35 grade and minimum 80 mm thickness underlain by 20mm thick layer of sand followed by 200mm thick 63 mm and down aggregate with interstices filled with selected moorum/ non-expansive soil. iii) All facility/buildings shall be provided with 1000 mm wide plinth protection all around with garland drain. It consists of 100 mm thick P.C.C. M-20 grade with 12 mm maximum size aggregate over 200 mm thick stone soling using 40 mm nominal size rammed, consolidated and grouted with fine sand. iv) An area of minimum 7.5m width all around the tank foundations and other facilities/buildings shall be paved. This paving shall be beyond the extent of plinth protection. Further, heavy duty paving shall be provided for passages		
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connecting the outer periphery road to have access to the various facilities/buildings.

- v) Wherever multiple FGD facilities are located in a cluster in the areas proposed for FGD, the entire extent of the cluster shall be provided with area paving maintaining minimum 7.5 m width around the facility buildings. Paving shall be extended up to nearest road for easy access to FGD facilities. Any functional requirement of paving for FGD facility not specifically mentioned in this document is also in scope of bidder.

7.24.15 Grade slab of buildings at ground floor: In buildings, the grade slab shall consist of 150mm thick RCC M25 grade base slab over an under bed as specified below. The under bed for ground floor slab shall consist of 75mm thick 1:3:6 PCC on stone soling of 230mm compacted thick with 63 mm and down aggregate with interstices filled with well graded selected sand/ moorum/ non-expansive soil on compacted and dressed sub - grade. Reinforcement for the slab shall consist of minimum 8mm dia. Bars @ 200 mm c/c at top & bottom of the slab in both directions. However, at unloading & maintenance area, gypsum storage shed stone soiling of minimum 400mm thick and grade slab with minimum 10mm dia bars @ 200 mm c/c at top and bottom in both directions shall be provided.

7.24.16 Further, top surface of grade slabs shall be finished with 50mm thick metallic hardener topping.

7.24.17 Bidder shall provide permanent access to all facilities/structures from the nearby roads.

8.00.00 LOADS AND LOAD COMBINATIONS

8.01.00 General

8.01.01 All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads, temperature loads, loads and forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility.

8.02.00 Dead Loads

8.02.01 Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi permanent nature including tanks, silos, bins, partitions, roofing, piping, cable trays, bus ducts etc. The content of tanks, silo, bins and hoppers etc., shall be measured at full capacity for this purpose.

8.02.02 The piping loads, cable tray loads and the contents of the tank, silos, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing load for uplift.

8.02.03 The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

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Sl. No.	Materials	Unit weight
1	Plain cement concrete	2.40 t/cum
2	Reinforced cement concrete	2.50 t/cum
3	Structural steel	7.85 t/cum
4	Brick work	1.9 t/cum
5	Cement plaster	2.1 t/cum
6	Floor Finish	2.4 t/cum
7	Coal	1.20 t/cum
8	Fly Ash	1.60 t/cum
9	Bottom Ash	1.60 t/cum

8.03.00 Imposed Loads

1.	All Buildings	
	(a) Roofs:	
	(i) Inaccessible roof (Flat):	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
	(ii) Accessible roof where equipment are placed	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load)
	(iii) Accessible roof without equipment	1.5 kN/Sq.m + hung loads if any + 0.5 kN/Sq.m (dust load).
2.	Power House Building	
	(a) Mezzanine Floor	15 kN/Sq.m plus hung loads
	(b) Operating Floor	
	(i) Equipment Lay down Area	35 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
	(ii) Rotor Removal Area	50 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
		Rotor removal area beams shall also be checked for half the rotor load at the center of the beam


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	(iii) Other Areas in Turbine Hall	25 kN/Sq.m plus hung loads
	(iv) All other Areas in Operating Floor except Turbine Hall	15 kN/Sq.m plus hung loads
	(c) Due to anchoring of conductors on any "A" row column	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kn (Shielding Wires) OR Actual load furnished by equipment supplier, whichever is higher
3.	Mill Building	
	(a) Ground Floor	25 kN/Sq.m
	(b) Feeder Floor	25 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)
	(c) Tripper Floor	15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load)
4.	Chimney shell	
	(a) Imposed load on service platform around Chimney shell, shall be taken as 500 kg/m ² . Design live load during construction/ erection shall be considered as 1000 kg/ m ² .	5 KN/Sqm+10 KN/Sqm
	(b) Imposed loads from duct joining the Chimney shall be considered.	
5.	Auxiliary Buildings	
	(a) Ground Floor	10 kN/Sq.m
	(b) Cable Spreader Floor	7.5 kN/Sq.m
	(c) Pump House operating Floor	15 kN/Sq.m

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	(d) Office Floor	5 kN/Sq.m
	(e) Switchgear room	15 kN/Sq.m
	(f) All other Floors	10 kN/Sq.m
6.	Non Plant Buildings	
	(a) Floors with equipment	10 kN/Sq.m
	(b) All other floors	5 kN/Sq.m
7.	Construction Load	Appropriate construction loads according to type of structure shall be considered.

8.04.00 Loading for Roads

- 8.04.01 Design of roads shall be in accordance with Indian Road Congress standard, IRC 37.
- 8.04.02 Railway supporting bridges such as bridges, culverts etc., shall be designed as per Railway bridge rules and relevant latest IS codes.
- 8.04.03 Culverts and allied structures including RCC pipes shall be designed for Class "AA" loading and checked for Class "A" loading as per IRC standards for two lane road and above.
- 8.04.04 Covers for trenches & channels which are not exposed to vehicular traffic shall be designed for Live load of adjoining area or 2 t/sqm whichever is higher. Where channels are likely to be exposed to vehicular traffic, the requirements of Code of practice for road bridges shall be adhered to.
- 8.04.05 Piping anchor and restraint forces of major piping shall be obtained from piping analysis results and be considered as live load in the structure design.
- 8.04.06 Ponding effects due to framing deflections for roofs, if any shall be considered.
- 8.04.07 In addition to the live loads, a minimum of 0.50kN/sqm shall be considered as Hung loads for electrical, ventilation & air conditioning. A load of 1.0 kN/sqm shall be considered as Hung loads for piping unless otherwise mentioned.
- 8.04.08 Live loads reduction shall be in accordance with the provisions of IS:875 & IS:1893 in case of seismic analysis.
- 8.04.09 All structures which is situated in the vicinity of Railway lines, the design has to conform to the Indian Railway standard Specification.

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8.05.00 **Earth Pressure Loads**

8.05.01 Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and underground liquid storage tanks earth pressure at rest shall be considered.

8.05.02 In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 2.0t/sqm shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Ground water pressure shall be arrived at considering water table at finished grade level.

8.06.00 **Wind Load**

8.06.01 Wind load on structures shall be calculated as per provisions of IS:875 (part 3). The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered for design.

8.06.02 Basic Wind speed 44 m/sec & Category of terrain and all other parameters as per IS:875 (Part 3)

8.06.03 In design of structures, wind force on equipments supported on frame including all fixtures, piping, staircase, ladders, etc., shall also be considered.

8.07.00 **Seismic Loads**

8.07.01 Seismic analysis shall be carried out as per the latest edition of IS:1893 (Part 1 & 4). Zone –II shall be considered for design

8.07.02 The Structures shall be classified into four categories as per Table 5 of IS: 1893 (Part 4)

8.07.03 Importance factor for each structure shall be as per Table 2 of IS:1893 (Part 4).

8.07.04 Method of analysis for each structure shall be decided as per clause 10.3 of IS: 1893 (Part 4), which depends on the seismic zone & category of the structure.

8.07.05 Response Reduction factor shall be as per Table 3 of IS: 1893 (Part 4).

8.08.00 **Temperature Load**

8.08.01 Expansion and contraction due to changes of temperatures of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS:800 and IS:456 for steel and concrete structures respectively.

8.08.02 Analysis shall be carried out for ambient temperature variation. The temperature variation shall be considered as 2/3 of average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum

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temperature during the hottest month of the year. The structure shall be designed to withstand thermal stresses due to 50% of the temperature variation. 8.08.03 Coefficient of thermal expansion of steel shall be taken as per IS: 800. Coefficient for thermal expansion for concrete shall be taken as per IS: 456. 8.09.00 Equipment Loads 8.09.01 All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant. Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition. 8.09.02 Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section. 8.09.03 Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. 8.10.00 Crane, Monorail & Elevator Loads 8.10.01 Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vender's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter. 8.10.02 IMPACT FACTOR i) Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows: 8.10.03 CRANE LOADS i) For vertical force, an impact factor of 25% of the maximum crane wheel load. ii) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail divided in proportion to the relative lateral stiffness of the rail support system. iii) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction. 8.10.04 MONORAIL LOADS i) Impact factor of 10% of lifted load of hoist for monorail and support design ii) Impact factor of 25% of the lifted load for electrical pulley and support design. 8.10.05 ELEVATOR i) A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams. 8.10.06 Pedestals supporting gravity take ups for conveyors and pedestals in elevator pits shall be designed assuming 100% impact factor.		
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8.11.00 **Steam Piping Load**

8.11.01 Minimum intensity of steam piping load shall be 6.0 kN/Sqm, for the areas at different levels, through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

8.12.00 **Thrust Load**

8.12.01 Thrust blocks will be designed against the thrust load from pipelines considering the test pressure in the pipelines

8.13.00 **Other Loads**

8.13.01 Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.

8.13.02 Roof girders / trusses in the service / maintenance bay of Turbine building shall be designed for crane erection loads.

8.13.03 Columns in turbine building near transformer yard shall also be designed to support tension due to string conductors and shield wire if the conductors are connected to the Turbine building columns.

8.13.04 The C row columns of Power House Building (Column adjoining first Row of Boiler columns) shall be designed for an additional load of 500 KN to account for piping/Cable rack Loads.

8.13.05 Loading due to Solar Panels or any other such structures mentioned elsewhere in the specifications shall be taken into consideration while designing the civil structures. Accordingly, such load combinations including aforesaid loads, shall be considered as mentioned in the latest relevant IS Codes.

8.14.00 **Basic Load Cases**

8.14.01 The following basic load cases shall be considered for the analysis:

i)	Dead load	:	D
ii)	Self weight of permanent equipment	:	EL
iii)	Live load on floor / walkway	:	L
iv)	Live load on roof	:	LR
v)	Crane load with lift	:	CR1
vi)	Crane load without lift	:	CR2
vii)	Wind load	:	WL
viii)	Seismic load	:	SL
ix)	Load due to soil pressure	:	SP
x)	Load due to surcharge	:	SCL
xi)	Load due to hydrostatic pressure	:	HP

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xii) Load due to temperature : TL

xiii) Special loads : SPL

8.15.00 **Load Combinations**

8.15.01 While designing consideration shall be given to the following load combinations:

- i) DL + LL
- ii) DL + LL + PL + Equip $\pm$ TL
- iii) DL + LL + PL + Equip + Cb + CtLA $\pm$ CS $\pm$ TL
- iv) DL + LL + PL + Equip + Cb + CtLB $\pm$ CS $\pm$ TL
- v) $0.9 \times \text{DL} \pm \text{EL}$ (for DL only) $\pm$ TL
- vi) $0.9 \times \text{DL} \pm \text{WL1} \pm \text{TL}$
- vii) $0.9 \times \text{DL} \pm \text{WL2} \pm \text{TL}$
- viii) DL + LL + PL + Equip + Cb + Ct $\pm$ EL $\pm$ TL
- ix) (* Appropriate portion of LL which is considered for working out EL shall only be taken)
- x) DL + LL + PL + Equip + Cb + CtL1 $\pm$ (CS1+WL1) $\pm$ TL
- xi) DL + LL + PL + Equip + Cb + CtL1 $\pm$ (CS1+WL2) $\pm$ TL

Where the above loads are:

PL = Pipe Load

DL = Dead loads of structures, floors, walls etc.

Equip = Equipment loads

LL = General live loads on floors.

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load from left to right

WL 2 = Wind load from right to left

EL = Earthquake load

TL = Temperature load

8.15.02 Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses will be permitted.

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8.16.00 **Load Combinations For Underground Structures**

- 8.16.01 Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.
- 8.16.02 Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).
- 8.16.03 Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
- 8.16.04 Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.
- 8.16.05 Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

8.17.00 **Special Structures**

- 8.17.01 For the following structures, additional loading criteria as mentioned below in addition to the criteria discussed above shall be considered:

i) **COAL BUNKERS**

- a) The following densities shall be considered for design of coal bunkers:
 - 1) For volume calculations : 800 kg/cum
 - 2) For structural design : 1200 kg/cum
- b) The coal bunker will be designed as per criteria outlined in IS:9178 (Part I & II). Due consideration shall be given for arching action and consequent increase in the vertical pressure at the bottom of bunker.
- c) For Design of Bunkers Recommendations made by CEA as under shall be followed.
 - 1) 100% of testing of welded joints is essential for bunker & bunker supporting structure i.e. Butt welds, Fillet welds & bevelled weld joints.
 - 2) All the fabrication drawings shall be approved by the Owner/Consultant.
 - 3) Connections shall be designed for 100%moment capacity.
 - 4) Suitable lateral supports to be provided preferably at various levels of bunkers for resisting earthquake and wind loads.
 - 5) Preferably separate independent beam supports for each bunker should be provided to prevent cascading failure.

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ii) **R.C.C CHIMNEY**

- a) Reference shall be made to IS: 4998 Part I (1992) – “criteria for design of Reinforced concrete chimneys – Part I, assessment of loads” for loading details. For wind loading IS: 875 and for seismic loading IS: 1893 shall be referred to.
- b) Wind load magnification on the Chimney induced by adjacent tall structures such as Cooling Towers/Boiler structures shall be included in model study conducted in wind tunnel, and necessary modification shall be made in the wind loading for design.
- c) Detailed design requirements in respect of the chimney have been described elsewhere in the specifications (Refer FGD Section Vol.-III, Part-A, Section-4).

9.00.00 FOUNDATIONS

9.01.00 Introduction

9.01.01 All main plant structures i.e. TG Building, Control Building, Boiler, ESP and other auxiliary buildings will be supported on isolated, combined or raft/pile foundations as per soil report and design requirement. Machine foundations for TG, ID/FD/PA fans, BFP and Misc. pumps and equipment foundations will also be supported on RCC foundations.

9.02.00 Design

9.02.01 The foundation design shall consider the following:

- i) Soil bearing capacities
- ii) Deep foundation capacities
- iii) Lateral earth pressures
- iv) Allowable settlements
- v) Structure, equipment and environmental loadings
- vi) Equipment performance criteria
- vii) Access and maintenance requirements
- viii) Temporary construction loadings

9.02.02 The foundation will be designed for the most critical combinations of forces and moments, resulting from all possible combinations of the various loading from the structural system. The foundation will be checked for overturning for minimum and maximum vertical loads. The foundation sections will be sized and reinforced adequately for bending moments and shear stresses and uplift. In addition to the earth pressure, a surcharge of 2T/m² shall be considered for the design of all underground structures such as channels, sumps, underground pump houses, tanks, trenches, reservoirs, etc.

9.02.03 Co-efficient of active earth pressure shall be considered as 0.33 and coefficient of passive earth pressure shall be 3.0 or based on Site Soil Investigation report

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whichever is higher. Earth pressure at rest shall be considered wherever necessary.

9.02.04 The foundation shall be checked for overturning, sliding and for uplift as per relevant IS Codes.

9.02.05 Partial contact between the foundation and soil strata shall be considered wherever applicable. The footing will be checked for minimum contact as specified in soil report and maximum bearing pressure will be calculated for the actual contact area only.

9.03.00 **Settlement of Foundations**

9.03.01 The total permissible settlement and differential settlement of the foundations will be governed by IS: 1904, IS: 13063 and from functional requirements. However, total settlement will be restricted to the following.

Foundation Type	Permissible settlement
Foundations for main power house columns, Boiler, ESP, Bunker	25 mm
Isolated/strip footing of width up to 6.0M	40 mm
Footings greater than 6.0M (raft)	75 mm
Foundations for TG	40mm or as per manufacturer recommendation

9.03.02 The permissible differential settlement between two adjacent footings (in a framed configuration) shall not be more than 6mm.

9.03.03 Analysis of proportioning of footings to minimize differential settlements will be carried out for all major foundations. Foundations for equipment shall be designed to meet the total and differential settlement established by the equipment manufacturer if they are more stringent than the allowable settlements listed above.

9.04.00 **Main plant structures**

9.04.01 Foundations for the main plant structures are those for Power House building columns, Boiler House columns, Mill and Bunker bay columns, ESP columns, etc. Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns shall have to be suitably lowered to accommodate underground services, pits, trenches, etc.

9.04.02 Common foundation should be provided for columns on both side of the expansion joint and shall be designed for loading on both columns.

9.05.00 **Tank Foundations**

9.05.01 The Storage tanks will be rest on thoroughly compacted fill of gravel, coarse sand or other stable material, in layers of 200 mm thickness to achieve a relative density of 85% using suitable compaction equipments topped with 150mm thick P.C.C. The P.C.C layer will be topped with 50mm thick Anti-corrosive asphalt layer, which in turn is topped with 50mm thick Premix carpet. The entire sand fill

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along with toppings will be confined within a RCC ring beam of appropriate design. In case of tank with flexible bottom plate, the compacted filling shall be confined within a coarse stone or gravel ring filling. The foundation system shall be designed as per IS: 803.

9.06.00 **Machine Foundations**

9.06.01 INTRODUCTION

- i) This section outlines the design philosophy and construction aspects of foundations for large equipment as follows:
 - a) TG foundation
 - b) ID/FD/PA Fan Foundations
 - c) Boiler Feed pump foundations
 - d) Condensate extraction pump foundations
 - e) Air compressor foundations
 - f) Miscellaneous Machine foundations

9.06.02 GENERAL

- i) For the foundations of Turbo-generator top deck, Boiler feed pump, Fans (ID, FD and PA), etc. detailed static and dynamic analysis will be performed. The static analysis will include operating conditions load cases and abnormal loads like short circuit, loss of blade, maximum unbalance and seismic forces.
- ii) Loadings (both static and dynamic) of major equipments are to be obtained from the manufacture certified drawing of the specified equipment.
- iii) For static and dynamic analysis of machine foundation following data will be furnished by the equipment manufacturer:
 - a) Loading diagram showing static and dynamic loads and points of application of loads,
 - b) Operating speed of m/c
 - c) Weight of rotating parts, maximum eccentricity of rotating mass from the geometric axis of rotation,
 - d) Location of C.G. of machines in all three axis,
 - e) Mass moment of inertia,
 - f) Allowable amplitude/velocity of vibration at machine bearing points,
 - g) Temperatures at various areas during operation
- iv) Design of foundations for major equipment shall be done in accordance with relevant parts of IS 2974. While designing following aspects shall also be taken care of.
- v) All dynamic foundations shall be isolated from building foundations; the isolation gap shall be minimum 25mm.

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- vi) The turbine generator pedestals will be designed to meet the manufacturer deflection criteria and other recommendations.
- vii) All rotating equipment foundations shall be rigid foundations. Natural frequencies of structures and components shall be away from running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. For design of foundation of large fans etc provision shall be kept in the foundation for addition of mass/area for retaining of the foundations if required at a later date.
- viii) Spring mounted foundation with visco dampers may be used for foundations which are resting over the building structures. The Vibration Isolation system supplied should be of GERB only.
- ix) In case of variable speed machines such as ID fan, one or more natural frequencies of the foundation may coincide with the operating frequency of the machine. If it is not possible to satisfy the codal frequency or amplitude criteria VIS with springs and viscous dampers shall be provided. It shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096. The frequency and amplitudes shall be checked as per relevant applicable code of practices or as per manufacturer's requirements. The permissible amplitude of vibration shall be as specified by the manufacturer and shall be in "satisfactory" range as per VDI 2056, whichever is more stringent.
- x) All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitable to ensure integral action.

9.06.03 LOADS

- i) All static and dynamic forces/loads which equipment supplier considers applicable.

9.06.04 ANALYSIS AND DESIGN

- i) The analysis and design of machine foundations will be carried out to ensure the following.
 - a) Compliance with the manufacturer's requirements and relevant standards.
 - b) No resonance phenomenon of a disturbing nature to machine operation should exist at the normal running speed.
 - c) Calculations to be performed for dynamic as well as static cases for reinforced concrete block type pedestal.

9.06.05 HEAVY EQUIPMENT FOUNDATIONS

- i) While designing following aspects shall also be taken care of:

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- a) Analysis and design of the Steam Turbine-Generator (STG) foundation shall be carried out in accordance with relevant codes IS: 2974 Part-3 and IS: 456 and/or manufacturer's requirements. The loads to be considered for static analysis and design shall consist of dead weight of the machine and foundation, machine power torque, condenser loads under normal operating condition, equivalent static load due to machine unbalance, thermal elongation forces, forces due to one sided operation of the condenser, forces due to condensate pump failure, vacuum loads, forces due to piping, frictional forces at machine sole plate level for turbine, generator and condenser, temperature distribution under operating condition, failure loads of turbine (blade unbalance/loss of blade/bowed rotor), failure loads of generator (short circuit loads), seismic loads due to generator, turbine and condenser and erection loads.

9.06.06 FOUNDATION SIZING

- The outline plan dimensions of foundations as given by the machine supplier will be adopted.
- The height of foundation will be selected after taking into consideration soil strata and operating level of the machine.
- The eccentricity of common CG of machine and foundation with respect to the centroid of base area should not exceed 5% of the corresponding base dimensions of foundation.

9.06.07 MISCELLANEOUS MACHINE FOUNDATION

- For other types of machines, most suitable type of foundations will be provided. Foundation for pumps, and minor rotating equipment etc., are usually in the form of solid block foundations, resting on the ground or on a floor of the building. At such machine supports, floor may be thickened and extra reinforcement provided. Also machines which are almost vibration free and is light to moderately heavy may be supported in the above manner.
- Rubber or neoprene pads under some of these machines to reduce transmission of vibrations to the supporting floor will be provided wherever required.

9.07.00 **Pile foundations**

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

- The pile foundation shall be of RCC, Cast-in-situ bored, precast/cast-in-situ driven pile as per IS: 2911. Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.
- The minimum diameter of pile shall be 450mm for cast-in-situ and 300mm for precast piles. The uplift and lateral load capacity shall be established by field test.
- Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.

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- iv) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter like (SPT & SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc. for Owner'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 Bidder for Owner's approval.
- vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical Lateral Uplift	}	Minimum of 3 Nos. in each mode or as per provision of IS:2911.

- vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per IS: 2911 (relevant part).
- viii) Number of routine pile load tests to be performed for each diameter/ allowable capacity of pile shall be as under:
- ix) Vertical- 1.0 % of the total number of piles provided.
- x) Lateral -1.0 % of the total number of piles provided.
- xi) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4).
- xii) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Owner.
- xiii) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4). Bidder shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.
- xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

9.08.00 **Other requirements**

- 9.08.01 After the tanks have been erected, hydro testing shall be done. Subsequent upon hydro testing of tank, the differential settlement noticed if any shall be rectified to the satisfaction of Engineer In-charge".

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10.00.00 DESIGN CRITERIA

10.01.00 Design Concepts

- 10.01.01 All buildings shall have framed super structure.
- 10.01.02 The main plant building, Control Room building, de-aerator supporting structures and Bunker building shall have structural steel framed super structure, with metal cladding on exterior face.
- 10.01.03 All other buildings except pump houses may have either RCC or structural steel framework. However, pump houses shall have structural steel super structure with Galvalume sheet roofing. Walls for pump houses shall be with brick masonry.
- 10.01.04 Unless specified otherwise, all buildings shall have minimum 230mm thick brick masonry on exterior face.
- 10.01.05 The concrete surface wherever contacts with soil or ground water shall be provided Bitumen painting/Bitumen felt for all areas/structures shall provide if required as per soil condition.
- 10.01.06 Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc.
- 10.01.07 Design detailing and fabrication of steel structures shall be done as per provisions of IS: 800 with updated version.
- 10.01.08 Welding shall be used for fabrication and erection. Site connections shall generally be with welding/bolts.
- 10.01.09 All structures close to railway line shall have clearances conforming to Railway norms.
- 10.01.10 Dispersion of load in any direction through soil shall be as per relevant codes.
- 10.01.11 Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.
- 10.01.12 Permissible deflection (unless specified otherwise in this specification) for latticed framework and beams of floors other than drive floor shall be span/325.
- 10.01.13 The allowable deflection for beams directly supporting drive machinery shall be restricted to span/500 unless specified otherwise in this specification.
- 10.01.14 The design and construction of RCC structures shall be carried out as per IS: 456. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.
- 10.01.15 Separate ladies and gents toilets in all buildings.
- 10.01.16 Rain water down take pipe shall be provided outside of all buildings.
- 10.01.17 For design and construction of steel-concrete composite members, IS: 11384 shall be followed.
- 10.01.18 For reinforcement detailing, IS:5525 and SP:34 shall be followed.

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10.01.19 Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more. 10.01.20 All RCC liquid retaining/ conveying structure (except water storage tanks) shall be designed in accordance with IS: 3370 by the working stress method, using limited steel stress. However, water storage tanks shall be designed as an uncracked section as per IS: 3370 by working stress method. Grade of concrete for the above structures shall be M-30 as per IS: 456. 10.01.21 Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures (requiring dry working condition). Dense and durable concrete with water cement ratio not more than 0.45 shall be used. Plasticiser/ super-plasticiser cum water proofing compound shall be added to the concrete. All the construction/expansion joints shall be properly treated with Copper strip water bar and/or chemical injection grouting after leak proof test as per IS:3370 standards. 10.01.22 Bidder shall submit a comprehensive scheme for water proofing treatment based on above or any other alternative scheme, internationally accepted for Owner/Engineer's approval prior to commencement of work. 10.01.23 or design of all underground structures, foundations, ground water table shall be assumed at the finished ground level unless specified otherwise. 10.01.24 Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest or co-efficient of active earth pressure, whichever is applicable, depending upon the structural configuration. However, for the design of substructure of pump houses, earth pressure at rest shall be considered. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding. 10.01.25 If R.C.C. floors and roofs except those cast over metal decking are assumed to act as diaphragm transmitting lateral loads to braced bays then main beams/ girders shall be provided with shear connectors. However, whenever large/ more number of cut outs is provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening/ chequered plate/grating on other side. 10.01.26 For R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns. 10.01.27 In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns. 10.01.28 PTFE bearing shall be provided where horizontal loads not to be transferred. 10.01.29 For calculation of seismic load, equipment load shall be considered as Dead Load. 10.01.30 Gratings/chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.		
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10.01.31 Design Service Life of various structures shall be as per latest relevant IS codes and NBC.

10.02.00 **Deflection Criteria**

10.02.01 The maximum deflection for various structures shall not exceed and be limited to the following:

S. No.	Description	Max. Value of
1.	For all structures	Span/325 or Height/325 as the case be unless noted otherwise.
2.	For all beams directly supporting equipment	Span/500
3.	For all roof purlins	Span/250
4.	For all grating/chequered plate	Span/250
5.	For cladding runners, roofing/ cladding sheets	Span /250

However, the maximum vertical deflection of Grating/chequered plate shall be limited to 6mm).

10.03.00 **Design Considerations**

10.03.01 Steam turbine generators, Boilers Feed Pumps, PA Fans, FD Fans and Coal mill foundations shall be supported on Conventional framed/Block foundation.

10.03.02 Detailed static and dynamic analysis shall be carried out for the foundations of TG. The static analysis shall include all operating conditions, load cases and abnormal loads like short circuit, loss of blade unbalance and seismic forces. Unbalance loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall be satisfied. RCC design shall be done by the working stress method for all machine foundations. A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by latest relevant codes. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft. The minimum grade of concrete for TG deck & TG foundation shall be M35.

10.03.03 All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer, whichever, is more stringent shall be satisfied. Minimum reinforcement shall be

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governed by codes. Minimum Reinforcement in base raft in either direction shall be as follows: i) At bottom face - 0.2% of gross cross-sectional area ii) At top face - 0.12% of gross cross-sectional area 10.03.04 For the foundations supporting minor rotating equipment weighing less than one tonne or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably. 10.03.05 All roads shall be of flexible pavements except as otherwise specified. Design of flexible pavement shall be carried out as IRC-37. The minimum requirements as specified in IRC-37 w.r.t. surfacing base and sub base shall be followed. The design traffic load shall be a minimum 10 million cumulative standard axles. All roads shall be designed for class 'AA' of traffic, i.e., traffic intensity of as above as per IRC-37. The road shall be designed for 30 years of life and considering a minimum traffic growth of 1% per annum. In case of concrete Road & pavement the design shall be carried out as per IRC-58. 10.03.06 All pipes and cable shall generally be routed above ground on structural steel trestles having minimum clear height of 3.0m. 10.03.07 A minimum clearance (clear headroom) of 8 m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 750mm width with handrails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, upto the pipe/cable trestles. 10.03.08 Within Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor. 10.03.09 Plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, average annual intensity of rainfall, etc. The storm water drainage shall cater to storm water runoff resulting from one hour rainfall intensity, with a return period of 100 years. These values shall be based on the recommendations of the Meteorological Department. The maximum velocity for pipe drains and open drains shall be limited to max. 1m/sec. However, minimum velocity of 0.6m/sec. for self- cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. Pipe or box culverts shall be provided at rail, road or other crossings. 10.03.10 Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec. and shall be connected by gravity or by pumping to the sewage treatment plant.		
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10.03.11 Codes, standards and manual published by India on Sewerage and Sewage treatment shall be followed for design purpose.

10.03.12 Roof decking sheets shall be designed to carry the self load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per code. In case composite action is considered in the design, suitable shear studs shall be provided as per codes.

10.03.13 Plant effluents shall be handled in separate drains/ pipes. The plant effluent drain shall not be mixed with storm water drain or sewer lines.

10.04.00 Factor of Safety Against Overturning and Sliding

10.04.01 The structure shall be checked for minimum factor of safety of 1.5 against overturning conditions (ratio of stabilizing moment to overturning moment) and sliding conditions (ratio of horizontal frictional resistance to horizontal sliding force) under static loads. To ensure an adequate factor of safety under earthquake conditions, the factor of safety against sliding shall not be less than 1.2.

10.04.02 Two layers of reinforcement (on inner and outer face) shall be provided for RCC sections having thickness of 150 mm and above.

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

Sl. No.	Structural Element	Main Reinforcement	Distribution Reinforcement/ Anchor Bars
1.	Foundation	12 mm	12 mm
2.	Beams	12 mm	10 mm
3.	Columns	12 mm	-

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

10.04.05 Minimum Reinforcement in all elements of liquid retaining / conveying structures shall be as per latest relevant code.

10.04.06 Minimum thickness of foundation slab / raft and base slab of all liquid retaining tanks/ pits shall not be less than 300 mm.

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

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

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

10.04.10 All liquid retaining structures shall be leak-proof. Water proofing of all liquid retaining structures shall be done by addition of plasticizer cum water proofing

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admixture conforming to codes, in the concrete at the time of mixing and through external treatment by chemical injection grouting at all construction joints as described in the specification. Addition of admixture should not reduce the strength of the concrete below the specified strength in any case. In addition, limit on permeability as given in codes shall also be met with.

10.04.11 Further if required, chemical injection grouting treatment shall be applied to make the structure leak proof, if leakage is observed during hydro - test or otherwise, with no cost implication to the Employer.

10.04.12 Plywood formwork shall be used for all water retaining/ conveying structures and for all over ground concrete works. It shall also be used for the inner face of sump of pump (i.e. faces of piers back walls, breast walls and baffle walls having contact with water. For all other areas steel/ plywood formwork shall be used.

10.05.00 **Liquid Retaining Structures**

Liquid retaining structures shall be designed for following load conditions;

10.05.01 UNDERGROUND STRUCTURES

- i) Water filled inside up to design level and no earth outside.
- ii) Earth pressure with surcharge of 2.5 t / m² and ground water table up to FGL outside and no water inside.
- iii) Stability against uplift shall be checked for completed structure and under construction stage with no water inside and ground water table up to FGL, with a minimum factor of safety of 1.20 against uplift. Installation of pressure relief valves shall not be permitted in the base slab of any liquid retaining / conveying structure.
- iv) The structure shall also be checked for normal working condition with water filled inside up to design level and earth pressure outside with no effect of surcharge and ground water table.

10.05.02 OVER - GROUND

- i) For design of over - ground liquid retaining structures appropriate load cases shall be considered.
- ii) In case of all liquid retaining / conveying structures, the structural design for shear forces shall be done as per working stress method stipulated in IS : 456. However, the nominal permissible shear stress in concrete shall be as per IS : 456 and permissible tensile stress in reinforcement steel shall be as per IS : 3370 (Part - II). The nominal (total) shear stress in concrete shall be checked as per the formula given in IS: 3370 (Part - II). In case, where nominal (total) shear stress in concrete exceeds the values specified in IS: 3370 (Part - II), the shear reinforcement shall be provided. In no case the nominal (total) shear stress in concrete shall exceed the permissible values specified in codes otherwise the section size shall be revised.
- iii) In design of counter fort retaining walls of underground liquid retaining structures (counter fort provided outside i.e. towards earth side), following shall be considered.

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- iv) Under load combination producing tension on outer face of counter fort (i.e. face in contact with earth) the section shall be designed for cracked conditions with permissible steel stresses as per IS : 3370 (Part - II). Inside face (face in contact with liquid) shall be designed for uncracked conditions. However walls of the liquid retaining structures shall be designed for uncracked conditions for tension on either face.
- v) For load condition with earthquake / wind forces, column / beams with minimum thickness / depth of 450mm and acting as a part of liquid retaining structure may be designed by limit state method, as per IS:456, with Partial Safety Factor for loads equal to 1.5 for all load cases considered in such load combinations.
- vi) For this load combination, when the column / beam face in contact with liquid is under tension, the calculated crack width under serviceability limit state of cracking (with partial safety factor equal to 1.0 for all loads including wind / seismic load) shall be less than 0.1mm, calculated as per relevant code of practice, to ensure leak proof conditions.
- vii) For other load combinations these columns / beams shall be designed as uncracked sections as per codes.
- viii) In the wall of liquid retaining structures with cylindrical shape such as clarifiers vertical reinforcement shall be checked assuming the walls were fully fixed at the base, and the horizontal reinforcement shall be provided to resist horizontal (hoop) tension assuming hinged condition at the junction of the base slab & wall.
- ix) Wherever sandwich slabs are provided in liquid retaining structures to take care of stability against uplift, only well graded sand of approved quality shall be used as fill material. The sand compaction shall be done with plate/ disc compactors in such a manner that the bottom slab is not structurally damaged.
- x) Clear free board of at least 300 mm above design (total) water level shall be provided in all liquid retaining / conveying structures.
- xi) Coefficient of active earth pressure shall be considered for design of free standing retaining walls and coefficient of earth pressure at rest shall be considered for design of top propped retaining walls.
- xii) The minimum concrete clear cover to Reinforcement bars in all RCC structures shall be as per standards. However in no case the clear cover shall be less than stipulated below:

1.	Slab	15 mm
2.	Beam	25 mm or dia of main reinforcement whichever is greater
3.	Foundation / base slab	Bottom 75 mm, for foundation in direct (for isolated footing in contact with earth and 50 mm for foundation or raft / foundation resting on lean / blinding strip and foundation beams) concrete. For sides and top 50 mm.
4.	Pile cap	Bottom 100mm, sides and top 50mm.
5.	Columns (below and above ground level)	50 mm

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6.	Sump / pit walls	25 mm on liquid face & 40 mm on soil face.
7.	Walls above ground	25 mm on either face.

Suitable additional reinforcement and shear keys shall be provided at all construction joints in the wall of liquid retaining structures.

10.06.00 **Design of Miscellaneous Items**

10.06.01 CABLE TRENCHES

10.06.02 The cable trenches and pre-cast removable RCC cover (with lifting arrangement) will be constructed using concrete grade M25. The cable trench walls will be designed for the following loads:

- i) Triangular earth pressure + live load on adjoining area or a surcharge pressure of 2T/m² whichever is Maximum. Surcharge load of 1 T/sqm if no vehicular load.
- ii) Cable trench covers will generally be designed for self-weight of top slab and concentrated load of 200 Kg at centre of span on each panel. In case of any road crossing, it will be designed for traffic loads.
- iii) Cable trench crossing the roads/rails will be designed for class AA loading of IRC/relevant IS code and should be checked for class AA loading as per IRC and transformer loading. Lifting hooks will be provided in the pre-cast covers.
- iv) Subsoil water level shall be assumed at 0.75m below the formation level for design of trench/pit walls.
- v) Min. thickness of precast trench cover slabs shall be 100 mm.

10.06.03 DRAINS

- i) The plant storm water drainage will be designed taking into account the finished grade levels of the plant and invert levels of existing drains, area drainage pattern within and outside the plant area, intensity of rainfall etc.
- ii) Runoff coefficient shall be taken as per IS 8835-1978.
- iii) Drains inside the building will have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, pre-cast RCC covers will be provided in place of steel grating.
- iv) Drains outside building (Garland drains) will have perforated pre-cast RCC covers of minimum 75mm thickness. In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness without perforations and designed for the vehicular loading will be provided.
- v) In the buildings suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting etc. will be provided for each floor with suitable floor drains.

11.00.00 **GENERAL REQUIREMENTS**

11.01.00 **General**

11.01.01 Design and construction of buildings, structure etc., shall take into account requirement for operation and maintenance of all equipment and its users. The

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buildings will have good architectural features. The surrounding area shall be properly micro levelled and graded.

11.02.00 Architectural Concepts for Buildings

- 11.02.01 All the Architectural design works shall be carried out by professionally qualified architects having adequate experience (minimum five years) in the design and detailing of architectural work of power plant buildings. Bidder may have in-house Architects with the required experience for the above or engage Architect Consultant having similar experience.
- 11.02.02 All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant building, surrounding structures and environment. Due considerations shall be given to orientation, landscape design, and interior design. All finishes for floors, walls, ceiling, structural elements, partitions for offices and industrial areas shall be suitable for their aesthetics, durability and functional requirements and shall include the latest building material & technology. Consideration shall be given for achieving standardization & fast track construction.
- 11.02.03 Power plant buildings shall be architecturally treated, based on functional requirements, in such a way that they retain the desired scale, and present a pleasing composition of mass and void. The overall impact of the buildings shall be one of aesthetically unified architectural treatment having a comprehensible scale, blending colour scheme with the surroundings.
- 11.02.04 Overall colour scheme of the buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts, and other service elements.
- 11.02.05 For adequate light and ventilation, National Building Code recommendations shall be followed. All buildings having height more than 4.0 m shall have fixed glazed ventilators.
- 11.02.06 Architectural design of all Power Plant Building shall be suitable for installation of solar photovoltaic panels on roof tops for renewable energy purpose.
- 11.02.07 All the buildings shall be architecturally designed to meet the National Building Code requirement & Fire Safety Regulations.
- 11.02.08 All public buildings shall be designed incorporating the provision of barrier free environment for physically disabled persons.
- 11.02.09 All the buildings and site development including landscaping shall be designed to take care of rain water harvesting & ground water recharging. Development of rainwater harvesting scheme for the project and obtaining approval of the scheme from Central Ground water board is in bidder's scope
- 11.02.10 For Control Rooms, CER, UPS Charger Room area in MPH/turbine build. dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall panelling for housing LVS.

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11.02.11 Full glass wall partition with aluminium frame over solid wall with 300 mm high toe wall & skirting 150 mm high to be provided between CCR and MPH Control room. 11.02.12 All control room shall be provided with air lock lobby having double glass door. 11.02.13 The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for green belt as indicated in "General Layout Plan". In addition to that laydown areas and other vacant land of the plant will be used by owner for the development of green belt. 11.02.14 All floor areas indicated in subsequent pages shall be total floor area required. 11.03.00 Roof Access 11.03.01 All roofs shall be provided with access thorough a staircase/cage ladder. Minimum 1000 mm wide access path shall be provided with cement tiles to approach equipment on roof. 11.04.00 Platforms and Walkways 11.04.01 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms and connecting walkways shall have a minimum width of 800 mm. However, in case of space restriction, the minimum allowable clear width shall be 600 mm. Platforms in front of the entry shall be at least 900 mm wide. Platforms located close to each other shall be connected with walkways. 11.04.02 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached. 11.04.03 Continuous walkway at least 500 mm wide shall be provided along the crane girder level with hand rails, on both side of the building. Approach to EOT crane shall be ensured by Cage ladder or staircase. 11.05.00 Stairs & Ladders 11.05.01 STEEL STAIRS i) All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and inclination with horizontal shall not be more than 35 deg. However, in case of space restriction, minimum clear width up to 750 mm and slope up to 45° may be provided. ii) The vertical height between successive landings shall not exceed 5 m. Channels (min MC 250) shall be provided as stair stringers. Treads shall be minimum 270 mm wide of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm (200 mm in exceptional cases). 11.05.02 STEEL LADDERS i) Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access.		
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ii) Ladders shall preferably be vertical and its angle with vertical shall not exceed 50. Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum). iii) Ladders shall be provided with a safety cage of minimum 750 mm dia. clear when the top of ladder is more than 4.5 m above the landing level. However, safety cages shall start at 2.5 m above the lower landing level. 11.05.03 RCC STAIRS i) All stairs shall have maximum riser of 180 mm and a minimum tread of 270 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs. 11.06.00 Edge Protection 11.06.01 Wherever possible around floor openings an RCC kerb of 150 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with angles of minimum size L 50x50x6mm with lugs for edge protection e.g. all-round the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of RCC cable / pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc. 11.07.00 Anchor Bolts and Insert Plates 11.07.01 Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts. 11.07.02 Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs shall be MS flats and shall preferably be fillet welded to the plate to transfer full strength of the lug. 11.08.00 Vertical Headroom 11.08.01 All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified. i) Finished floors to ceiling (buildings) 3000 mm ii) Doors, Walkways, Platforms, Stairs etc 2100 mm iii) False ceiling of office areas 3000 mm iv) Walkway above false ceiling 1000 mm v) Safety cage for ladders 2500 mm vi) Access for fork lift trucks 2800 mm vii) Main roads / Railway crossings & crane access 8000 mm <tr><td colspan="2">Doc no.: ETG061-BTG-CV-CSA-TS</td><td>STEAG Energy Services India Pvt. Ltd.</td><td>Page 68</td></tr>				Doc no.: ETG061-BTG-CV-CSA-TS		STEAG Energy Services India Pvt. Ltd.	Page 68
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viii) Other plant roads and truck access 5000 mm			
ix) Cable & Pipe rack except at Road / Rail crossings 3000 mm			
11.09.00 Expansion /Construction Joints			
11.09.01 Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using Copper strip water bars and Grouting nozzles for pressure grouting shall be provided. The minimum thickness of Copper strip water bars shall be 2 mm and minimum width 250 mm.			
11.09.02 Two part polysulphide sealant conforming to IS:12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS:1834 can be used. Preformed bitumen impregnated fiber board conforming to IS:1838 shall be used as joint filler. Sealing tapes shall be provided at expansion joints after PU sealant inside and outside structures			
11.09.03 Nito Bond shall be used for construction joint on walls of water retaining structures and underground structures.			
11.10.00 Drainage			
11.10.01 FLOOR DRAINAGE			
i) For all buildings and areas, suitable arrangement for draining out water collected from equipment blow downs, leakage, floor washing, fire fighting, etc., shall be provided on each floor. Gully traps, inspection pits, collecting pits etc., shall be located suitably and designed considering flow volume, easy access, maintenance and safety.			
ii) All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. These drains shall lead the water to drain sump.			
iii) Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.			
11.10.02 ROOF DRAINAGE			
i) Roof drainage system shall be provided for quick and efficient draining of rain water from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rain water down comers and fixtures. System shall be designed to handle design rain fall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains through down comers.			
ii) Rain water down comers shall be of uPVC Pipe conforming to IS 4985:2021.			
11.11.00 Sumps			
11.11.01 In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.			
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11.11.02 If oily or other effluents, which have to be treated in effluent treatment plant are collected in the sump, then the same shall be sent to common effluent collection tank. 11.12.00 Water Proofing of Underground Structures 11.12.01 All underground structures like basements, pump houses, water retaining structures etc., shall have plasticizer cum waterproofing cement additives confirming to IS: 9103. In addition, limits on permeability, as given in IS: 2545 shall also be met with. 11.12.02 The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 702 @ 1.7 kg/sqm (minimum) for water / damp proofing. 11.12.03 Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage. 11.13.00 Chemical injection grouting 11.13.01 Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. 11.13.02 Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete. 11.13.03 For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using percussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes. 11.13.04 After the nozzles are fully set, neat cement slurry admixed with water soluble non – shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm². Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer. 11.14.00 Anti Termite Treatment 11.14.01 Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches,		
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foundations filling bellow the floors etc., as per IS:6313 and other relevant Indian Standards.

11.15.00 **Plinth Level**

11.15.01 Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the formation level / grade level.

11.15.02 All cable vaults shall be located above ground level i.e., vaults shall not be provided as basements in the buildings.

11.15.03 Finished floor levels of Boiler area / transformer area yard paving shall be kept 150 mm lower than the finished floor level of turbine building.

11.16.00 **Statutory Requirements**

11.16.01 All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.

11.16.02 Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 500 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.

11.16.03 Adequate number of fire escapes shall be provided in a building. Fire proof doors (min. Two hours of fire rating), number of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS:1641 and IS:1642 shall be followed in addition to TAC requirements. All masonry fire walls shall be minimum 345 thick and RCC fire wall shall be minimum 200 mm thick.

11.17.00 **Brick / Stone Masonry And Parapet Wall**

11.17.01 All masonry works shall be designed in accordance with IS:1905, IS:2212, IS:4326 and other relevant IS codes as applicable. Structural design of load bearing and non-load bearing walls constructed with solid fly ash bricks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI.

11.17.02 All walls shall be non load bearing brick- in-filled panels walls. External walls of all buildings shall be at least one brick thick. All internal wall shall be at least one brick thick except for internal partition walls for office area, canteen, change rooms, first aid rooms and toilets which may be half brick thick. RCC bands shall be provided wherever necessary.

11.17.03 50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work.

11.17.04 M-sand shall be used for construction of brick works and river/natural sand shall be used for plastering and finishing works.

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11.17.05 Minimum 75 kg/ sq.cm compressive strength brick shall be used for non load bearing super structure brick work. Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided. 11.17.06 Type, thickness and height of external walling, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee (TAC) of IRDA India. 11.17.07 Even where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided. 11.17.08 All upstands and parapet walls on roof shall be of RCC constructions, minimum height of parapet walls shall be 900 mm and thickness 125 mm. 11.18.00 Structural Materials 11.18.01 Specification of materials will generally be in line with EPC specification adopted, unless otherwise specified. All materials will be tested quality conforming to latest relevant IS Code. 11.18.02 STRUCTURAL STEEL i) Structural Steel will conform to IS – 2062 Grade- A for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to IS – 2062 Grade-B will be used. ii) Coal Storage Bunkers shall be provided with 3.15 mm thick stainless steel lining conforming to ASI 409M, IS1570. iii) All steel surfaces exposed to marine environment are subjected to high degree of corrosion. The surfaces shall be painted epoxy based painting system as per the following specification: 11.18.03 SURFACE PREPARATION i) Steel surface which is to painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS05-5900. Primer paint shall be zinc silicate of approved brand. Dry film thickness of each primer coat shall be 50 microns. ii) The surface to be painted shall be manually or any other approved method compatible to the paint specifications. After cleaning, it shall be ensured that the cleaned surface is immediately applied with priming coat. iii) All fabricated steel material, except those galvanized or to be embedded in concrete, shall receive paint coatings as specified. Cutting of steel shall be after applying first coat of primer. 11.18.04 INDOOR/OUTDOOR STRUCTURES i) Surface preparation shall be done either manually or by any other approved method compatible to the paint specification given below. ii) Two coat of primer shall be provided.		
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iii) Top coat shall consist of two coat of Synthetic enamel of approved shade and colour with glossy finish. iv) Areas/Surfaces subjected to chemical attacks shall be painted with acid resistant paint v) The surface of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter by wire brush/ manual. Adequate care should be taken such that the surface does not possess a slick finish to which paint may not adhere properly. vi) Wherever steel columns are provided, base plate and stiffener shall be below the respective building / structure plinth level and shall be encased with reinforced concrete up to ground floor level (EL (+)0.00M level) vii) Wherever steel columns are used holding down anchor bolt shall be directly embedded in pedestals. For equipments, the bolt shall be either embedded or placed inside the pedestal and grouted with non-shrink grout of approved make. Ready mix non-shrink grout of GP2 brand or equivalent, of approved make shall be used for base grouting of major rotating equipments. 11.19.00 Handrails and Gratings and Other Requirements 11.19.01 All handrails shall be of 32mm nominal bore MS pipes (medium class) as per IS-1239. Handrails for platforms, walkways and projections shall be a two-rail system with the top rail 1000mm above the walkways surface and the intermediate rail 450mm below the top rail. Handrail post spacing shall be limited to 1500mm as far as possible but can be proportioned to the length of the protected horizontal opening. In such a case spacing shall be constructed with kick plates at bottom. It shall consist of 100 mm wide 8mm thick steel plate. 11.19.02 Steel grating shall be Black Bitumen Painted to match with specifications. Pressure locked grating. The grating shall be designed for 500 kg/m² loading and spans up to 1500 mm. Stair treads shall also be made of steel grating with nosing. 11.19.03 Steel ladder / staircase / platform will be provided for all equipment. Structures, pipe cables maintenance/operating platforms, access platforms, walkways, and crossovers etc. as per details shown in Mechanical GA. 11.19.04 All grating shall be of mild steel pressure locked type with black bituminous paint/painting prescribed in building structural steel. 11.20.00 Reinforcement Steel 11.20.01 Reinforcement shall consist of any of the following types but shall conform to requirements shown on the drawing: - i) Fe500/Fe550 (Conforming to IS: 1786) – from view point of physical and chemical properties for buildings in Plant. ii) Mild steel & medium tensile steel bars and hard drawn steel wire will confirm to grade –1 of IS: 432 (Part-1). Welded wire fabric will conform to IS: 1566. 11.21.00 Cement And Related Items		
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11.21.01 Ordinary Portland Cement (OPC) or PPC shall be used as recommended by soil investigation report. Grade of cement shall be 53/43 of approved manufacturer conforming to IS: 8112 will preferably be used. However, other types of cement such as Portland slag cement conforming to IS: 455 may also be used after approval from E-I-C. Ordinary Portland cement will be preferably used for TG foundation top deck, columns & beams.

11.21.02 All edges of opening for R.C floor with or without provision for covering by precast/ steel members shall have edge protection with M.S angle. The size of angle shall be 50 x 50 x 6 mm minimum.

11.21.03 All inserts supporting various services fixtures and loads shall be minimum 10.00 mm thick. Lugs required for anchorage in concrete shall be of flat iron of thickness not less than 6.0 mm or dia 8 mm HYSD bars.

11.21.04 Paving from last column row of TG building up to Chimney using M-20 with minimum reinforcement for shrinkage (8 ϕ @ 250 c/c top & bottom both ways) and with proper slopes and drainage arrangement. Floor finish with Ironite/IPS topping shall also be provided.

11.21.05 Paving in other areas shall consist of compacted sub grade, 230mm thk stone soling, and 150mm thk. RCC slab with shrinkage reinforcement

11.21.06 All cable trench bed shall have slope of 1/500 along the run and 1/250 perpendicular to the run. Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1: 6 plaster with 12 mm thick 1:6 cement sand mortar. Cable Trenches shall be covered with gratings / precast RCC covers in the Power House Building and in other areas concrete covers with edge protection angle shall be provided.

11.21.07 Pedestal shall be sized such that equipment / structure holding down bolts shall be within the reinforcement cage.

11.22.00 **Concrete**

11.22.01 Concrete work shall be carried out as per IS: 456. Design Mix concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal / volume mix can be permitted. Design mix shall be carried out as per IS: 10262. The grades of concrete for different machine foundations shall be as per mix design however minimum grade of concrete shall be as follows:

i) M-25 – For all RCC works unless specified otherwise in the specification.

ii) M-30/35 – For special structures as mentioned below: -

Sl. No.	Description	Minimum Grade of Concrete
1.	TG foundation and Top Deck	M-35
2.	ID, FD, PA fan, BFP and CEP foundation	M-30
3.	Coal Mill foundations	M-30
4.	Water retaining structures	M-30

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Sl. No.	Description	Minimum Grade of Concrete
	Special considerations:	
A	Unless specified 20mm and down aggregates shall be used for all structural concrete works. However 40mm and down aggregates may also be used under special conditions for the mass concreting in foundation.	

11.22.02 MINIMUM COVER TO ANCHOR BOLTS

Minimum distance from the centre line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

- Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50mm.
- Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm.
- All anchor bolts will have a clear cover of 100mm.

11.22.03 NOMINAL COVER TO REINFORCEMENT

The nominal cover to the reinforcement considering severe exposure as per IS 456: 2000 for all the structures, unless otherwise specified, shall be as follows:

- The nominal cover to the reinforcement to meet the durability requirements shall be as per the provisions of IS: 456. The nominal cover to meet the specified period of fire resistance shall also be met with the provisions of IS: 456.

11.22.04 MINIMUM THICKNESS OF STRUCTURAL CONCRETE ELEMENTS

The following minimum thickness shall be followed:

Sl. No.	Structure	Minimum Thickness
1.	Footing (all types including raft foundations without beam) (Tapered footings shall not have thickness less than 150 mm at the edges. Minimum average thickness shall not be less than 300 mm).	300 mm
2.	Pile cap	900 mm
3.	Basement walls & base slab	150 mm
4.	Slab thickness in raft foundations with beam & slab construction	150 mm
5.	Floor / roof slab, walkway, canopy slab resting on beams	150 mm
6.	Cable / pipe trench / launder walls & base slab	125 mm
7.	Parapet / chhajja / cantilevered canopy slab	125 mm
8.	Pre cast trench cover / floor slab	75 mm
9.	Precast floor slab / louvre (in contact with liquid)	100 mm
10.	Liquid retaining / leakproof structure walls and base slab	200 mm

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11.22.05 TEMPERATURE CONTROL OF CONCRETE

- i) The temperature of fresh concrete shall not exceed 23°C + 2°C when placed.
- ii) For maintaining the temperature of 25°C in the machine foundations, crushed ice shall be used in mixing water.

11.22.06 ADMIXTURE

- i) Admixtures shall be added to the concrete for promoting workability in addition to retarding setting time, for mass concrete work. For concreting of equipment foundations super plasticizers of approved quality shall be used.
- ii) The slump shall generally be in the range given below:
 - a) TG Top Deck 150mm to 200mm
 - b) BFP, ID/PA/FD Fan & Mill Deck 100mm to 150mm
 - c) Block Foundation 100mm to 150mm
 - d) Column 100mm to 150mm

11.22.07 FORM WORK

- i) Plywood formwork shall be used for the top decks of all machine foundations and also for columns of TG foundation.

11.22.08 ULTRASONIC TESTING

- i) Ultrasonic pulse velocity test shall be carried out for Top Deck of TG to ascertain the homogeneity and integrity of concrete.
- ii) Testing shall be done as per IS: 1331 (Part-1). The defects shall be rectified by using cement / epoxy grout etc.

11.22.09 GROUTING/ENCASING

- i) Non-Shrinking Grout for Equipment Foundations-
- ii) Special grout shall be provided in strict accordance with the manufacturer's instructions/specifications. Pre-mixed Grout Conbextra GP-2 of 'FOSROC' make or equivalent of crushing strength 650 kg/cm² shall be used for major equipment foundations.
- iii) Non-Shrinking Grout for Column Base Foundations-
 - a) Special grout shall be provided in strict accordance with the manufacturer's instructions/ specifications. Pre-mixed Grout Conbextra GP-1 of "FOSROC" makes or equivalent, having crushing strength of 450 kg/cm² for foundations where concrete grade M25 or higher is provided.
 - b) Proprietary material of approved manufacture used as an admixture to obtain non-shrinking grout shall be mixed in the proportion of 1:1:1 (1 cement: 1 admixture: 1 sand), or as per manufacturer's instructions.
- iv) Ordinary grout

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- a) Ordinary grout shall be provided for miscellaneous structure base plates viz. operating platforms (not supporting equipment), pipe supports up to 2.5 m height (above concrete top), cross-over, staircases and ladders.
- b) The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Based on requirement for obtaining non-shrink grout, aluminum powder may be used as an admixture. The grout proportions shall be limited as follows:

Use	Grout thickness	Mix proportions	W/C ratio
Fluid mix	Under 25 mm	One part Portland cement to one part of sand	0.44
General	25 mm and over but less than 50mm	One part Portland cement to 2 parts of sand	0.53

- 1) Sand shall be such as to produce a flowable grout without any tendency to segregate.
- 2) Sand for general grouting purposes shall be graded within the following limits:
 - Passing IS 2.36 mm sieve: 95 to 100%
 - Passing IS 1.18 mm sieve: 65 to 95%

11.23.00 Water

11.23.01 Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS: 456.

11.23.02 All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

11.24.00 Liquid Retaining Structures

11.24.01 Water channels and substructure of pump houses shall be designed as cracked section with limited steel stresses as per IS: 3370 (part I to IV) by working stress method.

11.24.02 All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. No pressure relieving devices shall be permitted in underground structures.

11.24.03 In all liquid retaining structures, Copper strip water bar shall be provided at each construction/ expansion joint. Coating of Nitto bond (Fosroc – epoxy bonding) or equivalent shall be applied for bonding of existing concrete and new concrete surfaces wherever construction joint is in the Liquid retaining structures or

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underground structures. The sequence of construction shall also be specified on drawings showing construction joints.

11.25.00 Concrete Screed

11.25.01 A screed or concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS: 456 shall be provided below all water retaining structures. A sliding layer of bitumen paper or kraft paper/Bitumen felt shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure.

11.26.00 Mud Mat

11.26.01 Minimum 100mm thick lean concrete 1:3:6 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

11.27.00 Monorails

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

11.28.00 Steel Platforms

11.28.01 All steel platforms above grade shall be provided with kick plates at edge of platform.

11.29.00 Fire Retardant Sealing

11.29.01 Duct banks consisting of PVC conduits conforming to IS: 4998 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound Manufactured by approved companies like HILTI or equivalent.

11.30.00 Dewatering

11.30.01 Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work.

11.31.00 Concrete Encasement

11.31.01 The underside level of base plates for structural steel columns shall be decided in such a way that bolts, gussets, etc., do not project above the floor level. These shall be encased by concrete cover upto floor level.

11.32.00 Grout

11.32.01 Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/mm² at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.

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11.33.00 **PTFE (Poly Tetra Fluoro-ethylene) Bearing**

- 11.33.01 The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation.
- 11.33.02 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/sq.cm.
- 11.33.03 In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata.
- 11.33.04 The stainless steel surface that 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 stainless steel plate shall be between 1.0 mm to 1.5 mm.

11.34.00 **Plant Effluent**

- 11.34.01 Plant effluent shall not be allowed to mix with either storm water or sewage but shall be carried in separate drains to the final disposal point.

11.35.00 **Water Supply & Sanitary Facilities**

- 11.35.01 Roof water tank of adequate capacity depending on the number of users and minimum 8 hours requirement shall be provided for each building and pump house. Separate tanks shall be provided for potable water and service water.
- 11.35.02 Polyethylene water storage tank conforming to IS: 12701 shall be used.
- 11.35.03 Galvanized MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for potable water supply.
- 11.35.04 No. of toilets and facilities provided in each building or pump house shall depend upon no. of users and as per IS: 1172. Minimum one (1) exclusive toilet shall be provided for handicapped user.
- 11.35.05 Each toilet block will have the following facilities:
- WC Orissa pattern (580 x 440 mm) as per IS: 2556 (Part-3) with all fittings including CI cistern of 10 L capacity as per IS: 774.
 - WC western type 390 mm high as per IS: 2556 (part 2) with toilet paper roll holder and all fittings including chromium plated flush type.
 - Wash basins (550x440 mm) with all fittings as per IS: 2556 (4).
 - Urinals (430x260x350) with all fittings as per IS: 2556 (part 6, section 1).
 - Bathroom mirror (600X450X5.5 mm thick).
 - CP brass towel Rail (600 x 20 mm)
 - Soap holder and Liquid soap holder dispenser.
 - Provision shall be for installation of water cooler.
 - Provision for ventilation shaft.
 - Eye and face fountain conforming to IS: 10592 In chlorination plant and battery Room.

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xi) IS: 1172, IS: 2064 & IS: 2065 shall be followed for water supply, drainage and sanitation work. 11.35.06 Stainless steel kitchen sink of size 600x400x20 for pantry. 11.36.00 Plinth Protection 11.36.01 All buildings will be provided with a width of 1000mm with plain cement concrete of M15 grade paving in 1% slope all around on the outside. 11.36.02 The plinth protection will be laid over prepared sub-grade and base formed with rubble-sand mix. laid to a thickness 230mm. RCC peripheral drains by the side of plinth protection for catering the storm water from roofs and adjacent area will be provided. 11.37.00 Grade Slab / Paving 11.37.01 The RCC paving minimum 150 mm thick of M20, over an underbed as specified herein shall be provided for areas mentioned below. i) RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. ii) The underbed for paving shall consist of preparation and consolidation of sub grade to the required level, laying of stone soling of 225 mm compacted thickness with 63 mm and down aggregate with interstices filled with selected sand followed by 75 mm thick 1:3:6 PCC (1 part cement, 3 parts sand and 6 parts stone aggregate) with 40 mm nominal size aggregate. iii) Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification. However mill maintenance area and vehicular passage shall be provided with non-metallic hard granular finish in place of metallic hardener topping. Non metallic hard granules shall be spread over the green concrete paving slab at the rate of not less than 5 kg/ sq.m. iv) Area between main plant building and ESP, ID, FD fan and up to outer edge of chimney will be provided with paving. This paving shall be provided for the full length of building. v) Ground floor of all buildings vi) 1m around station building & service cum workshop building. vii) Paving specifications shall be followed as specified above. 12.00.00 ARCHITECTURAL CONCEPTS AND DESIGN 12.01.01 Natural lights shall be used to the maximum extent, especially in the form of north light/ sky light. For adequate light and ventilation, National Building code recommendations shall be followed. 12.01.02 Entrance canopies chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided. 12.01.03 All the buildings shall be architecturally designed to meet the National Building Code (SP: 7) norms and local building bye laws, wherever applicable.		
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12.01.04 Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements may be required to be met with, wherever essential. The Architect Consultant shall be of National/International repute having experience in similar kind of works. The consultant shall evolve the design philosophy based on Owner/Engineer's guidelines and shall present it in the form of presentation drawings, Perspective views, 3-D Models and detail drawings.

12.02.00 Finishing Schedule

12.02.01 INTERIOR FINISH SCHEDULE

Sl. No.	Area Description	Floor Finish	Wall Finish/ Paint	Ceiling Finish/ Paint
1	STG Building			
	a) Ground Floor	IPS (cement concrete flooring) with non metallic floor hardener topping 12mm thick with a total thickness of 50mm. Skirting to match flooring.	Acrylic emulsion paint	Water bound distemper
	b) Cable vault	IPS (cement concrete flooring) with non metallic floor hardener topping 12mm thick with a total thickness of 50mm. Skirting to match flooring.	Acrylic emulsion paint	Water bound distemper
	c) Maintenance and unloading area	Epoxy flooring	Acrylic emulsion paint	Water bound distemper
	d) General circulation area like lift entrance area, office area and laboratory	25mm thick Granite flooring.	Acrylic emulsion paint	Water bound distemper
	e) Operating floor	25mm thick Granite flooring.	Colour coated Metal cladding on A-row & Gable end	Metal deck roofing
	f) Control room area	Vitrified ceramic tiles and Skirting to match flooring.	ACP cladding works	Aluminium false ceiling system
	g) Switch gear	Cement concrete with Metallic hardener topping	Acrylic emulsion paint	Water bound distemper

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Sl. No.	Area Description	Floor Finish	Wall Finish/ Paint	Ceiling Finish/ Paint
	h) SWAS room	Matt Finished Vitrified ceramic tiles	Aluminium composite panel cladding on walls and columns upto false ceiling level	Aluminium false ceiling system
	i) UPS Battery charger room	Matt finished Vitrified ceramic tiles.	Aluminium composite panel cladding on walls and columns upto false ceiling level	Aluminium false ceiling system
	j) Deaerator floor	Epoxy flooring		
	k) Conference room, senior executive room, Computer Room, Office room and staff room	Matt finished Vitrified ceramic tiles.	Partition in fire rated glass with fire rated frames with 2 hr fire rating & Aluminium Composite panel cladding for columns and walls	Aluminium false ceiling
	l) Record room	ceramic tiles	Acrylic emulsion paint	Aluminium false ceiling
	m) Toilet area	ceramic (anti-skid) tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Aluminium false ceiling
	n) RCC Stair case	20mm thick Granite flooring.	Polished Granite Stone up to 1.2m. ht. & Plastic emulsion Paint over	Water bound distemper

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Sl. No.	Area Description	Floor Finish	Wall Finish/ Paint	Ceiling Finish/ Paint
			wall putty finish for balance height.	
	o) Battery Room	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
2	Service building			
	a) Entrance Lobbies and Lift areas/ Foyer / Exhibition space.	20mm thick polished granite stone as/ pattern.	ACP cladding works	Aluminium false ceiling
	b) Conference room, senior executive room.	11 mm thk. Laminated wooden flooring	ACP cladding works	Aluminium false ceiling
	c) Office Room, Staff Room	Digitally glazed Vitrified ceramic tiles.	Acrylic emulsion paint	Aluminium false ceiling
	d) RCC Stair case	20mm thick polished granite stone as/ pattern.	Acrylic emulsion paint	Water bound distemper
	e) Toilet	Ceramic (anti-skid) tiles	Digitally glazed ceramic wall tiles up to False Ceiling Height	Aluminium false ceiling
	f) Pantry/ Kitchen	Ceramic tiles	Digitally glazed ceramic wall tiles up to False	Aluminium false ceiling



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Sl. No.	Area Description	Floor Finish	Wall Finish/ Paint	Ceiling Finish/ Paint
			Ceiling Height	
3	Compressor Building	IPS (cement concrete flooring) with non metallic floor hardener topping 12mm thick with a total thickness of 50mm. Skirting to match flooring.	Acrylic emulsion paint	Water bound distemper
4	ESP Control building			
	a) Switch gear	Cement concrete with Metallic hardener topping	Acrylic emulsion paint	Water bound distemper
	b) Cable vault	IPS (cement concrete flooring) with non metallic floor hardener topping 12mm thick with a total thickness of 50mm. Skirting to match flooring.	Acrylic emulsion paint	Water bound distemper
	c) Control room area	Vitrified ceramic tiles and Skirting to match flooring.	ACP cladding works	Aluminium false ceiling system
5	Balance buildings			
	a) Staircase area	20mm thick Granite flooring.	Acrylic emulsion paint.	Water bound distemper
	b) Battery room and areas coming in contact with Acid/Alkali	Acid and alkali resistant tile.	Acid and alkali resistant tile up to 1.2m height and chemical resistant paint for balance height	Chemical Resistant paint except in locations where Metal deck has been provided
	c) Control room buildings	Polished vitrified tiles/Heavy duty Ceramic tiles skirting matching with flooring.	Acrylic emulsion paint	Water bound distemper
	d) Cable Vault room	IPS (cement concrete flooring) with non metallic floor hardener topping.	Acrylic emulsion paint	Water bound distemper

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Sl. No.	Area Description	Floor Finish	Wall Finish/ Paint	Ceiling Finish/ Paint
	e) Toilet area	Heavy duty ceramic (anti-skid) tiles with matt finish. Dado of 2100mm high with glazed tiles of min. 5mm thick.	Acrylic emulsion paint	Water bound distemper
	f) Offices	Polished Vitrified tiles	Acrylic emulsion paint	Water bound distemper
	g) Switch gear	Cement concrete with Metallic hardener topping	Acrylic emulsion paint	Water bound distemper
	h) Air washer room/ pump houses	Epoxy flooring	Acrylic emulsion paint	Water bound distemper
	i) Maintenance bay	Epoxy flooring	Acrylic emulsion paint	Water bound distemper

Note:

- All wall and roof areas above false ceiling shall be plastered.
- The colour and pattern of finish shall be as per approved details.
- All materials shall be of reputed and established brand approved by Engineer-in-charge.
- Wherever alternative materials are specified, the final selection rests with Engineer-in-charge.
- This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
- All the finishing materials shall be applied/provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer.
- Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer-in-charge.

12.02.02 EXTERIOR FINISH SCHEDULE

Sl. No.	Area Description	Walls and Projections
1.	For STG building and balance area	Exterior emulsion paint (5 year warranty) over suitable primer of water proof paint over plastered surface. Approved colour/ colour combination of colour coated metal cladding
2.	Service building	ACP cladding

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Sl. No.	Area Description	Walls and Projections
3.	Building With Concrete Frame Work	Exterior emulsion paint (5 year warranty) over suitable primer of water proof paint over plastered surface.
4.	Exposed Metal Work	External sheet: Trough zinc aluminium alloy coated (Both sides) M.S sheet (0.6mm min. thickness) and permanently colour coated with polyfluro vinyl coating (PVF2) of dry film thickness (DFT) 20microns (min.) over primer on the outer face and suitable pre-coating of 7microns (min.) on inner face. Internal sheet: Galvanized M.S sheets (0.6mm min.) and permanently colour coated with silicon modified polyester paint of DFT 20 microns(min.) over primer on outer face and suitable pre-coating of min. 7 microns on inner face of internal sheet. Roof sheeting: The specification remains the same as that of side cladding except the minimum thickness and galvanization. The minimum thickness of roof sheeting shall be 0.8mm with galvanization rate of 275gm/sqm.
5.	Doors	
a)	All doors, windows and ventilators of all buildings.	Powder coated aluminium frame work with glazing
b)	STG building	On external walls: Powder coated aluminium frame work with glazing doors. For equipment entry: Steel sliding type/Rolling shutters. Office area: Powder coated aluminium frame work with glazing doors. Entrance lobby: Electro colour coated (anodized) aluminium frame work with glazing. Fire Protection Doors as per codal requirement.
c)	Switch Gear Building	Main entrance: Aluminium glazed double leaf with fixed sheet glass in anodized aluminium frame on either side. For equipment entry: Steel sliding type/Rolling shutters. Office & A/C area: Electro colour coated (anodized) aluminium frame work with glazing. For Cabin, Battery room and Swich Gear room: single leaf glazed aluminium doors. FPD as per codal requirement.
d)	Service Building	Powder coated aluminium frame work with glazing doors.
e)	Fire exit points	Fire-Proof doors with panic devices shall be provided at fire exit points as per the recommendations of applicable standards. Fire rating of the doors shall be as per code requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral

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Sl. No.	Area Description	Walls and Projections
		wool insulation.
f)	Toilet / Pantry area	Fiber door.
6.	Windows	
a)	STG building	Windows: Sliding type anodized aluminium frame work with 6mm thick glass and anodized aluminium frame work in areas where cladding is of sheeting. Ventilators: Aluminium framed louvers
b)	Switch gear building	Control room: Glazed aluminium sliding type window. Switch gear room: Glazed aluminium windows with wire glass. Other area: Electro colour coated (Anodized) aluminium frame work with glazing.
c)	Service Building	Windows: Sliding type anodized aluminium frame work with 6mm thick glass and anodized aluminium frame work in areas where cladding is of sheeting. Ventilators: Aluminium framed louvers
d)	Toilet / Pantry area	Fiber windows.

NOTE :

- i) The colour and pattern of finish shall be as finalized by Engineer.
- ii) All materials shall be of reputed and established brand approved by Engineer.

13.00.00 CORROSION PROTECTION**13.01.00 General**

- 13.01.01 All Steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of Corrosivity category (as per ISO 12944). Painting system for steel surfaces embedded in Concrete is given separately.
- 13.01.02 All Painting shall be done as per Technical Specification Painting scheme shall submitted by the Bidder.
- 13.01.03 All steel structures shall be designed by following basic design criteria in ISO 12944 Part 3. Minimum thickness of metal for any structural steel elements shall be not less than 6 mm where steel is fully accessible for cleaning and repainting and where it is feasible to follow design criteria given in ISO: 12944 part 3. However, where steel surfaces are inaccessible for cleaning and repainting or where it is not feasible to follow design criteria given in ISO: 12944 part 3, corrosion allowance of 1.5 mm shall be kept in thickness (over the design thickness or 6mm, whichever is more).

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13.01.04 Minimum thickness of tubular/ hollow steel sections conforming to IS: 4923 shall be 4.0 mm, provided the ends of such steel sections are effectively sealed unless higher thickness is specified elsewhere for specific structure.

13.02.00 Painting of Steel Surfaces Embedded In Concrete

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

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

13.03.00 Painting of Steel Surfaces (Other Than Those Embedded In Concrete)

CLASSIFICATION OF ENVIRONMENT	PRIMER COAT	INTERMEDIATE COAT	FINAL COAT
C3 - medium	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% $\pm 2\%$) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.	Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% $\pm 2\%$) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.	Intermediate coat shall be followed with the application of finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% $\pm 2\%$) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of

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			the coat shall be as approved by the Employer.
C5 - very high	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% $\pm 2\%$) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.	Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% $\pm 2\%$) of minimum 180 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.	Intermediate coat shall be followed with the application of finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% $\pm 2\%$) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the Employer.

13.03.01 For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.

13.03.02 The most frequent problem associated when top coating Primer is bubbling/pin holing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.

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13.03.03 In case top coating of zinc silicate with epoxy/polyurethane coatings, is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust. However, if white rust forms then clean the surface with high pressure water, dry and apply the subsequent coats as required. 13.03.04 Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme. 13.04.00 Coating for Mild Steel parts in contact with Water. 13.04.01 All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 g/ Sq.m. for galvanised Structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629. 13.04.02 The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified. 13.05.00 Gratings 13.05.01 All gratings shall be blast cleaned to Sa 2 ½ finish or cleaned by acid pickling as per ISO 8501-1 and shall be hot dip galvanized at the rate of 610 gm/sqm. 13.06.00 Hand Railings and Ladders 13.06.01 All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/sqm as per IS 4736. 13.06.02 All other MS handrails shall be painted as specified in clause above. However, Stainless steel handrails shall be provided as specified in General Architectural Specification. 13.07.00 Sea Worthiness 13.07.01 All Steel Sections and fabricated Structures, which are required to be transported on sea, shall be provided with anti-corrosive Paint before shipment to take care of sea worthiness. 13.08.00 For reinforced concrete work. 13.08.01 The protection for concrete sub-structure shall be provided based on aggressiveness of the soil, chemical analysis of soil/sub-soil water and presence of harmful chemicals/salts. 13.08.02 The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion. This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, etc., coating of concrete surface, etc., 13.08.03 Bidder shall furnish the details of corrosion protection measures.		
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14.00.00 AREA GRADING**14.01.00 Conformity with designs**

14.01.01 The Bidder shall carry out the work as per the drawings issued to him and/or Bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

14.02.00 Acceptance criteria**14.02.01 EXCAVATION**

- i) On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.
- ii) The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth.
- iii) Over excavation of the sides will be made good free of cost by the Bidder.
- iv) The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

1.05.00 AREA-FILLING

- i. The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification.
- ii. The actual method for measuring the compaction achieved will be as decided by the Engineer.
- iii. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

15.00.00 EARTH WORK**15.01.00 Scope**

15.01.01 This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

15.02.00 Information regarding site conditions

15.02.01 Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Bidder shall be taken as guidance only and variation there from shall not affect the terms of the contract.

15.02.02 The Bidder must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

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15.03.00 General

15.03.01 Excavation shall be carried out to correct lines and levels. This shall also include, proper shoring and strutting as required to maintain the sides of excavation as also all other safety measures such as creating safety barricades around excavated areas and warning lights at night.

15.03.02 Excavated materials shall be dumped to lead and lift as directed by the Engineer. The excavated material shall be stacked properly as directed by the Engineer.

15.03.03 The areas to be covered with embankments shall be stripped of topsoil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed by engineer. Combustible materials shall be stacked to be burnt in locations sufficiently remote to eliminate all danger of fire hazards.

15.03.04 All precious stones, coins, treasures, antiquities, any other archaeological and such other findings unearthed at the site during the course of execution shall be the property of the Owner. Such recovery shall be immediately brought to the notice of the owner's representative and the bidder shall duly preserve the same to his satisfaction.

15.03.05 For deep structures like Wagon Tippler, Lime Stone Hopper, ERH extra ramp shall be considered in excavation which can be used for shifting of materials and as concreting platform

15.04.00 Excavation

15.04.01 EXCAVATION OF SOILS

- i) All excavation work shall be carried out by mechanical equipments except for the last 150 mm of soil profile to be excavated out which shall be carried out manually to ensure properly compacted leveled / dressed surface, worthy of receiving PCC or other intended purpose. Excavation carried out to line and levels more than the specified shall be back filled with lean concrete mix 1:3:6 entirely at bidder's cost.
- ii) The excavation must be carried out in the most expeditious and efficient manner.
- iii) The excavated pits shall have side slopes or benching sufficient to safeguard against any cave-in/ collapse of soil as well as to provide for working space requirements as per actual soil conditions encountered.
- iv) All excavation shall be carried out to the minimum dimensions as required for safety and working space.
- v) Prior approval of the Engineer in-charge shall be obtained by the bidder in each individual case, for the method proposed to be adopted for the excavation, including dimensions, side slopes / benching, dewatering, disposal of excavated material, etc.
- vi) However this approval, shall not in any way absolve the bidder of his responsibility for any consequent loss or damage.

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- vii) All necessary precautions shall be taken to prevent damage to or interference with underground or over ground services such as cables, drains, piping, trenches, other foundation or piles, whether shown on drawings or not.

15.04.02 EXCAVATION IN HARD ROCK

- i) Where blasting is considered necessary for its excavation, the bidder shall obtain approval from the Engineer and authorities and excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The bidder shall obtain the necessary license for procuring, storing and using explosives. Blasting operations shall be conducted in a manner that these do not open seams nor damage or shatter the rock beyond the specified lines of excavation.
- ii) Normally a tolerance of 150 MM is allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Fissures and cracks below prescribed depth of excavation shall be corrected by removing loose fragments shattered or affected rock and replaced by Lean Concrete of Grade M-10 (1:3:6) in the case of foundations.

15.04.03 SITE LEVELLING

- i) Excavation / filling operations for site levelling shall be planned for execution to minimize handling of excavated material and transportation thereof. Blending of the materials shall be done by selective excavation and filling operation. Filling shall be done in horizontal layers not exceeding 300 MM compacted thickness or as directed by the Engineer subjected to compaction test 95% M.D.D. Heavy earth moving plant and vibratory rollers shall be deployed over the loose material of the fill to achieve good compaction at Optimum Moisture Content as directed by the Engineer. Adequate allowance shall be made for subsidence of fill material and excess or shortfall shall be made good by appropriate cutting / filling.

15.04.04 EXCESS EXCAVATION

- i) Excavation beyond the specified limits, done by the bidder but not directed by the Engineer, shall be considered as excess excavation. These shall be made good by the bidder as may be directed by the Engineer as under:
- ii) Excess excavation in case of site levelling shall be made good by filling and compacted to the same degree and material as the surrounding material.
- iii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material.
- iv) Excess excavation in case of foundation beyond required depths shall be made good by filling with Lean Concrete of Grade M-10 (1:3:6).

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15.04.05 BACK FILLING

- i) Select surplus soils from excavated materials shall be used as backfill. Fill material shall be free from lumps, salts, sulphates, organic or other foreign material. All fill material will be subject to Engineer's approval. The bidder shall remove fill material rejected by Engineer from the site at no extra cost to the Owner. Surplus fill material shall be deposited/ disposed-off as directed by the Engineer after the fill work is completed.
- ii) Bidder shall make arrangements for bringing select fill material in case required from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. All costs involved including paying of any royalty, transportation cost etc. in providing such borrow material shall be borne by bidder.
- iii) All back filling shall be carried out with approved material in layers not exceeding 200mm, watered and compacted with mechanical compaction equipment. However, the thickness of the backfill layers may be changed by the engineer depending on the fill material and equipment used. When filling reaches, the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours and the surface re-compacted as specified after drying to avoid settlements at a later stage.
- iv) The finished level of the filling shall be trimmed to the level/ slope. In case of compaction of granular material such as sands and gravel specified vibratory rollers shall be used. As rolling proceeds, water sprinkling shall be done to facilitate compaction.
- v) Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer. All soft spots shall be made good by removing, refilling with approved soil and compaction.
- vi) At locations where it is not possible to use mechanical equipment /rollers because of space restrictions / any other condition, the bidder shall be permitted to use pneumatic tampers, rammers, manual compaction etc. provided proper compaction is ensured.
- vii) All excavations shall be kept free of water. Grading in the vicinity of excavation shall be proper to prevent surface water running into excavated areas. Bidder shall remove by pumping or other means (as approved by Engineer-in-charge) any water, inclusive of rainwater and subsoil water accumulated in excavation pits and maintain all excavations in dewatered conditions until the foundation concrete work is completed and the pit is backfilled. Scheme of dewatering shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure that construction is progressing and there are no delays attributable to occurrence of water in the pits. Sumps made for dewatering must be kept clear of the excavations/ trenches required for further work. The bidder shall protect the earth fill from being washed away by rain or being damaged in any other way. Should any slip occur, the bidder shall remove the affected material and make good the slip at his cost.

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viii) To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the bidder at his cost. Field compaction test may be carried out at different stages of filling for full height. The compaction test, shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The bidder shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

ix) The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the compaction test does not achieve the stipulated value/ result.

15.05.00 **Blasting**

15.05.01 GENERAL

- i) Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments.
- ii) The Bidder shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.
- iii) No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

15.05.02 STORAGE OF EXPLOSIVE

- i) Storage of explosives shall be governed by the current Explosive Rules; Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose.
- ii) Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire.
- iii) A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge.
- iv) Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.
- v) Fuses and detonators shall be stored in separate magazines.
- vi) Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.
- vii) Magazine shoes without nails shall be used while entering the magazine.
- viii) The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

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ix) Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

x) The magazine shall not be opened during any dust storm or thunderstorm nor shall any person be allowed in the vicinity of the magazine.

xi) All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

15.05.03 CARRIAGE OF EXPLOSIVES

i) Detonators and explosives shall be transported separately to the blast site.

ii) Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat.

iii) Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

15.05.04 USE OF EXPLOSIVES

i) The Bidder shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The Bidder shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

ii) Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

iii) Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

iv) The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

v) For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

vi) All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

vii) The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

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viii) Blasting shall only be carried out at certain specified times to be agreed jointly by the Bidder and the Engineer.

ix) When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shotholes and filling the same with light charge of explosives.

x) Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

15.06.00 Disposal

15.06.01 The excavated soils will be disposed off in any or all the following manners:

i) By using it for backfilling straightway.

ii) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

a) By either spreading, Or

b) Spreading and compacting at designated filling areas and /or disposal areas.

iii) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

15.07.00 Disposal of Surplus

15.07.01 All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

15.07.02 Disposal of all surplus material within inside & outside plant boundary is included in the bidder's scope.

15.07.03 All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

15.08.00 Protection

15.08.01 The Engineer shall be notified by the Bidder as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer.

15.08.02 Excavated material shall be placed beyond 1.5 meters from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

15.08.03 Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

15.08.04 Adequate fencing is to be made enclosing the excavation.

15.08.05 The Bidder shall protect all under-ground services exposed by excavation. The Bidder shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

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15.09.00 Dealing with Surface Water 15.09.01 All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water. 15.09.02 No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with. 15.09.03 Where works are undertaken in the monsoon period, the Bidder may need to construct temporary drainage systems to drain surface water from working areas. 15.10.00 Dewatering 15.10.01 All excavations shall be kept free of water and slush. 15.10.02 Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. 15.10.03 The Bidder shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. 15.10.04 Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. 15.11.00 Plinth Filling 15.11.01 The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. 15.11.02 The finished level of the filling shall be trimmed to the slope intended to be given to the floor. 15.12.00 Filling in Trenches for Water Pipes and Drains 15.12.01 Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings. 15.12.02 Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. 15.12.03 Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed		
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and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

- 15.12.04 In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

15.13.00 Approaches and fencing

- 15.13.01 The Bidder should provide and maintain proper approaches for workmen and for inspection.

- 15.13.02 The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

15.14.00 Lighting

- 15.14.01 Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

16.00.00 ANTI TERMITE TREATMENT

16.01.00 General

- 16.01.01 The scope of work includes anti-termite chemical treatment of the structures against attack by termites.

- 16.01.02 The work shall be executed as specified in IS: 6313(Part-II) and as per approved specification of the manufacturer /agency having proven special know-how for the job.

- 16.01.03 Proper penetration and uniform distribution of treating solution shall be done in accordance with the instruction of the Engineer-in-charge and approved specification of the manufacturer /agency. Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water.

- 16.01.04 A chemical, conforming to IS: 8963 and from approved manufacturer / agency, shall be applied by pressure pumps, uniformly over the area treated.

- 16.01.05 Sub-structures etc. may be fully covered with the chemical barrier or from 500mm below ground level. Treatment shall be done in stages following the compaction of earth in specified layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centre close to the proposed superstructure/ wall surface and spraying the emulsion at the specified rate.

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16.01.06 Special care shall be taken at the locations, where pipes, conduits and cables enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with insecticidal solution as per approved specification and the instructions of the Engineer-in-charge. 16.02.00 Chemicals and rate of application 16.02.01 Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated. i) Chlorpyrifos Emulsifiable (IS: 8944 - 1978): 1.0 ii) Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978) Chlordane Emulsifiable : 0.5 iii) Concentrate (IS: 2682 - 1984): 1.0 16.02.02 Treatment of Column Pits, Wall Trenches and Basement Excavations i) Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. ii) The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M2 of surface area. iii) Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / Sqm of the vertical surface. 16.02.03 Treatment of Top Surface of Plinth Filling i) Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M2 of surface shall be applied prior to laying soling or sub- grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces. 16.02.04 Treatment of Soil Surrounding Pipes, Wastes and Conduits i) Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. 16.02.05 Treatment of Expansion Joints i) These shall receive special attention and shall be treated in a manner approved by the Engineer. 16.02.06 Treatment at Junction of the Wall and the Floor i) Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface. 16.03.00 Acceptance criteria 16.03.01 The Bidder shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.		
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17.00.00 CONCRETE AND ALLIED WORKS

17.01.00 The scope of work under this specification covers the general requirements for concrete using on-site production facilities/ batching plants including requirements with regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; grouting, quality and adequacy for making and providing formwork along with its supporting scaffolding/ props; requirements with regard to the quality, storage, bending, binding and fixing of reinforcement steel etc.

17.02.00 All works shall be in accordance with the relevant Indian standards and codes, best established engineering practices and as directed by Engineer in-charge from time to time. The decision of Engineer as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on bidder and no claim whatsoever will be entertained on this account.

17.03.00 Engineer in-charge shall have, at all times, the right to inspect all materials, equipment and operations including the sources of materials, procurement, transportation, storage of materials, the concrete batching and mixing equipment, and the quality control system, for approval. Such an inspection shall be arranged by the bidder to obtain Engineer's approval, prior to starting of any concrete work. This shall, however, not relieve bidder of any of his responsibilities with regard to quality, adequacy and usefulness of the job. Materials not conforming to the specifications shall be rejected and immediately removed from the site by the bidder.

17.04.00 Materials and operations shall satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Generally, materials complying with relevant codes/standards shall only be used. Other materials may be used in certain circumstances only after approval of the Engineer in-charge provided their performance suitability based on previous data, experience or tests can be established.

17.05.00 Self-compacting concrete (SCC) shall also be used wherever required due to dense reinforcement like less than 60mm clear distance between adjacent bars. It should be used mainly for underground structures and water retaining structures. The mix design of SCC shall be properly designed as per codes and standards.

17.06.00 Materials

17.06.01 FINE AND COARSE AGGREGATES

- i) Aggregates shall comply with the requirements of IS: 383 of "Coarse and Fine Aggregates for Concrete". The aggregates shall be hard, strong, dense, durable, clean and free from all deleterious impurities and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, seashells and organic impurities in such quantity as to affect the strength or

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durability of concrete. Aggregates, which are chemically reactive with alkalis of cement, shall not be used.

- ii) All aggregates shall be subject to inspection and testing from time to time. Sampling and testing shall be carried out in accordance with IS: 2386 of "Methods of Test for Aggregates for concrete". The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150-micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.
- iii) The nominal maximum size of the aggregates for each type of concrete work shall be according to relevant clauses of IS: 456. The aggregates shall be well graded; grading shall conform to relevant requirements of IS: 383. The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4th the minimum thickness of the member.
- iv) The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and as defined in IS: 383.
- v) The coarse aggregates shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignite, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious/foreign materials shall not exceed 5% by weight as per IS: 383. The stone chips shall be screened and washed before use where necessary.
- vi) Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates. Where two or more types of aggregates are stored close to each other, proper segregation shall be done to avoid mixing up.
- vii) M-sand grading as per IS:383-1970 shall be used for concrete works.
- viii) The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer: -

(a)	Very narrow space	:	12 mm
(b)	Reinforced concrete except foundation	:	20 mm
(c)	Ordinary Plain concrete and Reinforced concrete foundations	:	40 mm
(d)	Mass concrete	:	80 mm
(e)	Mass concrete in very large structure	:	150 mm
- ix) Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified

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proportions, strength and consistency that will work readily into position without segregation.

- x) Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles:
- xi) 150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases, it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.
- xii) This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

17.06.02 CEMENT

- i) Ordinary Portland Cement (OPC) or PPC shall be used as recommended by soil investigation report. Grade of cement shall be 53/43 of approved manufacturer conforming to IS: 8112 will preferably be used. However, other types of cement such as Portland slag cement conforming to IS: 455 may also be used. Ordinary Portland cement will be preferably used for TG foundation top deck, columns & beams.
- ii) The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from the Engineer in-charge.
- iii) The sampling of cement for testing shall be according to IS: 3535. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) & IS: 4032.
- iv) From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the bidder shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement found deteriorating while in the bidder's charge shall be rejected as unsuitable by the Engineer in-charge, which shall be removed from the site to outside the limits of work at the cost of bidder.
- v) Ensure due progress, the bidder shall at all times maintain on the site at least such stock of cement as decided by the Engineer in-charge from time to time. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.
- vi) The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well-ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 200mm clear off the floor leaving a space of 600mm around the exterior walls. The cement shall not be stacked more than 10 bags high. Cement stored for more than 90 days shall be tested prior to use on work.

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17.06.03 WATER

- i) Water used for mixing concrete and mortar and for curing shall be clean and free from impurities such as oil, acid, alkali, salts, organic materials or other substances that may be deleterious to concrete or steel.
- ii) The pH value of water shall generally be not less than '6'. Water for both mixing and curing shall meet the requirements of IS: 456.
- iii) Water shall be obtained from an approved source.
- iv) Drinking water is generally acceptable, where it is obtained from a source other than a drinking water supply main, it shall be tested to establish its suitability.
- v) Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.
- vi) Bidder shall make his own arrangements for storing water at site in tanks to prevent contamination.

17.06.04 ADMIXTURE FOR CONCRETE

- i) Admixtures to concrete shall not be used without the written consent of the Engineer in-charge. If allowed, the bidder shall furnish full specification, details from the manufacturer and shall arrange to carry out such test as per standard specification and as per Instruction of the Engineer in-charge, before any admixture is used in the work. Accelerating, retarding, water reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixture to IS: 2645. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment's.
- ii) Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts.
- iii) Admixtures may be used to modify one or more of the following properties of fresh concrete with care being taken to ensure that other properties are not affected adversely:
- iv) To retard or accelerate both initial and final setting times.
- v) To increase workability without increasing water content or to decrease the water content at the same workability.
- vi) To reduce segregation of concrete, mortars and grouts.
- vii) Admixtures used as integral waterproofing agent shall be free of chlorides and sulphates and shall conform to IS: 2645. The application and quantity shall be as per manufacturer's specification.
- viii) Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

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IS : 2645 : Integral cement water proofing compound

IS : 9103 : Indian standard specification for Admixtures Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, part 1 to 3)and may be one of the following:

- a) Accelerating admixtures:
 - b) Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10"
 - c) Retarding admixtures:
 - d) Modified ligno sulphonate based set retarding concrete admixture like, "Plastiment R".
 - e) Water reducing admixtures:
 - f) Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament".
 - g) Air entraining admixtures:
 - h) Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP "or surface - active agents like "Sika AER".
 - i) Water proofing admixtures
 - j) Modified lingo-sulphonate based waterproofing admixture like "Plastocrete Super".
- ix) However, the Bidder shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer.
- a) Type of admixture
 - b) Mix proportion & mode of application in concrete/mortar
 - c) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value infra red analysis & solid content)

17.06.05 REINFORCEMENT STEEL

- i) Reinforcing steel bars for concrete shall be round steel bars of the following types:
- a) Plain mild steel bars conforming to Grade-I of IS: 432 "Mild Steel & Medium Tensile Steel- for Concrete Reinforcement".
 - b) "High strength deformed steel bars conforming IS: 1786 for Concrete Reinforcement".
 - c) Reinforcement fabrics confirming to IS: 1566. "Hard Drawn Steel wire fabric reinforcement".
 - d) Thermo mechanically treated (TMT) high strength deformed bars.

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e) In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

ii) All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond.

iii) All material shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

17.06.06 ROUTINE TEST

i) All materials used for the works shall be tested before use. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by Engineer. Representative Samples shall also be got tested by the bidder in any external laboratory approved by Engineer in-charge at no extra cost to Owner. Bidder shall furnish manufacturer's test certificates and technical literature for the materials proposed to be used.

ii) The routine tests of materials, delivered at site shall be at the following intervals:

a)	Aggregates -	Fortnightly or for every 200m ³ for each aggregate sizes whichever is earlier.
b)	Cement -	Fortnightly or for each consignment.
c)	Water -	Once in two months for each supply source.

17.07.00 Concrete

The section below deals with the requirements of various grades of concrete and the parameters that need special attention to achieve dense concrete with the specified strength.

17.07.01 GRADES OF CONCRETE

i) The grades of concrete unless otherwise specified shall be in accordance with the following table. The grade of concrete to be used in each section of work will be as shown on the drawings:

Grade of Concrete	Minimum compressive strength (7 Days) N/Sq.mm	Specified Characteristic compressive strength (28 Days) N/Sq.mm
M15	10.0	15
M20	13.5	20
M25	17.0	25
M30	20.0	30
M35	23.5	35
M40	27.0	40

ii) Maximum nominal size of coarse aggregates:

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a) 12mm - For concreting in very narrow space or in very small thickness.

b) 20mm - For all PCC, reinforced concrete works.

17.07.02 MIX DESIGN
i) General

a) At the commencement of the contract the bidder shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling, placing and finishing as well as it develops the required strength, durability and surface finish upon hardening. The bidder shall get approval of Engineer to proportions before he starts concreting. Such approval shall not relieve the bidder of his responsibility to produce concrete having the required compressive strengths.

b) No departure from the approved proportions will be permitted unless the Engineer in-charge gives written permission for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is carried out according to the approved proportions. The design of mixes shall be made by the bidder at his own cost, for each grade of concrete as well as for various workability requirements. The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, cement content of concrete shall not be less than the quantities specified hereunder except for the cases specifically approved by the Engineer.

Grade of concrete	Minimum cement content/cu.m of finished concrete
M-15	300 kg
M-20	340 kg
M-25	375 kg
M-30	400 kg

c) The minimum cement content stipulated above shall be adopted irrespective of whether required strength is achieved with lesser quantity of cement. The strength requirements of the concrete mixes ascertained on 150mm cubes as per IS: 456 shall comply.

ii) Water Cement Ratio

a) Where a particular water cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete, the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water cement ratio. In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, the

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water cement ratio shall be kept low and preferably not exceeding 0.45. The water cement ratio, as achieved in the Mix Design or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

iii) *Workability*

- a) The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction it becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.
- b) The workability of fresh concrete at the place of batching/mixing shall be measured by compaction factor test and at the place of disposition by means of slump test. During the finalization of Trial Mixes, the relationship between compaction factor and slump test shall be established for each grade of concrete as well as for various levels of workability. The workability tests shall be carried out in accordance with IS: 1199.
- c) Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content, in consistent with added water.
- d) In cases where the cement content is to be limited to reduce the heat of hydration, and the water cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.
- e) With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete.
- f) The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedment and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C.

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Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
			structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. Structures with congestion due to reinforcement and inserts.

Note:

- a) Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer)
- b) With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199.

iv) *Trial Mixes*

- a) After approval of the mix design by the Engineer, the bidder shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.
- b) Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents, in the aggregates, shall be completed according to the IS: 383 and IS: 2386. Each trial mix shall be handled and compacted by method which the bidder proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.
- c) The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained by the mix design.
- d) Six numbers of 150mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant Codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

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- e) Before commencement of the concreting works of particular grade of concrete, the bidder must complete the work of trial mixes and subsequent testing of test cubes obtained there from the design of the approved Mix for that particular grade of concrete. The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the bidder.

17.08.00 Batching of Concrete

17.08.01 CEMENT

- i) Cement shall always be batched by weight.
- ii) A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.

17.08.02 AGGREGATES

- i) For both Design Mix concrete and Nominal Mix concrete the aggregates (coarse and fine) shall be batched by weight.
- ii) In particular cases, or where weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the bidder guarantees the uniformity of aggregates throughout the period of construction. For this purpose, the bidder shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the bidder to the satisfaction of the Engineer.
- iii) Where aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with I.S. 2386 (Part-III).
- iv) Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in moisture contents.

17.08.03 WATER

- i) Water may be measured either by weight or by volume.
- ii) It is very important to maintain the water cement ratio constant at its correct value.
- iii) For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible.
- iv) Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III).

17.09.00 Mixing and Transportation of Concrete

17.09.01 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456.

17.09.02 MIXING OF CONCRETE

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- i) Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water is in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.
- ii) The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.
- iii) Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.
- iv) Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Bachers conforming to IS: 2722 may be used.
- v) Batching plant conforming to IS: 4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement, water or total aggregates being measured and within + 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.
- vi) Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.
- vii) Where admixtures are employed, separate containers & measuring devices shall be used.
- viii) For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.
- ix) When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

17.09.03 TRANSPORTATION OF CONCRETE

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- i) Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by means that will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

17.10.00 Placing and Compaction of Concrete

17.10.01 Before placement of concrete, the bidder shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer-in-charge. To facilitate such checking, the bidder shall complete all his works according to the drawings and specifications well in advance before placement of concrete at least 36 hours for all major/important/complicated works and 24 hours for all normal works. The checks are purely in the interest of the work and to draw the bidder's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the bidder from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

17.10.02 All concrete works shall normally be placed at or below soil level and where in touch with soil with a levelling layer of lean concrete 1:3:6. In such cases the earth shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with the lean concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated; if necessary, wet soil/ unsuitable soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer at no extra cost to the Owner. Utmost care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

17.10.03 The concrete shall be placed and compacted before setting commences & should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be over vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. All inserts and embedment properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer. Concrete shall be placed on a clean surface free of all debris and other objectionable materials. Concreting shall not be done during rains unless all precautions have been taken by the bidder and permission has been given by the Engineer.

17.10.04 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer. The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas. For members involving vertical placing of concrete (eg. columns, walls etc.) each lift shall be deposited in horizontal layer extending the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction. For member

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involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible. Utmost care shall be taken to avoid the displacement of reinforcements/ embedded parts or movement of formwork or damage to faces of the formwork or transmission of any harmful vibration/shocks to the concrete, which has not yet hardened sufficiently.

17.10.05 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete, which is still plastic and workable. Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the bidder shall make at his own cost, suitable tongue and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided at no extra cost to Owner. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification, stipulated earlier, shall be done by the bidder. The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surround the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedment, holes, openings etc., well within the accepted tolerance limit.

17.11.00 **Construction Joints**

17.11.01 The construction joints shall be constructed as per locations and details indicated on the drawings. Where the location of the joint is not specified in the drawings, it shall be in accordance with best Engineering practice / decision of the Engineer-in-charge.

17.11.02 In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water tight.

17.11.03 For nominally reinforced slab the area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m. In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way. The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures/embedment. All construction joints shall be made to form a tongue and groove joint.

17.11.04 In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface prepared before placement of concrete.

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- 17.11.05 Placing of concrete in lifts exceeding 2m in columns and walls is considered a deep lift. Before commencement of work, the bidder shall submit for the approval of the engineer, the details of the methods he proposes to adopt for concreting. The placement of concrete shall preferably be by tremie, chute or any other approved method. In structures of heavy/ complicated reinforcement or in complicated form works, the bidder shall provide sufficient number of windows in the form works as directed by the engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.
- 17.11.06 When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with IS: 456.
- 17.11.07 When concreting in very hot weather the bidder shall take all precautions as stipulated in IS: 7861(Part-I) and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, especially in massive structure, does not exceed 38°C.
- 17.11.08 During windy weather, efficient protection is to be provided to prevent the cement from being blown away during the process of apportioning and mixing. All special care shall be taken to protect new concrete from the harmful effects of drying winds. During wet weather, the concrete shall be adequately protected as soon as it is in position. No concreting shall be carried out during periods of continuous heavy rain unless it is completely covered during mixing, transporting and placing.
- 17.11.09 EXPANSION AND ISOLATION JOINTS
- i) *General*
 - a) Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings.
 - b) In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer.
 - c) All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Bidder to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Bidder to get them tested in an approved laboratory.
 - d) Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications.
 - e) Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.
 - f) Rubber/Copper material shall be provided in the expansion and isolation joints.
 - ii) *Bitumen Board/Expanded Polystyrene Board*
 - a) Bitumen Board

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1) Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. 2) At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. 3) The sealing compound and the primer shall be applied as specified by the manufacturer. b) <u>Expanded Polystyrene Boards</u> 1) If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. 2) The thickness may vary from 12 mm to 50 mm. 3) The material will have to be procured from reliable manufacturers as approved by the Engineer. 4) The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. 5) A coat of Bitumen paint may have to be applied on the board against which concrete will be placed. iii) <u>Joint Sealing Strips</u> a) Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. b) The sealing strips will be non-metallic like rubber or P.V.C. c) Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Bidder is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanised. d) Non - metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:		
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1) Plain

2) Central bulb

3) Dumb-bell or flattened ends

4) Ribbed and Corrugated Wings

5) V shaped

e) As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

f) The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

iv) Rubber Sealing Strips

a) The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings of items and/ or as directed by the Engineer.

b) The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service.

c) The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

1) Specific Gravity : 1.1 to 1.15

2) Shore Hardness : 65A to 75A

3) Tensile Strength : 25 - 30 N/Sq.mm

4) Maximum Safe Continuous Temperature : 75 Deg.C

5) Ultimate Elongation : Not less than 350%

v) P.V.C. Sealing Strips

a) The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer.

b) The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use.

c) The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly:

1) Specific Gravity : 1.3 to 1.35

2) Shore Hardness : 60A to 80A

3) Tensile Strength : 10 - 15 N/Sq.mm

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4) Maximum Safe Continuous Temperature: 70 Deg.C

5) Ultimate Elongation : Not less than 275%

vi) *Joint Sealing Compound*

- a) When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound lay as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.
- b) Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

vii) *Isolation Joints*

- a) Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully.
- b) Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

viii) *Rubber Pad*

- a) Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer.
- b) The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness- 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

17.12.00 Mass Concreting

17.12.01 The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration.

17.12.02 The Bidder shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt.

17.12.03 The maximum height of lifts will depend on the type of cement used. The use of cement having low heat of hydration, could allow greater lifts.

17.13.00 Cold weather concreting

17.13.01 When conditions are such that any operation of concreting may be expected to be done at 5Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS: 456 and IS: 7861. (Part. II).

17.14.00 Hot weather concreting

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17.14.01 When depositing concrete in very hot weather, the Bidder shall take all precautions as per IS: 7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 400 C while placing. 17.14.02 Positive temperature control by pre cooling, post cooling or any other method, if required, will be specified`. 17.15.00 Concreting under water 17.15.01 When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS: 456. 17.16.00 Program of Works 17.16.01 At the beginning of every fortnight, the Bidder shall give his detailed concreting program for that fortnight to the Engineer. 17.16.02 Such programmes, shall specify all information such as the locations where concrete is to be poured., type/grade of concrete, volume of concrete to be poured, number and type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc. 17.17.00 Curing of Concrete 17.17.01 The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the bidder. 17.17.02 Any one of the following methods may be used for curing as approved by the Engineer: i) Curing by direct water. ii) Curing by covering the concrete with absorbent material and kept damp. iii) Curing by providing protective membrane. 17.17.03 CURING BY DIRECT WATER i) This is done either by ponding or spraying water. ii) Ponding is widely used for curing slab and pavements. Small earth bunds are formed over the edges of the slab and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 7 days of curing after final setting is sufficient. iii) Curing is done by spraying water by suitable means at approved time/ interval. While spraying, it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the formwork, while the concrete is still warm. Alternate wetting and over drying shall be avoided. Curing by spraying water shall be continued for at least 10 days after final setting.		
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17.17.04 CURING OF CONCRETE WITH ABSORBENT MATERIAL KEPT DAMP

- i) The entire concrete surface is covered either with Hessian, canvas or similar material and kept wet continuously for at least 10 days after final setting.

17.17.05 CURING BY PROVIDING PROTECTIVE MEMBRANE BY APPLYING A CURING COMPOUND

- i) This is achieved by applying a membrane-forming compound (curing compound) over the concrete surface. Generally these are available in emulsion form and shall be applied as per manufacturer's instructions.
- ii) The curing compound membrane forms a continuous adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself.

17.18.00 **Quality Control**

17.18.01 Bidder shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same.

17.18.02 The quality control operation shall include but not be limited to the following items of work:

(a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.
		:	For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
(b)	Aggregate	:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
(c)	Water	:	Impurities tests.
(d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
(e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
(f)	Reinforcement	:	Shapes, dimensions, length of plies, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Specification
(g)	Grades of	:	Usage and mix design, testing of all properties.

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	concrete		
(h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
(i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
(j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
(k)	Placing	:	Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
(l)	Compaction	:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
(m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
(n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
(o)	Curing	:	Methods and length of time.

17.18.03 Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

MIX PROPORTION (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORK ABILITY WITH DIFFERENT VALUES OF WATER – CEMENT RATIO CEMENT / TOTAL AGGREGATE RATIOS

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Sr. No.	WORKABILITY	WATER / CEMENT / RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
			20 mm size	38 mm size	20 mm size	38 mm size
(a)	Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
(b)	Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
(c)	0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
		0.7	1:10	1:12	01:08.7	01:10.6
(a)	Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
(b)	Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
(c)	25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
(d)		0.7	01:08.0	01:08.5	01:07.4	01:08.0
(a)	Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
(b)	Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
(c)	50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
(a)	High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
(b)	Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
(c)	100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
		0.7	01:06.2	01:07.4	01:05.5	01:06.5

17.18.04 NOTES:

- i) Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

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- ii) It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.
- iii) The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

17.19.00 **Steel Reinforcement**

17.19.01 All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements shall be cleaned thoroughly before bending and placement of the same.

17.19.02 **STORAGE**

- i) Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground.
- ii) Bars of different classifications and sizes shall be stored separately.
- iii) Reinforcement shall be stacked at least 15 cm above ground level and a coat of cement wash given at no extra cost to prevent scaling and rusting.

17.19.03 **BAR BENDING SCHEDULES**

- i) The Bidder shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Bidder to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later.
- ii) Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Bidder shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution.
- iii) Approval of such detailed drawings by the Engineer shall not relieve the Bidder of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

17.19.04 **CLEANING**

- i) All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

17.19.05 **CUTTING & BENDING OF REINFORCEMENT**

- i) Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Bidder before any bending is done.

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- ii) No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re bending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 °C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.
- iii) Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

17.19.06 PLACING IN POSITION

- i) All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.
- ii) Before actual placing, the Bidder shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

17.19.07 CONTROL

- i) The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.
- ii) The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

17.19.08 LAPPING / WELDING OF REINFORCEMENT

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17.19.09 Normally the lapping of reinforcement bars shall be by mechanical means satisfying the requirements of IS: 456. However, in case of congestion of reinforcement the welding of reinforcement may be adopted with special approval of Engineer. 17.19.10 Welding of mild steel reinforcement bars conforming to IS: 432(Part-I) and shall be done in accordance with IS: 2751 of "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction". 17.19.11 All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layer bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. The binding wires shall be soft annealed black wire. 17.19.12 Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456. 17.20.00 Miscellaneous Structural Steel Works 17.20.01 Fabrication of all structural steel work shall be done in accordance with IS: 800 "Code of practice for use of Structural Steel in General Building Construction". 17.20.02 Workmanship shall match to the best practice in modern structural shops. 17.21.00 Transportation and Storages 17.21.01 All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. 17.21.02 Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. 17.21.03 All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage. 17.21.04 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering works, reinforcement etc while concreting. Bidder will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at location of inserts as directed by engineer. 17.21.05 Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint. 17.22.00 Shuttering		
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17.22.01 GENERAL

- i) All shuttering, formwork, supports and staging shall be designed by the Bidder and be subject to approval by the engineer. The bidder shall submit drawings and calculations to the engineer for scrutiny when called upon to do so. The bidder shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of responsibilities.
- ii) The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.
- iii) The formwork shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. For ornamental and curved surfaces, the material shall be very good seasoned timber or plywood.
- iv) The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.
- v) All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The formwork shall be so designed that the sides are independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.
- vi) Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface. The joints in shuttering shall be arranged in a regular pattern approved by the engineer. Wrought shuttering shall be aligned within a tolerance of 3mm.
- vii) Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.
- viii) Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

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17.22.02 REMOVAL OF FORMS

- i) Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually and also without disfiguring the concrete surface.

- ii) Time period for shuttering removal shall be as follows:

Sl. No.	Description	Time period (Days)
1.	Walls, columns & vertical faces	24 to 48 hours as may be directed by the Engineer
2.	Bottom of slab upto 4.5m span	7 days
3.	Bottom of slab above 4.5m span and bottom of beam and arch, rise upto 6m span	14 days
4.	Bottom of beam and arch rise over 6m span	21 days

- iii) These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc. Before removing the formwork, the bidder must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

17.23.00 Sampling and Testing of Materials

17.23.01 GENERAL

- i) The Bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification.
- ii) The Bidder 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.

17.23.02 CEMENT

- i) Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths.
- ii) Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Bidder is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job.

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- iii) No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known.
- iv) The Owner, Engineer and Bidder will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Bidder.
- v) These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

17.23.03 AGGREGATES

- i) The Bidder shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII.
- ii) The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

17.23.04 WATER

- i) Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Bidder at regular intervals and whenever directed by the Engineer.
- ii) The final acceptance criteria in case of doubt will be as per IS: 3025 & IS: 456.

17.23.05 ADMIXTURE

- i) Air Entraining Agents (A.E.A)
 - a) Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Bidder by carrying out sufficiently large number of tests.
 - b) Thereafter, at regular intervals and whenever directed by the Engineer, the Bidder will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.
- ii) Other Admixtures
 - a) Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Bidder.

17.23.06 CONCRETE

- i) The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516.
- ii) Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS: 456.

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iii) To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 and shall be carried out by the Bidder every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

iv) The acceptance criteria of concrete shall be in accordance with Clause 15 of IS: 456.

v) Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Bidder. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good to the satisfaction of the Engineer.

17.24.00 **Testing of Concrete**

17.24.01 GENERAL

i) The bidder shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant standards and as supplemented herein. The bidder shall get all tests done at his site laboratory and / or an approved external laboratory as per the instructions of the engineer in-charge and submit to the Engineer the test result in triplicate.

ii) At the place of pouring concrete, slump tests shall be carried out by the bidder in accordance with IS: 1199 as directed by the Engineer-in-charge.

iii) The results of the slump tests/ tests shall be recorded in a register for reference duly signed by both the bidder and the engineer. That register shall be considered as the property of the owner and shall be kept by the Bidder at site in safe custody.

iv) For any particular batch of concrete, if the results do not conform to the requirements as specified or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Bidder shall remove the same immediately from the site, at no cost to the owner.

17.24.02 STRENGTH TEST OF CONCRETE

i) While placing concrete, the Bidder shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the engineer. The frequency of taking test cubes shall be according to IS: 456 or as directed by the engineer.

ii) The cubes shall be prepared, cured and tested according to IS: 516. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

iii) A register shall be maintained at site by the bidder with the following details entered for the cubes and signed both the bidder and the engineer. That register shall be considered as the property of the owner.

iv) Following details shall be available for the cubes having reference to the specific structural member:

a) Mark on cubes

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b) The grade of concrete

c) The mix of concrete

d) Date and time of casting

e) Crushing strength at 7 days

f) Crushing strength at 28 days

g) Any other information directed by the engineer.

v) The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under IS: 456.

17.24.03 NON-DESTRUCTIVE TESTS ON HARDENED CONCRETE

i) If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under IS: 456, non-destructive tests on hardened concrete like core test and /or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the engineer, by the bidder at entirely his cost. The core tests and load tests shall comply with the requirements of IS: 456. In case of other types of special tests like ultrasonic pulse velocity test etc., the relevant stipulation of clauses of IS: 456 shall be applicable.

17.24.04 CONCRETE BELOW SPECIFIED STRENGTH

i) In case of failure of test cubes to meet the specified requirements the engineer may take one of the following actions:

a) Instruct the bidder to carryout additional test and/or works to ensure the soundness of the structure at bidder's expense.

b) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at bidder's expense and the resultant structures affected due to such rejection shall be made good at bidder's expense.

c) Modification/remedial measures if approved by the engineer to be carried out at bidder's expense.

17.24.05 CONCRETE FAILED IN NON-DESTRUCTION TESTS

i) In case the test results of the core tests or load tests in a particular work do not comply with the requirements of clauses for load tests of IS: 456 the whole or part of the work concerned shall be dismantled and replaced by the bidder as may be directed by the engineer at no extra cost to the Owner and to the satisfaction of the engineer. No payment for the dismantled concrete including relevant formwork, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the bidder, to the satisfaction of the engineer.

17.24.06 ACCEPTANCE CRITERIA

i) *Standard Deviation*

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- a) Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS: 456.
- ii) *Acceptance Criteria*
 - a) The strength requirements and acceptance criteria shall conform to Clause 16 of IS: 456.
- iii) *Inspection And Core Tests*
 - a) Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS: 456.
- iv) *Load Test*
 - a) Load tests of structural members may be required by the Engineer, when the strength of test specimen results falls below the required strength, as per Load Test on Parts of Structures', Clause 17.6 of IS: 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.
 - b) If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Bidder. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by de-rating its load bearing capacity, provided the design criteria allows such de-rating.
 - c) A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS: 456.
 - d) The entire cost of load testing shall be borne by the Bidder. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.
 - e) If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good by the Bidder to the satisfaction of the Engineer.

18.00.00 STRUCTURAL STEEL WORKS

18.01.00 Scope of Work

18.01.01 The scope of work for steel structures will be as follows:

- i) Preparation and supply of shop detail drawings, erection drawings, shop material lists, site-bolt list, As Built drawings and dispatch documents for the steel structures /sheeting's/ glazing, etc.
- ii) Supply, fabrication, shop painting, finish painting at site, transportation, delivery and storage of all steel structures and sheeting including site bolts, electrodes,

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sheeting fixtures etc. complete in all respects, erection (including tools, tackles, cranes and any staging or false work required for erection), handling, transport and rectification of damaged structures, fixing, bolting, welding, alignment, leveling etc of all steel structures, complete in all respects.

18.02.00 **Miscellaneous**

18.02.01 Main structural elements will be welded continuously. Intermittent welds will be used only on secondary members, which are not exposed to weather or other corrosive influence. The size of fillet welds will not be less than 5mm.

18.02.02 Connection and splices will be made by welding or bolting with high tensile turned and fitted bolts. Black bolts will be used in connections and attachments of secondary members such as purlins, wall girts, etc. Bolts will be prevented from loosening by means of lock nuts, single coil spring washers or similar devices. Bolt diameter will not be less than 16mm. except for bolts securing roof and wall sheeting's, windows, doors and stitching of thin coverings. For bolted joints, min. two bolts will be used.

18.03.00 **Fabrication of Steel Structures**

18.03.01 DRAWINGS

- i) The Bidder will prepare fabrication drawings, erection drawings, bill of materials, drawing office despatch lists/shipping documents, schedule of bolts and nuts and as built drawings.
- ii) The fabrication drawings will show full length layout with all connecting members and connections marked thereon. The fabrication drawings will include all the necessary blown-up details required for the correct fabrication of the structures to meet the design requirements. These drawings will be made in conformity with the best modern practices and with due regard to speed and economy in fabrication and erection. Each erection piece will be clearly identified by an erection mark in these drawings.
- iii) The fabrication drawings will be prepared in such a manner that structures are despatched with maximum transportable lengths and work involved at site is minimum. Steelwork will be shop-fitted and shop- assembled as far as practicable. Erection drawings will consist of line diagrams showing every detailed member in position with the respective erection mark. Erection marks will appear on the left end of the members as detailed. All steel members will be erected with marks in the same relative position as shown in plan or elevation. In the case of bolted connections, the bolt dia., the hole dia., the actual location of holes and the coordinating scheme with connecting/ matching elements will be clearly indicated. In case of welded constructions, the size and length of welds along the relevant weld lines should be distinctly marked.

18.03.02 MATERIAL OF CONSTRUCTION

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- i) All steel and other materials used for steelwork and in association with steelwork will conform to appropriate Indian standards. Only tested materials will be used unless written authority is obtained for the use of untested materials for certain secondary structural members.
- ii) Unless otherwise specified in the drawings:
 - a) All rolled sections and plate will conform to Grade "A" as per IS: 2062.
 - b) Plated structures subjected to dynamic loading will conform to Grade "B" as per IS: 2062.
- iii) Steel sheets will conform to IS: 1079. Crane rail will conform to IS: 3443.
- iv) All black hexagonal bolts, nuts and locknuts will conform to IS: 1363 and IS: 1364 (for precision and semi precision hexagonal bolts). Washers will conform to IS: 5369. All HSFG bolts will conform to IS: 3757. Assembly of joints using HSFG bolts will conform to IS: 4000.
- v) Covered electrodes for arc welding will conform to IS: 814. Coding of electrodes will be as follows:
 - a) ER421 'C' X for mild steel of Grade 'A' and Grade 'B' as per IS: 2062.
 - b) EB 542 'C' H3X for Mild steel of Grade 'B' as per IS: 2062 for dynamically loaded structures (arising out of crane, vibratory screen, equipments etc.) 'C' is the value of the current as recommended by the electrode manufacturer.
- vi) Certified mill test reports of materials used in the work will be made available for inspection by the Owner / Consultant upon request.

18.03.03 METHOD OF CONSTRUCTION

- i) The method of construction will be either by welding or by bolting limiting the site work to the minimum possible.
- ii) Method of splicing will be similar to the method of construction adopted for structures.
- iii) Roof and wall sheets will be fixed to purlins and wall girts by stainless steel top speed screws/galvanized J-hook bolts, each complete with neoprene and stainless steel/galvanized washers.
- iv) The connection will ensure water leakproofness into the buildings.
- v) The spacing of these screws/bolts will be sufficient to prevent uplift of sheets by suction.
- vi) The roof and wall sheets will be stitched together at their edges by using studs, rivets or screws.
- vii) The overlaps of sheeting will be sufficient to prevent ingress of rainwater.

18.03.04 STRUCTURAL STEEL CONNECTION

- i) The bidder will be responsible for the design and the detailing of all connections. The design of connections will provide for adequate strength for the transfer of force in the structural elements indicated on the design drawings. For purposes

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of detailing of connections, the allowable stresses in material, bolts and welds will be as per IS: 800 and IS: 816 or as specified in the design drawings.

- ii) For all full strength butt welding of plates and sections thicker than or equal to 10mm, edge preparation will be done and got approved by the Owner / Consultant.
- iii) Two numbers of washers will be used for all bolted connections, one washer bearing against the head and other bearing against the nut.
- iv) The magnitude of forces shown on design drawings will be used at face values with no reductions for connections.
- v) All penetration for piping, conduit, cable trays, etc., through grating or plate flooring will be cut and suitably banded in the field, except when such penetrations are dimensioned in the drawings in which case they will be shop cut and banded.

18.03.05 FABRICATION

- i) Fabrication of all structural steelwork will be in accordance with IS: 800 or their equivalent foreign national standard of the country of origin of supply unless otherwise specified, and in conformity with various clauses of this Specification.
- ii) Wherever practicable and wherever perfect matching of parts is required at site, members will be shop assembled before despatch to minimize site work. Parts not completely assembled in the shop will be secured, to the extent possible, to prevent damage during despatch.
- iii) All pieces will be properly identified and bundled for transportation to work site. Care will be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials will be kept free of dirt, grease and foreign matter and will be protected from corrosion. All materials will be stored properly on skids above the ground which will be kept clean and properly drained. Girders and beams will be placed upright and stored. Long members such as columns and chord members will be supported on skids placed near enough to prevent damage due to deflection.
- iv) Bolts will be furnished according to bolt lists showing the location of their use and additional bolts will be supplied to cover wastage.
- v) All fabricated pieces will bear erection mark numbers painted/punched according to appropriate erection and shop drawings at a prominent location on the structure for easy identification.
- vi) All workmanship will be in accordance with the best practice in modern structural shops. Greatest accuracy will be achieved in the manufacture of every part of the work and all identical parts will be strictly interchangeable.
- vii) Shearing or flame cutting may be used at the bidder's option provided that a mechanically controlled cutting torch is used for flame cutting and that the resulting edges are clean and straight.
- viii) Unless clean square and true to shape all flame cut edges will be planed/cleaned by chipping or grinding. Where machine flame cutting is permitted for high tensile

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steel, special care will be taken to leave sufficient margin and all flame-hardened material will be removed by machining/edge planning.

- ix) Wherever shearing is used for cutting to size, sheared members will be free from distortions at sheared edge.
- x) The ends of all girder stiffeners will be in contact with the compression flange and will be planed or ground to fit tightly against flange plates to ensure full bearing unless otherwise stated on the drawings.
- xi) Holes for permanent black bolts will not be more than 1.5mm larger than the nominal diameter of the black bolts unless specified otherwise. All holes for turned and fitted bolts will be sub punched or drilled and reamed at site under assembly of connected parts to a tolerance of +0.3mm unless specified otherwise.
- xii) Holes in purlins, side-sheeting runners, packing plates and lacing bars may be punched full size. Holes in light framing with the exception of joint holes, may be punched full size. All punching and sub-punching will be clean and accurate and all drilling free from burrs. In block/batch drilling, parts will be separated after drilling and the burrs removed. No hole will be made by gas cutting process.
- xiii) The component parts will be so assembled that they are neither twisted nor otherwise damaged and specified cambers, if any, will be provided. No drifting of hole will be permitted except to draw the parts together. Drifts used will not be larger than the nominal diameter of the bolt. Sufficient trial assembly will be carried out in the fabrication works to prove the accuracy of workmanship and the number of such trials required will be at inspector's discretion.
- xiv) Where necessary, washers will be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt will project through the nut by at least one thread.
- xv) Each piece will be distinctly marked before delivery, in accordance with an approved marking diagram and will bear such other marks as well to facilitate erection. For easy identification at site a small distinguishing mark for each building will be painted at each end of every member before dispatch from fabrication shop. The fabricated steel work will be dispatched in sequence as per agreed program and for such portion as may be found convenient for erection or as ordered by the Owner/ Consultant.
- xvi) The bidder will provide suitable packing wherever necessary to guard against damage during handling and transportation to site. All fabricated parts will be adequately braced to prevent damage during transit.
- xvii) The tolerances for fabrication of steel structures will generally conform to IS: 7215.
- xviii) Any fabrication work which is considered not to be in keeping with the Technical Specification forming the Contract, or in absence of Technical Specification with recognized good practice, will be rectified/ replaced/ corrected at the bidder's expense as directed by the Owner/ Consultant. Site fabrication work will also conform to all specifications, stipulations, terms and conditions applicable for shop-welded structures as mentioned above.

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18.03.06 CONFORMITY WITH DESIGNS

- i) The bidder 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.
- ii) 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.

18.03.07 PAINTING

- i) 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, Air Drying, Red Oxide - Zinc Chromate Priming.
- ii) In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimer Paints Ltd., may be necessary.

18.03.08 QUALITY CONTROL

- i) The Bidder 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 Bidder'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 Bidder's fabrication shop whether located at Site or elsewhere. The Bidder 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 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 Bidder.
- ii) 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) Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing
 - (c) Electrodes : Manufacturer's certificated, thickness and quality of flux coating.

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(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 : Test 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.			
18.03.09 FINISH			
i) Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-buttressed over the whole section with a clearance not exceeding 0.2 mm locally at any place. ii) In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. iii) Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.			
18.03.10 SLAB BASES AND CAPS			
i) Bases and caps fabricated out of steel slabs, except when cut from 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.			
18.03.11 GALVANIZING			
i) General a) 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 Galvanising of Iron and steel. b) Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized. ii) Surface Preparation			
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- a) All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, 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.
- b) The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.
- c) The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

iii) *Procedure*

- a) 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.
- b) 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.
- c) The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

18.03.12 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

i) *Inspection*

- a) Unless specified otherwise, inspection to all work shall be made by the Engineer 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.
- b) The Bidder shall provide 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.

ii) *Testing and acceptance criteria*

a) General

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- 1) The Bidder 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, unless otherwise specified in the Contract.
 - 2) The Bidder 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.
- b) Steel
- 1) All steel supplied by the Bidder shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used.
 - 2) 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.
 - 3) All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.
- c) Testing Criteria for checking Lamination in raw steel plates
- 1) All raw steel plate of thickness more than 20 mm supplied by the Bidder shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.
 - Ultrasonic testing along the edge of specified points of the plates shall be carried out to detect lamination in the plates, if any.
 - If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.
 - 2) If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Bidder.
 - 3) If the plates in the fabricated item is found to be laminated, the component will be rejected
- d) Welding
- 1) All electrodes shall be procured from reliable manufacturers with test certificates.
 - 2) The correct grade and size of electrode which has not deteriorated in storage shall be used.

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3) 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 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Engineer, if the results are found to be unsatisfactory; and if the test shows no defect.

4) In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken.

e) Bolts, nuts and washers

1) All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform 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.

f) Shop painting

1) 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.

g) Galvanizing

1) 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 IS:4759 -specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

iii) *Tolerance*

a) 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.

b) The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

18.04.00 Erection of Steel Structures

18.04.01 SCOPE

i) The scope of work under erection of steel structures includes erection and transport equipments, tools and tackles, consumables, materials, labour and supervision in addition to the following:

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- a) Storing and stacking at site of erection of all fabricated structural components/ units/ assemblies till the time of erection.
- b) Transportation of structures to site.
- c) Receiving at site of structures including site handling /movement, unloading, storing and stacking at site of erection of technological structures such as bunkers and the related structures.
- d) All minor rectification/modification such as:
- e) Removal of bends, kinks, twists, etc. for parts damaged during transport and handling;
- f) Cutting chipping, filing, grinding, etc., if required, for preparation and finishing of site connections;
- g) Reaming for use of next higher size bolt for holes which do not register or which are damaged.
- h) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.
- i) Fabrication of minor items/missing items or such important items as directed by the Owner Consultant.
- j) Assembly at site of steel structural components wherever required including temporary supports and staging.
- k) Making arrangements for and providing all facilities for conducting ultrasonic X-ray or gamma ray tests on welds; getting the tests conducted by reputed testing laboratories, making available test films/ graphs, reports and interpretation.
- l) Rectifying at site, damaged portions of shop primer by cleaning and touch-up paint.
- m) Erection of structures including making connections by bolts/high strength friction grip bolts/welding.
- n) Alignment of all structures true to line, levels plumb and dimensions within specified limits of tolerances as per IS: 12843 "Tolerance for Erection of Steel Structures".
- o) Application of second coat of primer paint and two coats of finishing paint at site after erection.
- p) Supply of labour in sufficient numbers, where necessary, as directed by the Owner / Consultant.
- q) Conducting preliminary acceptance and final acceptance tests.
- r) Preparation of as built drawings, preparing of sketches/drawings to suit availability of material, convenience of fabrication, and erection and changes during fabrication and erection.
- s) All such works are subjected to approval by the Owner/ Consultant.

18.04.02 ERECTION DRAWINGS

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- i) The approved erection drawings and any approved, arrangement drawings, specifications or instructions accompanying them will be followed in erection of structures and miscellaneous connected items throughout the project.
- ii) If any dimension figured upon a drawing or plan differs from that obtained by scaling the drawing or plan, the dimension as figured upon the drawing or plan will be taken as correct. In case of discrepancy between large-scale details and small-scale drawings, the former will be followed. All such discrepancies shall be got clarified from Owner/ Engineer.

18.04.03 STORING AND HANDLING

- i) The fabricated materials on receipt at site will be carefully unloaded, examined for defects, checked, stored out for each building and stacked securely on skids above level ground which will be kept clean and properly drained. The fabricated materials will be verified with respect to markings on the marking plan or shipping list which will be supplied by the bidder.
- ii) Any material found damaged or defective will be stacked separately and the damaged or defective portions will be painted in distinct colour for identification. Such materials will be dealt with as ordered by the owner/consultant. No member slightly bent or twisted will be put in place until the defects are corrected. Members seriously damaged in handling will be rejected.

18.04.04 ASSEMBLY AND ERECTION

- i) Before starting erection, the bidder will submit to the owner/consultant for his approval the method he proposes to follow and the number of types of equipments and temporary, works he proposes to use for the erection.
- ii) The approval of drawings by the owner/consultant will not relieve the bidder from the basic approach to design as regards the loads which the erection equipment and temporary work will be called upon to carry and support. Adequate allowance and provision will be made for lateral forces and wind loads.
- iii) If in the opinion of the owner/consultant, the tools, tackles plant and equipment instruments, apparatus, etc. arranged by the bidder are not sufficient or are inadequate for the fulfillment of the contractual obligations of the bidder within the stipulated period, the owner/consultant will have the right to order the bidder and the bidder will comply with the order to bring/arrange such additional tools, tackles, plant and equipment instruments, apparatus, etc. to the site and employ the same to complete the work in time. All charges in connection thereof will be borne by the bidder.
- iv) The erection will be carried out according to the best modern practices and as laid down in the IS: 800 and other relevant standards referred to therein and according to this erection Specification together with approved erection drawings.
- v) The bidder will design, manufacture, erect and provide false work; staging, temporary supports, etc. required for safe and accurate erection of structural steelwork and will be fully responsible for the adequacy of the same.
- vi) The bidder will, if so required by the owner consultant, get his drawings, erection schemes and designs for such false work, staging, etc. approved by the

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owner/consultant, but such approval by the owner/consultant will not relieve the bidder of any of his responsibilities for the safety of such works. As far as possible, assemblies of structures will be made on the ground itself.

- vii) The bidder will provide adequate supervision at all stages of the work and examine each portion of the work for accuracy before commencing the erection of the next structural member. The bidder will also provide facilities such as adequate temporary access ladders, tools and tackles, instruments, etc. satisfactory to owner/consultant for his inspection at any stage during erection.
- viii) Instrumental checking for correctness of initial setting out of structures, and adjustment of alignment will be carried out in sequence at different stages as determined by design as against checking and adjustment of alignment in one stage after completion of entire erection. The final leveling and alignment will be carried out immediately after completion of each section of a building or when called for by the owner/consultant.

18.04.05 FIELD CONNECTIONS

- i) The holes of erection joints required to be machine bolted will be filled with temporary bolts and plugs after mounting the structures.
- ii) Wooden rams or mallet will be used in forcing members into position, in order to protect the metal from injury and shocks. Chipping of edges of plates will be done without breaking parent metal.
- iii) Where bolting is specified on the drawings, the bolts will be tightened to the maximum limit. The threaded portion of each bolt will project through the nut by at least one thread. Tapered washers will be provided for all heads and nuts having bearing on beveled surfaces. Use of special bolts, such as high strength friction grip bolts, will be according to the relevant Indian or other recognized standards subject to prior approval by Engineer.
- iv) Spring washers or lock nuts will be provided as specified in the design/shop drawings. All machine fitted bolts will be perfectly tight and the ends will be checked to prevent nuts from becoming loose. No unfilled holes will be left in any part of the structures. All field assembly and welding will be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint will be removed before field welding, for a distance of at least 50mm on either side of the joints.

18.04.06 ASSEMBLY BY HIGH STRENGTH FRICTION GRIP BOLTS

- i) The mating surfaces will be absolutely free from grease, lubricant, dust, rust, etc. and will be thoroughly cleaned before assembly. The preparation of the mating surfaces will be done as specified in the design drawings.
- ii) The nuts will be tightened upto the specified torque with the help of torque wrench or by half turn method with the help of pneumatic wrench lever. Torque value has to be specified in design / fabrication drawings itself. The direction of tightening of the nuts will be from the middle towards the periphery of the joint. The bolt head, nuts and edges of the mating surfaces will be sealed with a coat of paint to obviate entry of moisture. As far as possible, the diameter of bolts

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and mating surface preparation will be kept uniform to have specified unique torque.

18.04.07 QUALITY CONTROL

- i) The Bidder 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: -
 - a) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
 - b) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.
 - c) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.
 - d) The Bidder shall salvage, collect and deliver all the packing materials to the Owner.

18.04.08 WORKMANSHIP

- i) *Plant and equipment*
 - a) The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.
- ii) *Method and sequence of erection*
 - a) The method and sequence of erection shall have the prior approval of the Engineer.
 - b) The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.
- iii) *Temporary bracing*
 - a) Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings wherever 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.
 - b) 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.
 - c) The responsibility of the Bidder in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled,

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aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

iv) *Temporary floors for buildings*

- a) It shall be the responsibility of the Bidder 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 by-laws of state, Municipal or other local authorities.

v) *Setting out*

- a) 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.
- b) The Bidder shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning.
- c) For heavy columns, etc. the Bidder shall set proper screed bars if desired by the Engineer, to maintain proper level. Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

18.04.09 STAINLESS STEEL PLATE LINING IN BUNKER HOPPER

- i) The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing.
- ii) The stainless steel liner shall be fixed to the Bunker hopper by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16 ISMBOS- 311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways. The plug welding shall be ground flush with the lining plate.

18.04.10 SAFETY MEASURES DURING ERECTION

- i) The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS: 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

18.04.11 TESTING AND ACCEPTANCE CRITERIA

i) *General*

- a) 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. In course of dismantling, if any damage is done to any other parts of the

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structure or to any fixtures, the same shall be made good by the Bidder responsible, to the satisfaction of the Engineer.

- b) The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing
- c) Stiffness Test
 - 1) In this test, the structure or member shall be subjected, in 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.
 - 2) 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.
 - 3) The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.
- d) Strength Test
 - 1) 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.
 - 2) 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.
 - 3) Complete tests under both conditions may be necessary to verify the strength of the structure.
 - 4) The structure shall be deemed to have adequate strength if, during the test, no part fails and if on 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.
- e) Structure of same design
 - 1) 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, 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.

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2) 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 times 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.

f) Repair for subsequent test and use after strength tests

1) An actual structure which has passed the "Strength Test" as 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'.

ii) Tolerances

a) 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 steelwork applicable to this Project and as specified below:

b) For Buildings Containing Cranes

	Component	Description	Variation Allowed
1	Main columns	(a) Shifting of column axis at foundation level with respect to building line (i) In longitudinal direction (ii) In lateral direction	3.0 mm 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	3.5 mm from true vertical
		(i) For a column greater than 10M but less than 40M height	3.5 mm from true vertical for any 10M length measured between connection levels, but not more than 7.0 mm per 30 m length.


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	Component	Description	Variation Allowed
		(c) For adjacent pairs of columns across the width of the building prior to placing of truss.	9 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 level supposed to be at the same level.	2 mm
2	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 not greater than 10 mm whichever is the least.
		(b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
3	Crane Girders & Tracks	(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 thermit welding.	1.0 mm
		(d) Deviation of crane rail axis from centre line of web.	3.5 mm
4	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.	

c) For Building without Cranes

- 1) The maximum tolerances for line and level of the steel work shall be
 - 3.0 mm on any part of the structure.

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- The structure shall not be out of plumb more than 3.5 mm on each 10M 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.

iii) *Acceptance*

- a) Structures and members which have passed the tests and conform to all requirements specified in the aforesaid Sub-clauses and other applicable provisions of this Specification and are within the limits of tolerances specified in subsequent sub-clause and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

18.05.00 Bedding and Grouting

18.05.01 Base plates will be set to elevations shown in the drawings, supported and aligned using steel wedges and shims or any other approved method. The supply of wedges, shims and any other material for alignment will be the responsibility of the bidder as part of this work. Plates will be levelled, properly positioned and the anchor bolts properly tightened. The bedding/grouting will not be carried out until a sufficient number of columns have been properly aligned, levelled and plumbed, and sufficient girders, beams, trusses and bracings are in position to the satisfaction of the owner/consultant.

18.05.02 The Bidder will inform the owner/consultant when the base plates are ready for grouting for their verification. The bidder is responsible for final vertical and horizontal alignment of all the base plates.

18.05.03 If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Bidder. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder; 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added will be measured and paid separately.

18.05.04 Alternatively, non-shrink, free flow, cementitious grout like "Sika grout 214/ Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

18.06.00 Welding Specifications

18.06.01 GENERAL

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- i) The welding and welded work will conform to IS: 816 and other relevant codes unless otherwise specified. Electrodes will conform to IS: 814 and will be approved by the owner/consultant.
- ii) Welding will be done by Electrical Arc Process. Automatic welding will be employed for important structures as specified in the drawings. Generally, submerged arc, Automatic & Semi-automatic welding will be employed. Only where it is not practicable, Manual Arc welding may be resorted to. In case of Manual Arc Welding, recommendations of electrode manufacturer are to be strictly followed.
- iii) Welding will not be done under such weather conditions which might adversely affect the efficiency of the welding and where necessary, effective protection and other safeguards will be provided.
- iv) Only qualified welders suitable for the job will be employed. The Owner/consultant at his discretion can order periodic tests in accordance with IS: 817 of the welders and/ or of the welds produced by them at no extra cost. Welds will be made using requisite jigs and fixtures to avoid distortions or damage to members during/ after welding. Welds on exposed work will be finished uniformly smooth to present a neat appearance.
- v) The layouts and sequence of operations will be arranged so as to eliminate distortion and shrinkage stress to the satisfaction of the Inspector. Welding work will be under constant supervision of competent welding supervisor and will be done in a properly organized manner with the approved quality welding sets and with automatic welding machines. Details of welding procedure shall be agreed upon with the Owner/ consultant before the fabrication is commenced.

18.07.00 **Welding Procedure**

18.07.01 Welding procedure will include the following:

- i) Type and size of electrodes.
- ii) Current and arc voltage. (for automatic welding)
- iii) Lengths of run per electrode, or (for automatic welding) speed of travel.
- iv) Number and arrangement of runs in multi-run welds.
- v) Position of welding.
- vi) Preparation and set-up of parts.
- vii) Welding sequence.
- viii) Pre or, post -heating.
- ix) Any other relevant information.

18.07.02 The welding procedure will be arranged to suit the details of the joints as indicated in the drawings and the positions in which the welding is to be carried out. The welds will meet the requirements of quality specified.

18.07.03 All electrodes for use in the work to which the specification relates will be kept under dry conditions. Electrodes which are damaged by moisture will not be used unless it is certified by the manufacturer that when it is properly dried there

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will be no detrimental effect. Any electrode which has part of its flux coating broken away or is otherwise damaged will be discarded.

- 18.07.04 The bidder will prepare the edges with an automatically controlled flame cutting torch followed by grinding correctly to the shape, size and dimensions of the groove, prescribed in the design and shop drawings in case of U-groove joint, the edges will be prepared with an automatic flame cutting torch in two passes following a bevel cut with a gouging pass, or by machining.
- 18.07.05 The welding surfaces will be smooth, uniform and free from fins, tears, notches or any other defect, which may adversely affect welding. Welding surfaces or the surrounding surfaces within 50mm of weld will be free from loose scale, slag, rust, grease, paint, moisture or any other foreign material. Pre-bending of plates for three plate welded sections will be done where found necessary.
- 18.07.06 After completing each run of weld, all slag will be thoroughly removed, and the surface cleaned before starting the next run of weld. The weld metal, as deposited (including tack welds if to be incorporated) will be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal will be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld will have a uniform and consistence contour and uniform appearance.
- 18.07.07 All weld runs found defective will be cut by using chipping hammer, gouging torch, or suitable grinding wheel in such a manner that adjacent material is not injured in any way. Peeling of the welds involving deformation of the weld surface either during de slagging or thereafter will not be allowed.
- 18.08.00 **Control in Welding**
The extent of quality control in respect of welds for structural elements to be conducted by the Bidder at his own cost as follows:
- 18.08.01 VISUAL EXAMINATION
- i) All welds will be 100% visually inspected to check the following:
 - a) Presence of undercuts
 - b) Visually identifiable surface cracks in both welds and base metals.
 - c) Unfilled craters
 - d) Improper weld profile and size
 - e) Excessive reinforcement in weld
 - f) Surface porosity
 - ii) Before inspection, the surface of weld metal will be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.
- 18.08.02 DYE PENETRATION TEST (DPT)
- i) This will be carried out for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following:
 - a) Surface cracks

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b) Surface porosities

- ii) Dye Penetration Test will be carried out in accordance with American National Standard ASTM E 165.

18.08.03 ULTRASONIC-TESTING

- i) Ultrasonic test will be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by Owner, to detect the following:

- a) Cracks
- b) Lack of fusion
- c) Slag inclusions
- d) Gas porosity

- ii) Ultrasonic testing will be carried out in accordance with American National Standard ANSI/AWS DI-92 Chapter-6: Part C. Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. will be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface will be prepared to make it suitable for carrying out ultrasonic examination.

18.08.04 RADIOGRAPHIC TESTING

- i) This test will be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method will be decided by Owner to detect the following defects:

- a) gas porosity
- b) slag inclusions
- c) lack of penetration
- d) lack of fusion
- e) cracks

- ii) Radiographic testing will be conducted in accordance with American National Standard ANSI/AWSDI.1-92.

18.08.05 The Bidder will provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Owner / consultant.

18.09.00 Acceptable Limits of Defects of Weld

18.09.01 Limits of Acceptability of welding defects will be as follows:

- i) Visual inspection & Dye Penetration Test
 - a) The limits of acceptability of defects detected during visual inspection and Dye Penetration Test will be in accordance with clauses 8.15.1 & clauses 9.25.3 of American National Standard ANSI/AWS DI.1-92 respectively.

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ii) Ultrasonic Testing

- a) The limits of acceptability of defects detected during ultrasonic testing will be in accordance with clause 8.15.4 & clause 9.25.3 of American National Standard ANSI/AWS DI.1-92 respectively.

i) Radiographic testing

18.09.02 The limits of acceptability of defects detected during Radiographic testing will be in accordance with clause 8.15.3 & 9.25.2 of American National Standard ANSI/AWS DI.1-92 respectively.

18.10.00 **Drawings**

18.10.01 The Bidder will prepare steel structural arrangement drawings and design drawings along with design calculation of major elements and take their approval by Owner/ Consultant within the time schedule as per contract. Necessary number of prints of drawings and documents; as per contract will be submitted for approval. Bill of materials will form part of the fabrication drawings and will be included in the body of the drawing or prepared separately.

18.10.02 Even if the drawings are approved/ Commented by the Owner / Consultant, the Bidder will not be relieved of the responsibilities for the accuracy of the detailed dimensions shown in the drawings and the safety of all structural connections.

18.10.03 Erection drawings in requisite number of sets will be submitted to the Owner/ Consultant showing thereon all authorized additions and alterations in the process of erection. These drawings will show the "As-Built" status.

18.10.04 Supply and distribution of fabrication drawings and other material lists for the Bidders own use or for the use of his subcontractors will be the responsibility of the Bidder.

18.10.05 The Bidder will assume full responsibility for the correct setting out of all steel works and erecting correctly in accordance with alignment and levels shown on the approved drawings and plumbing of vertical members. Notwithstanding any assistance rendered to the Bidder by the Owner/ Engineer, if at any time during the progress of the work, any error should appear or arise therein, on being required to do so, the Bidder at his own cost will remove and amend the work to the satisfaction of the Owner/ Engineer.

18.10.06 The Bidder will provide his own measuring instruments for setting out, leveling and aligning work at his own expense.

18.10.07 The structures will have to be erected suitably detailed with erection of equipment or construction of civil works. The Bidder will ensure spirit of co-operation with other package contractors and strict adherence to the schedule so that erection schedules of the other parties are not affected.

18.10.08 The Bidder will at all times comply with such rules and regulations as stipulated in relevant factory acts, electricity rules, safety regulations, etc.

19.00.00 STEEL HELICAL SPRINGS AND VISCOUS DAMPERS UNITS

19.01.00 General Requirement

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19.01.01 This part of the specification covers the requirement for the manufacturing, testing, supply, transport to site, pre-stressing erection, supervision of erection by the vendor, release of prestress, alignment, commissioning, etc. of Steel helical springs and viscous dampers units. 19.01.02 The Steel helical springs and viscous dampers units supplied should be of proven make. 19.02.00 Codes and Standards 19.02.01 Some of the relevant applicable Indian standards and codes, etc, applicable to this section of the specification are listed below: i) DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses. ii) DIN : EN 13906-1 Cylindrical helical springs made from round wire and bar: calculation & design. iii) DIN : 2096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs. iv) ISO : 10816 /IS:14817 Criteria for assessing mechanical vibrations of machine. v) ISO : 1940/IS: 11723 Criteria for assessing the state of balance of rotating rigid bodies. 19.03.00 Design & Supply of Material 19.03.01 SUPPLY i) Steel helical springs and viscous dampers and associated auxiliaries shall consist of: a) Steel helical springs units (fully pre-stressable) and viscous dampers units along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc. b) Frames for pre-stressing of spring elements. c) Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc., of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided. d) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment, and commissioning of the Steel helical springs and viscous dampers. 19.03.02 DESIGN i) The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. However, for projects in high seismic zones, the minimum stiffness in horizontal direction shall be reviewed based on the design requirement and in no case it shall be less than 15% of vertical stiffness.		
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ii) The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is between 2 Hz to 4 Hz. The damper units or spring-cum damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50°C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units. iii) The Steel helical spring units and viscous damper units and their housings shall be designed for a minimum operating life of 30 years. Steel helical spring units shall conform to infinite life fatigue load calculations as per DIN EN 13906-1. 19.04.00 Manufacturing & Testing 19.04.01 Complete manufacturing and testing of the Steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor / supplier. For this purpose the Bidder / sub vendor shall submit the detailed quality plan for approval of engineer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include i) Manufacturing schedule and quality check exercised during manufacturing. ii) Detail of test to be carried out at the manufacturing shop with their schedule. iii) Special requirements, if any, regarding concreting of top deck. iv) Complete step-by-step procedure covering the installation and commissioning of the spring system. v) Manuals for erection, commissioning, testing and maintenance of the Steel helical springs and viscous dampers. vi) A checklist for confirming the readiness of the civil fronts for erection of Steel helical springs and viscous dampers. vii) Checklist for equipment required at each stage of erection. viii) Bill of materials and data sheet of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply. ix) Bill of material and data sheet for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and umbers. x) (j) Any other details which may be necessary to facilitate design and construction of the foundations / structures. 19.04.02 The springs shall conform to codes DIN EN 13906-1 and DIN 2096. The quality assurance and inspection procedure shall be finalized on the basis of the above codes and he quality plans be drawn accordingly. 19.05.00 Transportation 19.05.01 Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. 19.06.00 Erection and Commissioning		
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19.06.01 Complete erection and commissioning of the Steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. shall be carried out by a specialist supervisor of vendor. 19.06.02 The Bidder shall guarantee the performance of the Steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as Guarantee Period". 19.07.00 Supervision 19.07.01 The supervision of installation of Steel helical springs and viscous dampers including prestressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose. 19.08.00 Realignment of Spring System 19.08.01 If any realignment of the Steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the Bidder. 19.09.00 Acceptance Criteria 19.09.01 Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. 19.09.02 Following acceptance criteria shall be followed: i) General workmanship is being good as recommended by the manufacturer and approved by Equipment supplier. ii) Tolerances are within the specified limit. iii) Manufacturer's test certificate (MTC) shall be in compliance with the applicable codes / standards. iv) Bought out material is from the approved manufacturer / vendor. v) Bought out material is matching with the approved sample. 20.00.00 DISMANTLING & DEMOLITION WORK 20.01.00 Introduction and Scope of Work 20.01.01 This specification covers the general requirements, procedure, application of tools and safety precautions for demolition and dismantling work for existing concrete structures below ground level in BTG area. 20.01.02 It deals with dismantling of RCC equipment foundation, wall, floor slab, grade slab, rammed Murom/brick & boulders under grade slab, columns, pedestals, structural steel and earth work etc. It also covers supply, delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule. 20.01.03 Dismantling/ Demolishing/ removal of mechanical and electrical equipment is not included in the scope of work.		
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20.02.00 General

20.02.01 The bidder should visit the site and acquaint himself about site conditions and thoroughly understand the scope and nature of the work. The bidder is also required to submit the proposed execution plan and schedule of demolishing and dismantling and list of all available tools (manula & power tools) along with his quotation.

20.02.02 Dismantling/Demolishing needs to be vibration-less or with minimum vibrations so that adjacent structure is not affected. Use of chemical like crackamite is desirable. Crackamite chemical is used for expanding and splitting RCC by drilling holes and putting chemical in the holes thereby facilitating breaking and splitting.

20.02.03 Dismantling/Demolishing shall also requires power driven concrete saw, concrete splitting m/c, pocklain and other such tools as may be required for successful & safe execution of work.

20.02.04 Entire work of demolishing and dismantling shall be meticulously planned. Prior to start of work, the Bidder shall examine all the drawings, locations, adjoining structures, available working space etc. and then prepare his action/execution plan for demolishing and dismantling and submit to the Engineer-in-charge for his review. Comments, if any, shall be taken care by the Bidder and execution of the work shall be done based on the approved execution plan.

20.02.05 The bidder is required to submit complete proposal with sequence-wise operations.

20.02.06 The term Dismantling implies carefully taking up or down and removing without damage to adjoining parts of the structures. Apart from this specification, the demolition and dismantling of structures (part or whole) shall be in compliance with all statutory safety regulations. This shall consist of dismantling one or more part of the structures as specified or shown on the drawings. Prior consent and approval of the Engineer-in-charge shall be obtained in writing before starting any dismantling work. Any restriction imposed regarding working hours shall also be followed by the Bidder.

20.02.07 All materials obtained from dismantling/demolition operations shall be the property of Owner and shall be kept in safe custody until handed over to the owner.

20.02.08 Where it becomes necessary to disconnect any existing service line(s) (such as electrical, piping etc.) during dismantling/demolishing operation, the same shall be immediately brought to the knowledge of Engineer-In-Charge to maintain continuity and proper functioning of the service line(s).

20.02.09 Before the start of dismantling work, the bidder shall ensure that all the mechanical & electrical equipments or parts are removed from the foundation/ structure planned for dismantling.

20.03.00 Safety Precautions

20.03.01 The bidder shall adopt standard practices and procedures, use appropriate tools and workmen at all stages of work to guard against accidents to ensure complete safety.

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20.03.02

BIDDER shall provide necessary passageways as may be required, safety belts, helmets, safety shoes, lights and other safety equipments/gadgets as per standard rules of local authorities and for protection to his men and materials.

20.03.03

Necessary propping, shoring and/or underpinning shall be provided for the safety of the adjoining structure which is to be left intact before dismantling and demolishing is taken up. The work shall be carried out in such a way that no damage is caused to the adjoining property/structure.

20.03.04

Wherever required and/or instructed by Engineer-in-charge temporary enclosures made out of GI sheet, fencing, including danger lights etc. shall be provided by the Bidder and got approved by the engineer-in-charge before start of work to prevent accidents and to restricts entries.

20.03.05

Necessary precautions shall be taken to keep the dust -nuisance down as and when necessary.

20.03.06

Bidder must ensure the availability of adequate firefighting equipment / arrangements before starting actual demolishing / dismantling works. These facilities shall be made available throughout the entire operation of demolition and dismantling of structures.

20.03.07

All equipments, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as directed by the Engineer-in-charge, during demolishing & dismantling operations.

20.03.08

Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day's work.

20.03.09

Dismantled elements/components shall not be dropped from a height or thrown from a distance. Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being struck up due to corrosion etc. however the decision of Engineer-in-charge in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.

20.03.10

A large part of demolition safety involves proper dress and the use of appropriate safety accessories, especially when using power tools.

i)

Do not wear loose clothing that can get caught in machinery

ii)

Wear safety helmet all the time during work.

iii)

Remove any jewelry that can interfere with safe machinery operation

iv)

Wear safety goggles or glasses with side protection

v)

Use a face mask in dusty applications, ear plugs when the site is especially noisy or for extended periods of work

vi)

Heavy work gloves should be worn to protect against the steady vibration of power tools and the heat that can be generated, especially in the bit

vii)

Wear steel-toed safety shoes or boots.

20.04.00

Procedure

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20.04.01 The bidder shall plan appropriate application of tools and machinery as per requirement of work with consent of the Engineer-in-charge. It is expected that the bidder shall employ the required power operated tools/chemicals like crackamite for dismantling of RCC. Reinforcing steel shall also be recovered from dismantled RCC and shall be cleaned, stacked and be handed over to the Engineer-In-Charge. 20.04.02 Demolition and dismantling shall be restricted to the extent shown on drawings and as directed by the Engineer-in-charge. 20.04.03 Dismantling shall be commenced in a systematic manner. All elements shall be carefully removed without causing any damage. All materials which are likely to be damaged by dropping from a height shall be carefully dismantled first. The dismantling articles shall be passed by hands or proper tools depending upon requirements where necessary and lowered to the ground and not thrown or torn off by force. The materials then properly stacked as directed by the Engineer -in-charge. 20.04.04 Demolition of any structure shall be carried out in a proper sequence, as approved by the Engineer -in-charge. 20.04.05 Blasting in any form shall not be permitted. 20.05.00 Stacking and Disposal 20.05.01 Any serviceable material, obtained during dismantling or demolition such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned and stacked properly in separate lots by the bidder within the plant boundary as directed by the Engineer-in-charge. 20.05.02 All unserviceable materials shall be disposed off by the bidder within or outside the plant boundary as per the direction of the Engineer-in-charge. Areas required outside the plant boundary within 5 Km lead for dumping of disposed material shall given by OWNER. 21.00.00 BRICKWORK 21.01.00 General 21.01.01 All walls shall be non-load bearing infill panel walls. For initial height upto 3 metres from ground floor one brick thick masonry wall shall be provided wherever Aluminium cladding is specified. 21.01.02 All internal walls shall be with one brick thick in cement mortar (1:4). However, internal partition walls for office area and toilets shall be with half brick masonry thick with cement mortar (1:4). 21.02.00 Materials 21.02.01 Bricks used in the works shall conform to the requirements laid down in IS:13757. Flyash bricks shall be used. The class of the bricks shall be as specified. The nominal size of the traditional bricks is 230mm x 110mm x 70mm with tolerance upto +3 mm in each dimension, one brick and half brick walls shall be considered as 230mm and 115mm respectively. However, where the size of bricks in the conventional type are not commonly available in the area the sizes		
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shall be subject to approval of Engineer and the overall thickness including the interior/ external plaster thicknesses shall be maintained. 21.02.02 Bricks shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have an average crushing strength of 105 Kg/sq.mm unless otherwise specified in the item. 21.02.03 M-sand shall be used for construction of brick works. 21.02.04 The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works. 21.02.05 Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick samples shall be got tested as per IS: 3495 by Bidder at no extra cost to Owner. Bricks rejected by Engineer shall be removed from the site of works within 24 hours. 21.02.06 Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS:2250. Mix shall be in the proportion of 1:4. Sand for masonry mortar shall conform to IS:2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer. If so directed by the Engineer, sand shall be screened and washed till it satisfies the limits of deleterious materials. 21.02.07 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer. 21.02.08 The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. 21.02.09 Droppings of mortar shall not be re-used under any circumstances. Test on mortar samples if so directed by the Engineer shall be carried out at no extra cost. 21.03.00 Workmanship 21.03.01 Workmanship of brickwork shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 230mm thick and over shall be laid in English		
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Bond unless otherwise specified. 115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilized only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

- 21.03.02 All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line.
- 21.03.03 Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45°. But in no case the level difference between adjoining walls shall exceed one metre. Brickwork shall not be raised more than one metre per day.
- 21.03.04 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not less than 6mm and not more than 10mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.
- 21.03.05 During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.
- 21.03.06 Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the Engineer.
- 21.03.07 Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction.
- 21.03.08 For half brick partition walls two bars of minimum 6mm diameter MS bars shall be provided in every fifth layer.
- 21.04.00 **Finish**
- 21.04.01 Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered

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surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

21.04.02 STANDARD FINISH

- i) Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

21.04.03 NEAT CEMENT FINISH

- i) Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. and rubbed smooth with a trowel.

21.04.04 COLOURED PLASTER FINISH

- i) This shall be done in the same way as specified for ordinary cement. When coloured plastering is specified in more than one coat, the top coat only shall be made with coloured cement.
- ii) Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition. Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

21.04.05 PEBBLE-DASH FINISH

- i) Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

21.04.06 ROUGH-CAST FINISH

- i) A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

21.04.07 SCRAPED FINISH

- i) Ordinary plaster as described under Clause 2.2.2 of this specification after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

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21.04.08 TEXTURED FINISH

- i) Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering". Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer

21.05.00 Damp proof course

21.05.01 Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by pond for seven days.

21.06.00 Damp proof membrane

21.06.01 Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as mentioned. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Bidder shall be obliged to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

21.06.02 Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

21.07.00 Acceptance criteria

21.07.01 Finish to masonry and concrete shall fully comply instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as shown on drawings.

22.00.00 PLASTERING & POINTING WORK

22.01.00 General

22.01.01 Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.

22.01.02 Plaster of Paris (Gypsum Anhydrous) shall be used for plaster of paris punning over cement plastered surfaces for inside wall of all buildings. The finish surface shall be smooth and shall be of 2 mm nominal thickness.

22.01.03 All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.

22.01.04 All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.

22.01.05 Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as required by the approved drawing.

22.01.06 For walls with metal claddings shall also be provided with external plaster.

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22.02.00 **Materials**

- 22.02.01 The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency.
- 22.02.02 The quality of water and cement shall be as per relevant codes.
- 22.02.03 The quality and grading of sand for plastering shall conform to relevant codes/standards.
- 22.02.04 The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer, sand shall be screened and washed to meet the specification requirements.
- 22.02.05 The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement.
- 22.02.06 In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this shall be permitted only upto 30 minutes from the time of initial mixing of water to cement.
- 22.02.07 Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.
- 22.02.08 Natural/river sand shall be used for plastering works.

22.03.00 **Workmanship**

- 22.03.01 Preparation of surfaces and application of plaster finishes shall generally confirm to the requirements specified codes/standards.
- 22.03.02 Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.
- 22.03.03 All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

22.04.00 **Interior Plastering/ Even Surface Plastering**

- 22.04.01 This plaster shall be laid in a single coat of 12mm thickness.
- 22.04.02 The mortar shall be dashed against the prepared surface with a trowel.
- 22.04.03 The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine.
- 22.04.04 The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface.

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22.04.05 Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer.

22.05.00 Ceiling Plastering

22.05.01 This plaster shall be applied as mentioned above in a single coat of 6mm thickness.

22.06.00 Exterior Plastering/ Uneven Surface Plastering

22.06.01 This plaster shall be applied in 2 coats. The first coat shall be approximately 12mm thick. This coat shall be applied as stipulated for interior plastering except that it should be finished to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The first coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the first coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

22.06.02 Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

22.06.03 Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for atleast 7 days.

22.06.04 When the specification of work calls for waterproofing plaster the Bidder shall provide the waterproofing compound as specified while preparing the cement mortar.

22.06.05 For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

22.07.00 Rough Textured Plastering

22.07.01 In case of rough textured plastering on the exterior walls for special finish, over the two layers of plastering already carried out a third layer of 5mm thick plaster with pea gravel mixed in the 1:4 cement mortars is to be applied. The colour, type and size of pea gravel shall be as indicated by the Engineer.

22.08.00 Pointing

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22.08.01 Where pointing of joints in masonry work is specified on drawings, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green. 22.08.02 The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer. 23.00.00 WATERPROOFING TREATMENT 23.01.00 This part of the specification covers the requirement of providing water proofing treatment of roof or any other RCC surface under water pressure using high solids content Polyurethane based cold liquid applied coating. 23.02.00 Materials 23.02.01 High solids content Polyurethane based cold liquid applied coatings shall be as per ASTM C836-89 and shall comprise of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic. Any other equivalent material formulation permitted as per ASTM can also be considered for use. The material shall consist of high solids coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical features like high viscosity, min. 80% solids, high resistance to impact, abrasion and cracking, superior tensile strength, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates. It should also be resistant to acid (mild concentrated), alkalis and have a very low water absorption rate (0.5% max.) at ambient temperature after 7 days. The material shall not be older than 9 months after the date of manufacture and packing. 23.02.02 Reinforcing layer for the membrane shall be non-woven polyester scrim cloth. This shall be made of 100% polyester. Weight of cloth shall be 40 g/Sq.M. (min) 23.02.03 Extruded high density dimpled polyurethane shall have minimum weight of 500gms./ Sq.M., minimum thickness 0.5mm and mechanical resistance to compression not less than 230 KN / Sq.M. The stud height shall be 8 mm and minimum numbers of stud shall be 1800 / Sq.M. 23.02.04 Materials for cement mortar under bedding, cement-sand plaster over concrete roof and cement concrete under bedding shall be as specified elsewhere in this specification. 23.03.00 Fixing and Laying 23.03.01 ASTM C898 – 89 shall be followed as general guidance. 23.04.00 Water Proofing Treatment for Roof 23.04.01 Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed of approved profile having minimum base metal thickness of 0.8mm of galvanized (with minimum rate of galvanization of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield		
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strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Owner/Engineer. RCC slab of minimum 50 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours.

23.04.02 Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.

23.04.03 Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM - C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanized chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

23.04.04 For efficient disposal of rainwater, the runoff gradient for the roof shall not be less than 1:100 and the roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface.

23.04.05 For all Buildings are envisaged uPVC pipes shall be provided to drain off rain water from the roof. These shall be provided external face of buildings. Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size projections having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures. Gratings shall be of stainless steel.

23.04.06 Different layers required for water proofing treatment for roof shall be as shown on the working drawings. Different layers shall consist of the following:

i) Grading under bed.

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ii) Elastomeric membrane.

iii) Wearing course.

23.05.00 **Expanded Polystyrene Blocks**

23.05.01 The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C.

23.05.02 It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

23.05.03 The Bidder shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Bidder shall have to secure manufacturer's supervision.

23.05.04 Either of above items can be adopted subject to approval of engineer.

23.06.00 **Fillets**

23.06.01 Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation.

23.06.02 The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer. Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

23.07.00 **Water proofing by epoxy resin based application**

23.07.01 Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer.

23.07.02 The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic.

23.07.03 The application shall be resistant to growth of fungus and proof against saltpetre action.

23.07.04 If desired by the Engineer, a sample shall be prepared in advance and tested for water proofness for 48 hours under 300 mm depth of standing water.

23.08.00 **Flashing**

23.08.01 Unless otherwise stated flashing shall be done in the same way as the water proofing except that the last layer, instead of being finished with pea- sized gravel, shall be finished with two coats of bituminous primer.

23.08.02 The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof of mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

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23.08.03 Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer. 23.09.00 Waterproofing with app modified bituminous membrane 23.09.01 The RCC roof waterproofing with pre-fabricated APP (atactic polypropylene) modified waterproofing membrane with non woven polyester reinforcement treatment of 4 mm thickness, consisting 160 gsm high Molecular high- density non-woven polyester core, coated on both sides with APP modified bitumen which shall have high penetration, high heat resistance and high softening point. 23.09.02 It should also achieve good bonding with substrate and a strong adhesion between overlaps. This polymeric Asphaltic mix shall be protected on the bottom with thermo fusible HMHDPE film, on the top with another layer of HMHDPE. 23.09.03 The resultant membrane shall have very good elongation to absorb all structural movements. 23.09.04 The cement sand plastered surface on foam concrete is first cleaned to eliminate all sharp projections. 23.09.05 Suitable bituminous primer @ 0.27L/SQ.M. (IS:3384) is then coated on the surface. APP modified water proofing roll is unrolled over coated surface is first cleaned (with overlaps of 10cm) and bonded completely to the substrata. 23.09.06 The overlaps & complete bottom are then thermo-fused by flame. Special care is taken at singularities such as drains , expansion joints etc. 23.10.00 Surface finish 23.10.01 18 mm thick cement sand mortar (1:4) with chicken wire mesh interposed shall be laid over water proofing treatment. 23.10.02 Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided .The tiles shall be laid as per IS :1443. 23.11.00 Grading Underbed 23.11.01 The underbed shall be laid to provide an ultimate run - off gradient not less than 1 in 100 or as specified in the drawing. However no underbed is required where the slope has been provided in the structural frame work/ concrete. 23.11.02 Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. 23.11.03 The surface of roof and that part of the parapet, gutters, drain channels, drain mouths, or any other RCC surfaces etc., over which the underbed is to be applied shall be roughened and thoroughly cleaned of all foreign matter namely fungus, moss and dust, with wire brushing and dusting. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed. 23.11.04 The plaster shall be provided as specified elsewhere in this specification and this shall be laid to proper grade in continuous operation and fully compacted.		
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23.11.05 The concrete shall be used where the underbed is more than 25 mm (average) thick. It shall consist of cement concrete of grade M-20 with 12.5 mm nominal size graded aggregate. The mix shall be laid to proper grade in continuous operation and fully consolidated

23.11.06 The surface shall be even and smooth. Concrete work wherever required shall be done as specified elsewhere in this specification.

23.12.00 **Elastomeric Membrane**

23.12.01 For preparatory work, as a general guidance for laying the roof waterproofing treatment .The roof surface shall be thoroughly cleaned with a wire brush and all foreign matter, etc. shall be removed.

23.12.02 Well defined cracks on the surface shall be cut to 'V' section, cleaned and filled up flush with a paste of polyurethane based crack filling compound and white cement in a ratio of 1:2 or polymerised mastic (Bitumen mixed with inert fillers or Elastomeric membrane). Water proofing treatment shall be carried out into the drain pipe or out-lets by at least 100 mm.

23.12.03 For rain water pipe out-lets, a groove shall be cut all round to tuck the treatment. When a pipe passes through a roof on which water proofing treatment is to be laid, a cement concrete angle- fillet shall be built round it and the water proofing treatment taken over the fillet. In case of parapet walls, for tucking in the water proofing treatment, a horizontal groove shall be left in the vertical face at the time of construction.

23.12.04 At the junction between the roof and the vertical face of the parapet wall, a cement concrete fillet 75 mm (min) in radius shall be constructed.

23.12.05 At the drain mouths, the fillet shall be suitably cut back and rounded off for easy application of the water proofing treatment and easy flow of water.

23.12.06 **APPLICATION**

i) *Primer Coat*

a) It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of not more than 6 Sq.M. per liter.

b) The primer shall be allowed to dry for a minimum of 2 hours but not more than 24 hours time before the successive finishing coats of P.U. liquid membrane are applied.

ii) *Finishing Coats*

a) The finishing coats shall consist of minimum two successive liquid coatings of high solids content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness excluding primer coat shall be 1.5 mm. However, nominal rate of total liquid coating application shall not be less than 1.6 kg. /Sq.M. excluding primer coat. Each coat shall be allowed to dry for minimum 12 hours before

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applying the next coat. The surface shall be dry and smooth before application. The coating shall be continued upto parapets / walls for a minimum of 150 mm over the finished roof surface. It shall be continued into rain water pipes by at least 100 mm into inner surface of pipe. Reinforcing layer of polyester scrim cloth shall be placed over the 1st coat when the coat is tacky. The surface shall be dry and smooth before application. The coating shall be continued up the parapets/ walls for a minimum of 150 mm over the finished roof surface.

- b) Fine silica sand shall be spread over the final coat when coat is tacky to obtain a rough surface.
- c) Water proofing of membrane shall be tested by pounding of water.

23.13.00 **Wearing Course**

23.13.01 Finishing coat of elastomeric membrane shall generally be provided with wearing course consisting of minimum 25 mm thick PCC of Grade M20 (using 12.5 mm size aggregate) cast in panel of maximum size of 1.5 m x 1.5m and reinforced with galvanized chicken wire mesh. Sealing of Joints at the panel junctions shall be done using non bitumastic sealant/ elastomeric compound. Wearing course shall not be provided for vertical surfaces and inaccessible areas provided with elastomeric membrane. PCC wearing course and chicken wire mesh shall be provided as mentioned elsewhere in this specification.

23.13.02 The area of the roof surface which is subjected to foot traffic or used as a working area shall be suitably protected, as mentioned elsewhere in the specification, in such a way so to keep the top of the protective coating matching with top surface of the wearing course.

23.14.00 **Water Proofing Treatment for Concrete structures**

23.14.01 The elastomeric membrane for the raft shall be provided over the lean concrete / PCC. The membrane shall be applied in the similar manner as mentioned for water proofing treatment for roof. The top surface of elastomeric membrane shall be protected by providing 20 mm thick PCC of grade M20 (using 12.5 mm size aggregate) cast in panel of maximum size 1.5 m x 1.5m.

23.14.02 The elastomeric membrane for the vertical wall shall be provided on the outer face exposed to water pressure. The membrane shall be applied in the similar manner as mentioned for water proofing treatment for roof. The exposed surface of elastomeric membrane shall be protected by providing extruded high density dimpled polyurethane membrane.

23.14.03 **Water Bar/Seal/Special Treatment of Construction Joint**

- i) Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods:

- a) Method 1

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- 1) A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days:

- Compressive strength : 55 to 60 N /Sq. mm
- Flexural Strength : 25 to 30 N /Sq. mm.
- Tensile strength : 15 N Sq. mm (approx)
- Bonding strength to concrete : 3 N / Sq. mm (approx)
- Bonding strength to steel : 20 N / Sq. mm (approx)

- 2) The whole operation shall be done as per manufacturer's specification. The Bidder shall provide manufacturer's supervision.

b) Method 2

- 1) One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm.
- 2) The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

ii) *Waterproofing Admixtures*

- a) The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

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- b) The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.
- c) The product shall be stored in strong moisture proof packing.
- d) However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/cm.m a melamine based super plasticizer will be preferable.

iii) *In concrete:*

- a) The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer.
- c) The Bidder shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Engineer.

iv) *In Plaster:*

- a) The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours.
- b) The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification.
- c) The additive shall be of quality and type approved by the Engineer.
- d) On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

23.15.00 Bituminous or Tar Coating on External Surface

23.15.01 The surface to be waterproofed shall be rendered absolutely dry, clean and dust free.

23.15.02 The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M.

23.15.03 When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely.

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23.15.04 In place of hot application by coal tar/asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

23.16.00 Protective Coating on Inside Surface

23.16.01 Two coats of cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

23.17.00 Bitumen Felt: Application for Tanking

23.17.01 This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

23.17.02 The materials shall conform to IS: 1322, and the workmanship to IS: 1609.

23.17.03 The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items.

23.17.04 Cleaning the surface, keeping it dry providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item.

23.17.05 A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Bidder as well as his specialist sub-contractor jointly and severally, for this item of work.

23.17.06 Free rectification of any defects noted in the work within this guarantee period will be carried out by the Bidder even if it is beyond the specified maintenance period of the contract as a whole.

23.18.00 Polyethylene Films: Application in Walls or base of Structures

23.18.01 Waterproof treatment shall be applied as outlined and as per sequence given hereunder:

- i) The concrete surface shall be made smooth with 12 mm cement plaster 1:6
- ii) Apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) Lay black polyethylene film 250 microns (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.
- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.
- v) (e) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250 micron polyethylene film as second layer similar to (c) above.
- vii) Lay second layer of 100 gm. brown craft paper laminated similar to (d) above.
- viii) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

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ix) Protecting with a layer of 75 mm plain cement concrete M-100 or a layer of brick lay in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortars as shown on the drawing. 23.19.00 Protective Coating on Concrete Surface 23.19.01 ON FOUNDATION i) The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing or instructed by the Engineer, by using bitumen emulsion protective coating of approved manufacturer. ii) Wrapping of poly urethane rubber/PVC/Seepage proof sheets as per latest ASTM standards shall be provided, if required for the underground structures like wagon tippler, reclaiming hopper, limestone hopper that are likely to encounter underground water, so as to prevent the water leakages. 23.20.00 Acceptance criteria 23.20.01 The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. 23.20.02 The finishing course shall be fully secured and shall have an even density. 23.20.03 There shall not be any bubble formation or crushed or squeezed insulation or underbed. 23.20.04 The Bidder shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. 24.00.00 METAL CLADDING 24.01.00 Scope 24.01.01 Work included in this section covers the furnishing and installation of sandwich/double skin/single skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The Bidder shall furnish all labour, materials, tools and equipment required to complete the work. 24.02.00 Shop Drawings 24.02.01 Showing fabrication details of sandwich/double skin/single skin metal cladding with Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc. 24.03.00 Test Reports		
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- 24.03.01 Two copies of Test Reports and Source of Quality Control Tests.
- 24.04.00 **Permanent Colour Coated Aluminium Cladding System**
- 24.04.01 Permanent colour coated aluminium cladding of approved manufacturers of approved colour combination shall be provided for buildings having structural steel frame work & and any other building with Aluminium cladding recommended with Aluminium accessories and with thermal insulation as specified in the Architectural Drawings.
- 24.04.02 Permanent colour coated Aluminium roof and wall cladding of approved manufacturers of approved colour combination shall be provided for boiler roof/ canopy, and cladding over parapet walls of buildings where metal cladding is specified.
- 24.05.00 **Flashings, Caps, Trim Closures For Jambs, Lintels, Cornices**
- 24.05.01 All flashings, trim closures, caps etc. required for the Aluminum cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the sandwiched Aluminum cladding.
- 24.05.02 Overlap shall be min. 100 mm or as specified by manufacturer.
- 24.06.00 **Products**
- 24.06.01 GENERAL
- All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner.
 - Cladding material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Single skin materials shall be interlocking type 150mm wide strip.
 - Material shall be prefabricated panel conformed to relevant ASTM or alternative codes and standard. Troughed galvanized M.S. sheets having 0.6 mm minimum base metal thickness (bare material) with minimum rate of galvanization of 275 gms./sq.m. as per IS-277 of minimum yield strength of 250MPa as per IS-513(or High tensile steel sheet coated with zinc aluminium alloy @ 150 gms./sq.m. of 0.5 mm minimum base metal thickness and having minimum yield strength of 350 MPa, as per AS-1397) shall be used for the cladding system.
 - Roof insulation shall have a minimum R-value of 2.083 M2 oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.
 - Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be

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mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

24.06.02 MATERIAL

- i) Base Material : High tensile steel
- ii) Metal protection : Galvalume
- iii) Organic coating : Silicon Modified Polyester (SMP) Fluoro polymer (PVF2) and plastisols to resist aggressive climate of the jobsite.
- iv) Material shall be prefabricated sandwich panel with polystyrene insulation /high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm or as recommended by manufacturer to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel
- v) Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg/ M3 for polystyrene and shall have minimum R-value 2.083 M2 oK/Watt.
- vi) Panel size shall be largest available size.
- vii) Warranty for precoated profiled metal sandwich /double skin cladding shall be for a minimum period of 40 years.
- viii) *Sealants*
 - a) Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.
- ix) *Profile HDPE Filler*
 - a) Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.
 - b) Metal flashing shall be of similar material and colour of top skin.

24.07.00 Double skin insulated metal cladding

24.07.01 GENERAL

- i) Metal cladding may be of double skin separated by an approved insulation in between. External sheet shall be of interlocking type.
- ii) Double skin wall cladding shall be comprising of 150F external panels manufactured out of 0.6 mm TCT (Total coated thickness) aluminium alloy AA3105/5050 with stove enamelled coil coated finish, sufficient to withstand most aggressive climate, on both sides of approved shade.
- iii) The 150mm wide panels (150F) shall be clipped on to the concealed runners and shall be interlocked with each other.

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iv)

The inner sheeting shall be Hi Rib 0.5mm TCT silicon modified polyester coated galvalume steel (AZ 150 gsm aluminium- Zinc alloy meta metallic coating of total 550 Mpa yield stress as per AS-1397).

v)

The external panels shall be 150mm wide 17mm deep. The inner sheet shall have 1000-1020 mm cover width 28-30 mm high crests @250-255mm c/c with side laps. The inner sheet shall be fixed to structural system by means of corrosion protected self-drilling, self-tapping fasteners.

vi)

The sub girts of size 50mmx50mmx50mm manufactured out of 16 G G.I (1.6mm) 'Z' shape shall be fixed to inner sheeting on face side at purline locations.

vii)

The external panels shall be fixed with the help of concealed runners 34.5 wide x48mm deep out of 0.95 mm thick aluminium strip with cut outs to hold the panels in a module of 150mm at 1600mm c/c and fastened on side girts.

viii)

Bidder shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

25.00.00

SHEETING WORK IN ROOF AND SIDING

25.01.00

Scope

25.01.01

This specification covers the erection of asbestos, C.G.I., aluminium or metal sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium or metal gutters, flashings etc., as shown on drawings.

25.02.00

Storage of materials

25.02.01

Care & storage before installation

i)

Do not have uncovered sheets left lying in the open, Store in a covered area. If it is stored outside, cover the sheets with waterproof covers.

ii)

The sheet should be stacked neatly, above the ground and in an inclined fashion/gentle sloping.

iii)

It is advisable to keep each bundle of sheet, separately.

25.03.00

Handling and human traffic movement

25.03.01

On large building, handling time can be reduced by lifting sheet bundles with Crane, onto the roof frame. Care must be taken such that the weight of sheet bundle is not too much that it affects the structure. Where mechanical handling facilities are not present, sheets can be un-loaded & passed on to the roof, one at a time.

25.03.02

Sheets should not be dragged over the ground or any rough surface. Sheets should also not be dragged over each other. Tools used for erection should be carried and not dragged over the sheets.

25.03.03

During erection & maintenance time, worker should careful when walking on roof. General procedure of walking on roof are :

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- 25.03.04 When walking parallel to the ribs, walk on at least two ribs.
- 25.03.05 When walking across the ribs, walk close to or over the roofing supports.
- 25.04.00 **Fasters & sealant**
- 25.04.01 The steel sheet be fastened with nominal 40 mm zinc coated or nominal 25 mm zinc-tin alloy coated, Hex head, Self-drilling screw as per As 3566-2002 class 3 fastener of approved make with EPDM washer.
- 25.04.02 The fastener size shall be calculated as per the design or manufacturer's recommendations. Natural cure, Silicon sealants should be water resistant, non-corrosive, resistance to extreme temperatures, retain good flexibility and of approved make. It shall be applied at all end laps as per approval by the engineer-in-charge.
- 25.05.00 **Workmanship**
- 25.05.01 The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.
- i) *Asbestos Sheetting*
- a) Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge capping, corner pieces, ventilators, north light curves etc.
- ii) *C.G.I. Sheetting and Aluminium Sheetting*
- a) Side laps shall be 2 corrugations for roof and one corrugation for side sheetting. End laps shall be minimum 150 mm for roof and 100 mm for side sheetting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground.
- b) The sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers.
- c) Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.
- iii) *Fibre Glass Reinforced Plastic Sheetting*
- a) This shall be of thickness and profile as mentioned in the drawing.
- b) Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheetting the end and side laps and fixing device shall be same as used for general sheetting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in drawing.


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- c) In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.
- iv) *Metal sheeting*
- a) Sheeting should be fixed, strictly as per construction drawings. The maximum length of sheets should be the maximum transportable length.
- b) The number of sheets and the length of sheets to be worked out considering the minimum number of laps/joints in the roof system.
- c) The sheets and all accessories should be factory cut & then sent to site. Cutting of sheets at site should be avoided. If cutting of sheet at site is required, metal sheets should be cut by a Power saw with a metal cutting blade which leaves less redundant burr.
- d) Manufacturer's recommendations should be strictly followed.
- e) Before installation of roofing & cladding, it should be ensured that the supporting structure should be in true plans/perfect alignment, correctly placed & securely fixed.
- f) Cladding erection for each elevation should commence at the bottom & proceed towards the top in order to ensure tight fitting laps.
- g) The installed profiled sheets have a side lap of at least one corrugation. The end lap should have sufficient overlap depending upon the slope of the roof. The end laps should use sealant so as to ensure that there is no leakage of rain water from the joints.
- h) The General guidelines:

	Roof Slope	End lap (min.) mm	End lap (max.) mm.
(a)	Less than 1 in 4 (15°)	150	250
(b)	Greater than 1 in 4 (15°)	150	250
(c)	Wall	100	200

- i) The suggested end laps & no. of fasteners used should be as per manufacturer's recommendations.
- j) During cutting, drilling operations, the resulting small, sharp left over metallic particles or swarf can result stains on the coated steel roof. Swarfs should be removed & the Coated steel surface properly cleaned.
- k) During fastner installation, the installer should stand 90° to the panel, facing the purlin & drive the fastner until it is tight and the washer is firmly seated. Fasteners should not be over-driven. Proper fastner driver as recommended by manufacturer should be used for self drilling screw.

25.06.00 Acceptance criteria

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25.06.01 The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked: i) Side and end laps ii) Absence of cracks, holes or damages in sheet iii) Spacing of bolts, screws along with washer iv) Provision of double washers (G.I. and asbestos or bituminous washers) v) Proper installation of flashing 26.00.00 PAINTING, WHITE WASHING AND POLISHING ETC 26.01.00 General 26.01.01 All painting on masonry or concrete surface shall be applied by roller. Acrylic emulsion paint, Oil bound distemper and Cement paint shall be of approved make. The paint shall be applied on a coat of primer over dried, prepared plastered surface as per manufacturer's guidelines. 26.01.02 Minimum two finishing coats of paint shall be applied over a coat of primer. The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness. 26.01.03 White wash shall be made from good quality fat lime .It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30kg of sodium chloride dissolved in hot water shall then be added per 10kg of lime used for the white wash to be ready for application. 26.01.04 Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer. 26.01.05 All the materials shall be of the best quality from an approved manufacturer. Bidder shall obtain prior approval of the Engineer for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers. 26.01.06 Bidder shall obtain the approval of the Engineer regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting. 26.01.07 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata. 26.01.08 The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence e. Efflorescence shall be removed only by dry brushing of the growth and cracks shall be filled with gypsum. Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them. 26.02.00 Materials		
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26.02.01 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 & paint or one shade is obtained the same manufacturing batch. All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied. 26.02.02 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 recognised manufacturers and shall be approved by the Engineer. 26.02.03 All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. 26.03.00 White Wash & Colour Wash 26.03.01 The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied. The dry surface shall present a uniform finish without any brush marks. 26.03.02 Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed. 26.03.03 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 edition. 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 of water 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 quantity of indigo or synthetic ultramarine blue shall be added to the lime. 26.04.00 Exterior Emulsion Paint 26.04.01 The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. 26.04.02 The paint shall be applied with a brush with stiff bristles. 26.04.03 The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions 26.04.04 The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water- proofing in addition to decoration. The paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m.		
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26.04.05 A minimum of 2 coats of the same colour shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. 26.04.06 The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after the application of final coat. 26.05.00 Waterproof Cement Paint 26.05.01 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. 26.06.00 Oil Bound Distemper 1.12.02 The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for atleast 48 hours. 1.12.03 A minimum of two coats of oil bound distemper shall be applied. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. 26.07.00 Plastic Emulsion Paint 26.07.01 The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. 26.07.02 Unevenness in the plaster shall be made good by applying plaster of paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. 26.07.03 The paint shall be laid an evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. 26.07.04 The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied. 26.07.05 Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches. 26.08.00 Acrylic Emulsion Paint 26.08.01 Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided.		
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26.08.02 Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. 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 and water without any deterioration in colour, or without showing flaking, blistering or peeling. 26.09.00 Acid, Alkali Resisting Paint 26.09.01 A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions. 26.10.00 Synthetic Enamel Paint 26.10.01 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 interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933. 26.11.00 Storage 26.11.01 The Bidder shall arrange for safe and proper storage of all materials and tools. 26.11.02 The storage space if allotted within the building shall be adequately protected from damage, disfigurement & stains. 26.11.03 Paint shall be kept covered at all times and mixing shall be done in suitable containers. 26.11.04 All necessary precautions shall be taken by the Bidder to prevent fire. 26.12.00 Preparation of surface 26.12.01 Before starting the work the Bidder shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on. 26.12.02 WOOD i) 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 shellac 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. 26.12.03 MASONRY, CONCRETE AND PLASTERED SURFACE i) 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 re- surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with		
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minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

ii) Surface with mildew or efflorescence shall be treated as below:

a) Mildew

- 1) All mildewed surfaces shall be treated with an approved fungicide such as ammonia cal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

26.12.04 METAL

- i) All metal surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal.
- ii) All galvanised iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction.
- iii) Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

26.13.00 Application

26.13.01 GENERAL

- i) 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 Bidder 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. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.
- ii) All materials shall be evenly applied so as to be 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.
- iii) All priming undercoats for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.
- iv) 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 1 & 2). The total dry thickness of the film should not be less than 120 micron.

26.13.02 WHITE WASHING

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- i) 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 application of the lime solution.
- ii) 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.

26.13.03 DRY DISTEMPER

- i) 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 a solution of 100 gms. of zinc sulphate to 1 litre of water and then allowed to dry. Dry distemping shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly.

26.13.04 OIL BOUND WASHABLE DISTEMPER

- i) 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.

26.13.05 WATERPROOF CEMENT PAINT

- i) 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.

26.13.06 ACRYLIC EMULSION PAINT

- i) 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 strictly as per manufacturer's specification.

26.13.07 SYNTHETIC ENAMEL PAINT

- i) Shall be applied on properly prime red 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.

26.13.08 ALUMINIUM PAINT

- i) 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.

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26.13.09 CLEAR SYNTHETIC VARNISH

- i) The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction.
- ii) 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.
- iii) For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. All dust and dirt shall be removed from the surface as well as from the neighbourhood.
- iv) The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flattened 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.

26.13.10 FRENCH POLISH

- i) All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt sienna or umber.
- ii) 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. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly dampened with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

26.13.11 CHEMICAL RESISTANT PAINT

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

26.13.12 EPOXY COATING/PAINTING

- i) On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers' specification:
- ii) One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.
 - a) ARALDITE GY 250 : 100 Parts by weight
 - b) HARDENER HY : 840 - 50 Parts by weight

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iii) Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

- a) ARALDITE GY 250 : 100 Parts by weight
- b) HARDENER HY 830 : 45 Parts by weight
- c) HARDENER BY 850 : 15 Parts by weight
- d) SILICA FLOUR : 20 Parts by weight
- e) FLOW CONTROL AGENT: 2 Parts by weight

iv) Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

26.14.00 Acceptance criteria

- 26.14.01 All painted surfaces shall be uniform and pleasing in appearance.
- 26.14.02 All varnished surfaces shall be of uniform texture and high glossy finish.
- 26.14.03 The colour, texture etc. shall match exactly with those of approved samples.
- 26.14.04 All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

27.00.00 DOORS, WINDOWS & GLAZING

27.01.00 Scope

27.01.01 The work in general shall consist of supplying and/or erecting and installing of all metal doors, windows, ventilators, louvres, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

27.02.00 General

- 27.02.01 Doors, windows and ventilators of air-conditioned, non air conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of all buildings shall have, electro colour dyed (anodized with 15 micron coating thickness) aluminium framework with glazing.
- 27.02.02 Main entrance of the common control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing. Doors shall be of double action floor springs mounted.
- 27.02.03 For common control building, double glazed wall panels with hermetically sealed glass with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of common control room and control equipment room(s) to have a clear view ;one glass, on external side of control room shall be tinted one.
- 27.02.04 Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

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27.02.05 All windows and ventilators on ground floor of all buildings shall be provided with suitable grill. Grills shall be provided inside and windows shutter shall open outside of the buildings. 27.03.00 Fire Proof Door 27.03.01 Fire-Proof doors with panic devices shall be provided at all fire exit points as per the recommendations of codes and standards. However minimum fire rating shall be 2 hours. These doors shall be double cover plated type with mineral wool/wood insulation. 27.03.02 Fire proof doors shall be provided at all fire exit points and also to restrict the spread of fire within buildings whether from internal fire or from external fire. 27.03.03 All necessary accessories and hardware shall also be supplied along with doors. Fireproof door shall be provided with zinc silicate primer (minimum DFT 75 microns) after blast cleaning the surface to near white metal surface (Sa 2 ½). The doors shall be finish with suitable fire retardant painting system. 27.03.04 Fitting and fixing in position shall be similar to aluminum work of doors, windows etc. After installation of steel door, etc., all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat. All coupling mullions, transoms, frames, etc., in contact with adjacent steel and other members, shall be well bedded in mastic. 27.03.05 Hollow extruded section of minimum 3 mm wall thickness shall be used for all aluminium doors, windows and ventilators. 27.03.06 Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.00m. 27.03.07 Electrically operated, self operable/closing, aluminium framed with tinted glass (12mm thick) sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building. 27.03.08 The doors, windows and ventilators of all buildings shall be in anodized aluminium framework with float glass of minimum 5.5 mm thickness. 27.03.09 All inaccessible (where regular maintenance is not feasible) ventilators and windows shall be provided with 6mm thick Multiwall Polycarbonate plain or tinted sheet for preventing solar radiations. The Multiwall Polycarbonate sheets shall be fire and u/v resistant, and suitable for continuous use up to a temperature of 1000C. Suitable aluminium beading shall be used. The open ends of the sheet shall be sealed as per manufacturer's recommendations. 27.03.10 The sky light/ north light shall have Multiwall Polycarbonate sheet fixed with anodized aluminium frame of approved colour & the same shall be made leak proof. 27.03.11 All windows and ventilators located in fire prone areas shall be provided with minimum 6 mm thick wired glass Ground glass of minimum 4 mm thickness shall be used for all windows/ventilators in toilets 27.03.12 For single glazed aluminium partitions and doors, float glass of minimum 5.5 mm thickness shall be used. Double glazing shall consist of two 6 mm thick glass		
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hermetically sealed and separated by 12 mm gap to provide thermal insulation. The outer side of the glazing shall be of tinted glass where exposed to sunrays. Ground glass of minimum 4 mm thickness shall be used for all windows/ventilators in toilets.

27.03.13 Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.

27.04.00 **Installation**

27.04.01 MATERIALS

- i) Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.
- ii) Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.
- iii) Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 1948 and 1949 or as manufactured by Indian Aluminium Company Limited or approved equivalent. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.
- iv) Hardware and fixtures shall be as specified in "Schedule of Fixtures" and the best quality from approved manufacturers shall only be used. "Schedule of Fixtures" is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Bidder's responsibility
- v) Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61- 80 Kg. unless otherwise stated in schedule. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix- A. The Bidder shall submit samples of each type of hardware to the Engineer. The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

27.04.02 FABRICATION

- i) *Steel Doors, Windows, Ventilators, Louvers, etc.*
 - a) Door Frames
 - 1) Frames shall be fabricated from 16 G sheets.
 - 2) They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers.

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- 3) Welded construction with mitered corners shall be used.
- 4) Rubber door silencers shall be furnished for the striking jamb.
- 5) Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied.
- 6) Frames shall be brought to site with floor ties/weather bars installed in place.

b) Double Plate Flush Door Shutters

- 1) Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centers.
- 2) Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces.
- 3) Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door.
- 4) Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting.
- 5) Pairs or double doors shall have meeting stile edges bevelled or rebated.
- 6) Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts.
- 7) They shall also be reinforced for closers, push-plates and other surface hardware where necessary.
- 8) Any drilling and tapping required for surface hardware shall be done at site.
- 9) Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

- 1) Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.
- 2) Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

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- 3) The manufacturing shall be done as specified elsewhere in the specification "Double Plate Flush Door Shutters".

d) Sliding Doors

- 1) Sliding doors shall be either double plate or single plate construction as called for in drawings and schedules made out of 18 gauge steel sheets with adequate stiffeners.
- 2) The Bidder shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in the Schedule of Items, the Bidder shall make provision for openings to the door for monorail beams.
- 3) Doors shall close positively to exclude rainwater from seeping in.
- 4) When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

- 1) Door threshold shall be provided as shown on drawing.
- 2) Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

- 1) These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.
- 2) All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

ii) *Aluminium Door, Windows and Frames*

- a) Extruded sections shall have a minimum 3 mm wall thickness
- b) All sections shall be approved by the Engineer before fabrication is taken up.
- c) Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness.

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- d) The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.
- e) All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work.
- f) Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners.
- g) Field connections of all work may be made with concealed screws or other approved type of fasteners
- h) Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

iii) *Aluminium Structural Glazing*

- a) Providing and fixing of barriered semi unitised structural glazing system at all levels through designing and selection of mullion and transoms profiles anodised (15 to 20 micron) or powder coated (50 to 70 micron), selected for their fixing on the structure depending on the structural conditions, functional, statistical requirement and should withstand the wind load criteria as per IS-875 (part-III) – 1987.
- b) Double insulated hard coated toughened glass consist of 6mm outer single safety glass, 12mm inter space and 6mm inner clear glass panel glued onto the glass glazing frame profile selected according to the vision / spandrel panel (Aluminium Composite Panels) requirement with DC 995 structural sealant.
- c) Proper supporting element should be provided for taking care of the respective infill load and reliving in case of the glass bonding failure. (The profile sections shall be Hindalco Alupuram unit, HYDRO product or equivalent). Floor to floor height would be 4.2m approx and width of glazing supporting frame would be 1.0m approx.

27.04.03 SHOP COAT OR PAINT

- i) The shop paint for steel doors, windows, etc. shall be best lead or zinc chromate primer paint from approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.
- ii) Where called for in the Schedule of Items all steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 Oz per sq. ft. One coat zinc chromate primer coat shall then be applied as shop paint.
- iii) Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali

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paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

27.04.04 HANDLING & STORAGE OF FABRICATED MATERIAL

- i) All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.
- ii) When taking delivery of items supplied either from supplier or owner, the Bidder shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.
- iii) All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

27.04.05 ASSEMBLY & ERECTION AT SITE

- i) In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 and as shown on drawings.
- ii) The Bidder shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations
- iii) The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff.
- iv) Necessary holes, chases, etc. required for fixing shall be made by the Bidder and made good again as per original, after installation without any extra charge.
- v) After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.
- vi) All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Bidder shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions.
- vii) For all frames supplied by either the Owner or the Bidder mastic shall be supplied by the Bidder and caulking done properly as per drawings, specifications and as per instructions of the Engineer.
- viii) Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms. Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor.

27.05.00 Glass and glazing

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27.05.01 SCOPE

- i) The work in general shall consist of supplying and installing all glass and glazing including all clips, putty, mastic cement from approved manufacturer having uniform refractive index and free from flaws, specks and bubbles etc. wherever required as shown on drawings and specifications.

27.05.02 INSTALLATION

i) *Materials*

- a) Glare reducing or heat absorbing glass shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Glass shall be float glass of required thickness and shall be clear or tinted as indicated.
- c) Wired glass shall be thick rolled glass with centrally embedded 42g. Wire mesh of Georgian type. This may be of clear or coloured glass, as shown on drawings.
- d) Obscure glass shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS : 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.
- g) EPDM gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.
- h) Float glass
- i) Double glazing

ii) *Glazing, setting and finish*

- a) All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Bidder.
- b) All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Bidder.
- c) Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

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- d) After completion of glazing work, the Bidder shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones.

27.06.00 Acceptance criteria

27.06.01 FOR FABRICATED ITEMS

- i) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- ii) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- iii) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.
- iv) Door leaves shall be undercut where shown on drawings.
- v) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- vi) All welds shall be dressed flush on exposed and contact surfaces.
- vii) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.
- viii) Provisions for hardware and fixtures to be installed at site.
- ix) Glazing beads shall be cut with mitred corners.
- x) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- xi) Shop coats shall be properly applied.
- xii) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

27.06.02 FOR INSTALLED ITEMS

- i) Installations shall be at correct location, elevation and in general on a true vertical plane.
- ii) Fixing details shall be strictly as shown on drawings.
- iii) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete
- iv) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- v) All openable section shall operate smoothly without jamming.
- vi) Locks, fasteners, etc. shall engage positively. Keys shall be non interchangeable.
- vii) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

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viii) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

27.06.03 FOR GLAZING

i) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

ii) Glazing shall be carefully done to avoid direct contact with metal frames.

iii) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

iv) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

28.00.00 CARPENTRY & JOINERY

28.01.00 Scope

28.01.01 This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate. This shall also include the supply and fixing of all hardware and fixtures shown in drawing.

28.02.00 Installation

28.02.01 MATERIALS

i) *Timber*

a) Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose, knots cracks or other defects.

b) Where specified, timber shall be treated with approved wood preservative before use.

c) Before starting the carpenters work, the Tenderer shall have the rough timber approved by the Engineer.

ii) *Plywood*

a) Plywood shall be commercial quality with decorative surface veneer.

b) Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol-formaldehyde resin of B W R grade conforming to IS:848.

iii) *Decorative Laminated Plastic Sheets*

a) The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

iv) *Flush Doors*

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- a) Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges.
- b) The core for solid core doors shall be of block board or wood particle board.
- c) Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer.
- d) The Bidder shall give a guarantee that the adhesive used is phenol formaldehyde of B W R grade, conforming to IS: 848.
- e) The thickness shall be as specified in the drawing.
- v) *Panel Doors*
 - a) Panel door shall be of teakwood shutter frame and panels of teakwood.
 - b) Other considerations shall be as mentioned in item (d) above.
- vi) *Fixtures*
 - a) Fixtures for doors, windows, furniture, etc. shall be as shown on drawing.

28.02.02 WORKMANSHIP

- i) *General*
 - a) The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.
 - b) Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blockboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.
 - c) Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete.
 - d) The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M S grills or guard bars shall be provided to windows where called for in the drawings.
- ii) *Finish*
 - a) All carpentry work after finishing shall be sand papered smooth.
 - b) A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

iii) *Surface Treatment*

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- a) When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished
- b) The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions.
- c) The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

28.03.00 **Acceptance criteria**

28.03.01 DOOR AND WINDOW FRAMES

- i) All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles.
- ii) After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

28.03.02 DOOR AND WINDOW SHUTTERS

- i) Shall be of proper size, shape and design and free of warp.
- ii) When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

28.03.03 PARTITIONS, PANELING, PELMETS, FURNITURE, ETC

- i) *General*
 - a) These shall conform to drawings in all details. No unsightly nailmarks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.
- ii) *Partition*
 - a) Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.
- iii) *Pelmets*
 - a) Shall be checked for rigidity of fixing and adequate clearance of fixture.
- iv) *Cupboard Shutters*
 - a) Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.
- v) *Drawers*
 - a) Shall operate smoothly and have back stops to prevent them from being pushed too far. Locks shall engage securely.
- vi) *Loose Furniture*
 - a) When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

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29.00.00 ROLLING STEEL SHUTTERS / GRILLS

29.01.00 Scope

29.01.01 This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

29.02.00 Installation

29.02.01 COMPONENTS

- i) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 2.25 mm thick for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- ii) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia rods.
- iii) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.
- iv) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- v) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.
- vi) Shafts shall be of steel pipe of sufficient size to carry the torsion load with a maximum deflection of 1/360th of span.
- vii) Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- viii) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.
- ix) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.
- x) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated drawing.
- xi) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

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- xii) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

29.02.02 MANUALLY OPERATED SHUTTERS/GRILLS

- i) Manually operated shutters shall be easily operable by one person.
- ii) The speed of operation shall be about 1.3 metres per second.
- iii) In general, manually operated shutters shall be push pull type for openings upto 9 Sq. metre in area.
- iv) Larger shutters shall be either chain and gear operated or crank and gear operated.
- v) The crank handle shall be removable.
- vi) All shutters shall be lockable from one or both sides as described as desired by the Engineer.

29.02.03 POWER OPERATED SHUTTERS/GRILLS

- i) These shall be operable from a push button station conveniently located beside the door or as shown on drawings.
- ii) One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system.
- iii) Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

29.02.04 SHOP COAT

- i) Shutters shall be painted with one coat of red lead or zinc chromate primer.
- ii) Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

29.02.05 ERECTION

- i) Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions.
- ii) Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up.
- iii) All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

29.03.00 Acceptance Criteria

29.03.01 SHOP INSPECTION

- i) After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

29.03.02 FIELD INSPECTION

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- i) After installing the shutters, the Bidder shall test the performance of the shutter in the presence of the Engineer.
- ii) The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

29.03.03 GUARANTEE

- i) The Bidder shall give one year's guarantee for the successful operation of the shutters.
- ii) This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

30.00.00 MISCELLANEOUS METAL

30.01.00 Scope

30.01.01 This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer.

30.01.02 The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described.

30.02.00 Installation

30.02.01 FABRICATION/CASTING

- i) *General*
 - a) All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.
- ii) *Shop Connections*
 - a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
 - b) Welding of steel shall be done in accordance with the IS: 816. Use of metal arc welding for general construction in Mild Steel.
 - c) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.
- iii) *Shop Coat*
 - a) Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and

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painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer.

30.02.02 ERECTION

- i) *Bracing*
 - a) The Bidder shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.
- ii) *Temporary Bolting-Up*
 - a) As erection proceeds the Bidder shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.
- iii) *Turned Bolt*
 - a) For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.
- iv) *Welding*
 - a) Where specified on drawings, welding shall be done in accordance with IS:816 for steel and IS: 2812 for Aluminium and Alloys.
- v) *Cutting and Fitting*
 - a) No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other package contractor. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.
- vi) *Drifting*
 - a) Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.
 - b) Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

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vii) *Grouting*

- a) All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Bidder and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

viii) *Anchor Bolting*

- a) When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Bidder shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

ix) *Pipe Joints*

- a) M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

x) *Spot Painting*

- a) All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

xi) *Making Good*

- a) All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

30.03.00 Acceptance criteria

30.03.01 All items shall be of correct shape, size, weight etc. shown on drawings.

30.03.02 For installed items, the tolerances shall be follows :

- i) Permissible deviation from straightness - 1 in 1000.

30.03.03 Seats, stiffener connections etc. Shall be as per approved drawings and shall not interfere with architectural clearances.

30.03.04 All castings shall be free from blow holes, cracks and other blemishes.

31.00.00 FALSE CEILING

31.01.00 Aluminium panel lineal false ceiling system shall consists of the following Aluminium panel (coil coated) lineal / panel ceiling system shall consist of rolled formed, coil coated aluminium precoated magnesium alloy (Al-Mg AA 5050) carrier and panels of minimum 0.9 mm and 0.5 mm thickness respectively. The ceiling system shall be of approved pattern. The system shall be complete with edge cover profile, special panels, carrier splice, etc. The carrier shall be suspended from roof by 4 mm diameter galvanized steel wire hangers having special height adjustment clips made from spring steel at maximum spacing of 1.2 m c/c both ways.

31.02.00 The materials used for false ceiling system shall be Armstrong / Hunter Douglas.

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31.03.00 **False Ceiling with Mineral Fibre Tiles**

- 31.03.01 False ceiling shall consist of regular or tapered edge light weight mineral fibre tiles of size of 600 x 600 or 600 x 1200 or as per architecture design with minimum tile thickness of 15 mm. Exposed surface shall be semi perforated (fine fissured) with nominal depth of perforation as 4 mm. The material shall be humid resistance upto 95% RH with fire performance of class 0/class 1 (as per BS 476) and shall not sag for 10 years under 95% RH.
- 31.03.02 Metal suspension system shall conform to ASTM C-635 and shall be hot dipped M.S. galvanized. Nominal size of T-section shall be 24 x 38 mm for main runners and 24 x 30 mm or 24 x 25 mm cross runners. 24 mm wide exposed flange surface shall be permanently colour coated. Suspension system shall be as per manufacturer's specification.
- 31.03.03 Gypsum plaster board, used for false ceiling, shall be minimum 12mm.
- 31.03.04 Glass wool insulation shall be laid on top of false ceiling panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.
- 31.03.05 Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.
- 31.03.06 Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This under deck insulation shall consist of Glass insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.
- 31.03.07 Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.

32.00.00 **FLOORING & ROOFING WORK**

32.01.00 **General**

- 32.01.01 The nominal total thickness of floor finish shall be 50 mm i.e. under bed and topping. The floor shall be laid on an already laid and matured concrete base. The under bed for floors and similar horizontal surfaces shall consist of cement concrete (1 part cement, 2 part sand and 4 part stone chips by volume). Stone chips shall be 12.5 mm down well graded.
- 32.01.02 Sunken RCC slab shall be provided in false flooring area and all toilet areas so as to keep the finished floor level of these areas 12 mm below as that of the surrounding area. For toilet area, sunken slabs shall be made water tight by suitable water proofing treatment.
- 32.01.03 Metallic hardener topping shall be 12 mm thick using uniformly graded iron particles, properly treated.
- 32.01.04 Granite flooring shall generally conform to relevant codes and shall be uniform and of thickness not less than 20mm.

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32.01.05 Vitrified tiles (heavy duty) of size 300 x 300 x 7.5 mm thick (minimum) of reputed manufacturer and of approved finish shade and colour to be used. 32.01.06 Vitrified ceramic tiles of size 400mm x 400mm or 600mm x 600mm (Mat or Mirror Polished) and of specified thickness from reputed manufacturer shall be used. The finish, shade and colour shall be as per the approved Finishing Schedule. 32.01.07 Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be up to 2100 mm height from finished floor level. Skirting and Dado shall match with the floor finish. 32.01.08 For pathways, chequered/ design concrete tiles over 20 mm thick, 200x200 mm size of approved shade and colour shall be used. Inter locking concrete blocks used for paving shall be of minimum M-30 grade of concrete, and of thickness 60 mm, of approved colour and pattern. It shall be laid on the sub base and bedding as per recommendation of manufacturer of interlock concrete blocks. 32.01.09 Terrazzo tiles and cement tiles shall generally conform to the IS: 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm². 32.01.10 The type, quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as per specifications and as approved by Engineer. 32.01.11 The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1 mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm. 32.01.12 The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/ coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix. 32.01.13 Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in relevant codes. 32.01.14 Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado. 32.01.15 The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. A layer of 25mm average thickness of cement mortar consisting of one part of cement to 3 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. Sand for the mortar shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles.		
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32.01.16 Neat cement slurry using 4.4 kg of cement per one sq.m of floor area shall be spread over the hardened mortar bedding. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade on the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for at least 14 days after fixing of the tiles. 32.01.17 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. 32.01.18 Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado. 32.01.19 Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. 32.01.20 Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding. 32.01.21 Machine grinding and polishing shall be commenced only after a gap of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out. 32.01.22 Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of 3mm in any 3m length is acceptable in a nominally flat floor. 32.02.00 Granite Floor Finish 32.02.01 Granite floor shall generally conform in all respects to the standards and codes and shall be used with cement with or without pigment.. 32.02.02 The size, thickness and colour of the Granite for flooring/skirting shall be as specifications/approved by the Engineer. The topping shall be uniform and of thickness not less than 20mm. 32.03.00 Glazed Tile Finish 32.03.01 Glazed earthenware tiles shall be of the best quality from an approved manufacturer to the standards & codes.		
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32.03.02

The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as per specifications /approved by the Engineer.

32.03.03

The total thickness of glazed tile finish including the bedding mortar shall be 20mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

32.03.04

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall have minimum fineness modules of 1.5.

32.03.05

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

32.03.06

Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

32.03.07

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

32.03.08

Neat cement slurry using 3.3 kg cement per one sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1 mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

32.03.09

All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

32.03.10

Specials consisting of caves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

32.04.00

Tiled finish

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32.04.01 These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

32.04.02 TERRAZZO TILE FINISH

- i) The finish will consist of manufacture terrazo tile and an underbed.
- ii) *Thickness*
 - a) The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.
 - b) The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.
- iii) *Tiles : Terrazzo*
 - a) The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.
 - b) Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be + 1 mm and the thickness + 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.
 - c) The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm. The total thickness including the topping shall be as specified but not less than 20 mm in any case.
 - d) The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.
 - e) The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.
 - f) The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.
- iv) *Mix : Underbed*
 - a) The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

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v) *Laying*

- a) The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide. At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.
- b) After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

vi) *Grinding and Polishing*

- a) Grinding shall not commence earlier than 14 days after laying of tiles.

32.04.03 CHEQUERED TILE FINISH

- i) The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.
- ii) *Thickness*
 - a) Thickness shall be same as above.
- iii) *Tiles : Chequered*
 - a) The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.
 - b) The tiles shall conform to requirements specified elsewhere in the specification except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

iv) *Underbed*

- a) As per clause summarized as above.

v) *Laying*

- a) As per clause summarized as above.

vi) *Grinding and Polishing*

- a) As per clause summarized as above except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

32.04.04 TERRAZO FINISH : IN SITU

- i) It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

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ii) *Thickness*

- a) Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.
- b) All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

iii) *Mix*

a) Underbed

- 1) The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.5 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

b) Topping

- 1) The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1.5 parts of marble chips by volume shall be added and thoroughly mixed dry again.
- 2) The pigment must be stable and no fading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. : 30. The size of marble chips may be between 1 mm to 20 mm.
- 3) Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

iv) *Laying*

- a) The underbed shall be laid in panels. The panels shall not be more than 5 sq.m in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq. M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

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- b) Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.
- c) After lying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. Slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.
- v) *Curing*
- a) The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.
- vi) *Grinding and Polishing*
- a) When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes.
- b) The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days.
- c) Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole.
- d) The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120).
- e) The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer.
- f) The final polishing shall be positioned till before handing over if desired by the Engineer.
- g) Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M, water sprinkled on to it and finished by buffing with felt or hessian bobs.

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- h) The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

32.05.00 Acid Resisting Tiling Work

32.05.01 The ceramic unglazed vitreous acid resisting tiles when fractured shall appear fine-grained in texture, dense and homogeneous. Tile shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in the dimensions shall be within the limits specified in the respective code and standard. The size and thickness of tiles for use in the flooring/skirting/dado shall be as specified /approved by Engineer. The tiles shall be bedded and jointed using chemical resistant mortar of the resin type The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5mm.

32.05.02 The surface shall be applied with a coat of bitumen primer. The primed surface shall then be applied with a uniform coat of bitumen. Tiles shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

32.05.03 For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile. Two adjacent sides of the tile shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully.

32.05.04 This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

i) *Tiles*

a) The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

b) Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

ii) *Laying*

a) The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

32.06.00 Granolithic Finish

32.06.01 Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

32.06.02 THICKNESS

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i) The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise. 32.06.03 MIX i) The mix shall consist of 1 part cement: 1 part coarse sand: 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added. 32.06.04 LAYING OF MONOLITHIC TOPPING i) The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish. ii) Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base. iii) The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips. iv) For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern. 32.06.05 LAYING OF TOPPING SEPARATELY ON HARDENED BASE i) The base concrete shall be prepared as stated in above and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping. 32.06.06 CURING i) Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period. 32.06.07 GRINDING i) If grinding is specified, it shall start only after the finish has fully set. However, the ultimate polish required shall be decided upon by the Engineer. 32.06.08 FINISHING i) Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified. The concentration and method of application of the solutions shall be as specified in IS : 5491. 32.07.00 Patent Stone		
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32.07.01 It shall consist of an underbed and a topping laid on an already laid and matured concrete base. 32.07.02 THICKNESS i) The patent stone finish shall have thickness as stipulated under relevant clause except that the topping shall be 6 mm thick. 32.07.03 MIX i) Underbed a) The mix shall be as stipulated requirements specified elsewhere in the specification. ii) Topping a) The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume. 32.07.04 LAYING i) The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place. ii) The maximum area of each panel shall be 3 Sq.M of which no side shall be more than 2 M long. iii) A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. iv) The topping shall towelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface. v) After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer. 32.08.00 Floor Hardener Topping 32.08.01 Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base. 32.08.02 Floor hardener of the metallic or non-metallic type as per manufacturer's specifications suitable for the performance of normal/medium/heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as per specifications. 32.08.03 For monolithic application with the floor finish/slab, the thickness of the layer shall be 12mm. The topping shall be laid within 2 to 3 hours after concrete is laid and it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be re moved before		
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placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Troweling to a smooth finish. After the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days.

32.08.04 The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

32.08.05 Surface shall be prevented from any damages due to subsequent building operations by covering with 75mm thick layer of sand.

32.09.00 **Mastic Asphalt Finish**

32.09.01 This is a one layer treatment on concrete or brick base.

32.09.02 THICKNESS

- i) The thickness shall be as specified in the drawing

32.09.03 MATERIALS

- i) Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.
- ii) Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.
- iii) Fine aggregate shall be crushed and graded natural lime stone or other hard-work.
- iv) Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

32.09.04 COMPOSITION

- i) Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25Kg. or prepared at site.
- ii) If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated.
- iii) At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

32.09.05 LAYING

- i) The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.
- ii) The mastic shall be laid in suitable panels of about 15 Sq.M in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

32.10.00 **Epoxy Flooring**

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32.10.01 Epoxy Flooring shall be provided with surface preparation of concrete substrate with Captive Shot Blasting Machine OR Light Grinding to form the required anchor profile on the floor substrate followed by application of epoxy resin based moisture barrier underlay of 2 mm thickness including filling of saw cut joints with epoxy cementitious resin based moisture barrier underlay as per manufacturer specification. Application of self smoothing epoxy floor topping of epoxy based resin of 2 mm thickness over epoxy resin based moisture barrier underlay including application of solvent free epoxy resin based two component primers. 32.10.02 It shall include application of PU Sealant at Expansion and Isolation Joint respectively including surface preparation of the joint, fixing of backup strip and application of sealant. 32.11.00 Acceptance criteria 32.11.01 The finish shall be checked specially for: i) Level, Slope, Plumb as the case may be ii) Pattern and Symmetry iii) Alignment of joints, dividing strip etc. iv) Colour, texture v) Surface finish vi) Thickness of joints vii) Details at edges, junctions etc. viii) Performance ix) Precautions specified for durability. 33.00.00 ACID/ ALKALI RESISTANT LINING 33.01.00 The material shall conform to the following: 33.01.01 Bitumen primer shall conform to IS: 158. 33.01.02 Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412. 33.01.03 A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively . 33.01.04 Mortar: Potassium silicate & resin type mortars shall conform to 4832 Part-I&II respectively. 33.02.00 Requirements for acid/ alkali resistant flooring and lining for different areas shall be as mentioned elsewhere in this specification. 34.00.00 WATER SUPPLY 34.01.00 Scope		
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34.01.01 This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. 34.01.02 The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises. 34.02.00 Materials 34.02.01 All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. 34.02.02 Unless specifically allowed by the Engineer, the Bidder shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. 34.02.03 Ultimate choice of type, model and manufacturer lies completely with the Engineer. 34.02.04 The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. 34.02.05 Pipe threads, sockets and similar items shall be specially protected till final installation. 34.02.06 Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site. 34.03.00 Pipes and pipe fittings 34.03.01 Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types, as approved during detailed engineering: i) Cast Iron ii) Steel: lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised. iii) Reinforced Concrete iv) Prestressed Concrete v) Lead (Not to be used for potable water) vi) P. V. C. vii) Copper viii) Brass ix) Wrought iron 34.04.00 Water reservoirs 34.04.01 Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. 34.04.02 Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications or relevant IS Code.		
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34.05.00 Related works

34.05.01 All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Bidder unless specifically excluded.

34.06.00 Regulation

34.06.01 The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Bidder) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

34.07.00 Installation

34.07.01 While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Bidder for approval of the Engineer.

34.07.02 Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

34.07.03 PIPE LINES

i) Laying

a) In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

b) Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

ii) Back Flow

a) The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

iii) Contamination

a) There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

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- b) No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

iv) *Underground Pipings*

- a) Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.
- b) The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.
- c) The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

v) *Concealed Piping*

- a) Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure.

vi) *Jointing of Pipes*

- a) Jointing of pipes shall be completely leakproof and durable. Instruction of them manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

1) **Cast Iron**

- Spigot and Socket Joints: Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the remainder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead.
- Flanged Joints : Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt.

2) **Steel**

- Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Jointing compound, if used, shall be lead free and approved by the Engineer.

3) **GI Pipes**

- The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound.

4) **Lead**

- Lead and lead alloy pipes shall be jointed with wiped solder joints.

5) **Concrete**

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- Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar. 6) P. V. C. - Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used. 7) Tyton Joint - The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. vii) <i>Painting</i> a) Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead or zinc chromate primer. b) Top coats shall be minimum 2 coats of best quality paint. 34.08.00 Storage Tank - Pressed Steel Tank 34.08.01 Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank. 34.08.02 All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. Internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition. 34.08.03 Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete. 34.08.04 G. I. WATER TANK i) G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron		
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sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.

ii) In case it is desired by the Engineer that corners of tank should be welded instead of riveted then the sheets shall be welded to form a tank will not have angle iron frame.

iii) Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

34.09.00 **Valve, Cocks, Taps**

34.09.01 All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. Nominal size and material shall be as per schedule.

34.10.00 **Protection**

34.10.01 Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

34.11.00 **Testing and acceptance**

34.11.01 INSPECTION BEFORE INSTALLATION

- i) All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards.
- ii) Any defective items shall be clearly marked as rejected and forthwith removed from the site.

34.11.02 TESTING OF MAINS AFTER LAYING

- i) After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM² or double the maximum working pressure, whichever is greater.
- ii) The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached.
- iii) In either case due precaution shall be taken to ensure that the required test pressure is not exceeded.
- iv) Pressure gauges shall be accurate and shall preferably have been recalibrated before the test.

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v) The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. vi) The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains. 34.11.03 TESTING OF SERVICE PIPES AND FITTINGS i) The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. ii) The service pipe shall then be inspected under working conditions of pressure and flow. iii) When all draw- off taps are closed, the service pipes shall be absolutely water-tight iv) All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost. 35.00.00 DRAINAGE AND SANITATION 35.01.00 General 35.01.01 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches. 35.02.00 Installation 35.02.01 All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance. 35.02.02 All pipe lines, fittings and fixtures shall be installed leak proof and the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases. 35.03.00 Rainwater down-comers 35.03.01 Rainwater down comers shall be standard Cast Iron Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer. 35.03.02 Rainwater down-comers shall run along and be secured to walls, columns etc. where desired by the Engineer these may have to be installed in chases cut in the structure 35.03.03 All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be		
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provided against the vertical surface to which the pipe is fixed. All bends and junctions shall be supplied with watertight cleanouts.

35.03.04 Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

35.03.05 All horizontal pipes shall have a minimum fall of 1 in 100.

35.04.00 Gutters

35.04.01 The gutters shall be made of G.I. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

35.04.02 Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

35.05.00 Soil and drainage pipes

35.05.01 GRADIENTS

i) If not specified the minimum gradients of soil and drainage pipe line shall be as follows.

a)	100 mm nominal dia	:	1 in 35
b)	150 mm nominal dia	:	1 in 65
c)	230 mm nominal dia	:	1 in 120
d)	300 mm nominal dia	:	1 in 200

35.05.02 RELATION WITH WATER SUPPLY PIPE LINES

i) Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

35.05.03 LAYING

- i) Each separate pipe shall be individually set for line and for level.
- ii) Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart.

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- iii) Each pipe shall be separately and accurately boned between sight rails.

35.05.04 SUPPORT AND PROTECTION ON PIPELINES

- i) All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel.
- ii) To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground.
- iii) If anywhere the excavation has been carried too low packing shall be done in concrete.
- iv) Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer.
- v) The minimum support and protection for glazed stoneware pipes shall be as follows:
 - a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
 - b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.
 - c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.
 - d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.
 - e) Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

35.06.00 Entry into structures

35.06.01 For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used to allow easy repairs and replacement of the pipes.

35.06.02 When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer.

35.06.03 After laying of the pipeline the openings and chases shall be mended.

35.07.00 Ducts

35.07.01 Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a

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gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

35.08.00 **Traps and Ventilating Pipes**

35.08.01 Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

35.08.02 Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

35.09.00 **Manhole and Inspection Chambers**

35.09.01 The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gull chamber shall not exceed 6 metre unless desired otherwise.

35.09.02 Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

35.09.03 Connecting to existing sewer lines shall be through a manhole.

35.09.04 Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

35.10.00 **Cutting of Pipes**

35.10.01 Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

35.11.00 **Jointing**

35.11.01 Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone. with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

35.11.02 All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing

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shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer.

i) *Cast Iron Pipes*

- a) Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

ii) *Concrete Pipes*

- a) Care shall be taken to place the collar centrally over the joint.

35.12.00 Trenches and other excavations

35.12.01 Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

35.12.02 Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

35.12.03 All excavation shall be properly timbered, where necessary. Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

35.12.04 Where the excavation proceeds through roads necessary permissions shall be secured by the Bidders from the appropriate authorities. Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

35.12.05 The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

35.13.00 Fixtures

35.13.01 All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

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35.13.02 All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Bidder shall produce the test reports and convince the Engineer about their durability.

35.13.03 WATER CLOSET

i) *Raised type*

a) It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

ii) *Squatting type*

a) It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

35.13.04 URINALS

i) It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

35.13.05 WASH BASIN

i) It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

35.13.06 SINK

i) It shall be made of Marble or Granite. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, and lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

35.13.07 BATHROOM MIRROR

i) It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets.

35.13.08 GLASS SHELVES

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i) Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated. 35.13.09 TOWEL RAIL i) Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated. 35.13.10 INSTALLATION i) All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Bidder. 35.14.00 Effluent disposal 35.14.01 Effluent Disposal i) The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed CI pipes laid in a trench filled with broken bricks. 35.14.02 Joining C.I. Pipes / dispersion trenches Minimum dia of the CI pipe shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be made with lead. The entire length of the pipe within the trench shall be buried in 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for fill in the top of trench. 35.15.00 Testing and acceptance 35.15.01 INSPECTION BEFORE INSTALLATION i) All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site. 35.15.02 TESTING OF PIPELINES i) Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. ii) General guidance for the tests are given below: a) Smoke test 1) All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. b) Water test		
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- 1) For pipes other than Cast Iron
- 2) Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.
- 3) Subsidence of test water may due to one or more of the following cases :
 - Absorption by pipes and joints
 - Sweating of pipes or joints
 - Leakage at joints or from defective pipes
 - Trapped air.
- 4) Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.
- 5) For cast iron pipes
- 6) Cast iron sewers and drains shall be tested as for glazed ware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

- 1) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore
- 2) By means of a mirror at one end of the line and lamp at the other.

35.15.03 FIXTURES ETC.

- i) All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

36.00.00 PLANT STORM WATER DRAINAGE

36.01.00 Plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, intensity of rainfall, etc. The storm water drainage shall cater to storm water runoff resulting from one hour rainfall intensity, with a return period of 100 years. These values shall be based on the recommendations of the Meteorological Department. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8

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m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. Pipe or box culverts shall be provided at rail, road or other crossings. Minimum 450mm earth cushion shall be provided for pipes over paved area or minimum 600mm over pipe culverts. If adequate earth cushion is not available, the pipe shall be encased in RCC-M20 of 200mm thick.

- 36.02.00 All plant effluent drainage shall be through buried concrete pipes unless otherwise specifically required. Catch pit shall be provided at the source location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipelines. Manholes shall be provided. Catch pits shall have minimum diameter of 600 x 600mm. They shall be of RCC construction with CI grills. The main and branch connection pipes shall be sized for the expected mass discharge subjected to a min of 250mm NB and 100mm NB respectively. The pipes shall be properly sloped and shall carry discharge to neutralization pit/ETP/oil wash separator as required.
- 36.03.00 All storm water drain shall generally be through open drains. Open storm water drains shall be provided on both sides of the roads and shall be designed to drain the road surface as well as all the free and covered areas, etc. which will be connected to the rain harvesting tank designed as per the norms and regulations. The drain shall be minimum 300mm wide at the base.
- 36.04.00 Open RCC rectangular section shall be provided for all drains. RCC drains located within and along both sides of peripheral roads of the main plant area, shall be covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0m intervals. The thickness of the wall and base slab shall be minimum 150mm.
- 36.05.00 Similarly all artery drains and the drains along the periphery of building shall also have perforated precast RCC covers of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 m intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. The thickness of side walls and bottom slab of RCC drains shall be minimum 200 mm or as per design considerations whichever is higher. RCC box/pre cast R.C.C pipe culverts shall be provided for road and rail crossing.
- 36.06.00 All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.
- 36.07.00 Invert of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level.
- 36.08.00 For pipe drains, concrete pipes of class NP3 (Minimum) shall be used. For road and rail crossings concrete pipes of class NP3 and NP4 respectively shall be used. The pipes shall be laid as per IS: 783. In this case open catch water drain shall be provided on the other side of road and connected to pipe drain through RCC manholes. RCC manholes shall be provided at every 30m interval along

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the length, at connection points and at every change of alignment, gradient and diameter of pipeline. 36.09.00 The invert of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main/ trunk drains under all conditions. Garland drain shall be provided with brick masonry wall minimum 200mm thick over 100mm thick PCC. It should be minimum 300mm wide and 300mm depth. It should be connected with nearest main drains. 36.10.00 Storm water drains with depths more than 800mm shall be provided minimum 600mm width. 37.00.00 RAIN WATER HARVESTING 37.01.00 A detailed scheme for rain water harvesting to recharge the ground water aquifer shall be prepared in consultation with Central Ground Water Authority /State Ground Water Board and it is to be implemented for effective operation. 37.02.00 This shall include ground water recharging with clean water collected from roof of buildings like Administration Building and collection of clean rain water from other areas in a pond. 38.00.00 ROADS 38.01.00 General 38.01.01 All main plant roads (Part-B) will be in concrete rigid pavement with minimum 300 thick PQC as per IRC except patrolling roads. The width of the main road on East side of BTG island road shall be 4 lane road 15m wide including 1m divider. 1.5m shoulder shall be provided on both side of road. BTG Island shall be having 10 m wide road and 1.5 m wide shoulder on either side. The minimum radius of curvature of the turnings shall be as per IRC standards. All necessary culverts shall be in the scope of the Bidder. 38.01.02 All internal roads of BTG Island shall be Concrete rigid pavement with minimum 7.0m wide road and 1.5m wide shoulder on both side of roads. 38.01.03 The scope of work shall also include the patrol road around the plant area and parallel to boundary wall. The patrol road will be 4m wide and 0.75m shoulder on either side of patrol road for all around plant area parallel to compound wall. It should be WBM pavement. 38.01.04 Structural and Geometric design of road shall be done in accordance with the IRC Class AA loading Shoulders shall have sufficient load bearing capacity to support loaded trucks. A slope of 1 in 30 shall be provided on shoulders. Road lighting, road signs, and marking shall be provided to the road network. 38.01.05 Roads and parking areas of main plant area shall be of rigid pavement type and shall be designed in accordance with the provision of the relevant IRC Codes of Practices. Top level of parking area shall be flushed with crown of the connecting roads with a cross slope. 38.01.06 300mm thick with 8mm TOR at 250mm c/c both ways at top and bottom (double layer) with provision of edge beam of minimum width 150 mm should be		
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considered to avoid uplift & displacement criteria. Two layer of granular sub-base 125mm thick each layer plus 100mm thick PCC shall be provided.

- 38.01.07 The sub-grade shall be compacted to at least 98% Proctor Dry Density. The actual thickness road pavement, sub-base thickness, reinforcement etc., shall be provided as per design and functional requirements.
- 38.01.08 Roads shall be designed for IRC and MOST standards (MORTH).
- 38.01.09 The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for manoeuvring of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Finished top (crest) of roads shall be 200 mm above the surrounding grade level.
- 38.01.10 Minimum radius of curvature along the inner side of the carriageway shall normally not be less than 15m. However, it can be reduced for minor roads suitably as per layout requirements and site conditions subject to approval by the Owner/ Engineer. Road width and turning radii shall also be checked for adequacy with respect to the largest foreseeable vehicles and equipment.
- 38.01.11 All service and utility lines crossing under roads shall be taken through concrete pipes/ ducts/culverts and designed for imposed loading. Number of such crossings shall however be kept to a minimum.
- 38.01.12 Plant effluents shall be handled in separate drains/ pipes. The plant effluent drain shall not be mixed with storm water drain or sewer lines.
- 38.01.13 The joints, dowel bars, tie bars, joint pillars, ceiling compounds tolerances curing shall be as per latest IRC MOST standards.
- 38.02.00 **Roads – Bitumen Roads [Part – A]**
- 38.02.01 **QUALITY CONTROL**
- i) The Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter and recent codal provisions.
 - ii) **Horizontal Alignments**
 - a) Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings.
 - b) The edges of the carriageway as constructed shall be correct within a tolerance of (+) 25mm there from the corresponding tolerance for edges of the roadway and lower layers of pavement shall be + 40 mm.
 - iii) **Surface Regularity of Sub grade and Pavement Courses**
 - a) The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

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- b) The longitudinal profile shall be checked with a 3meter long straight edge, at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.
- c) The levels of the sub grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

TABLE 1 TOLERANCES IN SURFACE LEVELS (Table 900-1 of MORT&H)

1.0	Sub grade	+ 20 mm
2.0	Sub-base + 10 mm :	- 25 mm
(a)	Flexible pavement	-20 mm
(b)	Concrete pavement (Dry lean concrete or Rolled concrete)	+6 mm - 10 mm
3.0	Base-course for flexible pavement	
(a)	Bituminous course	+ 6 mm/ - 6 mm
(b)	Other than bituminous	+ 10 mm
	(i) Machine laid	-10 mm/+15 mm
	(ii) Manually laid	- 15 mm
4.0	Wearing course for flexible pavement :	
(a)	Machine laid	+ 6 mm, - 6 mm
(b)	Manually laid	+10 mm, -10 mm
5.0	Cement concrete pavement	+ 5 mm, - 6 mm *

- d) * This may not exceed - 8 mm at 0- 30 cm from the edges. Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.
- e) For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance. Maximum permitted number of surface irregularities shall be as per table 900-2 of mort & h). The maximum allowable difference between the road surface and underside of a 3 m


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straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

(a)	for pavement surface (bituminous and cement concrete).	:	3 mm
(b)	for bituminous base courses .	:	6 mm
(c)	for granular sub-base/base courses	:	8 mm
(d)	for sub-bases under concrete pavements	:	10 mm



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TABLE -3 PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sr. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge				Cross Profile	
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding mm				Maximum permissible variation from specified profile under camber template. mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1.0	Earthen subgrade	25	30	-	-	-	15
2.0	Granular subbase	15	-	30	-	-	12
3.0	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.0	Water Bound Macadam with normal size metal (20-50 mm and 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.0	Surface dressing ** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam or built-up spray grout	12	-	-	20	-	8
6.0	Open graded premix carpet mixseal surfacing	10	-	-	-	30	6
7.0	Bituminous macadam	10	-	-	-	20***	6
8.0	Semi-dense carpet	10	-	-	-	20***	6
9.0	Asphaltic Concrete	8	-	-	-	10***	4

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Sr. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge				Cross Profile	
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding mm				Maximum permissible variation from specified profile under camber template. mm
			18	12	10	6	

NOTES :

- **For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.
- *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.
- Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

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38.02.02 RECTIFICATION

- i) Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Bidder shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.
- ii) Subgrade: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305 of MORT&H.
- iii) Granular sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401 of MORT&H.
- iv) Water Bound Macadam/Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406 of MORT&H.
- v) Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.
- vi) For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width.
- vii) Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

38.02.03 EXECUTION

- i) **Kerb**
 - a) Material
 - 1) Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15. The blocks shall be 100 mm wide and of suitable length. The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level.
 - b) Laying
 - 1) The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the

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kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm. The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face.

ii) Sub-base (granular sub-base)
a) Description

- 1) This work shall consist of laying and compacting well-graded material on prepared sub grad in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

b) Materials

- 1) The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 4.
- 2) While the gradings in Table 4 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 5.

TABLE 4 : GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS (TABLE 400-1 of MORT&H)

Sr. No.	IS Sieve	Per cent by weight passing the IS sieve		
	Designation	Grading I	Grading II	Grading III
1.0	75.0 mm	100	-	-
2.0	53.0 mm	80-100	100	-
3.0	26.5 mm	55-90	70-100	100
4.0	9.50 mm	35-65	50-80	65-95
5.0	4.75 mm	25-55	40-65	50-80
6.0	2.36 mm	20-40	30-50	40-65
7.0	0.425 mm	10-25	15-25	20-35
8.0	0.075 mm	3-10	3-10	3-10
9.0	CBR Value (Minimum)	30	25	20

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c) Note:

- 1) The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

d) Physical Requirements

- 1) The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days. The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition)
- 2) when tested in compliance with BS: 812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent

e) Spreading and Compacting

- 1) Immediately prior to the laying of sub-base, the sub grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.
- 2) The sub-base material shall be spread on the subgrade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.
- 3) The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.
- 4) Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree.

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5) Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

6) Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material. Rolling shall be continued till the density achieved is at least 95% of the maximum dry density for the material determined as per IS:2720 (Part VII).

iii) *Water bound macadam sub-base/base course*

a) Description

1) Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling, and bonded together with screenings, binding material, where necessary and water, laid on a prepared subgrade or sub-base, as the case may be, and finished in accordance with the requirements of MORT&H Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer.

b) Materials

1) Coarse Aggregates

- Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quantity. The aggregates shall conform to the physical requirements set forth in Table 5.

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TABLE 5 (Table 400-6 of MORT&H): PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES

Sr. No.	Test	Test Method	Requirements
1.0	* Los Angeles Abrasion value	IS : 2386 (part – 4)	40 per cent (Max)
	OR * Aggregate Impact value	IS : 2386 (part-4) or IS : 5640**	30 per cent (Max)
2.0	Combined Flakiness and Elongation Indices (Total) ***	IS : 2386 (Part-1)	30 per cent (Max)

- Aggregate may satisfy requirements of either of the two tests.
- ** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS : 5640.
- *** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

2) Crushed or Broken Stone

- Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3) Grading Requirements of Coarse Aggregates

- The coarse aggregates shall conform to one of the gradings given in Table 6, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE 6 (Table 400-8 of MORT&H): GRADING REQUIREMENTS OF COARSE

Grading No.	Size Range	IS Sieve Designation	Per cent by weight passing
1.0	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2.0	63 mm to 45 mm	125 mm	100

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		90 mm	90-100
		63 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.0	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2	0-5
	Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Grading e.g. 2 & 3, it shall be 75 mm.		

4) Screenings

- Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75micron sieve does not exceed 10 percent.
- Screenings shall conform to the grading set forth in Table7.

TABLE 7: GRADINGS FOR SCREENINGS (Table 400-8 of MORT&H)

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS Sieve
A	13.2 mm	12.2 mm	100
		11.2 mm	95-100
		5.6 mm	15.35
		180 micron	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micron	15.35

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5) Binding Material

- Binding material to be used for water bound macadam as a filter material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part-5). The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m³/10m² and 0.08-0.10m³/10m² for 100 mm compacted thickness.
- The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

iv) *Construction Operations*

a) Preparation of Base

- 1) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material.
- 2) Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

b) Inverted Choke

- 1) If the water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared subgrade before application of the coarse aggregates is taken up.

c) Spreading Coarse Aggregate

- 1) The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.
- 2) The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles.
- 3) In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.
- 4) The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

d) Rolling

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- 1) Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of approved type. Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.
 - 2) The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade.
- e) Applications of Screenings
- 1) After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders. The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.
 - 2) The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.
- f) Sprinkling and Grouting
- 1) After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly.
 - 2) The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in

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its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

g) Application of Binding Material

- 1) After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate.
- 2) After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them.
- 3) These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

h) Setting and Drying

- 1) After the final compaction of water bound macadam course, the road shall be allowed to dry overnight.
- 2) Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled.
- 3) No traffic shall be allowed on the road until the macadam has set.

v) *Tack coat*

a) Description

- 1) The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

b) Materials

- 1) Binder: The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, IS: 8887 of a type and grade as specified in the Contract or as directed by the Engineer as applicable, or any other approved cutback.

c) Construction Operations

- 1) Preparation of Base
 - The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom and high pressure air jet, or by other means as directed by the Engineer.

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2) Application of Binder

- Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square metre area for an existing bitumen treated surface and 10 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The normal range of spraying temperature for a bituminous emulsion shall be 20 degree Celsius - 70 degree Celsius and for a cutback 50 degree Celsius – 80 degree Celsius if RC-70/MC-70 grade is used. The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The tack coat shall be applied just ahead of the on-coming bituminous construction.

38.02.04 BITUMINOUS MACADAM BINDER COURSE
i) Description

- This work shall consist of construction, in a single course, of 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

ii) Materials
a) Binder

- The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS: 73.

b) Aggregates

- The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones.
- They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats.
- The aggregates shall preferably be hydrophobic and of low porosity. The aggregates shall satisfy the physical requirements in Table-8.

**TABLE-8 PHYSICAL REQUIREMENTS OF AGGREGATES OF BITUMINOUS
MACADAM**

Sr. No	Test	Test method	Requirements
1.0	Los Angeles Abrasion *	IS:2386 (Part IV)	35% Maximum

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	Value			
2.0	Aggregate Impact Value *	-do-	30%	"
3.0	Flakiness Index	IS:2386 (Part I)	35%	"
4.0	Stripping Value	IS:6241	25%	"
5.0	Water Absorption	IS:2386 (Part III)	2%	"

Aggregates may satisfy requirements of either of the two tests. The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables 9 & 10.

TABLE-9: AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sr. No.	Sieve Designation	Percent by weight passing the sieve	
		Grading A	Grading B
(a)	63 mm	100	
(b)	50 mm	90-100	
(c)	40 mm	35-65	100
(d)	25 mm	20-40	70-100
(e)	20 mm	-	50-80
(f)	12.5 mm	5-20	-
(g)	4.75 mm	-	10-30
(h)	2.36 mm	-	5-20
(i)	75 micron	0-5	0-4

TABLE 10: AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sr. No.	Sieve Designation	Percent by weight passing the sieve	
		Grading A	Grading B
(a)	50 mm	100	
(b)	40 mm	90-100	
(c)	25 mm	50-80	100
(d)	20 mm	-	70-100
(e)	12.5 mm	10-30	-
(f)	10 mm	-	35-60

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(g)	4.75 mm	-	10-30
(h)	2.36 mm	-	5-20
(i)	75 micron	0-5	0-4

c) Fine aggregates

- 1) Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter
- 2) Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter

d) Proportioning of Materials

- 1) The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.
- 2) The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

e) Variation in Proportioning of Materials

- 1) The Bidder shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix.
- 2) A variation in binder content of +/- 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

iii) Construction Operations
a) Weather and Seasonal Limitations

- 1) Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

- 1) The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer.
- 2) The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

c) Tack Coat

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- 1) A tack coat shall be applied over the base.
- d) Preparation and Transport of Mix
- 1) Hot mix plant of adequate capacity shall be used for preparing the mix.
 - 2) The temperature of binder at the time of mixing shall be in the range 150 Deg.- 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.
 - 3) The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.
- e) Spreading
- 1) The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.
 - 2) The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.
 - 3) In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the centre line of the pavement.
 - 4) Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.
- f) Rolling
- 1) After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.
 - 2) Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except that on super-elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement.
 - 3) The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter mediate rolling

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shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel lubricating oil be used for this purpose.

- 4) Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.
- 5) Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.
- 6) The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

38.02.05 OPEN-GRADED PREMIX CARPET

i) *Description*

- a) This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

ii) *Materials*

a) Binder

- 1) The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

b) Aggregates

- 1) The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and

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vegetable or other deleterious matter. They shall preferably be hydrophobic type.

- 2) The aggregates shall satisfy the quality requirements set forth in Table 8 except that the Flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

TABLE-11: QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Sr. No.		
1.0	Aggregates of Carpet	
	(a) Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve.	0.18 Cu.m
	(b) Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve.	0.09 Cu.m
	Total:	0.27 Cu.m
2.0	Binder for premixing (quantities in terms of straight run bitumen.	
	(a) For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m.	9.5 kg
	(b) For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m.	5.1 kg
	Total:	14.6 Kg.

iii) Construction Operation

a) Weather and Seasonal Limitations

- 1) Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

b) Preparation of Base

- 1) The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked

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earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

- 1) A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

d) Preparation of Premix

- 1) Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.
- 2) The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.
- 3) The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.
- 4) The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows.

e) Spreading and Rolling

- 1) The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the centre line of the pavement
- 2) When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

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- 3) The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

f) Seal Coat

- 1) A seal coat conforming to clause 3.8 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

38.02.06 SEAL COAT

i) Description

- a) This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.
- b) Seal coat shall be of either of the two types below, as specified:
- 1) Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stonee chippings.
 - 2) Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

ii) Materials

a) Binder

- 1) The binder shall be bitumen of a suitable grade as directed by the Engineer and conforming to the requirements of IS:73, 217 or 454 as applicable or any other approved cutback
- 2) The quantity of binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square metre area for Type A and Type B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

- 1) The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 10 square metre area. The chippings shall satisfy the quality requirements spelled out in Table VI except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

- 1) The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious

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substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

iii) *Construction Operations*

a) Preparation of Base

- 1) The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

b) Construction of Type A Seal Coat

- 1) The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.
- 2) Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.
- 3) Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the centre except in super elevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

c) Construction of Type B Seal Coat

- 1) Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.
- 2) The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with the former.

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3) The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

4) As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6-8 tonne smooth wheeled power rollers. Rolling shall be continued till the pre-mixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

iv) *Opening to Traffic*

1) In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type a seal coat, traffic shall not be permitted until the following day.

38.02.07 REPAIR OF EXISTING WATER BOUND MACADAM SURFACE

i) Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

ii) Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

iii) The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides and re-laid with graded material as per specification of granular sub-base and then surfaced with water bound macadam as per specification for the same.

38.02.08 BITUMINOUS CONCRETE

i) *Scope*

a) This clause specifies the construction of bituminous concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

ii) *Materials*

a) Bitumen

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- 1) The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specification for Paving Bitumen. IS:73 and of the penetration indicated in Table 500-18 of MORT&H, for bituminous concrete or this bitumen as modified by one of the methods specified in clause 521 of MORT&H, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.
- b) Coarse Aggregates
 - 1) The coarse aggregates shall be generally as specified in clause 507.2.2 of MORT&H, except that the aggregates shall satisfy the physical requirements of Table 500-17 of MORT&H.
- c) Fine Aggregates
 - 1) The fine aggregates shall be all as specified in clause 507.2.3 of MORT&H.
- d) Filler
 - 1) Filler shall be generally as specified in clause 507.2.4 of MORT&H. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 of MORT&H then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.
- e) Aggregate grading and binder content
 - 1) When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall
 - 2) Within the limits shown in Table 500-18 of MORT&H for gradings 1 or 2 as specified in the Contract.
- iii) *Mixture Design*
 - a) Requirements for the mixture
 - 1) Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-19 of MORT&H.
 - 2) The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORT&H.
 - b) Binder content
 - 1) The binder content shall be optimised to achieve the requirements of the mixture Set out in Table 500-19 of MORT&H and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the

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aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

c) Job mix formula

- 1) The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 of MORT&H as obtained by the Bidders.

d) Plant trials-permissible variation in job mix formula

- 1) The requirements for plant trials shall be all as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 as obtained by the Bidders.

e) Laying trials

- 1) The requirements for plant trials shall be all as specified in clause 507.3.5 of MORT&H.

iv) *Construction Operations*

a) Weather and seasonal limitations

- 1) The provisions of clause 501.5.1 of MORT&H shall apply.

b) Preparation of base

- 1) The surface on which the bituminous concrete is to be laid shall be prepared in accordance with clauses 501 and 902 of MORT&H as appropriate, or as directed by the engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air.

c) Tack coat

- 1) Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of clause 503 of MORT&H.

d) Mixing and transportation of the mixture

- 1) The provisions as specified in clauses 501.3 and 501.5.4 of MORT&H shall apply.

e) Spreading

- 1) The general provisions of clauses 501.5.3 and 501.5.4 of MORT&H shall apply.

f) Rolling

- 1) The general provisions of clauses 501.6 and 501.7 of MORT&H shall apply, as modified by the approved laying trials.

v) *Opening to traffic*

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- a) The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the engineer in writing.
- vi) *Surface finish and Quality control*
- a) The surface finish of the completed construction shall conform to the requirements of clause 902 of MORT&H. All materials and workmanship shall comply with the provisions set out in section 900 of this specification.
- vii) *Arrangements for traffic*
- a) During the period of construction, arrangements for traffic shall be made in accordance with the provisions of clause 112 of MORT&H.

38.03.00 Concrete Roads [Part-B]

38.03.01 QUALITY CONTROL

- i) The Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.
- ii) All works performed shall conform to the lines, grades, and cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.
- a) Horizontal Alignments
- 1) Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 40 mm.
- b) Longitudinal Profile
- 1) The levels of the sub grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below :
- Sub-grade ± 25 mm
 - Sub-base ± 20 mm

38.03.02 EXECUTION

- i) *Shoulder construction*
- a) Description
- 1) This work shall consist of constructing shoulders on either side of the pavement, accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

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b) Materials

- 1) Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub- base construction respectively.
- 2) Hard Shoulders shall be 80mm thick PCC interlocking blocks(grade M-35) over PCC M-7.5 with sand bedding on an under-bed of 150mm thick WBM on either side of the roads. Precast Kerb stone, for construction of shoulder, shall be of precast concrete blocks having a concrete grade of M-25. The blocks shall be 100 mm wide and of suitable length and depth

c) Construction Operations

- 1) Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.
- 2) During all stages of shoulder construction, the required cross fall shall be maintained to drain off surface water.

ii) *Kerb*

a) Material

- 1) Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15.
- 2) The blocks shall be 100 mm wide and of suitable length.
- 3) The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level

b) Laying

- 1) The Kerb shall be laid by cutting trenches 150 mm deep.
- 2) The width of the trench shall be minimum and just sufficient to insert the kerbs.
- 3) The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.
- 4) The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face.

iii) *Sub-base (granular sub-base)*

a) Description

- 1) This work shall consist of laying and compacting well-graded material on prepared sub grade in accordance with the requirements

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of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

b) Materials

- 1) The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table-I below:

TABLE-I: GRADING FOR GRANULAR SUB-BASE MATERIALS

Sr. No.	Sieve designation	Percent by weight passing the sieve		
		Grading 1	Grading 2	Grading 3
1.0	80 mm	100	100	100
2.0	63 mm	90-100	90-100	90-100
3.0	4.75 mm	35-70	40-90	50-100
4.0	75 micron	0-20	0-25	0-30
5.0	CBR Value (Minimum) for fraction of material passing 20 mm sieve	30%	25%	20%

- **Note:** The material passing 425 micron sieve for all the three grading when tested according to IS: 2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

c) Physical Requirements

- 1) The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days.

d) Spreading and Compacting

- 1) Immediately prior to the laying of sub-base, the sub grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

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- 2) The sub-base material shall be spread on the sub grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.
- 3) Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part VIII). While adding water due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.
- 4) Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.
- 5) Rolling shall be continued till the density achieved is at least 100% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

38.03.03 CEMENT CONCRETE (PLAIN AND REINFORCED)

i) General

- 1) All concrete work shall be according to ISI relevant Codes unless mentioned otherwise herein and the ISI Codes particularly IS:226, IS:455, IS:385, IS:1786 & IS:456 latest editions shall form a part of the present specification.

ii) Materials

a) Cement :

- 1) The cement used shall be ordinary Portland cement/ Blast Furnace slag cement/ Portland Pozzolana cement, sulphate resistant cement of Mahagenco's approved manufacture and shall be fresh when

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delivered. Consignments shall be used in the order of delivery. Damaged or partly set cement shall not be permitted to be used and shall be removed from site at once.

- 2) Admixture shall be used only if approved by the Engineer. The Bidder shall furnish to the Engineer, the manufacturer's certificate for cement for each consignment, procured by the Bidder direct. If at any time, the Engineer feels that the quality of cement is not upto the specification, he can stop the work and send samples of cement for testing to an approved laboratory. The Bidder shall have no claim for any loss arising out of such suspension of work.

b) Aggregate :

1) General

- Aggregate shall consist of natural sand, crushed stone procured from a source known to produce satisfactory aggregate for concrete and shall be chemically inert strong, hard, durable against weathering, of limited porosity and free from adhering coatings, clay lumps, coal and coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. They shall conform to IS: 383 - latest edition.

2) Sand and Fine Aggregate :

- It shall be clean, sharp and coarse and free from all impurities and shall be washed and/or screened at the site if so demanded by the Engineer. Sand and fine aggregate shall correspond to IS: 383 - latest edition. The fine aggregate shall not contain more than 3 percent of clay or foreign matter. Fineness modulus of sand shall not be less than 2.5.

3) Coarse Aggregate:

- This shall consist of broken trap, basalt or granite or some other suitable stone from a source to be approved by the Engineer and shall meet the requirements of IS: 383 - latest edition. The coarse aggregate shall be machine crushed, hard, strong, durable, free from clayey films or loamy admixtures, vegetable or organic matters and shall be washed with water and/or screened if so demanded by the Engineer. The aggregate shall be well graded. The pieces shall be angular in shape and shall have granular or crystalline surface. Friable, flaky and laminated pieces, mica and shell may be present only in such quantities that will not affect adversely the strength and/or durability of concrete and to the approval of the Engineer. The maximum size of coarse aggregate shall be 38 mm for lean concrete and M10 Grade concrete and 20 mm for M15 Grade concrete.

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- Where permitted by the Engineer, the maximum size of the coarse aggregate may be large. All aggregate shall be uniformly graded. The amount of fine particles occurring in the Free State or as loose adherent shall not exceed 1% when determined by laboratory sedimentations tests. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of the weight.

c) Water :

- Water shall be clean, fresh and free from organic or deleterious matter in solution or in suspension in such amounts that may impair the strength or durability of the concrete. The Bidder shall, however, satisfy himself that the quality is upto the desired standard and shall also submit an analysis from an approved analyst if so desired by the Engineer, free of charge.

d) Reinforcements :

- The reinforcement shall be mild or to steel bars conforming to the latest edition of IS: 432 or IS: 1786.
- All reinforcing bars must be completely free from grease, oil, dirt, scales, scrap able rust, bituminous material, paint, pitted surface and manufacturing defects.

e) Tie bars.

- Tie bars in longitudinal joints shall be deformed steel bars of strength 415 Mpa complying with IS: 1786 and in accordance with the requirements given below. The bars shall be free from oil, dirt, loose rust and scale. Design of tie bar shall be as per IRC: 58.
 - Tie bars projecting across the longitudinal joint shall be projected from corrosion for 75mm on each side of the joints by a proactive coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used.
 - Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of slab. Alternatively, tie bars at longitudinal joints may be mechanically or manually inserted into the plastic concrete from the above by vibration using a method which ensure correct placement of bars and reoccupation of the concrete around the tie bars.
 - Tie bars shall be positioned to remain within the middle third of the slab depth as indicated in the drawing and approximately parallel to the surface and approximately perpendicular to the line of joints, with the centre of each bars on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30mm below the joint groove.

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f) Separation Membrane.

- 1) Separation membrane shall be used between the concrete slab and the sub base. Separation membrane shall be impermeable plastic sheeting 125 micron thick laid flat without creases. Before placing the separation membrane, the sub base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300mm and any damaged sheeting shall be replaced at the Bidders expense. The separation membrane may be nailed to the lower layer with concrete nail.

iii) Joints

- a) The location and type of joints shall be shown in the drawing. The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It should be ensured that the full required depth of cut is made from edge to edge of the pavement. Transverse and Longitudinal joints in the pavement and sub base shall be staggered so that they are not coincident vertically and are at least 1m and 0.3m apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and personal without damaging the texture of the pavement. Sawing operation could start as early as 6-8 hours depending upon the season. All joints shall be designed as per IRC: 58.

b) Transverse joints.

- 1) Location of construction joints/ expansion joints shall be as per drawing. Transverse joints shall be straight within the following tolerance along the intended line of joints which is the straight line transverse to the longitudinal axis of the carriageway at the position proposed by the Bidder and agreed to by the Engineer, except at the junction or roundabouts where the position shall be as described in the drawing.
 - Deviations of the filler board in the case of expansion joints from the intended line of the joint shall not greater than $\pm 10\text{mm}$.
 - The best fit straight line through the joints grooves as constructed shall not more than 25mm from the intended line of the joint.
 - Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10mm.
 - Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width.

c) Longitudinal joints.

- 1) The longitudinal joints shall be saw cut as per details of the joints shown in the drawing. The groove may be cut after the final set of the

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concrete. Joints should be sawn to at least 1/3 the depth of the $\pm$ 5mm as indicated in the drawing.

- 2) Dowel bars: Dowel bars shall be mild steel rounds in accordance with details/ dimensions as indicated in the drawing and free from oil, dirt, loose rust or scale. They shall be straight free of irregularities and burring restricting slippage in concrete. The sliding ends shall be sawn or cropped clearly with no protrusions outside the normal diameter of the bar. The dowel bar shall be supported on cradles/dowels chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full reoccupation of the concrete around the dowel bars.
- 3) Unless shown otherwise on the drawings, dowels bars shall be positioned at mid depth of the slab within a tolerance of $\pm$ 20mm, and cantered equally about intended lines of the joint within a tolerance of $\pm$ 25mm.
- 4) Dowel bars shall be covered by a thin plastic sheath for at least two thirds of the length from one end for dowels bars in contraction joints or half the length plus 50mm for expansion joints. The sheath shall be tough, durable and of an average thickness not greater than 1.25mm.
- 5) For expansion joints, a closely fitting cap 100mm long consisting of waterproofed cardboard or an approved synthetic material like PVC or GI pipes shall be placed over the sheathed end of each dowel bar. An expansion space at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of the cement slurry between dowels and cap it may be taped. Design of dowel bars shall be as per IRC: 58.

d) Joint sealing compound.

- 1) The joint sealing compound shall be hot poured, electrometric type or cold polysulphide type having flexibility, resistance to age hardening and durability. If the sealant is of hot poured type it shall confirm to AASHTO M282 and cold applied sealant shall be in accordance with BS5212 (PART 2).

iv) *Storage of Materials*

a) Cement :

- 1) Cement shall be stored at the works in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Sufficient storage shall be arranged by the Bidder to ensure continuity of consumption.

b) Aggregates :

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- 1) Aggregates shall be stored on planking, steel plates or concrete. Different sizes shall be separated with wooden, steel, or concrete bulkheads. Care shall be taken to prevent any segregation of various sizes of particles. The aggregates must not be allowed to come in contact with dirt, clay and other injurious substances at any stage. The aggregate shall be stored in easily measurable stacks.
- c) Reinforcement :
 - 1) Reinforcing steel shall be stored as far as possible under cover. It shall be protected from oil, grease, dirt, etc. The stacks shall be easily measurable.
- v) *Workmanship*
 - a) Reinforcement
 - 1) Bending :
 - Reinforcement bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bars correctly bent only will be used. Bends and shapes shall comply strictly with the dimensions in the approved bar bending schedule. Bending schedule shall be prepared by the Bidder and got approved by the Engineer before bending and he shall be entirely responsible for its correctness. No reinforcement shall be bent when in position in the work without approval of the Engineer, whether or not it is partially embedded in concrete. Unless described otherwise, lapping dimensions shall conform to IS:456 - latest edition and all bending shall correspond to IS:2502 - latest edition.
 - 2) Placing in Position :
 - Fixing of reinforcement shall correspond to IS: 2502 - latest edition. Reinforcements shall be accurately fixed and maintained in position by such means as mild steel chairs and concrete spacer pieces, Bars intended to be in contact at passing points shall be securely bound together at all such points by No. 20G annealed soft iron wire conforming to IS:280 - latest edition. Binders and the links shall tightly embrace the bars with which they are intended to be in contact and shall be securely bound. The vertical distances between successive layers of bars shall be maintained by provision of mild steel spacer bars at such intervals that the main bars do not sag perceptibly between adjacent spacer bars.
 - The placing of reinforcement shall be completed well in advance of concreting immediately before concreting; the reinforcement shall be examined for accuracy of placing and cleanliness by the Engineer and corrected if it is so desired by him. The cover for concrete over the reinforcements shall be as shown or as

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specified on the approved drawings. Unless otherwise directed, all laps shall be minimum 52 times the diameter of the bar in case of H.T. deformed bar and 40 times diameter of the bar in case of mild steel.

b) Formwork :

- 1) The formwork shall conform to the shape, line and dimensions as shown on the plans and shall be made of timber close and tight to prevent leakage of mortar with necessary props, bracings and wedges sufficiently strong and stable so that it should not yield on laying of concrete.

c) Concrete :

- 1) Mix: The following concrete mixes shall be used for concrete roads.
- 2) Grade M15 with minimum cement content of 325 kg/cum shall be used for DLC layer below PQC and minimum grade of M35 with minimum cement content of 360 kg/cum shall be used for PQC.
 - Water cement ratio and slump shall be determined to suit strength requirements of the concrete mix.
 - Mixing :
 - ♦ The aggregate and sand shall be washed free from all dust and earthy matter if required by the Engineer. The above materials will then be accurately measured in boxes. The quantity of cement shall be determined by weight. The quantity of water shall be predetermined after allowing for moisture content in the aggregate. All the ingredients as proportioned shall then be mixed in a mechanical mixer till the mass is uniform in texture and consistency, but in no case the mixing time shall be less than two minutes. Hand mixing if permitted by the Engineer as a special case shall be carried out on a water tight platform using 10% extra cement at Bidder's cost and care shall be taken to ensure that the mixing is continued till the mass is uniform in colour and consistency.
 - Placing and Compacting :
 - ♦ Concrete shall be transported from the place of mixture to the place of final deposit within 30 minutes after water has been added and shall be compacted before initial setting commence and should not be subsequently disturbed. Method of transporting and placing shall be such as to preclude segregation. Concrete shall be thoroughly worked around the reinforcements, etc. and into all corners of formwork. For compaction of concrete, mechanical vibrators shall be used. Concrete shall not be placed in water.
 - Curing :

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◆ Concrete shall be cured for at least 28 days from the date of placing of concrete.

• Testing of Concrete :

◆ Concrete shall be tested in accordance with IS:516 - latest edition and accepted in accordance with IS:456 - latest edition.

38.03.04 TESTING AND ACCEPTANCE CRITERIA

i) *Roads*

a) All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Bidder as per direction of the Engineer. No extra payment shall be made for such tests.

ii) *Masonry and plastering*

a) Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

iii) *Cement concrete*

a) The strength requirements and acceptance criteria shall conform to the relevant clauses of IS: 456.

39.00.00 CULVERTS

39.01.00 Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

39.02.00 The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

39.03.00 Pipe culverts and drainage pipes

39.03.01 MATERIALS

i) The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

ii) Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS: 458- Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tendered shall specifically mention the particular manufacturer's product he proposes to use.

iii) Cement shall be ordinary Portland Cement as per IS:269,8112 - Latest edition.

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iv) Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

v) Fine aggregates for concrete shall be as per IS: 383 - Latest edition.

39.03.02 LAYING OF PIPES

i) Laying of concrete pipes shall correspond to IS:783 - Latest edition – and to specification given below:

ii) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Bidder. Side slips, if there be any, shall be removed by the Bidder. After laying of the pipes are completed, backfilling of the trenches shall be done in the layers of 250 mm, measured loose, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

iii) Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

iv) When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

v) Laying of pipes shall start from the outlet and proceed towards inlet.

vi) All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

a) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition -having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

b) When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M15.

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- c) The drop walls shall be made with first class brickwork in 1:4cement mortar.
- d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.
- e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up.
- f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS: 783 - latest edition.

39.03.03 RELATION WITH WATER SUPPLY PIPELINE

- i) Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

39.04.00 **Testing and acceptance criteria**

39.04.01 Roads

- i) All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Bidder as per direction of the Engineer. No extra payment shall be made for such tests.

39.04.02 Masonry and plastering

- i) Masonry and finish to masonry and concrete shall fully comply with the drawings, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

39.04.03 Cement concrete

- i) The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

40.00.00 **INTER PLANT TRENCHES**

40.01.00 All cable and pipe trenches shall be of RCC with minimum M25 grade. Trenches located outside the buildings shall project at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.

40.02.00 Trenches shall be covered using precast RCC cover of minimum M25 grade, each not weighing more than 65 kg and shall be provided with a lifting hooks.

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40.03.00 As far as possible, trenches in the open area shall be avoided for running cables especially in areas where the water table is high. Instead cable racks running above ground shall be provided.

40.04.00 Formation of Drains:

40.04.01 The road side drains and minimum side slope shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

40.04.02 The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per Dwg. and as mentioned in the Schedule of items. Lining of drains may be of bricks or cement concrete blocks of M15 grade concrete as shown on drawing or as directed by the Engineer.

41.00.00 FENCING & GATE

41.01.00 Fencing

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

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

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

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

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

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

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41.01.07 Toe walls either of brick masonry with bricks of minimum 75 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement point (Sandtax Matt) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacing's. 41.02.00 Gate 41.02.01 All gates shall be of structural steel of minimum 5.0 metres clear width for single lane access road and 7.75 m clear width for double lane access roads. 41.02.02 The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m. 42.00.00 FIELD QUALITY PLAN 42.01.00 Field Quality Plan detailing out all the equipment, quality practices and procedures etc to be followed by the Bidder during various stages of site activities starting from receipt of materials/equipment shall be submitted by the Bidder for Owner / Engineer/ Consultant's approval. 42.02.00 All major bought out items shall be included in the quality plan. The Quality plan shall inter alia include following works/ Bought out items wherever relevant with respect to the Technical specifications and drawings. 42.03.00 Earthwork & roadwork's including selection of fill material, compaction, proctor density tests, preparation of sub-grade and sub-base for paving/road works etc. 42.03.01 Bituminous paints for water proofing & Bituminous concrete's 42.03.02 Cement, reinforcement steel & structural steel procurements 42.03.03 Coarse/ Fine aggregates, water for concrete 42.03.04 Cast-in-situ concrete & allied works 42.03.05 Masonry & allied works 42.03.06 Sheetting & Allied Works 42.03.07 Water supply & sanitation 42.03.08 Structural steel works including approved welding procedures 42.03.09 Floor finishes, tiling etc. 42.03.10 Doors including fire proof doors, windows, ventilators, partitions, louvers, rolling shutters etc 42.03.11 False ceiling & insulation systems 42.03.12 Roof metal decking/ Wall claddings		
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- 42.03.19 Roof water proofing
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- 42.03.21 Drainage/ Cross drainage works/ Hume pipes
- 42.03.22 Glazing & aluminium works as specified

43.00.00 CODES & STANDARDS

Sl. No.	Code No.	Description
A		GENERAL
i.		Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.
ii.		National Building Code of India.
iii.		"Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.
iv.		IS-1200: Method of measurement of Building and Civil Engineering Works.
v.		IS-1256: Code of Practice for Building Bylaw.
B		EARTHWORK
i.	IS-1498	Classification and identification of soils for General Engineering purposes.
ii.	IS-3764	Safety Code for excavation work.
iii.	IS-7293	Safety Code for working with construction machinery.
C		CONCRETE
i.	IS-269	Ordinary and low heat Portland cement.
ii.	IS-383	Coarse and fine aggregate from natural sources for concrete.
iii.	IS-432	Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
iv.	IS-455	Portland Slag Cement.
v.	IS-456	Code of Practice for Plain and reinforced concrete
vi.	IS-460	Test Sieves (all parts)
vii.	IS-516	Methods of test for strength of concrete

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Sl. No.	Code No.	Description
viii.	IS-1199	Methods of sampling and analysis of concrete.
ix.	IS-1489	Portland pozzolana cement Fly ash based (Part 1) and calcined clay based Part 2)
x.	IS-1566	Hard drawn steel wire fabric for concrete Reinforcement.
xi.	IS-1786	High strength deformed steel bars and wires for concrete reinforcement
xii.	IS-1834	Hot applied sealing compounds for joints in concrete.
xiii.	IS-2386	Methods of test for aggregates for concrete (all parts)
xiv.	IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement.
xv.	IS-3370	Code of practice for concrete structures for storage of liquids (all parts).
xvi.	IS-3414	Code of practice for design and installation of joints in buildings.
xvii.	IS-4948	Welded steel wire fabrics for general use.
xviii.	IS-6452	High Alumina Cement for Structural use.
xix.	IS-7320	Concrete slump test apparatus.
xx.	IS-7861	Code of practice for extreme weather concreting (all parts).
xxi.	IS-8041	Rapid Hardening Portland cement.
xxii.	IS-8112	High strength ordinary Portland Cement.
xxiii.	IS-14687	Formwork for concrete structures.
xxiv.	IS-10262	Recommended guidelines for concrete mix design.
D		FOUNDATIONS
i.	IS-1904	Code of practice for structural safety of buildings: Willow foundations.
ii.	IS-2950	Code of practice for design and construction of raft foundations.
iii.	IS-2974	Code of practice for design and construction of Machine foundations (all parts)
iv.	IS-2911	Code of practice for design and construction of Pile foundations.
v.	IS-5624	Specification for foundation bolts
vi.	IS-8009	Code of Practice for calculation of settlement of Foundations
vii.	IS-11089	Code of practice for design and construction of Ring foundations
viii.	IS-13301	Guidelines for vibration isolation for machine foundations

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TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND
ARCHITECTURAL WORKS

REV. - 0

Sl. No.	Code No.	Description
ix.	IS-1080	Code of practice for design and construction of willow foundations in soils (other than raft, ring and shell)
x.	DIN: 4024	Machine Foundations:-Flexible supporting structures for machine with rotating masses
xi.	DIN: 2089	Helical Compression spring out of round wire & rod- Calculation and design
xii.	DIN: 2096	Helical Compression spring out of round wire & rod Quality requirement for hot formed compression springs
xiii.	VDI: 2056	Criteria for assessing mechanical vibration of machine
xiv.	VDI: 2060	Criteria for assessing the state of balance of rotating rigid Bodies.
E		LOADING
i.	IS-875	Code of practice for Design loads for buildings and structures
F		MASONRY
i.	IS-712	Building limes
ii.	IS-1077	Common Burnt Clay Building Bricks.
iii.	IS-1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
iv.	IS-1528	Methods of sampling and physical tests for refractory materials
v.	IS-1597	Code of practice for construction of stone masonry (all parts)
vi.	IS-2212	Code of practice for brickwork
vii.	IS-2116	Sand for masonry mortars
viii.	IS-2185	Concrete masonry units.(all parts - Hollow and Solid concrete blocks).
ix.	IS-2250	Code of practice for preparation and use of masonry mortars.
x.	IS-2572	Code of practice for construction of hollow concrete block masonry
xi.	IS-2691	Burnt clay facing bricks
xii.	IS-3414	Code of practice for design and installation of joints in buildings.
xiii.	IS-3495	Methods of tests of burnt clay building bricks.
xiv.	IS-4441	Code of practice for use of Silicate type chemical resistant mortars.
xv.	IS-4860	Acid Resistant Bricks
xvi.	IS-13757	Burnt Clay Fly Ash Building Bricks
xvii.	IS-1905	Code of Practice for structural Use of Unreinforced

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REV. - 0

Sl. No.	Code No.	Description
		Masonry
G		DOORS, WINDOWS AND VENTILATORS
i.	IS-399	Classification of commercial timbers and their zonal distribution.
ii.	IS-883	Code of practice for design of structural timber in building.
iii.	IS-1003	Timber paneled and glazed shutters (all parts).
iv.	IS-1038	Steel doors, windows and ventilators
v.	IS-1081	Code of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators.
vi.	IS-1361	Steel windows for industrial buildings
vii.	IS-2835	Transparent sheet glass for glazing and framing purposes.
viii.	IS-1948	Aluminum doors windows and ventilators.
ix.	IS-1949	Aluminum windows for industrial building
x.	IS-2191	Wooden flush door shutters (Cellular and hollow core type)
xi.	IS-2202	Wooden flush door shutters (solid core type)
xii.	IS-3103	Code of practice for Industrial ventilation
xiii.	IS-3548	Code of practice for glazing in buildings
xiv.	IS-3614	Fire check doors
xv.	IS-4021	Timber door, windows and ventilator frames
xvi.	IS-4351	Steel door frames.
xvii.	IS-6248	Metal rolling shutters and rolling grills
xviii.	IS-7452	Specifications for hot-rolled steel sections for Door, Windows and ventilators.
xix.	IS:4020	Methods of tests for wooden flush doors shutters
xx.	IS:5807	Method of test for clear finishes for wooden Furniture.(Part I&IV)
H		ROOF AND FLOORING
i.	IS-2204	Code of practice for construction of reinforced concrete shell roof
ii.	IS-3201	Criteria for the design and construction of precast concrete trusses.
iii.	IS-2210	Criteria for Design of R.C. shell structures and folded plates.
iv.	IS-809	Rubber flooring materials for general purposes.
v.	IS-1195	Bitumen mastic for flooring
vi.	IS-1196	Code of practice for laying bitumen mastic flooring.

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REV. - 0

Sl. No.	Code No.	Description
vii.	IS-1198	Code of practice for laying, fixing and maintenance of linoleum floors.
viii.	IS-1237	Cement concrete flooring tiles
ix.	IS-1443	Code of practice for laying and finishing of cement concrete flooring tiles
x.	IS-2114	Code of practice for laying in situ terrazzo floor finish.
xi.	IS-2571	Code of practice for laying in situ cement concrete flooring
xii.	IS-5491	Code of practice for laying in situ granolithic concrete floor topping
xiii.	IS-5766	Code of practice for laying burnt clay brick flooring.
xiv.	IS-1197	Code of practice for laying of rubber floors
xv.	IS-2441	Code of practice for fixing ceiling coverings
I		WATER PROOFING
i.	IS-1322	Bitumen felts for waterproofing and damp proofing.
ii.	IS-1346	Code of practice for waterproofing of roofs with bitumen felts
iii.	IS-1609	Code of practice for laying damp proof treatment using bituminous felts.
iv.	IS-3036	Code of practice for laying lime concrete for a waterproofed roof finish
v.	IS-3037	Bitumen mastic for use in waterproofing of roofs
vi.	IS-3067	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings
vii.	IS-3384	Bitumen primer for use in water proofing and damp proofing.
viii.	IS-4365	Code of practice for application of bitumen mastic for waterproofing of roofs.
ix.	ASTM-C836-89a	Standard specification for High Solid content, cold liquid applied elastomeric water proofing membrane for use with separate wearing course.
x.	ASTMC8 98-89	Standard guide for use of High Solid content, cold liquid applied Elastomeric water proofing membrane for use with separate wearing course.
J		SOIL ENGINEERING
i.	IS-1498	Classification and identification of soils for general engineering purposes.
ii.	IS-1892	Code of practice for sub-surface investigation for foundations.

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REV. - 0

Sl. No.	Code No.	Description
iii.	IS-2131	Method for standard penetration test for soils.
iv.	IS-2720	Methods of test for soils (all parts).
K		WATER SUPPLY, DRAINAGE AND SEWERAGE
i.	IS-404	Lead pipes
ii.	IS-458	Concrete pipes
iii.	IS-651	Salt glazed stoneware pipes and fittings.
iv.	IS-771	Glazed fire-clay sanitary appliances (all parts).
v.	IS-774	Flushing cisterns for water closets and urinals other than plastic cisterns.
vi.	IS-783	Code of practice for laying of concrete pipes.
vii.	IS-1172	Code of basic requirements for water supply, drainage and sanitation
viii.	IS-1626	Asbestos cement building pipes, gutters and fittings (all parts)
ix.	IS-1742	Code of practice for building drainage.
x.	IS-2064	Code of practice for selection, installation and maintenance of sanitary appliances.
xi.	IS-2065	Code of practice for water supply in buildings
xii.	IS-2470	Code of practice for installation of septic tanks (all parts).
xiii.	IS-3114	Code of practice for laying of Cast Iron pipes.
xiv.	IS-4127	Code of practice for laying of glazed stoneware pipes.
xv.	IS-12251	Code of practice for Drainage of Building Basement.
xvi.	IS-1200	Method of measurement
xvii.	IS-1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
xviii.	IS-1537	Vertically cast iron pressure pipe for water, gas and sewage.
xix.	IS-3486	Cast iron spigot and socket drain pipes.
xx.	IS-5329	Code of practice for sanitary pipe work above ground for buildings.
xxi.	IS-3076	Low density polyethylene pipes for potable water supplies.
xxii.	IS-1538	Cast iron fittings for pressure pipes for water, gas and sewage.
xxiii.	IS-1230	Cast iron rainwater pipes and fittings
xxiv.	IS-1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
xxv.	IS-784	Pre-stressed concrete pipes

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Sl. No.	Code No.	Description
xxvi.	IS-1726	Cast iron manhole covers and frames.
xxvii.	IS-5961	Cast iron grating for drainage purposes.
xxviii.	IS-5219	"P" and "S" traps. [Part-I]
xxix.	IS-772	General requirements for enamelled cast iron sanitary appliances.
xxx.	IS-775	Cast iron brackets and supports for wash basins and sinks.
xxxi.	IS-777	Glazed earthenware wall tiles
xxxii.	IS-2548	Plastic water closet seats and covers (all parts).
xxxiii.	IS-2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
xxiv.	IS-1703	Specification for copper alloy floats valves (horizontal plunger type) including water supply fittings.
xxxv.	IS: 2526	Vitreous sanitary appliances (Part I to XV)
xxvi.	IS: 2963	Specification for copper alloy waste fittings for wash basins and sinks.
xxvii.	IS: 3311	Specification for waste plug and its accessories for sinks and wash basins.
xxviii.	IS: 5434	Specification for non-ferrous alloy bottle traps for marine use.
xxix.	IS: 3006	Specification for chemically resistant glazed stoneware pipes and fittings.
xl.	IS: 4984	High density polyethylene pipes for potable water supplies.
xli.	IS: 3889	Centrifugally cast(spun) iron spigot & soil waste and ventilating pipes, fittings and accessories.
L		PAVING AND ROAD WORKS
i.	IS-73	Paving bitumen
ii.	IS-702	Industrial Bitumen
iii.	IS-1201	Method of testing tar and bituminous materials. thru' 1220
iv.	IRC-37	Guidelines for design of flexible pavements
v.	IRC-73	Geometric design of Roads
vi.	IRC-6	Standard specification & code of practice for Road Bridges, Section II – Loads & stresses
vii.	IRC-21	Standard specification & code of practice for Road Bridges, Section III – Loads & stresses
M		EARTHQUAKE RESISTANT DESIGN
i.	IS-1893	Criteria for earthquake resistant design of structures.
ii.	IS-4326	Code of practice for earthquake resistant design and

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Sl. No.	Code No.	Description
		construction of buildings.
iii.	IS-13920	Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice.
N		STRUCTURAL STEELWORK
i.	IS-800	Code of practice for general construction in steel.
ii.	IS-802	Code of practice for use of structural steel in Overhead Transmission Line. Part-I : Load and permissible stresses. Part-II: Fabrication, Galvanizing, Inspection and Packing.
iii.	IS-806	Code of practice for use of steel tubes in general building/ construction.
iv.	IS-808	Rolled steel beams, channels and angle sections.
v.	IS-813	Scheme of symbols for welding.
vi.	IS-814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
vii.	IS-816	Code of practice for use of metal arc welding for general construction in mild steel.
viii.	IS-817	Code of practice for training and testing of metal arc welders.
ix.	IS-818	Code of practice for safety and health requirements in electric and gas welding and cutting operation.
x.	IS-819	Code of practice for Resistance spot welding for light assemblies in Mild Steel.
xi.	IS-919	Recommendations for limits and fits for engineering.
xii.	IS-1024	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
xiii.	IS-1161	Steel tubes for structural purposes.
xiv.	IS-1182	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
xv.	IS-1200	Method of measurement of steelwork and ironwork. [Part-VIII]
xvi.	IS-1239	Mild steel tubes, tubular and other wrought steel fittings (all parts)
xvii.	IS-1363	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
xviii.	IS-1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
xix.	IS-1365	Slotted counter sunk head screws (dia range 1.6 to 20

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**TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND
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REV. - 0

Sl. No.	Code No.	Description
		mm)
xx.	IS-1367	Technical supply conditions for threaded steel fasteners
xxi.	IS-1443	Code of practice for laying and finishing of cement concrete flooring tiles.
xxii.	IS-1608	Method for tensile testing of steel products.
xxiii.	IS-1730	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
xiv.	IS-1731	Dimensions for steel flats for structural and general engineering purposes.
xxv.	IS-1852	Rolling and cutting tolerances for hot rolled steel products.
xvi.	IS-1977	Structural steel (Ordinary quality)
xvii.	IS-2016	Plain Washers
xviii.	IS-2062	Steel for General structural purposes.
xix.	IS-2074	Ready mixed paint, air drying, red oxide zinc-chrome and priming.
xxx.	IS-2633	Methods of testing uniformity of coating of zinc coated articles.
xxi.	IS-3613	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
xxii.	IS-3664	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
xxiii.	IS-3757	High strength structural bolts.
xiv.	IS-4000	High strength bolts in steel structures.
xxv.	IS-4759	Hot dip zinc coatings on structural steel and other allied products.
xvi.	IS-5334	Code of practice for Magnetic Particle Flaw detection of welds.
xvii.	IS-7215	Tolerances for fabrication of steel structures.
xviii.	IS-7280	Base-wire electrodes for sub-merged arc welding of structural steels
xix.	IS-7318	Approval test for welders when welding [Part-I] procedure approval is not required.
xl.	IS-8500	Structural steel - micro alloyed (medium and high strength qualities).
xli.	IS-9595	Recommendation for metal arc welding of carbon and carbon manganese steels.
xlii.	AWS D.1.1	Structural Welding Code.
xlili.	IS-1786	Code of Practice for HYSD Bars

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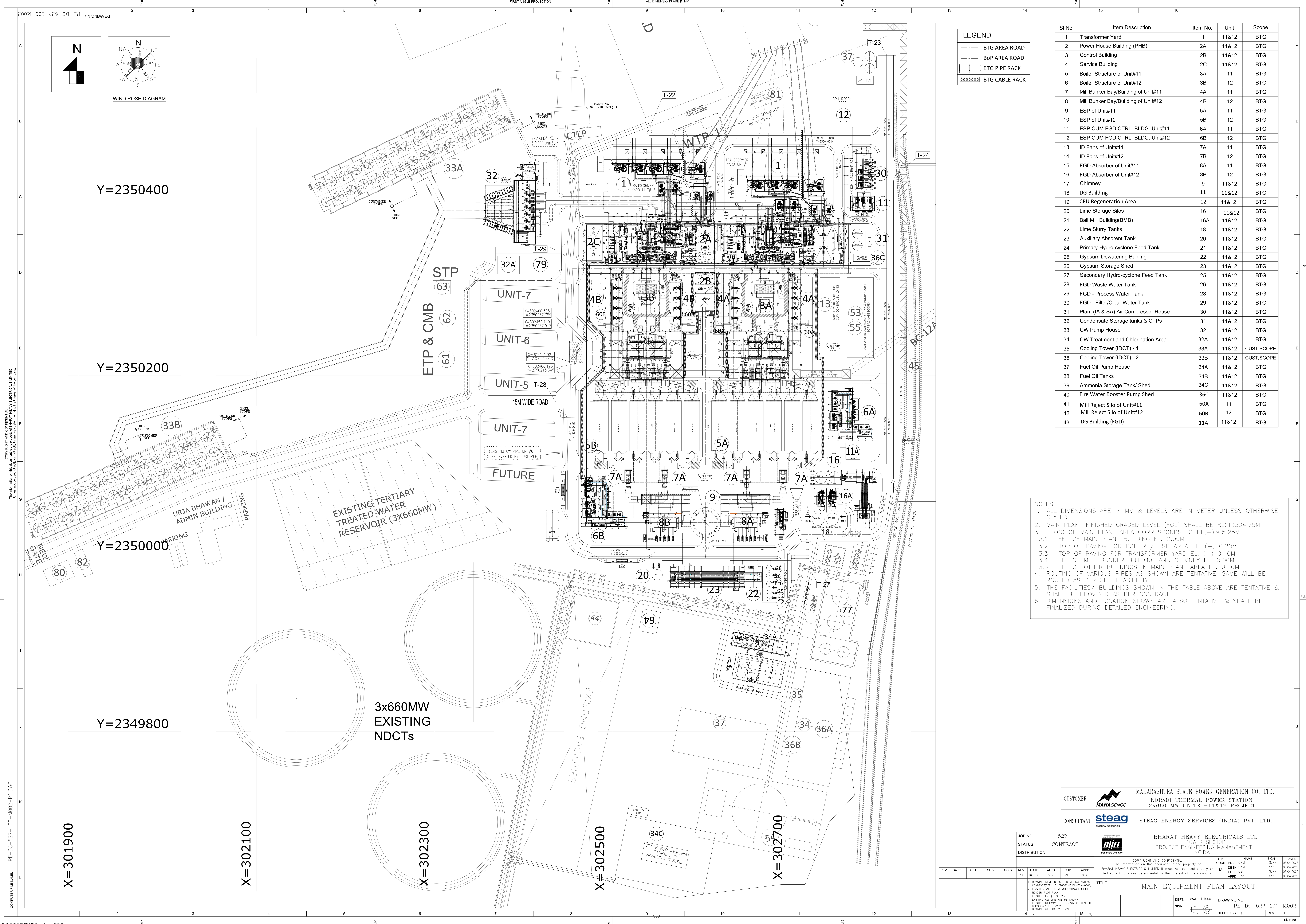
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TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND
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REV. - 0

Sl. No.	Code No.	Description
xliv.	IS-3502	Specifications for Steel Chequered Plates
O		PAINTING
i.	IS-348	Specification for French Polish.
ii.	IS-427	Specification for Distemper, dry colour as required.
iii.	IS-428	Specification for Distemper, oil emulsion, colour as required.
iv.	IS-1477	Code of practice for painting of ferrous metal in buildings.[I & II]
v.	IS-2338	Code of practice for finishing of wood and wood [I & II] based materials.
vi.	IS-2339	Specification for Aluminum Paints for general purposes in dual containers.
vii.	IS-2395	Code of practice for painting concrete, masonry and plaster surface.
viii.	IS-2932	Specification for enamel, synthetic, exterior undercoating, b) finishing.
ix.	IS-2933	Specification for enamel, exterior a) undercoating, b) finishing.
x.	IS-5410	Specification for cement paint.
xi.	IS-2074	Ready Mixed paint , air-drying , red oxide zinc chrome, Priming
P		ENVIRONMENTAL PROTECTION
i.		Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003
Q		DESIGN AIDS
i.	SP: 6	ISI handbooks for structural engineers
ii.	SP: 16	Design Aids for Reinforced Concrete to IS: 456
iii.	SP: 7	National Building code of India- "Accepted standards and Good practice" listed in Appendix to Building code.
iv.	SP: 34	Handbook of concrete reinforcement and detailing (SCIP)



LEGEND	
	BTG AREA ROAD
	BoP AREA ROAD
	BTG PIPE RACK
	BTG CABLE RACK

Sl No.	Item Description	Item No.	Unit	Scope
1	Transformer Yard	1	11&12	BTG
2	Power House Building (PHB)	2A	11&12	BTG
3	Control Building	2B	11&12	BTG
4	Service Building	2C	11&12	BTG
5	Boiler Structure of Unit#11	3A	11	BTG
6	Boiler Structure of Unit#12	3B	12	BTG
7	Mill Bunker Bay/Building of Unit#11	4A	11	BTG
8	Mill Bunker Bay/Building of Unit#12	4B	12	BTG
9	ESP of Unit#11	5A	11	BTG
10	ESP of Unit#12	5B	12	BTG
11	ESP CUM FGD CTRL. BLDG. Unit#11	6A	11	BTG
12	ESP CUM FGD CTRL. BLDG. Unit#12	6B	12	BTG
13	ID Fans of Unit#11	7A	11	BTG
14	ID Fans of Unit#12	7B	12	BTG
15	FGD Absorber of Unit#11	8A	11	BTG
16	FGD Absorber of Unit#12	8B	12	BTG
17	Chimney	9	11&12	BTG
18	DG Building	11	11&12	BTG
19	CPU Regeneration Area	12	11&12	BTG
20	Lime Storage Silos	16	11&12	BTG
21	Ball Mill Building(BMB)	16A	11&12	BTG
22	Lime Slurry Tanks	18	11&12	BTG
23	Auxiliary Absorbent Tank	20	11&12	BTG
24	Primary Hydro-cyclone Feed Tank	21	11&12	BTG
25	Gypsum Dewatering Building	22	11&12	BTG
26	Gypsum Storage Shed	23	11&12	BTG
27	Secondary Hydro-cyclone Feed Tank	25	11&12	BTG
28	FGD Waste Water Tank	26	11&12	BTG
29	FGD - Process Water Tank	28	11&12	BTG
30	FGD - Filter/Clear Water Tank	29	11&12	BTG
31	Plant (IA & SA) Air Compressor House	30	11&12	BTG
32	Condensate Storage tanks & CTPs	31	11&12	BTG
33	CW Pump House	32	11&12	BTG
34	CW Treatment and Chlorination Area	32A	11&12	BTG
35	Cooling Tower (IDCT) - 1	33A	11&12	CUST.SCOPE
36	Cooling Tower (IDCT) - 2	33B	11&12	CUST.SCOPE
37	Fuel Oil Pump House	34A	11&12	BTG
38	Fuel Oil Tanks	34B	11&12	BTG
39	Ammonia Storage Tank/ Shed	34C	11&12	BTG
40	Fire Water Booster Pump Shed	36C	11&12	BTG
41	Mill Reject Silo of Unit#11	60A	11	BTG
42	Mill Reject Silo of Unit#12	60B	12	BTG
43	DG Building (FGD)	11A	11&12	BTG

- NOTES:-
- ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METER UNLESS OTHERWISE STATED.
 - MAIN PLANT FINISHED GRADED LEVEL (FGL) SHALL BE RL(+)+304.75M.
±0.00 OF MAIN PLANT AREA CORRESPONDS TO RL(+)+305.25M.
3.1. FFL OF MAIN PLANT BUILDING EL. 0.00M
3.2. TOP OF PAVING FOR BOILER / ESP AREA EL. (-) 0.20M
3.3. TOP OF PAVING FOR TRANSFORMER YARD EL. (-) 0.10M
3.4. FFL OF MILL BUNKER BUILDING AND CHIMNEY EL. 0.00M
3.5. FFL OF OTHER BUILDINGS IN MAIN PLANT AREA EL. 0.00M
 - ROUTING OF VARIOUS PIPES AS SHOWN ARE TENTATIVE. SAME WILL BE ROUTED AS PER SITE FEASIBILITY.
 - THE FACILITIES/ BUILDINGS SHOWN IN THE TABLE ABOVE ARE TENTATIVE & SHALL BE PROVIDED AS PER CONTRACT.
 - DIMENSIONS AND LOCATION SHOWN ARE ALSO TENTATIVE & SHALL BE FINALIZED DURING DETAILED ENGINEERING.

CUSTOMER

MAHARASHTRA STATE POWER GENERATION CO. LTD.
KORADI THERMAL POWER STATION
2x660 MW UNITS -11&12 PROJECT

CONSULTANT

STEAG ENERGY SERVICES (INDIA) PVT. LTD.

JOB NO.

527

STATUS

CONTRACT

DISTRIBUTION

REV.

DATE

ALTD

CHD

APPD

REV.

DATE

ALTD

CHD

APPD

1. DRAWING REVISED AS PER MPPCL/STEAG COMMENTARY. NO. ETR001-SHEL-FEM-0001.

2. LOCATION OF UNIT & CWP SHOWN IN LINE.

3. TENDER PLOT PLAN.

4. EXISTING CWP LINE UNIT#6 SHOWN.

5. EXISTING RAILWAY LINE SHOWN AS TENDER TOPOGRAPHY SURVEY.

6. DRAWING GENERALLY REVISED.

DEPT

CODE

NAME

SIGN

DATE

DRW

10M

527

03.04.2025

DES

10M

527

03.04.2025

CHD

10M

527

03.04.2025

APPD

10M

527

03.04.2025

TITLE

MAIN EQUIPMENT PLAN LAYOUT

DEPT

SIGN

SCALE 1:1000

DRAWING NO.

PE-DG-527-100-M002

SHEET 1 OF 1

REV.

01



TENDER RFx : 3000046202

VOLUME – I

SECTION – 2B

Terms & Conditions of the Contract – Site Works

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	KORADI THERMAL POWER STATION 2x660 MW UNITS – 11 & 12 PROJECT (BTG PACKAGE)		Section: 2B
	RFx No. 3000046202		REV: 00
	TERMS & CONDITIONS OF THE CONTRACT- SITE WORKS		
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2.0	Regulations of Local Authorities and Statute	:	302
3.0	Access to Site and Works on Site	:	302
4.0	Facilities to be Provided by the Owner at Site	:	302
5.0	Contractor's Site Office Establishment	:	304
6.0	Insurance	:	305
7.0	Cooperation with other Contractors	:	306
8.0	Discipline of Workmen	:	307
9.0	Contractor's Field Operations	:	307
10.0	Manpower Report	:	311
11.0	Protection of the Work	:	311
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13.0	Employment of Labour	:	312
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1.0 General: 1.1 The conditions contained in this Section of the contract shall supplement the conditions contained in the other Sections and shall govern the portion of the work to be performed at Site. 2.0 Regulations of Local Authorities and Statute: 2.1 The Contractor shall comply with all the rules and regulations of local authorities during the performance of his field activities. He shall also comply with the Minimum Wages Act, 1948 and the payment of Wages Act (both of the Government of India) and the rules made there under and any other Acts, Regulations enacted by the statutory authorities in respect of employment of Staff/workmen employed or engaged by him or his sub-contractor. 2.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, the Contractor shall not be liable for such expenses for items mentioned in Table-1, Section-3 where the Owner is responsible. 3.0 Access to Site and Works on Site: 3.1 Suitable access to and possession of the Site shall be provided to the contractor by the owner to enable him to execute the site works. 3.2 The Works so far as it is carried out on the Owner's premises, shall be carried out at such time as the owner may approve. 3.3 In the execution of the works, no persons other than the Contractor or his duly appointed representative, sub-contractor duly approved by the owner and their workmen shall be allowed to do work on the Site, except by the special permission, in writing, of the Engineer or his representative. 3.4 Any damage / disturbances caused to any of the existing facilities shall be promptly repaired and restored as existing, by the Contractor, at his own cost. 4.0 Facilities to be Provided by the Owner at Site: 4.1 Open Space for Site Office: 4.1.1 Contractor shall be given suitable open space only for establishing his site office at a location to be decided by the engineer free of rent. Contractor shall not use the site for any purpose other than for performing activities pertaining to the contract. No space for labour colony shall be provided.		
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4.2 Electricity: 4.2.1 The contractor shall be provided with supply of electricity for construction purpose at the Voltage level of 11 KV$\pm$ 10%, which shall normally be at one point in the project site or at the discretion of the Engineer, at more points. The Contractor shall make his own further distribution arrangements. The supply of electricity shall be on non-chargeable basis. 4.2.2 The Contractor shall submit his electrical power requirement at site to the Engineer within 30 days from the date of award of the contract so as to allow him to arrange same well in advance. However, the load demand of the Contractor shall be catered in stages depending upon the requirement of work as assessed by the Engineer. 4.2.3 Supply of Electricity for construction purpose together with taxes and duties thereon shall be free. However, penalty, if any levied by the electricity supplier for inefficient use/wastage of energy etc. shall be recovered from the contractor. However, EPC contractor shall maintain the power factor at 0.9. Any penalty/excess charges due to low PF levied by MSDECL/distribution licensee shall be recovered from contractor's bill. 4.3 Water: 4.3.1 Supply of water for construction and potable use shall be made available at one point each at the location decided by the project manager. The contractor shall make further distribution arrangements thereafter at his own costs. 4.3.2 The supply of water together with taxes and duties, if any, levied thereon shall be free of cost. However, the contractor shall always ensure its legitimate use. In case of wastages, penalty levied by the project manager shall be recovered from the contractor. No review of such penalty shall be done as water is one of the most precious resources. 4.4 Storage Space: 4.4.1 Reasonable open space shall be provided to the Contractor for the storage of materials during the period of storage and erection. 4.4.2 The Contractor shall make proper arrangement for safe storage and protection of the equipment/materials during storage and erection till commissioning.		
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4.4.3 Wherever required, the Contractor should provide covered storage for the protection of climatic conditions sensitive equipment such as electrical meters, panels, motors etc. and for fragile materials as well. 4.5 Power Station railway Siding and Shunting Locomotive: 4.5.1 The owner will allow the contractor to use the railway siding facilities and shunting locomotive, which shall be operated by the Owner's operator (when construction in the vicinity of the owner's existing Power Station) for unloading of material and equipment despatched against the contract as and when available without any charge. However, use of the locomotive by the contractor shall be purely subject to its availability. In the event the shunting locomotive is not available, the contractor shall be required to make alternative arrangement at his risk and cost. The unloading of the material from wagons at the siding shall be the responsibility of the contractor. The modalities regarding the use of owner's railway siding and shunting locomotive by the contractor for shunting of wagons shall be mutually discussed and decided between the contractor and the Engineer. 4.5.2 The contractor shall not use the railway siding for any other purpose other than unloading of material pertaining to the contractor against this contract. The contractor shall note that owner's other contractor for project and O&M works shall be operating at the Power Station siding. The contractor shall therefore take the prompt action to unload the material from the wagons and transport the same from siding immediately so as to avoid congestion at siding. 5.0 Contractor's Site Office Establishment: 5.1 The Contractor upon signing of the Contract shall establish his office at the work site and in addition to a Project Co-ordinator stationed at his headquarters, nominate another responsible officer as his resident representative, suitably designated for the purpose of overall responsibility and co-ordination of the works to be performed at Site. Such person shall function from the site office to be established by the contractor. 5.2 Any written order or instruction of the Engineer or his duly authorised representative shall be communicated to the said authorised resident		
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representative of contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

6.0 Insurance:

6.1 Apart from the Marine-cum-Erection Insurance Policy procured by the contractor, the contractor shall, at his own costs arrange to procure insurance for following aspects.

6.2 Third Party Insurance:

6.2.1 Before receipt of equipment at site but without limiting his obligations and responsibilities under this clause hereof, the Contractor shall insure against his liability for any equipment, material or physical damage, loss or injury which may occur to any property, including that of Owner, or to any person including employee of the owner, by or arising out of the execution of the contract or in the carrying out of contract. The third party insurance cover shall be provided for the period from date of FOB /Ex-factory despatch till taking over of the entire equipment after testing, commissioning and trial operation, if any.

6.2.2 Third party insurance shall be effected for a minimum cover as under:

a)	Per person in case of fatal disability	:	Rs 300,000
b)	Property damage per occurrence	:	Rs. 2,500,000
c)	Total cumulative during the period of the policy on the basis of reinstatement	:	Rs. 10,000,000

6.2.3 Terms shall include a provision whereby, in the event of any claim being brought or made against the Owner in respect of which the Contractor would be entitled to receive indemnity under the policy, the insurer will indemnify the Owner against such claims and any costs, charges and expenses in respect hereof

6.3 Accident or Injury to Workmen:

6.3.1 Owner shall not be liable for or in respect of any damage or compensation payable at law in respect or in consequence of any accident or injury to any workman or other person in the employment of the contractor or any of his subcontractors, save

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and except an accident or injury resulting from any act or willful default of the Owner. 6.3.2 Contractor shall indemnify and keep indemnified Owner against all such damages and compensations, save and except as aforesaid and against all claims, proceedings, costs charges and expenses whatsoever in respect thereof, or in relation thereto. Contractor shall insure against accident etc. to workmen provided always that, in respect of a person employed by any of his sub-contractors, the Contractor's obligations to insure as aforesaid under this clause shall be satisfied if the subcontractor shall have insured against the liability in respect of such persons in such manner that the Owner is indemnified under the policy, but the contractor shall require such subcontractor to produce to the Owner through Contractor, when required, such policy or policies of insurance and the receipt for the payment of the current premium. 6.4 If the contractor, in any or all cases covered under the clause "INSURANCE" as also his subcontractor shall fail to effect and keep in force the insurance hereof, or any other insurance which may be required to effect under the terms of the contract, then and in any such case Owner may effect and keep in force any such insurance and pay such premium or premia as may be necessary for that purpose and from time to time deduct the amount so paid as aforesaid from any payment due or which may become due to the Contractor, or recover the same as a debt due from the Contractor. 6.5 If the contractor has purchased Marine-cum-Erection Insurance (stipulated at Section-2 clause no. 28.0) inclusive of insurance for scope mentioned at clause no. 6.2 & 6.3 above, the premium amount for both should be indicated separately in policy. 7.0 Cooperation with other Contractors: 7.1 The contractor shall co-operate with all other contractors or tradesmen of the owner, who may be performing other works on behalf of the owner and the workmen who may be employed by the owner and doing work in the vicinity of the works under the contract. The contractor shall also so arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other contractors and his workmen. Any injury or damage that may be sustained by the employees of the other contractors and the owner, due to contractor's work shall promptly be made good at his own expense. The Engineer shall		
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determine the resolution of any difference or conflict that may arise between the contractor and other contractors or between the contractor and the workmen of the owner in regard to their work. If the Works of the Contractor is delayed because of any acts or omission of another Contractor, the provisions of Clause No. 31.0, Section – 2 shall apply. 7.2 The Engineer shall be notified promptly by the contractor of any defects in the other contractor's work that could affect the contractor's works. The Engineer shall determine the corrective measures, if any, required rectifying this situation after inspection of the works and such decisions by the Engineer shall be binding on the contractor. 8.0 Discipline of Workmen: 8.1 The Contractor shall adhere to the disciplinary procedure set by the Engineer in respect of his employees and workmen at Site. The Engineer shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site if, in the opinion of the Engineer, such employee has miss-conducted himself or be incompetent or negligent or otherwise undesirable and then the Contractor shall remove such a person objected to and provide in his place a competent replacement. 8.2 The Contractor shall at all time take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst his employees and for preservation of peace and protection of persons and property at and in the neighbourhood of works. 9.0 Contractor's Field Operations: 9.1 The Contractor shall keep the Engineer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Engineer shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the Engineer or the Owner or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods. 9.2 The Contractor shall have the complete responsibility for the conditions of the work at Site including the safety of all persons employed by him or		
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his sub- contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Engineer is not intended to include review of Contractor's safety measures in, or near the work site, and their adequacy or otherwise. 9.3 Work To Be Open For Inspection And Contractor To Be Present: 9.3.1 All works under or in course of execution or executed under the contract shall at all times be open to the inspection & supervision by engineer. Contractor shall at all times during the working hours and at other times with notice of engineer's visit to works shall have responsible representative available to receive instructions from the engineer, orders/instructions given to authorised representative shall be considered as if they are given to the contractor himself. 9.4 Notice Before the Work is Covered Up: 9.4.1 The Contractor shall give adequate notice (normally seven days) to Engineer in writing before covering up or otherwise placing beyond the reach of inspection & measurement any work in order that the same may be measured & correct dimension thereof recorded. If contractor covers such works without notice, then Engineer reserves the right to get the same uncovered at the risk & cost of the contractor. 9.5 Inspection and Testing: 9.5.1 Contractor shall perform all inspection, expediting and quality surveillance as may be required for performance of the Services. Contractor's responsibilities under this sub-clause shall include, without limitation, inspecting all supplies, materials and equipment that comprise or will comprise the Plant or that are to be used in performance of the work. 9.5.2 In the event that the progress and quality of the work is not proceeding in accordance with the Contract, Owner or Owner's Representative shall be entitled to make recommendations to Contractor or any Sub-contractor for the purpose of remedying such failure and any such defects and deficiencies or variances. Any inspection performed or not performed by Owner hereunder shall not be a waiver of any of Contractor's obligations under the Contract or be construed as an approval or acceptance of any of the		
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work or Services hereunder or absolve the Contractor in any manner of its liabilities, responsibilities and obligations under the Contract. 9.5.3 The Contractor shall, where required give due notice to the Owner/Owner's Representative whenever such work is ready before covering up or putting out of view. The Owner's Representative shall then either carry out the inspection, examination, measurement or testing or notify the Contractor that it is waived. 9.5.4 The Owner's Representative shall have the right to re-inspect any work though previously inspected and approved by him at the Site, before and after the same are erected. If by the above inspection the Owner's Representative rejects any work, the Contractor shall make good for such rejections either by replacement or modifications/repair as may be necessary to the satisfaction of the Owner's Representative. 9.5.5 The Owner/Owner's Representative shall be entitled, during design, engineering, manufacture, fabrication and preparation at any places where work is being carried out, to inspect, examine and test the materials and workmanship, and to check the progress in the performance of the work at no extra cost to the Owner. The Contractor shall give all reasonable facilities and assistance, including access to Documents to carry out such inspection, examination, measurement and testing. All inspection and tests shall be in line with approved Inspection & Test Plans and Owner/Owner's Representative shall carry out necessary inspection as per the Contract. Should any inspected work or service fail to conform to the Contract, the Owner may reject such work or service and the Contractor shall either replace or make alterations necessary to meet Contract requirements free of cost to the Owner. The Owner's right to inspect, tests, and wherever necessary, reject the work or service shall in no way be limited or waived by reason of any part of the work having previously been inspected, tested and passed by the Owner/Owner's Representative. 9.5.6 The Contractor shall agree, with the Owner / Owner's Representative about the time and place for the testing of any equipment / materials and other parts of the work as specified in the Contract. The Owner / Owner's Representative shall give the Contractor not less than 48 (Forty eight) hours notice of his		
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intention to attend the Tests. The Contractor shall present to the Owner/Owner's Representative the calibration certificates of all the testing and measuring instruments proposed to be used for carrying out the Test. In case the Owner/Owner's Representative is not satisfied with the calibration certificates, the Contractor shall arrange to get the concerned instrument(s) recalibrated to the satisfaction of the Owner/Owner's Representative. 9.5.7 If the Owner's Representative does not attend at the time and place agreed, or if the Contractor and Owner's Representative agree that the Owner's Representative shall not attend, the Contractor may proceed with the Tests, unless the Owner's Representative instructs the Contractor otherwise. Participation by Owner or Owner's Representative in or their absence from or failure to participate in any Tests (other than the Performance Tests) shall not relieve or absolve the Contractor from any Guarantee or Warranty or obligations of Services under or in pursuance of the Contract. 9.5.8 The Contractor shall promptly forward to the Owner / Owner's Representative duly certified reports of the Tests. 9.5.9 If the Owner / Owner's Representative requires such equipment, materials, design or workmanship to be re-tested, the Tests shall be repeated under the same terms and conditions. Contractor shall undertake an additional testing of any material, equipment or the work, if the Owner / Owner's Representative believes the results of earlier Tests are not accurate or do not establish the true condition to specification of equipment, material or work being tested. If such retesting demonstrate that the work, equipment or material being so tested conforms to the requirements of Contract, then Owner shall bear the cost of such additional Test and the cost of any required uncovering and covering the Goods or Services and shall grant the extension of time for completion, if necessary. If however such retesting confirms Owner's conclusion and cause the Owner to incur additional costs, such costs shall be recoverable from the Contractor by the Owner and may be deducted by the Owner from any monies due, or to become due, to the Contractor. Neither the failure by Owner / Owner's Representative to discover defects, nor any payment to Contractor in respect of the Tests, shall prejudice the rights of Owner thereafter to require and obtain from Contractor the performance of the Services in accordance with the		
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Contract herewith. Owner shall not be deemed to have accepted any Services as a result of any additional testing. 9.6 Rejection: 9.6.1 If, as a result of inspection, examination or testing, the Owner / Owner's Representative decides that any equipment, system, materials, design or workmanship has failed in such inspection, examination or tests or is defective or otherwise not in accordance with the Contract, the Owner's Representative may reject such equipment, system, materials, design or workmanship and shall notify the Contractor promptly, stating his reasons. The Contractor shall then promptly correct or replace, such item or portion so as to pass retesting and otherwise meet and conform to such requirements. Following any such rejection, all expenses reasonably incurred by the Owner in consequence of such retesting or inspection shall be borne by the Contractor. No changes to Project Schedule or increase in the Contract Price shall be granted with respect to such additional testing. Contractor shall solely bear any cost resulting there from. 10.0 Manpower Report: 10.1 The Contractor shall submit to the Engineer, on the first day of every month, a man power schedule for the month, detailing the man power scheduled for the month, skill-wise and area-wise. 10.2 The Contractor shall also submit to the Engineer on the first day of every month, a manpower report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill-wise and the areas of employment of such labour. 11.0 Protection of the Work: 11.1 The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Engineer. The Owner or the Engineer for any damage or loss to the Contractor's Works will entertain no claim and the Contractor shall be responsible for the complete restoration of the damaged works to its original condition to comply with the specifications and drawings. Should any such damage to the Contractor's Works occur because of other party not under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works, the same shall be resolved as per the		
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provision of the Clause: 'Co-operation with other Contractors'. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the work immediately and no cause thereof will be assigned pending resolution of such dispute. 12.0 Security: 12.1 The Contractor shall have total responsibility for all equipment and works at Site till taking over by the owner. The Contractor shall make suitable security arrangements, employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the contractor shall enter & leave the project site only with the written permission of the Engineer in the prescribed manner. 13.0 Employment of Labour: 13.1 The Contractor will be expected to employ on the work only his regular skilled employees with experience of this particular work. No female labour shall work beyond the time stipulated as the statute in this regard. No person below the age of eighteen years shall be employed. 13.2 Contractor's employees shall wear identification badges while on work at site. 13.3 In case the Owner becomes liable to pay any wages or dues to the labour or to any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contract Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, all such payments shall be recovered from the Contractor. 13.4 As far as possible unskilled labour shall be engaged from the area in the vicinity of the site. 13.5 The contractor shall at all times have due regard to the local religious festivals & customs. 13.6 Contractor shall comply with all the provisions of labour, civil, State & Central laws, statutory rules, regulations under the law. In case of his non- compliance with any provision, he will indemnify the owner from and against all liabilities, damages, penalties, demand etc. 13.7 The Contractor in the event of his engaging 20 (twenty) or more workmen at site shall obtain independent licence under the Provisions of the Contract Labour (Regulation and abolition act) from the concerned state		
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labour authorities for which necessary certificate (Form 2) shall be issued by an Engineer. 14.0 First Aid: 14.1 The Contractor shall provide necessary first aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first aid. 14.2 The Owner will provide the Contractor, in case of an emergency, the services of an ambulance, if available, for transportation to the nearest hospital. 15.0 Cleanliness: 15.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris, etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Engineer. Materials & Stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage. 15.2 The offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Engineer. Proper sanitary arrangements shall be provided by the Contractor in the work areas, office and residential areas of the Contractor. 15.3 In the event Contractor fails to keep his work area clean, the Engineer shall be free to engage alternate labour, after serving written notice to that effect to the Contractor, to clean up the Contractor's work area and realise the amount spent on this account from the Contractor. 16.0 Lines and Grades: 16.1 All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works. Basic horizontal and vertical control points will be established and marked by the Engineer at site at suitable points. These points shall be used as datum for the Works under the Contract. The Contractor shall inform the Engineer well in advance of the times and		
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places at which he wishes to do work in the area allotted to him, so that suitable datum points may be established and checked by the Engineer to enable the Contractor to proceed with his works. Any works done without being properly located may be removed and/or dismantled by the Engineer at the Contractor's expense. 17.0 Fire Protection: 17.1 The work procedures that are to be used during the erection shall be those, which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the site at least once each day. Fuels, oils and volatile or flammable materials shall be stored in safe containers away from the construction equipment and materials storage areas. Untreated canvas paper, plastic or other flammable materials shall not at all be used at site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the site, the same shall be removed and replaced with acceptable materials before moving into the construction area or storage. 17.2 Similarly, corrugated paper fabricated cartons, etc., will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of waterproof and flame resistant type. All the other materials such as working drawings, plans, etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding, sparks, cutting flames, and other similar fire sources. 17.3 Contractor's all the supervisory personnel and sufficient number of workers shall be trained for fire fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the site during the entire period of the Contract. 17.4 The Contractor shall provide enough fire protection equipment of different types for the warehouses, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all times. 18.0 Contractor's Area Limits: 18.1 The Engineer will mark out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move		
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out of the areas marked out for his operations. In case of such a need for the contractor's personnel to work out of the areas marked out for him, the same shall be done only with the written permission of the Engineer. 19.0 Contractor's Cooperation with the Owner: 19.1 In cases where the performance of the erection work by the Contractor affects the operation of the system facilities of the Owner, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the Engineer and the same shall be acceptable at all times to the Contractor. The Engineer may impose such restrictions on the facilities provided to the Contractor such as electricity, water etc. at such places as he may think fit in the interest of the Owner and the Contractor shall strictly adhere to such restrictions and co-operate with the Engineer. 20.0 Trials and Operations: 20.1 The trials and operations of the equipment furnished and erected by the Contractor shall be the responsibility of the Contractor. Such trials & operations shall be coordinated with the Owner and shall be performed with owner's explicit clearance. 20.2 The contractor shall provide all test instruments, calibrating devices etc. and the workmen required for the successful performance of the same. 21.0 Material Handling and Storage: 21.1 All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded, transported and stored in the storage spaces by the Contractor. 21.2 Contractor shall be responsible for examining all the shipment and notify the Engineer immediately of any damage, shortage, discrepancy, etc. for the purpose of Engineer's information only. The Contractor shall submit to the Engineer every week a report detailing all the receipt during the week. The Contractor shall take prompt actions for replenishments for any shortages or damage in transit, handling and/or in storage and erection of the equipment at the Site. 21.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipment received by him and keep such record open for the inspection of the Engineer at any time. 21.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or		
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handling of the equipment without the specific written permission of the Engineer. The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at Site. 21.5 All electrical panels, control gear, motor and heating shall be properly dried by such other devices before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage. 21.6 All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and a record of such measured insulation values maintained by the Contractor. Such records shall be open for inspection by the Engineer. 21.7 The Contractor shall ensure that all the packing materials and protection devices used for the various equipment during transit and storage are removed before the equipment are installed. 21.8 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage. 21.9 All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame proof covering material wherever applicable. 21.10 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Engineer will have the right to get it moved to the area earmarked for the Contractor at the Contractor's cost. 21.11 The Contractor shall be responsible for making suitable indoor storage facilities on the open land to be made available by the owner to store all equipment, which require indoor storage. Normally, all the electrical equipment such as motors, control gear, generators, exciters and consumables like electrodes, lubricants, etc. shall be stored in the closed storage space. The Engineer in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas, which the Contractor shall strictly comply with.		
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21.12 Dismantling work should be done with due diligence so as not to damage the equipment. The dismantled materials / equipment should be handed over to the owner at the storage place & site indicated by the owner. 22.0 Construction Management: 22.1 The field activities of the contractors working at site will be coordinated by the Engineer and the Engineer's decision shall be final in resolving any disputes or conflicts between the Contractor and other contractors and tradesmen of the Owner regarding scheduling and co-ordination of work. Such decision by the Engineer shall not be a cause for extra compensation for the Contractor. 22.2 The Engineer shall hold weekly meetings of all the Contractors working at Site, at a time and a place to be designated by the Engineer. The contractor shall attend such meetings and take notes of discussions during the meeting and the decision of the Engineer and shall strictly adhere to those decisions in performing his works. In addition to the above weekly meetings, the engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called, will also attend such meetings. 22.3 The Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action. 22.4 The Engineer shall, however, not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier. 23.0 Taxes and Duties: 23.1 GST payable to the contractor against the services rendered to the owner pursuant to this contract shall be paid at the rates prevailing as on the date of incidence of the tax against the GST compliant tax invoice submitted by the contractor. 23.2 However, in case of services rendered are beyond contractual work completion schedule, the rate of payment/reimbursement of GST shall be		
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lower of the rate as applicable on Scheduled completion date and as per the actual date w.r.t time of supply of services under GST Law provision. In case of increase in GST rates after the scheduled completion date, the difference will also be paid to the contractor, if such delay is held, by the owner, to be not solely attributable to the contractor. 23.3 Except for GST, no tax shall be payable to the contractor on the services rendered against this contract. Other taxes applicable, if any, on the services against this contract shall be borne by the contractor. 23.4 The contractor shall be solely responsible for payment of all taxes & duties as stipulated above applicable to for services against this contract to appropriate authorities and shall indemnify the owner from any law, suits and litigation whatsoever that arise due to non-compliance of payment of taxes & duties by the contractor with appropriate authorities. It will be the exclusive responsibility of the contractor to pay the full amount of all statutory taxes and/or duties in time to the appropriate authorities as and when the same are due for payment irrespective of the fact that the payments of the related invoices of the contractor are released by the owner in full or part or otherwise. It shall also be sole responsibility of the Contractor to pay any penalty imposed or expenses for court cases and tribunal enquiry instituted on account of omission/ deficit of payments towards such taxes/ duties, if any. The Contractor shall indemnify the Owner in all such matters and the Owner shall not be liable in any way in the matters of payment of taxes & duties and applicable statutory fees etc. by the contractor pursuant to the contract. 23.5 Throughout the contract completion period and thereafter, the contractor shall ensure compliance under GST Law. 23.6 The total amount payable to the Contractor as per the rates of taxes at clauses 23.1 to 23.5 above applicable as on record date shall however be limited to amount of taxes indicated in the online bid price submitted by the Contractor. Amount of taxes payable on Price Adjustment shall be paid extra apart from amount of taxes indicated in the online bid price submitted by the Contractor. 23.7 Mahagenco reserves the right to ask the vendor for submission of undertaking and / or certificate from CA/ CMA firm that the taxes are paid to the concerned authorities.		
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24.0 Statutory Variation in Taxes & Duties:		
24.1 If the rates of GST are increased by the respective statutory authorities OR the concession available as on Record Date are withdrawn by the respective statutory authorities OR If any tax(es) or duty(ies) are introduced by the Indian Central or State Govt. or Local body with effect from the next day of record date, such changes shall be to Owner's account and to be paid by Owner against documentary evidence. Similarly, benefit of downward revision and benefit of abolishment of Taxes and duties need to be passed on to Mahagenco by the Contractor.		
24.2 However, Statutory variation shall be reimbursed against the services rendered during the contractual completion period only. The contractor shall have to bear payments against such statutory variation on services rendered beyond contractual completion period except statutory variation covered under clause 23.2 above.		
24.3 However, in case contract period is extended due to reasons attributable to the Owner then Statutory Variation for the extended period shall be reimbursed by the Owner to the Contractor against documentary evidence.		
24.4 If any new tax or duty is introduced by the Indian Central or State Govt. which is in lieu of the GST, provisions of Clause No. 23.0 and 24.0 above shall be applicable.		
25.0 Contract Price Adjustment:		
25.1 The contract price (excluding taxes) less advance paid shall be subject to adjustment in accordance with the formula stipulated under the Schedule – 3, Section-I, Volume-I of the contract.		
25.2 The price adjustment shall subject to a ceiling of $\pm 20\%$ of the contract price (excluding taxes). This ceiling shall be applicable for the contract price (excluding taxes) and not to the price billed in individual invoices.		
26.0 Billing Break-up of Contract Price:		
26.1 The billing Break-up shall be submitted to Chief Engineer (P&P) for approval (Chief Engineer Civil – 1, in case of Civil Construction Contract). In the event of order for more than one unit, the contractor shall initially submit his contract price allocation for individual unit. The individual unit shall be treated as one project (WBS Level 1). In case of award of the contract for more than one unit, first of all, the unit wise contract price allocation shall be submitted. Items/Equipment shared by more than one		
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unit shall be included in the scope of the first unit scheduled for erection and commissioning. 26.2 Initially, the contractor shall submit the contract price allocation for services to be rendered as per the major package say SG/STG etc. (WBS level 2) as per the project schedule which shall be further allocated to till level 3 WBS of the project schedule (the Equipment). 26.3 Subsequently, the contractor shall submit detailed breakup of services to be rendered for particular level 3 WBS indicating the UoM, Quantity, price Per unit etc. and respective activity code against every service (line item) strictly in owner's standard template in Microsoft Excel (*.xls or *.xlsx format). The BBU shall be in line with Project Completion Schedule. The contractor should note that this is a mandatory requirement. 26.4 Pursuant to provisions of Clause No. 16, Section - 2, Volume - I, Contractor Obligations, in exceptional case, if any service is left to be incorporated in the Billing Breakup, the same shall be rendered by the contractor without any additional financial burden on the owner. 27.0 Payment Terms: 27.1 Application for the Payments: 27.1.1 For all payments, the application and the invoices along with the documents listed in the relevant clauses of terms of payment shall be submitted by the Contractor to the Project Manager. However, for the Advance Payment, the application and the invoices along with the documents listed in the relevant clauses of terms of payment shall be submitted by the Contractor to the Chief Engineer (P&P) & the advance payment shall be released from Head Office, Prakashgad, Mumbai. 27.1.2 The invoice (except in case of advance payment), shall invariably contain the Work Order (approved BBU) number, Item code as per the Work Order, the date completion of the particular service and any other details called for. 27.1.3 Each such application shall state the amount claimed and shall set forth in detail, in the order of the Work Order, particulars of the services rendered pursuant to the contract. No sum shall be included in any payment application in respect of the service that, according to the decision of the Engineer, does not comply with the contract.		
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27.1.4 The payments shall be released by the Project Manager or the financing institute(s) with whom the owner has tied up the funding for this project through Crossed Cheque/NEFT/RTGS. 27.2 Advance Payment: 27.2.1 10% of contract price and taxes payable on the advance payment, if any, shall be paid within 30 days upon mobilisation of contractor's establishment at site for undertaking services against this contract and submission of the documents as under: - Invoice in triplicate (one original + two copies). - A Copy of Letter of Award issued by the owner duly acknowledged by the contractor. - A copy of the acceptance of the contract performance security issued by the owner/the Project Manager. - A copy of the acceptance of the bank guarantee of equivalent amount submitted by the contractor against advance payment. - A copy of "site mobilisation of contractors establishment" certificate issued by the owner/the Project Manager. - A copy of All Risk Marine-cum-Erection Insurance. 27.2.2 In the event of order for more than one unit, the unit wise advance shall be in proportion with the contract price allocated to the respective unit. 27.2.3 The advance paid as above shall be interest free up to the scheduled date of Trial operation of the unit as per the approved project schedule. The advance shall be adjusted against the services rendered by the contractor on prorata basis and shall be determined by the value of services rendered by the contractor against the contract irrespective of the fact whether payment against such services are made by the owner or otherwise. However, the contractor may seek accelerated/onetime adjustment of the advance on or before the scheduled date of Trial operation of the unit as per the approved project schedule. 27.2.4 For the un-recovered advance, if any, beyond the scheduled date of completion of trial operation of the unit as per the approved project schedule, interest at the rate of whichever is higher of i) one percent higher than the rate of borrowing by the owner for this		
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project or ii) the prevailing Retail Prime Lending Rate (RPLR) of State Bank of India shall be levied.

27.2.5 The Contractor may, if he so desires, reduce the value of Bank Guarantee(s) submitted against advance payments after every six (6) months to the extent of advance actually adjusted. The application for reduction in the value of the Bank Guarantee shall be submitted to the Project Manager.

27.3 Payments towards Services Rendered:

27.3.1 82% of the Contract price (excluding taxes and duties) as per the approved billing breakup minus advance adjustment on prorata basis (e.g. 72% if advance paid till then is 10%) together with applicable tax as stipulated under Clause No. 23 above shall be paid on prorata basis within 30 days from the date of submission of the invoice and related documents as mentioned below:

(i)

Invoice

:

1 original
+ 2 copies

(ii)

Service entry sheet approved by the Owner

:

3 copies

27.3.2 18% payment of invoice value shall be retained and out of which 13% payment of invoice value shall be released on achievement of important milestones in the project completion as stipulated below.

27.3.3 Milestone Payments:

13% payment of invoice value out of retained 18% of invoice value shall be released within 30 days from the date of achievement of milestones as under and submission of the application of release of respective payment:

S.N.	Milestone	Payment (% of half of the Contract Value) for each unit
1	Commencement of Boiler Erection	0.5
2	Commencement of TG building foundation	0.5

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	3	Completion of STG Foundations & Deck	0.5
	4	Completion of foundation for ESP column erection	0.5
	5	Completion of ID/FD/PA fan Foundations	0.5
	6	Hydro Test	0.5
	7	Completion of De-aerator Erection	0.5
	8	Completion of Condenser Erection	0.5
	9	Chemical Cleaning of Boiler	0.5
	10	TG Box up	0.5
	11	Readiness of SCR	0.5
	12	Completion of Oil Flushing	0.5
	13	Boiler Light Up	0.5
	14	Readiness of GT	0.25
	15	Readiness of FGD	0.25
	16	Synchronisation of Unit	0.5
	17	Coal Firing	0.5
	18	Trial Operation	5.0
Contract value for this purpose shall be excluding Taxes and duties.			
27.4 Balance 5% payment shall be released upon completion of successful PG Test within 30 days from the date of submission of application for release			
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of payment along with i) Certificate issued by the owner/engineer declaring completion of successful Performance Guarantee Test and ii) Certificate issued by the Project Manager declaring the completion of all the services to be rendered against the contract. 27.5 Payment of Price Adjustment: 27.5.1 82% payment towards the Price Adjustment on Site Works along with taxes thereon shall be paid within 30 days from the date of submission of invoices along with documentary evidence (one original + two copies). 27.5.2 Balance 18% payment of price adjustment shall be released as per the provisions of Clause No. 27.3.3 and Clause No. 27.4 above. 27.6 Payments against Statutory Variation: 27.6.1 100% Payments towards Statutory Variation as per Clause No. 24.0 above shall be made to the contractor along with payment of respective invoice and documentary evidence of applicability of such statutory variation. 27.7 Deleted 27.8 Statutory Deductions (Tax Deduction at Source): 27.8.1 Statutory deduction towards any taxes & duties as may be applicable, shall be made by the owner from the contractor's respective invoices, as per the prevailing statutory requirements and necessary TDS certificate shall be issued by the owner. 27.8.2 However, if the contractor submits the certificate(s) from the statutory authorities exempting the contractor from deduction of such tax(es) or allowing deduction at lower rate or allowing deduction of certain amount, as the case may be, the action as per the stipulations of the certificate shall be taken while releasing the payments to the Contractor. 27.8.3 As per Building & Other Construction Workers Act-1996, BOCW cess @1% of contract price of Erection, Testing & Commissioning Contract and Civil works contract shall be deducted from the invoices of the contractor and deposited to the concerned authorities. Any increase or decrease in the rate from the next day to the Record Date shall accrue to the Owner. 27.9 Deleted 27.10 Deleted.		
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28.0 Field Office Records: 28.1 The Contractor shall maintain at his Site Office up to date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain drawings, specifications, supplementary data etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such built drawings and engineering data shall be submitted to the Engineer in required number of copies. 29.0 Contractor's Material Brought at Site: 29.1 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the Engineer. All such goods shall, from the time of their being brought vest in the Owner, but may be used for the purpose of the works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Engineer. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto. 29.2 The Owner shall have a lien on such goods throughout the period of contract for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the contract. After giving a 15 (fifteen) days notice in writing of his intention to do so, the Owner shall be at liberty to sell and dispose of any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid. 29.3 After the completion of the works, the Contractor shall remove from the Site under the direction of the Engineer the materials such as construction equipment, erection tools and tackles, scaffolding etc, brought by him for purpose of execution of the works covered under the contract. If the Contractor fails to remove such materials, within 15 (fifteen) days of issue of a notice by the Engineer to do so, then the Engineer shall have the liberty to dispose of such materials as detailed under Clause above and credit the proceeds there to the account of the Contractor. 29.4 Removal of erection equipment, tools and tackles, left out material of		
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supplies, consumables etc.; upon completion of the works, shall generally be as per Clause No. 37 of this Section. 30.0 Protection of Property and Contractor's Liability: 30.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection, from any damage resulting from his operation of all persons including members of public and employees of the Owner and the employees of other Contractors and sub contractors and all public and private property including structures, building, other plants and equipment and utilities either above or below the ground. 30.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign boards, warning lights and alarms etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the Engineer and the owners of Public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his work and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities. 31.0 Painting: 31.1 All exposed metal parts of the equipment including piping, structures, railings etc. wherever applicable, after installation unless otherwise surface protected, shall be first painted with at least one coat of suitable primer which matches the shop primer paint used, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting, and the same being inspected and approved by the Engineer for painting. Afterwards, the above parts shall be finished with two coats of alloyed resin machinery enamel paints. The quality of the finish paint shall be as per the Indian Standards or equivalent and to be of the colour as approved by the Engineer. 32.0 Unfavourable Working Conditions: 32.1 The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms etc and during other unfavourable construction conditions. No field activities shall be performed by the Contractor under conditions, which might adversely affect the quality and efficiency thereof, unless the Contractor takes special precautions or measures in a proper and		
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satisfactory manner in the performance of such works and with the concurrence of the Engineer. Such unfavourable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the Schedule. 33.0 Protection of Monuments and Reference Points: 33.1 The Contractor shall ensure that any finds such as relic, antiquity, coins, fossils etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Engineer. Similarly the Contractor shall ensure that the bench marks, reference points, etc., which are marked out either with the help of Engineer or by the Engineer shall not be disturbed in any way during the performance of his Works. If any work is to be performed which disturb such references, the same shall be done only after these are transferred to other suitable locations under the direction of the Engineer. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc. 34.0 Work and Safety Regulations: 34.1 The Contractor shall ensure proper safety of all the workmen, Materials, Plant and equipments belonging to him or to Owner or to others, working at the Site. The Contractor shall also be responsible for provision of all safety notices and safety equipment required both by the relevant legislations and the Owner's Representative, as he may deem necessary. 34.2 The Contractor shall notify well in advance to the Owner's Representative of his intention to bring to the Site Container filled with liquid and gaseous fuel or explosive or petroleum substance or such chemicals, which may involve hazards. The Owner's Representative shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the Work and the Contractor shall strictly adhere to and comply with such instructions. The Owner's Representative shall have the right at his sole discretion to inspect any such container or such construction plant/equipment for which Material in the Container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained by the Owner and the Owner shall not entertain any claim of the Contractor towards additional safety provisions/conditions to be provided for/ constructed as per Owner's Representative's Instructions.		
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34.3 Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying out such provision and / or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual Published by the Chief Inspector of Explosives of India as well as other relevant and Applicable Laws, rules and regulations. All such storage shall have prior approval of the Owner's Representative. In case, any approvals are necessary from the Chief Inspector (Explosive) or any statutory authorities, the Contractor shall be responsible for obtaining the same. 34.4 All equipment used in construction and erection by Contractor or his Sub contractors shall meet Indian and International Standards of safety and where such standard do not exist, the Contractor shall ensure these to be absolutely safe. All equipment shall be strictly operated and maintained by the Contractor or his Sub contractors in accordance with Manufacturer's operation manual and safety instructions and as per Guidelines and Rules of the Owner in this regard. 34.5 Periodical Examinations and all Test for all lifting/hoisting equipment and tackles shall be carried out in accordance with the relevant provisions of Factories Act 1948, Indian Electricity Act 2003 and all relevant Law/Rules in force from time to time. A register of such examinations and Test shall be properly maintained by the Contractor and will be promptly produced as and when desired by Owner's Representative or by the Person authorised by him. 34.6 The Contractor shall be fully responsible for the safe storage of his and his Sub-contractor's radioactive sources in accordance with BARC/DAE Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, storage and handling of such material will be taken by Contractor. 34.7 The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by Owner's Representative who will also have right to examine these safety equipment to determine their suitability, reliability, acceptability and adaptability. 34.8 Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced, qualified and competent Person strictly in accordance with the Code of Practices/Rules		
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framed under relevant laws, rules and regulations not restricted to Indian Explosives Act pertaining to handling, storage and use of explosives. 34.9 The Contractor shall provide safe working conditions to all workmen and employees at the Site including safe means of access, railings, stairs, ladders, scaffoldings, etc. The scaffoldings shall be erected under the control and supervision of and experienced and competent Person. For erection, good and standard quality of material only shall be used by the Contractor. 34.10 The Contractor or his Sub contractors shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the Owner or other Contractors under any circumstances, whatsoever, unless expressly permitted in Writing by the Owner to handle such fuses, wiring or electrical equipment. 34.11 Before the Contractor or the Subcontractors connects any electrical appliances to any plug or socket belonging to the other Contractor or Owner, he shall: - Satisfy the Owner's Representative that the appliance is in good working condition and; - Inform the Owner's Representative of the maximum current rating, voltage and phases of the appliances and; - Obtain permission of the Owner's Representative detailing the sockets to which the appliance may be connected. 34.12 The Owner's Representative will not grant permission to connect until he is satisfied that: - The appliance is in good condition and fitted with a suitable plug, and - The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheath surrounding the cores. 34.13 No electric cable used by the other Contractor/Owner will be distributed without prior permission. No weight of any description will be imposed on any cable and no ladder or similar equipment will rest against or attached to it. 34.14 No repair work shall be carried out on any live equipment. The equipment shall/must be declared safe by Owner's Representative and a permit to Work shall be issued by Owner's Representative before any repair work is carried out by the Contractor or his Sub contractors. While		
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working on electric lines/equipments whether live or dead, suitable type or sufficient quantity of tools will have to be provided by Contractor or his Subcontractors to electricians/workmen/officers. 34.15 The Contractor shall employ necessary number of qualified, full time Electricians/Electrical Supervisors to maintain his temporary electrical installations. 34.16 The Contractor employing more workmen than specified under Factories Act 1948 whether temporary, casual, probationer, regular or permanent or on Contract, shall employ at least required numbers of full time officers exclusively as Safety Officer to supervise the safety aspects of the equipment and workmen who will coordinate with the Project Safety Officer and Owner's Representative. In case of Work being carried out through Sub-contractors, the Sub-contractor's workmen/employees will also be considered as the Contractor's workmen/employees for above purpose. The name and address of such Safety Officers of Contractor will be promptly informed in Writing to Owner's Representative with a copy to Safety officer-in-charge before he starts Work or immediately after any change of the incumbent is made during currency of the Contract. 34.17 In case any accident occurs during the construction/erection or other associated activities undertaken by the Contractor thereby causing any minor, major or fatal injuries to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Owner's Representative in prescribed form and also to all the authorities envisaged under the Applicable Laws. 34.18 The Owner's Representative shall have the right at his sole discretion to stop the Work or supply of Goods, if in his opinion the Work or supply of Goods is being carried out in such a way that it may cause accidents and endanger the safety of the persons and/or property, and/or equipment. In such cases, the Contractor shall be informed in Writing about the nature of hazards and possible injury/accident and he shall comply with the instructions of the Owner's Representative including removal of shortcomings promptly. The Contractor after stopping the specific Work or supply of Goods, can, if felt necessary, appeal against the order of stoppage of Work within 3 (three) Days of such stoppage of Work and Owner's decision in this respect shall be conclusive and binding on the Contractor. 34.19 The Contractor shall not be entitled for any damages/compensation for stoppage of Work or supply of Goods due to safety reasons as provided		
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in clause 34.18 above and the period of such stoppage of Work will not be taken as an extension of time for completion of Work or supply of Goods and will not be the ground for waiver of levy of Liquidated Damages, 34.20 The Contractor and his Sub contractors shall follow and comply with all Safety Rules, relevant provisions of Applicable Laws pertaining to safety of workmen, employees, Plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. 34.21 Contractor shall prepare a safety programme for the Plant and the Project and submit the same for approval of the owner. The contractor shall, and shall cause all Sub-contractors to, implement and administer such safety program on approval of the Owner (which shall not be unreasonably withheld). The safety programme shall necessarily include: a) Development of a Project safety manual (the “Safety Manual”) establishing safety guidelines and requirements for Contractor, Sub-contractor (including a fall prevention program). Copies of this manual shall be provided to Owner/Owner’s Representative immediately upon its development and Contractor shall incorporate into such Safety Manual any and all reasonable comments of Owner/owner’s representative. b) Conducting of weekly Project safety meetings with the employees and agents of Owner, Contractor, Sub-contractor and Owner’s other Contractors and their Sub-contractors. c) Development, implementation and enforcement of procedures for advising employees and agents of Owner, Contractor, Sub-contractor and Owner’s other Contractors and their Sub-contractors of, and correction of, safety violations and deficiencies. d) Taking of all other actions necessary to provide a safe Work environment in accordance with Applicable Laws and Applicable Permits. Contractor shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to avoid damage, injury or loss to: i) All persons employed by the Owner, Contractor and its Sub-contractors and Owner’s other Contractors and their Sub-contractors in connection with the Work or supply of Goods or Owner and its Contractors and Sub-contractors (whether in the performance of their obligations under the Contract or otherwise) and all other persons who may be affected by the		
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performance of the Work or supply of Goods or any of such persons. ii) All supplies used in connection with the Plant and all equipments to be incorporated into the Plant, whether in storage on or off the Site under the care, custody or control of Owner, Contractor, any Sub-contractor or Owner's other Contractors and their Sub-contractors. iii) At all times (including during Commissioning, start-up, testing and Initial Operation, Reliability Operation and Tests before Take Over including Performance Tests of the Plant) Contractor shall require all Sub-contractors working on or supplying equipments or construction equipment to the Site to comply with all safety requirements in effect at all such times and of all Applicable Laws and Applicable Permits. Contractor shall, and shall cause the Sub-contractors to, comply with all Applicable Laws and Applicable Permits. 34.22 Actions against Failure to meet Safety Norms: 34.22.1 In the event any employee of the contractor is found to be committing breach of safety norms and/or instructions given by the Safety Officer nominated by the Project Manager, for the first instance he shall be fined for payment of INR 1000/-. However, if the same employee found to be committing breach again, the fine for second and third occasion shall be INR 2,000/- and INR 3,000/- respectively. However, for the fourth occasion, such employee shall be asked to leave the site forthwith. 34.22.2 If the contractor/subcontractor is repeatedly neglects to direct/make his employees to adhere to the safety norms and wilfully neglects or fails to demonstrate improvement in this matter, the owner may debar the contractor/subcontractor from participating in bid for such work or remove the name of subcontractor from the approved vendor/subcontractors list. 35.0 Foreign Field Personnel: 35.1 The Contractor shall submit to the Owner data on all personnel, if any, he proposes to bring into India for the performance of the Works under the Contract, at least 60 (sixty) days prior to their departure to India. Such data will include for each person the name, his present address, his		
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assignment and responsibility in connection with the Works, and a short resume of his qualification, experience etc., duration of his stay in India in relation to the work to be performed by him. 35.2 Any person unsuitable and unacceptable by the Owner shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the Owner, the Contractor shall within a reasonable time make alternate arrangement for providing a suitable replacement and repatriation of such unsuitable personnel. 35.3 No person brought to India for the purposes of the works shall be repatriated without the consent of the owner in writing based on a written request from the Contractor for such repatriation giving reasons for such an action to the Engineer. The Owner may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation. 35.4 The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political, religious & social affairs and shall conform to any other rules and regulations the Government of India, the Owner and the Engineer may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and co-ordination with their co-workers and the community and shall not engage themselves in any other employment either part time or full time nor shall they take part in any local politics. 35.5 The engineer shall have right to review the list of such personnel submitted by the contractor and ask to add more personnel if he is of the opinion that the proposed personnel are inadequate in number or shall ask to reschedule their visits to India or increase their stay, if he deems fit to do so in the interest of the project. 35.6 The owner shall assist the contractor, to the extent possible in obtaining necessary permits for such personnel to travel to India and back by issuing necessary certificates and other information needed by the Governmental agencies. 36.0 Deleted 37.0 Closing of Site Office: 37.1 After completing the works at site, the contractor shall remove all temporary works constructed by him for establishing the office, storage, etc. under the direction of the Engineer and hand over back to the owner		
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the clear space as was allotted by the owner while establishing the site establishment. 37.2 The contractor shall remove all erection equipment brought by him to site for execution of the contract as well as all left out material of supplies, consumables, etc. belonging to him with due permission of the owner. 37.3 All the balance supplies left over after completing the erection works & belonging to the Owner shall be deposited and stacked in the stores as instructed by the Owner. 37.4 Unless all material are removed and clear space is handed over back to the owner, release of contract performance security shall not be considered by the owner. 37.5 On completion of the erection activities the contractor shall return the labour licence to the Labour Commissioner and submit a proof of having cancelled the labour licence to the owner. 38.0 Disposal of Scrap: "The Contractor shall with the agreement of the Owner/Project Manager promptly remove from the site any 'Scrap' generated during performance of any activities at site in pursuance of the Contract. The term 'Scrap' shall refer to scrap / waste / remnants arising out of the fabrication of structural steel work and piping work at the project site in the course of execution of the contract and shall also include any wastage of cables during the termination process while installing the cables. The ownership of such Scrap shall vest with the Contractor except in cases where the items have been issued by the Owner from its stores for their installation only without any adjustment to the Contract Price. The removal of scrap shall be subject to the Contractor producing the necessary clearance from the relevant authorities (Custom, Excise etc.), if required by the law, in respect of disposal of the scrap. The liability for the payment of the applicable taxes/duties shall be that of the Contractor. The Contractor shall also indemnify to keep the Owner harmless from any act of omission or negligence on the part of the Contractor in following the statutory requirements with regard to removal/disposal of scrap. The Indemnity-cum-Undertaking Agreement shall be furnished by Contractor as per proforma enclosed in Annexure-XIX of Section-I. Further, in case the laws require the Owner to take prior permission of the relevant Authorities before handing over the scrap to the Contractor, the same shall be obtained by the Contractor on behalf of the Owner ".		
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1.0 Convenience to Public: 1.1 All operations necessary for the execution of the works and for the construction of any temporary works shall so far as compliance with the requirements of the contract permits be carried on so as not to interfere unnecessarily or improperly with the public convenience or the access to use and occupation of public or private roads and foot paths or to properties whether in the possession of the owner or of any other person and the contractor shall save harmless and indemnify the owner in respect of all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any such matter. 1.2 The contractor shall provide all necessary fencing and lights required to protect the public from accident and shall also be bound to bear the expenses of defence of every suit, action or other legal proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay damages and costs which may be awarded in any such suit, action or proceedings to any such persons or which may with the consent of the contract be paid in compromising any claim by any such person. 1.3 Any damage/disturbances caused to any of the existing facilities shall be promptly repaired and restored as existing by the contractor at his own cost. 2.0 Protection of Works: 2.1 The contractor shall, in connection with the works, provide and maintain at his own cost all lights, guards, fencing and watching when and where necessary or required by the engineer or by any competent statutory or other authority for the protection of the works or for the safety and convenience of the public or others. 3.0 Facilities for other Contractors: 3.1 The contractor shall in accordance with the requirements of the Engineer afford all reasonable facilities for any other contractors employed by the owner and their workmen, for the workmen of the owner and of any other properly authorized authorities or statutory bodies who may be employed in the execution on or near the site of any work not included in the contract or of any contract which the owner may enter into in connection with or ancillary to the works.		
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4.0 Removal of Persons Employed from Site:

4.1 The contractor shall employ in and about the execution of the works only such persons as are careful skilled and experienced in their several trades and callings and the engineer shall be at liberty to object to and require the contractor to remove from the site any person employed by the contractor in or about the execution of the works who in the opinion of the engineer indulges in misconduct or is incompetent or negligent in the proper performance of his duties or whose activities directly or indirectly adversely effect the quality and/or the progress of the work and such persons shall not be re-employed upon the works without the permission of the Owner's Engineer.

5.0 Contractor's Liabilities:

5.1 The contractor shall supply at his own cost all materials, plant, tools, appliances, ladders cordage, tackle, scaffolding and any temporary works, which may be required for the proper execution of the work in the original, altered or substituted from and whether included in the specification or other document forming part of the contract or referred to in these conditions or not and which may be necessary for the purpose of satisfying or complying with the requirements of the Engineer-in-charge as to any matter on which under these condition he is entitled to be satisfied or which is entitled to require together with carriage therefore to and from the work. The contractor shall also supply without charge the requisite number of persons with the means and materials necessary for the purpose of setting out works and counting, weighing and assisting in the measurement or examination at any time and from time to time of the work of materials. Failing this the same may be provided by the Engineer-in-charge at the expense of the contractor and the expenses may be deducted from any money due to the contractor under the contract or from his security deposit or the proceeds of sale thereof, or of a sufficient portion thereof.

6.0 Contractor's other Liabilities:

6.1 Compensation for all damage done intentionally or unintentionally by contractor's labour whether in or beyond the limits of the owner properly shall be estimated by the Engineer-in-charge, or such other officer as he may appoint and the estimates of the Engineer-in-charge, subject, to the decision of the Engineer-in-charge on appeal, shall be final and the

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contractor shall be bound to pay the amount of the assessed compensation on demand, failing which the same will be recovered from the contractor as damages or deducted by the Engineer-in-charge from any sums that may be due to or become due from Owner to the contractor under this contract or otherwise. 6.2 The contractor shall bear the expenses of defending any action or other legal proceedings that may be brought by any person for injury sustained by him owing to neglect of precautions to prevent the spread of fire and he shall also pay any damages and cost that may be awarded by the court in consequences. 7.0 Royalty Charges Levied by Government: 7.1 Any royalty required to be paid for excavation work, back filling, materials borrowed from outside for development/embankment etc. shall have to be paid by the contractor to the concerned revenue authorities at his own cost and the contractor shall be fully responsible for the same. 8.0 Codes and Standards: 8.1 All works under this contract, unless specified otherwise, shall conform to the latest revision and/or replacement of Indian Standard Specification and Codes of Practice as on "Record Date". In case specifically Indian Standard Specification does not cover any particular aspect of work, any other standard practice specified by the Engineer shall be followed. If there is any change in codes and standard after Record date, suitable time extension/compensation as mutually agreed shall be given, if required. 9.0 Action Where No Specification: 9.1 In the case of any work for which there is no specification as is mentioned, such a work shall be carried out in accordance with the Divisional specifications and in the event of there being no Divisional specification the work shall be carried out in all respects in accordance with the instructions and requirements of the Engineer-in-charge. 10.0 Right to Waive and for Specific Clause: 10.1 The Engineer can waive and/or relax any of the clauses of the technical specifications and/or other contract document and the cost tendered shall be suitably reduced by the Engineer based on the actual financial implications due to such waivers and/or relaxations.		
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11.0 Calculations and Design: 11.1 The contractor shall submit design basis report for all schemes and all his civil, structural, electrical, instrumentation, mechanical and architectural design and calculations, design and detail drawings for approval of the owner/consultant. However, the checking and approval of design calculations and drawings by the Owner/Consultant shall not relieve the contractor from his responsibilities of correctness in design, details, and specific performance of the plants. 11.2 All Design Basis Reports, design calculations and drawings shall be submitted to the owner/Consultant in triplicate for each submission. On receipt of final approval the contractor shall submit three (3) copies of design calculations and required number of copies of drawings to the Owner/ Consultant. 12.0 Change in Design: Deleted. The provisions of Clause No. 46, Section-2, Volume-I read with Clause 25, Section-2, Volume-I shall be applicable. 13.0 Drawing: 13.1 The contractor expressly agrees that the drawings enclosed with the bid specification serve specific purpose of giving some idea of the job and considered to preliminary for the bidding purpose only. These drawings are by no means complete and final and do not show the full range of the works under the scope of the contract. The works shall be carried out only after approval by the Owner/Consultant on the basis of the drawings marked “Approved/Released for construction” with additions, alterations, modifications, revision made to the aforesaid drawings from time to time and also according to drawings supplied by the contractor and approved by Owner/consultant from time to time. 13.2 The contract being the lump sum/ EPC contract based on the contractor's own design and drawings, it is expected that the submission of design and drawings to the Owner/Engineer/Consultant shall be done in time to ensure that, there is no hindrances/hold-up for execution of the works due to the drawings and delay in progress. 13.3 Before any portion of the works is taken in hand the contractor must prepare at his own cost and submit design and drawings for the approval of the Owner/ consultant any of the construction, fabrication, and erection and the material lists for the works and temporary works which may be		
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required to be done under the provisions of the contract and at the same time call the attention of the Engineer to any modification of the drawings which the contractor may desire to make. 13.4 On receipt of the said design and drawings and material lists the Owner/consultant shall check and verify the detailed design and drawings and return one copy of the said drawings and material lists to the contractor indicating thereon the corrections, modifications and additions required to execute the works in accordance with the contract. The owner/consultant shall also indicate by making on the drawings the approval status such as “Approved”. 13.5 After necessary corrections, modifications, if any, the contractor shall submit required number of hard copies and soft copy (pdf/ AutoCAD as applicable) of each of the said drawings and material lists to the Owner/Engineer/consultant for necessary distribution and record. 13.6 The provisions of Clause No. 25.0, Section 2 shall be applicable. 13.7 All the drawings and material lists are to be prepared in metric units and while preparing the drawings and material lists, only figures dimensions of the contract drawings are to be followed in preference of scaling. The titles of the drawings and material lists shall be as directed by the Owner/Consultant. 13.8 No major revision affecting the design shall be made without prior approval of the Engineer after the drawing and material list has been approved. If any minor revision is made, the Engineer shall be immediately informed about it and required number of copies of the revised drawings and material lists with one (1) transparency of each shall be submitted to the owner/consultant. 13.9 The contractor shall physically verify all dimensions in the field before any portion of the works is executed or taken in hand. The approval of the owner/consultant on any or all drawings and material lists prepared and submitted by the contractor shall not relieve him of any of his responsibilities and obligations under the contract, the contractor shall at all times be responsible and shall pay for all costs involved in any alteration, modification and addition to the works due to any discrepancies errors and omissions on the drawings and material lists and in other documents supplied by him whether such drawings and material lists and other documents have been approved by the Owner/Consultant or not.		
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13.10 The provisions of Clause No. 52.0, Section 2 shall be applicable. 14.0 Drawings to be Made Available at Site: 14.1 One copy of the approved drawings furnished to the contractor as aforesaid shall be kept by the contractor at the site and the same shall at all reasonable times be available for inspection and use by the Engineer and the Engineer's representative and by any other person authorised by the Engineer in writing. 15.0 Works to be Executed Under the Direction of Owner's Representative: 15.1 All works to be executed under the contract shall be executed under the direction and subject to the approval in all respect of the Chief Engineer (Civil-I)/ Chief Engineer (Civil-II)/Dy.Chief Engineer (Civil)/Supdtg. Engineer (Civil) of the owner for the time being, who shall be entitled to direct at what point or points and in what manner they are to be commenced and from time to time carried on. 16.0 Decision of the Competent Authority of the Owner to be Final: 16.1 Except where otherwise specified in the contract and subject to the powers delegated by owner under the owner's rule then in force, the decision of the competent authority of the owner for the time being shall be final, conclusive and binding on all parties to the contract upon all questions relating to the meaning of the specifications, designs, drawings and instruction herein before mentioned and as to the quality of workmanship or material used on the work, or as to any other question, claim, right, matter or thing whatsoever, in any way arising out of or relating to the contract designs, drawings specifications estimates instruction, orders or these conditions or otherwise concerning the works or the execution or failure to execute the same, whether arising during the progress of the work, or after the completion or abandonment thereof. 17.0 Deleted 18.0 Deleted 19.0 Works, Materials and Plants: A) Materials, Workmanship and Tests: All materials and workmanship shall be of the respective kinds described in the contract and in accordance with the Engineer's instructions and shall be subjected from time to time to such tests as the Engineer may direct at the place of manufacture or fabrication or on the site or at all or any of such places. The contractor shall provide such assistance, instruments, machines,		
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labour and materials as are normally required for examining, measuring and testing any work and the quality, weight or quantity of any materials used and shall supply samples of materials before incorporation in the works for testing as may be selected and required by the Engineer. B) Contractor's Supply of Samples: The contractor shall carry out tests of materials or finished work as the Engineer in writing may require and shall supply free of cost samples necessary for this purpose. The cost incurred in this respect shall be borne by the contractor. C) Owner's Access to the Works: The owner's Engineer and any person authorized by them shall at all times have access to the works and to the site and to all workshops and places where work is being prepared or where materials, manufactured articles and machinery are being obtained for the works and the contractor shall afford every facility for and every assistance in or in obtaining the right to such access. D) Examination of Works: No work shall be covered up or put out of view without the approval of the Engineer and the contractor shall afford full opportunity for the Engineer or his authorized representative to examine and measure any work which is about to be covered up or put out of view and to examine foundations before permanent work is placed thereon. The contractor shall give due notice to the Engineer whenever any such work or foundations is or are ready or about to be ready for examination and the Engineer shall without unreasonable delay unless he considers it unnecessary and advises the contractor accordingly attend for the purpose or examining such work or of examining such foundations. E) Removal of Improper Works and Materials: The Owner's Engineer shall during the progress of the works have power to order in writing from time to time for: - The removal from the site of any materials which in the opinion of the Engineer are not in accordance with the contract. - The substitution of proper and suitable materials. - The removal and proper Re-execution (notwithstanding any previous test thereof or interim payment therefore) to any work		
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which in respect of materials or workmanship is not in the opinion of the Owner's Engineer in accordance with the contract. In case of default on the part of the contractor in carrying out such order the owner shall be entitled to employ and pay other persons to carry out the same and all expenses consequent thereon or incidental thereto shall be borne by the contractor and shall be recoverable from him by the owner or may be deducted by the owner from any money due or which may become due to the contractor. Seven (7) days notice in writing shall be given to the contractor for removal of work / material from site. F) Deleted 20.0 Materials to be Procured by the Contractor: 20.1 The owner will not supply any materials such as cement, M.S. reinforcement bars, Structural Steel, M.S. Plates and other materials to the contractor for execution of the works and the contractor has to make his own arrangement for procurement of all these materials from the market at his own. The contractor shall have to procure all the materials only from the suppliers/manufacturers approved by the owner. All materials procured by the contractor shall conform to the relevant I.S. Specifications and as per tender provisions. The contractor shall furnish manufacturer's test certificate to the owner's engineer in accordance with specification for the materials procured by the contractor. 20.2 In addition to manufacturer's test certificate, the contractor will have to carry out the tests as regards to the conformity/suitability of the above materials as per decision/direction of Owner i.e. for Cement, Reinforcement Steel, and Structural steel etc. The decision of the Owner's Engineer shall be final and binding on the contractor. The cement, steel etc. to be procured by the contractor shall be as under: - Cement shall be of 33/43/53 grade conforming to IS: 269, IS: 8112, IS: 12269 as the case may be, sourced only from the manufacturers approved by the owner. - The reinforcement steel shall conform IS: 1786 and /or IS: 432 as the case may be and the structural steel shall conform to IS: 808, IS: 1730, IS: 1732 and IS: 2062 manufactured by TISCO or SAIL or of the manufacturers approved by the owner.		
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iii) All other materials procured by the contractor shall conform to the tender specification and the relevant I.S. codes. The contractor shall obtain necessary written permission from the owner before procurement of these materials. The owner shall provide necessary and all required assistance to the contractor for procuring these materials. 20.3 The contractor shall have to provide suitable store/building etc. at site for proper storage of materials procured for execution of the works at his cost. 20.4 Unsuitable materials procured by the contractor shall be immediately removed from the site. In case the same is incorporated in the work, the contractor shall remove such work and reconstruct the same. The cost for reconstruction of the same shall be borne by the contractor. The decision of the Engineer-in-charge in this regard shall be final. Similarly the number and type of tests to be conducted on these materials would be decided by the Engineer-in-charge. 20.5 Any materials if supplied by the Owner, the recovery will be effected at rates fixed by the Engineer-in-charge based on 'Cost Rate' or 'Market Rate' whichever is higher plus GST plus 15% to cover Owner’s overhead charges. The contractor shall also have to pay interest charges on the above amount at Owner’s borrowing rate plus one percent per annum in case the cost of the materials has not been recovered within a reasonable period of one month from the date of issue of these materials by the Owner to the contractor duly reckoned at every month. 20.6 Deleted 21.0 Materials: 21.1 All the materials use and equipments supplied such as pipes, valves, motors, pumps, etc. shall be of best quality conforming to relevant Indian Standards and subject to the approval of the Owner/Engineer. If desired by the Engineer, the contractor shall get tested any of the materials being used and/or equipments supplied by him at no extra cost. Before procurement of any of the materials or equipments, the contractor should obtain the written approval from the Owner/Consultant and shall be procured only from the approved suppliers, after pre-dispatch inspection and clearance by the Owner's Engineer. 22.0 Notification of Delivery/Despatch: 22.1 The notification of delivery or dispatch in regard to each and every consignment shall be made by e-mail and by detailed letter to the Owner’s			
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Engineer at Site immediately upon dispatch or delivery with a copy to the Chief Engineer (Civil - I), MAHAGENCO, Estrella Batteries Expansion Building, 1st Floor, Dharavi Road, Matunga, Mumbai-400 019. 23.0 Workmanship: 23.1 Workmanship shall be of the best possible quality and skilled workmen except for those, which normally require unskilled persons, shall carry out all work. If the bye-laws of the local Government, Municipal and other authorities require the employment of licensed or registered workmen for various trades, the contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the contractor shall have with no additional cost to the owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specification. If desired by the Engineer, the contractor shall make necessary tests for water tightness of the liquid retaining structures at no extra cost. 24.0 Quality Control: 24.1 The contractor shall establish and maintain quality control for the various aspects of the works, methods, materials and equipment used. The quality control operation shall include but not be limited to the items of works specified in the detailed specifications. 25.0 Contractor shall Execute, Complete and Maintain the Works as per the Direction of Engineer: 25.1 Save in so far as it is legally or physically impossible the contractor shall execute, complete and maintain the works in strict accordance with the contract to the satisfaction of the Engineer and shall comply with and adhere strictly to the Engineer's instructions and directions on any matters. The contractor shall take instructions and directions only from the Engineer or from the Engineer's Representative unless otherwise provided for in the contract. 26.0 Work to be Open to Inspect, the Contractor or Reasonable Agent to be Present: 26.1 All works under or in course of execution or executed in pursuance of the contract shall at all times be open to inspection and supervision of the Engineer-in-charge and his subordinates and the contractor shall at all time during usual working hours and at all other times at which reasonable notice of the intention of the Engineer-in-charge or his subordinates to visit the works shall have been given to the contractor, either himself by present to receive orders and instructions or have a		
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responsible agent duly accredited in writing, present for that purpose. Orders given to the contractor's duly authorized agent shall be considered to have the same force and effect as if they had been given to the contractor himself. 27.0 Notice to be Given Before Work to be Covered Up: 27.1 The contractor shall give not less than 5 days notices in writing to the Engineer-in-charge or his subordinate in charge of the work before covering up or otherwise placing beyond the reach of measurement any work in order that the same may be measured, and correct dimensions thereof taken before the same is so covered up or placed beyond the reach of measurement any work without the consent in writing of the Engineer-in-charge or his subordinate in charge of the work, and if any work shall be covered up or placed beyond the reach of measurement without such notice having been given or consent obtained the same shall be uncovered at the contractor's expense, and in default thereof no payment or allowance shall be made for such work, or for the materials with which the same was executed. 28.0 Temporary Works: 28.1 The contractor at his own cost and inclusive of all materials, labour, supervision and other facilities, shall provide all necessary temporary works required for proper execution of the works. 28.2 The layout and detail of such temporary works shall have the prior approval of the Engineer, but the contractor shall be responsible for proper strength and safety of the same. All temporary works shall be so constructed as not to interfere with any permanent work of other agencies. If it is necessary to remove any of the temporary work or works due to requirement of Owner, the contractor shall remove the same and re-erect the same at his own cost. Nothing extra shall be payable by the Owner on this account to the contractor, notwithstanding the fact that the location was allotted by the Owner to the contractor. 29.0 Engineer May withheld Certificate: 29.1 The Owner's Engineer may by any certificate make any correction or modification in any previous certificate which shall have been issued by him and shall have power to withhold any certificate if the works or any part thereof is not being carried out to his satisfaction.		
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30.0 Certificate of Payment Not to Constitute Approval of Works:

30.1 No certificate shall be deemed to constitute approval of any work or other matter in respect of which it is issued or shall be taken as an admission of the due performance of the contract or any part thereof or of the accuracy of any claim or demand made by the contractor or of additional or varied work having been ordered by the Owner’s Engineer nor shall any other certificate conclude or prejudice any of the power of the Engineer.

31.0 Actions and Compensation Payable in Case of Bad Works:

31.1 If at any time before the security deposit and/or retention money is refunded to the contractor, it shall appear to the Engineer-in-charge or his subordinate in charge of the work that any work has been executed with unsound, imperfect or unskillful workmanship or with materials of inferior quality, or that any materials or articles provided by him for the execution of the work are unsound or of a quality inferior to that contracted for or are otherwise not in accordance with the contract, it shall be lawful for Engineer-in-charge to intimate this fact in writing to the contractor and then notwithstanding the fact that the work materials or articles complained of may have been inadvertently passed, certified and paid for, the contractor shall be bound forthwith to rectify, or remove and re-construct the work so specified in whole or in part, as the case may require of if so required shall remove the materials or articles so specified and provide other proper and suitable materials or articles at his own charge and cost, and in the event of his failing to do so within a period to be specified by the Engineer-in-charge in the written intimation aforesaid, the Engineer-in-charge may rectify or remove, and re-execute the work or remove and replace the materials or articles complained of as the case may be, at the risk and expense in all respect of contractor. Should the Engineer-in-charge consider that any such inferior work or materials as described above may be accepted or made use of, it shall be within his discretion to accept the same at such reduced rates as he may fix thereof.

32.0 Dewatering:

32.1 No separate payments would be made by the owner for dewatering of sub-soil or surface water if required at any time during the construction or during the period of maintenance including monsoon period and the price quoted by the tenderer for the EPC contract under price bid are deemed to be inclusive of cost of such dewatering where necessary for all the works / packages.

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32.2 All the excavations or any other works shall be kept free of water and slush. Grading in the vicinity of excavation / works shall be controlled to prevent surface water running into excavated areas. The contractor shall remove by pumping or any other means approved by the Engineer, any water inclusive of rain water and sub-soil water, curing water of his agencies, leakage of existing lines etc. in brief any type of water entering the work area and getting accumulated in excavation and keep the trench / pits de-watered until the construction of foundation structures and backfilling are complete in all respects. Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of sub soil or blowing in due to differential head of water during pumping.			
33.0 Rates of Extra Item:			
33.1 Deleted.			
33.2 Contractor to Furnish Receipt and Voucher: The contractor shall furnish to the Engineer all such receipts, tax invoices or other vouchers in original as may be necessary to prove the amount paid and before ordering materials shall submit to the Engineer quotations for the same for approval.			
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CARRYING OUT TOPOGRAPHICAL / CONTOUR SURVEY FOR PROPOSED
2 X 660 MW KORADI EXPANSION PROJECT



CREATING OUR ENVIRONMENTAL & ECONOMIC FUTURE THROUGH THE 2008-2012 CONGRESSIONAL BUDGET AND APPROPRIATIONS PROJECT			
DETAILS SHEET			
TOTAL AREA SURVEYED		TOTAL AREA: 89,500 AC.	
		- 1,811 B. ACRES	
		- 189,124 ACRES	
T B LOCATION			
LOC	TH	TH	TH
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TH16A100	606.57	20,249,096.715	0.0184038

NOTES:-
1. All Dimensions are in meter unless otherwise stated.
2. Level value of this drawing are based on GPS MSL.
3. Boundary is as per shown and C-Cover provided.

LEGEND			
	MAIN ROAD		TOTAL STATION POINT
	INTERNAL ROAD		TREE
	STREAM/TALA		LAMP POST
	DRAIN		ELECTRIC POLE
	COMPOUND WALL		TELEPHONE POLE
	INTERNAL WALL		GATE
	LOW/LOW LEVEL LINE		FIRM LOCATION
	H.T. LINE		FLAG POST
	CONTOUR MAJOR/UM		LEVEL
	CONTOUR MINOR/UM		STONE
	DRAIN		CHAMBER
	FENCING		HAND PUMP
	BOUNDARY POINT		TOWER
	GRUTCH/BORG LOCATION		BUILDING/STRUCTURE

FOR		FOR	
Name	Signature	Name	Signature
Received By		Checked By	
Placed By		Approved By	

CLIENT	MAHARASHTRA STATE POWER GENERATION COMPANY LTD.
PROJECT	CARRYING OUT DETAILED TOPOGRAPHIC SURVEY PROPOSED SITE FOR POWER PLANT AT KORADI
TITLE	TOPOGRAPHIC AND CONTROL SURVEY PLAN



MAHARASHTRA STATE POWER GENERATION CO. LTD.

**KORADI THERMAL POWER STATION
2x660 MW UNITS - 11 & 12 PROJECT**

**BID DOCUMENT
FOR
EPC CONTRACT (MAIN PLANT PACKAGE)**

RFx No. 3000046202 (BTG Package)

**VOLUME - V, -
ANNEXURE - 8**

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PAINTING REQUIREMENTS

Steag Energy Services India Pvt. Ltd.
(A wholly owned subsidiary of STEAG Group, Germany)
A-29, Sector-16, NOIDA-201301, India

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	VOLUME - V
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PAINTING REQUIREMENTS

PREPARED BY



(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.

(A wholly owned subsidiary of STEAG Energy Services GmbH, Germany)
A-29, Sector-16, NOIDA-201301, India

FEBRUARY, 2024

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1.00.00 GENERAL

1.01.00 This section covers minimum requirements of PAINTING REQUIREMENTS for 2 x 660 MW pulverized fuel based thermal power plant; to meet well established engineering practices and other relevant codes and standards. PAINTING REQUIREMENTS will cover the following:

1.01.01 All un-insulated carbon steel and alloy steel equipment, structures, vessels, drums, tanks, etc.

1.01.02 All un-insulated carbon steel and alloy steel piping, fitting, valves, ducting, etc.

1.01.03 All structural steel work, pipe structural steel supports, walkways, handrails, ladders, platforms, etc.

2.00.00 SURFACE PEPARATION AND PAINTING

2.01.00 Surface preparation methods and painting shall be as specified herein.

2.02.00 If the bidder desires to use any method/materials (paint/primer) other than that specified, specific written approval shall be obtained from the owner/engineer, for using the substitute method/material.

2.03.00 Unless specified otherwise, paint shall Not be applied to following surfaces –

2.03.01 Surface of insulation

2.03.02 Surface of non-ferrous materials like, stainless steel / nickel / copper / brass / monel / aluminium / haste alloy / lead / galvanised steel

2.03.03 Surface of plastic and / or plastic coated materials

2.03.04 Valve stem

2.03.05 Pump rods, shafts

2.03.06 Bearings

2.03.07 Gauges

2.03.08 Lined surfaces

2.03.09 Clad surfaces

2.03.10 Nameplates

2.03.11 Code stampings

2.03.12 Push buttons

2.04.00 All pipelines shall be colour coded for identification, as per approved colour coding scheme, finalised during detailed engineering.

2.05.00 Where band colour is specified, same shall be provided at min. 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

2.06.00 The scope includes-

2.06.01 Supply of all necessary materials, equipment, weather and adjacent surface protection, scaffolding; to ensure the work is carried out in accordance with the specification and mutually agreed programme.

2.06.02 Surface preparation, application and quality control of painting and surface protection of all equipment, steel structures and piping of the project/plant.

2.06.03 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas. Protection against any external damage, till handover of the project is the responsibility of the bidder.

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2.06.04 Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

2.06.05 All necessary precautions to meet the requirements of the specification, taking into consideration safety (of personnel and equipment) and environment protection.

3.00.00 CODES AND STANDARDS

3.01.00 All materials, testing, and application shall be as per the stipulation of applicable approved International standards so far as they are equal to or more stringent than this specification. In addition to the codes and standard mentioned elsewhere in the specification, the latest edition of following standards and their amendments of any or their approved equivalent shall be followed:

Colours for ready mixed paints and enamels	IS: 5
Methods of Sampling and Test for Paints, Varnishes and Related Products	IS: 101 (All relevant Parts & Sections)
Specification for Ready Mixed Paint, Brushing, Zinc Chrome, Priming	IS: 104
Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide	IS: 144
Ready Mixed Paint, Brushing, Bituminous, Black, Lead-free, Acid, Alkali And Heat Resisting	IS: 158
Glossary of terms relating to paints	IS: 1303
Code of Practice for Painting of Ferrous Metals in Buildings	IS: 1477
Ready Mixed Paint, Air Drying, Red Oxide-Zinc Chrome, Priming	IS: 2074
Aluminium paints for general purposes	IS: 2339
Colour code for identification of pipe lines	IS: 2379
Code of practice for painting of concrete, masonry and plaster surfaces: Part 2 schedules.	IS 2932
Code of practice for painting of nonferrous metals in buildings	IS; 2524
Recommended Practice for Hot-Dip Galvanizing of Iron and Steel	IS: 2629
Enamel, Synthetic, Exterior : (a) Undercoating (b) Finishing	IS; 2932
Code of Practice for Whitewashing and Colour-washing	IS: 6278
Identification of pipeline used in thermal power plants	IS: 9404
Pictorial surface preparation standards for painting of steel surfaces	IS: 9954
Ready Mixed Paint, Air Drying, Red Oxide - Zinc Phosphate, Priming	IS; 12744

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Aluminium Paint, Heat Resistant	IS: 13183
Determination of dry film thickness	ISO 2808
Preparation of steel substrates before application of paint & related Products. Part-1: Rust grades & preparation grades of uncoated steel substrates & steel substrates after overall removal of previous coatings	ISO 8501-1
Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)	ISO 8502-3
Corrosion protection of steel structures by Protective paint systems	ISO 12944 (Part 1 to 8)
Paints & Varnishes (Performance requirements)	ISO 20340
Code of practice for protection of iron & steel structure against corrosion	BS EN ISO 14713
Swedish standard for surface preparation	SIS 55900
Society for Protective Coatings	SSPC
Surface preparation by Pickling	SSPC-SP-08
American Standard Test Method for paints and coatings	ASTM
Surface preparation & Protective coating	NORSOK M-501
Discontinuity (Holiday) testing of new protective coatings on conductive substrates	NACE SP0188

4.00.00 GENERAL REQUIREMENTS

- 4.01.00 The plant shall be designed to meet the complete requirements for a 2 x660 MW pulverized fuel based thermal power plant taking into consideration the plant location, environmental conditions, meteorological conditions, available input quality considerations to meet continuous, safe, efficient, economic and reliable working of the complete system for a period not less than 30 years.
- 4.02.00 All the equipments shall be protected against external corrosion by providing suitable painting.
- 4.03.00 Surface preparation and coatings should be durable enough, so that no repainting should be required for at least 10 years.
- 4.04.00 The painting should ensure optimal protection of the installation.
- 4.05.00 Painting should be environment friendly and easy to apply.
- 4.06.00 The surfaces to be provided with painting shall be properly & thoroughly properly prepared before painting.
- 4.07.00 Minimum requirements are specified herein.
- 4.08.00 Painting system for the plant shall be selected for medium corrosivity category, i.e. C3 and medium durability category, i.e. 7-15 yrs, as per ISO 12944. However, a minimum requirement of the specification has to be met.
- 4.09.00 System specific requirement of painting may be mentioned in other part/section of the specification. If there is any contradiction between this section and the other, the better painting scheme should be implemented.

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- 4.10.00 This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).
- 4.11.00 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used.
- 4.12.00 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:
- 4.12.01 Surface preparation
- 4.12.02 Film thickness (min. & max.)
- 4.12.03 Min. & max. Recoating intervals at relevant temperatures
- 4.12.04 Mixing ratio, thinner details and coating repair systems
- 4.13.00 Owner/Engineer may take random sample of paint/materials, for testing, to ensure the quality of materials being used.
- 4.14.00 Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish, in accordance with the requirements of this specification.
- 4.15.00 For equipment that has received shop prime coat, touch-up prime coat and additional coats, as required, shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.
- 4.16.00 During surface preparation and painting, necessary precautions should be taken to protect other (non target) surface from abrasive blasting, coating over spray and splatter. Any damage to other surfaces should be suitably repaired by the bidder, to the satisfaction of the owner/engineer.
- 4.17.00 Following should be covered in the painting schemes / schedules and quality plans-
- 4.17.01 Recommended paint scheme for the project.
- 4.17.02 Procedure for surface preparation & application.
- 4.17.03 Latest published product & instructions for application data.
- 4.17.04 Pre-qualification for equipment and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
- 4.17.05 Paint repair procedures.
- 4.18.00 Painting records shall contain:
- 4.18.01 Equipment/component/location, which is painted
- 4.18.02 Date of painting
- 4.18.03 Paint details such as specification no., colour, date of manufacturer, expiry date, shelf life & pot life.
- 4.18.04 Application method and equipment
- 4.18.05 Ambient conditions at the time of painting.
- 4.18.06 Surface temperature.
- 4.18.07 Drying time between coating, DFT and number of coatings.
- 4.19.00 **Surface Preparation**
- 4.19.01 All surfaces to be painted shall be thoroughly cleaned of oil, grease and other native & foreign materials.

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- 4.19.02 Surfaces shall be free from moisture and contamination from chemicals and solvents.
- 4.19.03 Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Painting Scheme/Schedule.
- 4.19.04 Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.
- 4.19.05 Mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper.
- 4.19.06 Cleaning with solvents shall be resorted to only in such areas where, it is required, to achieve the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.
- 4.19.07 Machined surfaces shall be protected during the cleaning operations.
- 4.19.08 The blast cleaned surface shall be checked for signs of salt contamination as per ISO 8502-6 & 9. The maximum allowable level of contamination shall be 20 mg/m². Surfaces that do not meet these criteria should be reprocessed.
- 4.19.09 The following surface preparation schemes are majorly envisaged. Depending upon the requirement, any one or combination of these schemes, or equivalent, may be employed to achieve the necessary surface preparation before application of primer.

SP1	Solvent cleaning
SP2	Application of rust converter (Ruskil or equivalent grade)
SP3	Power tool cleaning
SP4	Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes, prior to application of primer)
SP4*	Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns
SP5	Shot blasting/ abrasive blasting
SP6	Emery sheet cleaning/Manual wire brush cleaning

4.19.10 **MANUAL CLEANING**

- i) Manual/power tool cleaning shall be done as per grade St-2 or St-3, of ISO 8504-3. This method to be used for repair painting or on already painted surface and in case of usage on new construction painting, prior approval may be obtained from owner/engineer.

	Condition of surface	ISO 8504-3	SIS 55900	SSPC
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted & pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted & pitted	D St3	D St3	SP3

- a) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum

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cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2

- b) Grade St-3: Very thorough scraping and wire brushing, machine brushing, grinding etc. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3

4.19.11 BLAST CLEANING

- i) **Compressors**: Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110 °C. The blasting activity shall be performed at ambient temperatures above 5°C and relative humidity less than 85%. Steel temperature shall be 3°C above dew point. Necessary safety precautions for equipment and operator shall be adhered to.
- ii) **Abrasives**: Abrasives used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives may be chilled iron grit or shot steel and malleable iron grit and shots non metallic abrasive (aluminium oxide, copper slag, garnet etc.).
- iii) Removal of mill scale and rust using abrasives such as grit or shot under high pressure. The grade of blasting performed in line with the approved painting scheme.
- iv) The quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the surface profile depth and cleanliness. Abrasives shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertaining to the work.
- v) Profile measurements for abrasive blast cleaned surface shall be made with a Profile comparator and permanent record shall be maintained with Testex Press-O-Film.
- vi) Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 6 hours, and in any case, must commence before signs of degradation occur).
- vii) After blasting cleaning, depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 mm may be used.

4.20.00 **Application of Primer & Paint**

- 4.20.01 The paint/primer manufacturer's instructions regarding thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.
- 4.20.02 Surfaces prepared as per the agreed/approved surface preparation scheme shall be applied with primer paint within 6 hours after preparation of surfaces.
- 4.20.03 Paint application shall be by brush, roller or spray gun. Local regulations regarding spray and roller coating shall be observed. A smooth uniform film shall be applied to the surfaces to be coated.
- 4.20.04 Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats.

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- 4.20.05 When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.
- 4.20.06 Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.
- 4.20.07 Painting shall be performed when the temperature of the surface is greater than 3°C above the dew point of the surrounding air and relative humidity of the air is less than 85%, unless local conditions dictate otherwise, and the Owner is in agreement. Guidance on the estimation of the probability of condensation can be found in ISO 8502-4. The measurement of these conditions is the responsibility of the bidder.
- 4.20.08 In addition, paints shall not be applied under the following conditions:
- When the surface temperature is greater than 60 °C, unless a higher temperature is agreed by the paint manufacturer.
 - When the air temperature is less than approximately 5°C, depending on local conditions.
 - When there is the likelihood of an unfavourable change in weather conditions within two hours after painting.
 - When there is a deposition of moisture in the form of rain, condensation, frost, etc., on the surface.
 - When the available light is less than 500 lux.
- 4.20.09 Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld edge preparation areas shall be applied with one coat of weldable primer for distance of 50 mm either side of the weld line.
- 4.20.10 For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.
- 4.20.11 On the internal surface of 1000 NB & above pipes (non-sea water application), a primer coat followed by hot coal tar enamel or coal tar epoxy painting (cold) shall be applied.
- 4.20.12 When zinc rich primers are used, care shall be taken to mask to avoid any possibility of over spraying onto duplex, austenitic stainless steels; nickel alloys or 9% nickel steel components.
- 4.20.13 Two pack coatings like Air drying epoxy, Polyurethane coatings etc shall be mixed in the ratio recommended by manufacturer to ensure proper and complete curing of the coatings. The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing / agitation and not the reverse. Power agitation is preferred over hand mixing.
- 4.20.14 Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed. Excess thinner is not recommended, as increase in volume, leads to lower DFT, sagging, longer curing time, etc.
- 4.20.15 Coating containing heavy or metallic pigments that have a tendency to settle shall be kept in suspension by continuous use of a mechanical agitator whilst

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being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

- 4.20.16 For Primer, high quality surface preparation is necessary and good amount of moisture is required for proper curing. Below 70 % relative humidity, curing time may go up to 7 days or more. In such a case additional water sprinkling may be ensured for completion of curing. Additionally Inorganic zinc silicate cannot be recoated; even with itself. Typically it should be used when coating bare steel surface for first time.
- 4.20.17 The most frequent problem associated when top coating Primer is bubbling/pin-holing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.
- 4.20.18 Touch up paintings on damaged areas: Surface preparation by manual tools, wire brush/ emery paper etc. Minimum 6 inches peripheral area, adjoining to damaged area to be covered. If metal surface is exposed, it is to be painted with Zinc rich epoxy (70 micron) or suitable primer with existing paint scheme. If primer is intact, intermediate & top coat to be done with specified DFT in scheme.
- 4.20.19 **SPRAY APPLICATION**
- All adjacent areas to be masked properly to avoid spread of painting to non-target area.
 - Approval of Owner / Engineer shall be obtained during spray painting which may cause interference to other works.
 - Airless or pneumatic spray applications are preferred methods of application. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90° to the surface being painted.
 - Correct spray tips, air pressures, etc, as recommended by the equipment supplier shall be followed, If spray painting is to be carried out.
 - Correct combination of air volume, air pressure and fluid flow are to be ensured, in case of conventional air spray, to get good atomisation, for a defect free painted surface. The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method as most paints have to be thinned to a suitable viscosity for satisfactory atomisation, and so lose their high build properties. Vendor shall follow manufacture's instruction.
 - Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied as paint in the tank can be prevented from settling, reduces application time and also enables the gun to be turned to any angle to coat objects effectively without spilling paint.
 - Airless spray is recommended as high build coatings can be applied without thinning, very rapid application is possible, giving an economic advantage, compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and less dust and fume hazards.
 - Each coat shall be applied uniformly and completely over the entire surface. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface re-sprayed.

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- ix) Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

4.20.20 BRUSH APPLICATION

- i) Brush application may be used for the following:
- Wherever, paint manufacturer recommends brush application.
 - When areas cannot be properly coated by spraying for reasons such as material or environmental considerations
 - For the initial coat of paint to corners, edges, crevices, holes, welds or irregular surface prior to spray application
 - For 'touch up' or repairs to localize damaged paint or areas of incorrectly applied paint
 - Areas where spray painting cannot be applied properly, due to practical reasons such as, material or environmental.
- ii) Brushes shall be of a style and quality that will permit the proper application of paint.
- iii) Brush applications should be done in two passes that are perpendicular to each other 'wet on wet' so that a smooth coat, as near uniform in thickness as possible, is obtained thereby avoiding running and droplets. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.
- iv) During the application of each coat, all areas such as corners, edges, welds, small brackets, bolts, nuts and interstices shall receive additional paint to ensure that these areas have at least the minimum specified dry film thickness and to ensure continuity of coating.

4.20.21 ROLLER APPLICATION

- Roller application shall only be used on relatively large surface areas and only if spraying is not an option.
- Roller application shall be in accordance with the paint Manufacturer's instructions.
- Roller application shall only be used if the first or priming coat of paint has been applied by brush.

4.20.22 COATING MATERIALS

- The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, specification, State or Local regulatory bodies.
- Material for coating shall be suitable for the intended use and shall be selected based on evaluation of all relevant aspects such as-
 - Corrosion protective properties
 - Health, safety and environment requirements
 - Properties related to application conditions, equipment and personnel
 - Experience with the coating materials and coating system
- All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer.
- All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

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- v) Performance standard as listed below shall be established by paint manufacturer and the quality records shall be submitted for review –
- Adhesion test (pull off test)
 - Flexibility test
 - Salt spray test (min 1000 Hrs)
 - UV resistance test (external coating)
 - Cathodic dis bonding test (internal coating)
 - Abrasion test (internal coating)
 - Impact resistance test

- vi) Performance tests of coating materials shall be as per the table below:

Abrasion Resistance	ASTM D4060
Adhesion / Pull-off strength of coatings	ASTM D4541
Dry heat resistance	ASTM D2485
Flexibility	ASTM D1737/522 (D522, 180° bend, for top coat only)
Pencil hardness (top coat only)	ASTM D3363
Salt fog resistance	ASTM B117, 2000 hrs
Weather resistance	ASTM G23, Type D
Density	ASTM D1475
Dripping properties	ASTM D883
Drying/curing or film formation	ASTM D1640
DFT/Coat	AS per SSPC guidelines
Water/Humidity resistance for 2000 hrs	ASTM D2247
Accelerated environment exposure resistance	ASTM D 822

4.20.23 STEEL STRUCTURES

- Primer coat:** All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% $\pm 2\%$) of minimum 70 micron DFT to be applied over blast cleaned surface conforming to Sa 2 ½ finish of ISO 8501-1 with surface profile 40-60 Micron. The primer coat shall be applied in shop immediately after blast cleaning by airless spray technique. Zinc dust composition and properties shall be Type-II as per ASTM D520-00.
- Intermediate coat:** Primer coat shall be followed with the application of Intermediate coat of two component polyamide cured epoxy with MIO Content (containing lamellar MIO minimum 30% on pigment, solid by volume minimum 80% $\pm 2\%$) of minimum 100 micron DFT. This coat shall be applied in shop after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.
- Final Coat:** Intermediate coat shall be followed with the application of finish coat of two pack aliphatic Isocyanate cured acrylic finish paint (solid by volume minimum 55% $\pm 2\%$) with Gloss retention (SSPC Paint Spec No 36, ASTM D 4587, D 2244, D 523) of Level 2 (after minimum 1000 hours exposure, Gloss loss less than 30 and colour change less than 2.0 ΔE) and minimum 70 micron

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DFT. This coat shall be applied shop after an interval of minimum 10 hours and within six (6) months (from the completion of Intermediate coat), Colour and shade of the coat shall be as approved by the owner/consultant.

4.20.24 GRATINGS & STEP THREADS

- i) Surface preparation: Gratings and step threads shall be cleaned by acid pickling as per SSPC-SP-08.
- ii) *Hot dip galvanising*: The hot dip galvanising shall be done as per IS 2629 .The average mass of coating shall be 610 gm/m².
- iii) *Post galvanising treatment*: Immediately after galvanising, post treatment such as chromating shall be applied to retard white rust attack.
- iv) Touch up mechanical damages: The repair of damages coatings shall be done as per the recommended practice ASTM A 780.

4.20.25 All Mild steel (MS) handrails and ladders in outdoor locations and in pump valve pits shall be galvanised at the rate of 610 gm/m² as per IS 4736. All other MS handrails shall be painted as specified for structural steel

4.20.26 COATING OF MILD STEEL PARTS IN CONTACT WITH WATER

- i) All mild Steel parts coming in contact with water or water vapour shall be hot dip galvanised. The Minimum Coating of Zinc shall be 610 gm/m² for galvanised structures and shall comply with IS: 4759 and other relevant Codes. Galvanising shall be checked and tested in accordance with IS: 2629.
- ii) The galvanising shall be followed by the application of an etching Primer and dipping in black bitumen in accordance with BS: 3416, unless otherwise specified.

4.20.27 SG membrane walls and other flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.

4.20.28 All un-insulated equipments, pipes, valves etc covered in Part-A, Section-2 (Steam Turbine & Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron.

- i) The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner:
 - a) Primer coat – Epoxy based zinc phosphate
 - b) Intermediate coat –Epoxy based TiO₂ pigmented coat
 - c) Finish coat – Epoxy based finish coat / Two pack polyurethane coat
- ii) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminium paint (to be selected based on the service condition of component as per IS- 13183). Two coats of paint shall be applied with total DFT 40 micron.

4.20.29 FGD SYSTEM

- 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.

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- 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.
- 4.20.30 Specification for the application of Epoxy coating for internal protection of storage tank & other vessels/tanks (as applicable) shall be as follows:
- Primer - One coat of unmodified epoxy resin along with polyamide hardener.
 - Paint - Two (2) coats of unmodified epoxy resin along with Aromatic adduct hardener.
 - Total thickness of primer and paint should not be less than 400 microns.
- 4.20.31 Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves & other equipments shall be as follows:
- For indoor tanks, vessels, piping, valves and other equipment:
 - Surface preparation shall be done either manually or by any other approved method.
 - Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.
 - Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.
 - Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.
 - Total DFT of paint system shall not be less than 150 microns.
 - For outdoor tanks, vessels, piping, valves and other equipment:
 - Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.
 - Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.
 - Intermediate coat (or under coat) shall consist of one coat of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.
 - Top coat shall consist of one coat of epoxy paint suitably 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.
 - The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.
 - Total DFT of paint system shall not be less than 300 microns.

5.00.00 QUALITY CONTROL AND INSPECTION

- 5.01.00 Paint materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specification and shall be accompanied by manufacturer's test certificates.
- 5.02.00 The painting work shall be subjected to inspection by Owner / engineer at specific stages. The vendor shall offer following stage of inspection:
- 5.02.01 Before and after surface preparation

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- 5.02.02 Before and after application of primer
- 5.02.03 Before and after application of subsequent coats
- 5.02.04 During paint qualification test
- 5.03.00 Following coating inspection and test shall be carried out:
- 5.03.01 Ambient and steel temperature, relative humidity and dew point min twice in a shift.
- 5.03.02 Surface finish & profile check each component or once per 10 m2 after surface preparation.
- 5.03.03 Salt contamination test – Free from salt contamination.
- 5.03.04 Dry Film Thickness as per ISO 2808 No.6.
- 5.03.05 Holiday Test as per ASTM D 5162/ NACE SP0188.
- 5.03.06 Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.
- 5.04.00 Vendor shall provide the expert technical services of the paint manufactures as and when required by Owner / engineer to ensure both the surface preparation and applications are carried out as per their recommendations. This service shall be provided without any obligation to Owner.

6.00.00 SUGGESTED COLOUR CODES FOR PAINTING

6.01.00 Suggested colour codes, for some major items area as below:

Item / Service	Ground Colour (IS: 5)
Turbine (enclosure & pedestals)	Golden yellow (356)
Generator and exciter	Golden yellow (356)
Transformers	Light grey (631)
Boiler casing, ESP & ducting	Nut Brown (413)
Structures, platforms & ladders	Dark admiralty grey (632)
Handrails	Golden yellow (356)
Fans, pumps, motors	As per OEM
Water tanks	Sea Green (217)
Fuel oil (LDO) tanks	Light brown (410)
Other Tanks & vessels (without insulation and cladding)	Light grey (631)
Air receivers	Sky blue (101)
Machine guards	Signal red (537)
Crane/hoist Structure & trolley	Golden yellow (356)
Crane hook	Crimson (540)
Piping	As per IS: 9404
Other Electrical	As per electrical specs
Buildings	As per Civil specs

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7.00.00 COATING/PAINTING SCHEME/SCHEDULE

Sl. No.	Description	Surface preparation	Primer Coat			Intermediate Coat			Finish Coat			Total DFT (min.)
			Primer	No. of Coats	DFT (μ)	Primer	No. of Coats	DFT (μ)	Primer	No. of Coats	DFT (μ)	
1.	Boiler & Auxiliaries											
a.	All insulated surfaces with temperature <95 °C	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	60				Zinc Chrome (Alkyd base)	2 ¹	40 ¹	100
b.	All insulated surfaces with temperature >95 °C	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
2.	HP Piping											
a.	All insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipments etc.	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
b.	All un-insulated Piping, fittings/ components, Pipe clamps, Vessels/Tanks, Equipment etc.											
i.	Design temperature < or equal to 60°C	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (Alkyd base)	3	105	155

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ii.	Design temperature from 60°C to 200°C	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
iii.	Design temperature >200°C	SP3/SP4 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
c.	Constant Load Hanger (CLH) and Variable Load Hanger (VLH)	SP4* Sa 2 ½	Zn rich epoxy (92% Zn. In dry film (min.) %VS=35 (min.)	1	40				Aliphatic acrylic polyurethane, 134, %V=40 (min.)	1	30	70
d.	Other piping hanger / supports. Un-insulated valves	SP4* Sa 2 ½	HB Zn Phosphate (Alkyd base)	2	50				Zinc Chrome (epoxy base)	2	50	100
e.	Un insulated valves, Cast/forged											
i.	Design temperature < or equal to 60°C	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base)	2	70				Zinc Chrome (epoxy base)	2	50	120

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ii.	Design temperature >60°C	SP3/SP5 Sa 2	Heat resistant Al. (Grades as per IS: 13183)	1	20				Heat resistant Al. (Grades as per IS: 13183)	1	20	40
f.	Weld edges	SP6 Sa1	Weldable primer	1	25							25
3.	All LP piping, fittings, components, valves, associated equipment	SP3/SP5 Sa 2	HB Zn Phosphate (Alkyd base / Zinc Chrome (Alkyd base)	2	50	Zinc Chrome (Alkyd base)	1	30	Zinc Chrome (epoxy base)	2	70	150
4.	All auxiliary steel structural steel components (Outdoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	75	HB MIO Epoxy (TiO ₂ pigmented)	1	75	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	70 30	250 μ

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5.	All auxiliary steel structural steel components (Indoor)	SP4* Sa 2 ½	Inorganic Ethyl Zn silicate	1	35	HB MIO Epoxy (TiO ₂ pigmented)	1	35	a) Epoxy coat b) Final coat of Aliphatic Acrylic PU, 134	2 1	50 30	150 μ
6.	ESP											
a.	All surfaces with temperature <95 °C	SP3/SP4 Sa 2	Zinc Chrome (Alkyd base)	1	25				Zinc Chrome (epoxy base)	1	30	55
b.	All insulated surfaces with temperature >95 °C	SP3/SP4 Sa 2	HB Zn Phosphate (Alkyd base)	2	30							60
2.	Indoor structure	Sa 2 ½	HB Zn Phosphate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 μ
3.	Insulated parts exposed to temp > 120°C	Sa 2 ½	In organic Zn silicate	2	60							60 μ
16.	For insulated piping <125 °C	Sa 2 ½	Polyamide cured epoxy coating	2	250							250 μ

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7.	Un insulated silencer, steel stacks >120 °C	Sa 2 ½	Ethyl Zn silicate	1	40				HR silicone aluminium paint	2	40	80 μ
4.	Water treatment plant / CPU (external)	Sa 2 ½	Zn rich epoxy	2	80	HB MIO Epoxy	2	200	Aliphatic polyurethane	2	80	360 μ
6.	Coal fuel piping	Sa 2	Ethyl Zn silicate	1	40				HR aluminium paint	2	40	80 μ
8.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 μ
9.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4 mm
Sl. No.	Description	Surface preparation	Primer Coat			Intermediate Coat			Finish Coat			Total DFT (min.)
			Primer	No. of Coats	DFT (μ)	Primer	No. of Coats	DFT (μ)	Primer	No. of Coats	DFT (μ)	
10.	Buried piping (internal)	Sa 2 ½	Solid rigid polyurethane 500 μ									500 μ
11.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	120	Poly urethane	2	60	260 μ
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400 μ
13.	DM water tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 μ
14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80	HB MIO Epoxy	1	150	HB coal tar epoxy	1	150	380 μ
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75							75 μ

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17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinate d rubber	2	80	160 μ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80				Chlorinate d rubber	2	100	180 μ
19.	Switch yard, floor grills, walkways	Sa 2 ½	Hot dip galvanised coating wt. 610 gm/m ² (coating thickness of 80 μ)									80 μ

Note:

- * Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.
- 1) The first 2 finished coats (total min.DFT of 70 microns) shall be done at shop and the 3rd finish coat (min.DFT 35 Microns) shall be applied at site.
 - 2) For valves below 65NB and temperature up to and including 540 °C, Parkerizing/zinc phosphate corrosion resistant coating as per ASTM F1137 is also acceptable in lieu of Aluminium paint.
 - 3) For corrosion protection of threaded hanger rods and variable spring cages, electro galvanizing in full compliance to minimum Corrosion category C3 as per EN ISO12944 is also acceptable.
 - 4) For spring cages, 2 coats of 30 μm (min) zinc-rich epoxy resin primer with zinc content > 80 weight % in dry film followed by 2 coats of 30 μm (min) top coat of Acrylic resin Co-polymerisate with a total combined minimum DFT of 120μm is also acceptable in lieu of above specified paint scheme.
 - 5) For corrosion protection, all inner parts of the hangers (CLH/VLH) shall be at least in full compliance to Corrosion category C3 as per EN ISO12944.
 - 6) For Cast/forged valves up to & including design temperature 60Deg.C, Aluminium painting as per IS-13183 Gr-3 or better with total DFT 40Micron is also acceptable.

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8.00.00 DRAWINGS AND DOCUMENTS TO BE SUBMITTED

8.01.00 Drawings and Documents to be Submitted with the bid

8.01.01 Write-up on Surface Preparation & Painting

8.01.02 Filled-in Data Sheet-B (if applicable)

8.02.00 Drawings and Documents to be Submitted after Award of Contract

8.02.01 Painting Scheme / Schedule (Project / Various areas)

8.02.02 Product and application data sheets of paints & associated materials (Various materials)

8.02.03 Quality Plan of shop painting (Various areas)

8.02.04 Field Quality Plan for surface preparation and painting at site (Project / Various areas)

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Sr. No.	Volume	Part/Section No.	Page	Clause No.	Bid Specification Stipulation	Bidder's query/Stipulation	Owner's Clarification
1	II	SECTION: 1		3.11.02	Chimney of adequate height (150 m) along with ESP, FGD & SCR is considered to contain ground level concentration of SPM, SOx, NOx etc. within acceptable limits prescribed by MOEF.	There is mismatch in specification regarding height of RCC Chimney (Wet Stack). Customer to confirm height of Chimney to be considered(140 m or 150 m)	Chimney height shall be maximum 140 m including top of lightning arrestor
2	II	SECTION: 2		2.13.13 xxii) m)	Twin flue RCC Chimney (Wet stack) of 140 m height		
3	II	SECTION: 2		9.02.38 xii)	Twin flue RCC (Wet stack) Chimney 140m high shall be located beyond ESP.		
4	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		3.02.03 (3)	15 m away from cooling towers	This is the BTG Package and cooling tower is not a part of this package. Hence, battery limit for CW Channel shall be kept at 10 m away from CW Forebay. Kindly confirm.	Bid Specification Prevails
5	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.13.13, page 45	iv) Site development works: Site clearance, site grading, roads, drainage and cross drainage works, including temporary roads/drains, if required.	Please furnish grading plan drawing with bounday co-ordinates in Auto Cad format for estimation of cutting and filling quantity. FGL of proposed plant area shall be marked in the drawing.	Please refer plot plan for FGL and terminal points for BTG scope. Plant levels, please refer topography survey report.
6	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		2.05.02, page 8	Site grading of the area as identified in the Property Plan.		
7	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		3.02.03, SI no 4, Page 57	Sewage pipeline up to collection sump at STP area is in bidder's scope.	Please provide the location of Sewage collection sump/STP.	Please refer plot plan.
8	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.13.13 (v), Page 45	 cutting of existing roads and making good, drainage, roads, rail track, fencing	Please provide the drawings or mark the road, etc. in plot plan whose dismantling and repair is required for this package scope of works.	Bidder to visit the site and collect necessary data.
9	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.13.13 (vi), Page 45	Dismantling of buried/semi-buried structures, if any, encountered within the plant limits.	Please furnish the details/drawings of existing buried/semi-buried structures, whose dismatling area required.	Since the proposed plant location is in the existing plant area, Bidder to visit the site and collect necessary data.
10	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		9.01.03, Page 129	Drain shall be provided on one side of patrolling road.	Patrolling road not in bidders scope, hence drains for patrolling road also will not be in bidders scope. Kindly confirm.	Noted.
11	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		9.02.15, Page 132	Adequate number of permanent stores and open paved yard shall be provided.....	As per Clause 2.13.13, permanent store and open paved yard is not in bidders scope. Kindly confirm.	Noted.
12	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		9.02.44, xiii),Page 142	Fabrication yard and laydown area shall also be developed as green belt.	Green belt is not in bidder scope. Kindly confirm.	Noted.
13	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.02.13, Page 67	The development of green belt is not in bidder scope.		
14	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		2.04.03, Page 8	Drainage study	As per CI 3.02.03 (2) Section 2/Lead specifcation, drains within the BTG area are only in bidders scope. Hence drainage study shall not be in bidders scope. Kindly confirm.	Required study shall be done by the bidder, for the design of efficient drainage system, in the BTG area.
15	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.13.13, page 46	iii) Site related investigations: Topographical survey and detailed Geo Investigations. Area drainage study to be done if required.....		
16	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.14.37, page 52	vi) Rain water harvesting shall be completed.	1. Rain water scheme for BTG scope is only in bidders scope. Kindly confirm. 2. Ground water recharge (refer clause 37.01.00) is required as per	Providing rain water harvesting

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17	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.02.09, Page 66	Development of rainwater harvesting scheme for the project and obtaining approval of the scheme from Central Ground water board is in bidder's scope	2. Ground water recharge (refer clause 9.01.09) is required as per specification, hence there shall not be any roof water collection pond. Kindly confirm. 3. Please provide the detailed specification, scheme and requirement of water storage pond/capacity for the rain water harvesting, if required.	system, for individual buildings (BTG package), along with sump, is in bidder's scope.
18	Volume II - Section 2		237	20.14.00	Noise Control Design and layout of building to minimize transmission of noise...	Bidder understands this clause is applicable only for mechanical equipment, not applicable for civil buildings. Kindly Confirm.	Designing building and structures to minimize transmission of noise is applicable to Civil structures also.
19	Volume II - Section 2		129	9.01.03 (vii)	Top of road shall be 0.20mm above from ground level.	Bidder understand that top of road value is a typo error. Owner to kindly check and confirm.	Top of road shall be 0.20m above from ground level.
20	IV	D (PAGE-41)		7.24.05	Limestone unloading shed: It shall be an underground RCC framed and RCC walled water retaining structure and steel structure on over ground from RCC pedestal at height of 0.5m and having side and roof cladding with galvalume sheet.M.S grizzly is provided on RCC hopper top as per required size of lime stone and sump with sump pump is considered for dewatering of the pit. RCC stair case, machine hatch, monorail shall be considered for access to the pit with the prohibition of pent house.	Kindly furnish the thickness of galvalum sheet to be adopted.	Please refer clause no. 24.06.01 iii for thickness of sheets.
21	IV	D (PAGE-41)		7.24.05	Limestone unloading shed: It shall be an underground RCC framed and RCC walled water retaining structure and steel structure on over ground from RCC pedestal at height of 0.5m and having side and roof cladding with galvalume sheet.M.S grizzly is provided on RCC hopper top as per required size of lime stone and sump with sump pump is considered for dewatering of the pit. RCC stair case, machine hatch, monorail shall be considered for access to the pit with the prohibition of pent house.	Kindly furnish the crack width to be adopted in water retaining structure.	Crack width for concrete works for water retaining structure shall not be exceed 0.2mm.
22	IV	D (PAGE-41)		7.24.05	Limestone unloading shed: It shall be an underground RCC framed and RCC walled water retaining structure and steel structure on over ground from RCC pedestal at height of 0.5m and having side and roof cladding with galvalume sheet.M.S grizzly is provided on RCC hopper top as per required size of lime stone and sump with sump pump is considered for dewatering of the pit. RCC stair case, machine hatch, monorail shall be considered for access to the pit with the prohibition of pent house.	We undrstand that on the inner face of hopper, 50mm thick of guniting has to be provided for liner.	Hopper shall be provided with liner plate over 50mm thick guniting.
23	IV	D (PAGE-41)		7.24.05	Limestone unloading shed: It shall be an underground RCC framed and RCC walled water retaining structure and steel structure on over ground from RCC pedestal at height of 0.5m and having side and roof cladding with galvalume sheet.M.S grizzly is provided on RCC hopper top as per required size of lime stone and sump with sump pump is considered for dewatering of the pit. RCC stair case, machine hatch, monorail shall be considered for access to the pit with the prohibition of pent house.	Kindly furnish the grizzly details which is to be provided above hopper.	Grizzly opening shall be with 250mm x 250mm opening. Minimum thickness of plate shall be 25 mm, & it shall be suitable for hammering and breaking bigger lumps

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24	IV	D (PAGE-41)		7.24.06	Limestone storage silo: Silo of required capacity made of structural steel as specified in mechanical portion along with roof covering overhead structural shed and access platforms/walkways shall be provided as per soil investigation.	Kindly furnish the shell thickness to be adopted for Lime stone silo.	The storage silos and hopper cones shall be fabricated of minimum 10 mm thick carbon steel with a SS lining of grade SS304 of minimum 4 mm thickness in the complete cones to ensure reliable discharge of material.
25	IV	D (PAGE-41)		7.24.07	Lime stone Crusher house	Kindly furnish the thickness of side cladding to be adopted for crusher house	Please refer clause no. 24.06.01 iii for thickness of sheets.
26	IV	D (PAGE-41)		7.24.07	Lime stone Crusher house-Crushers shall be supported on RCC deck slab which in turn will rest on vibration isolation system consisting of springs & dampers.	We under stand that s RCC deck shall be isolated from the floor. However, the vibration isolation system consisting of springs and dampers shall be rest on main building framework .Kindly confirm.	Bidder's understanding is correct.
27	IV	D (PAGE-130)		18.01.01(ii)	Structural steel work	We understand that site fabrication of steel structure is allowed.Kindly confirm	Bidder's understanding is correct.
28	IV	D (PAGE-130)		18.01.01(ii)	Structural steel work	We understand that hollow section (Min. 4mm thick)can also be provided along with rolled section for structural steel work.Kindly confirm.	Please refer Vol-III, Part-D, of the specification, however, in additional to this bidder to consider corrosion allowance
29	IV	D (PAGE-41)		7.24.02	Buildings for FGD System: FGD System may comprise of various buildings	Kindly furnish the construction details of gypsum shed.	RCC framed structure with RCC/brick masonry wall (up to Tripper floor) and structural steel shed with permanently colour coated profiled sheet roof and side cladding (above Tripper floor). Roof shall be provided with troughed profile permanently colour coated sheet with slope.
30							
31	Volume-III	Part-D		7.05.02	PA/ FD/ ID Fan and Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level.	It is clarified that the offered FD,ID and PA Fans are Constant Speed Axial Fan with Blade pitch control and foundation shall be RCC Block Foundation without Vibration isolation system. This is in line with BHEL Supplies for MAHAGENCO Bhusawal 1X660 MW EPC Package.	Noted
32	Volume-III	Part-D		9.01.01	Machine foundations for TG, ID/FD/PA fans, BFP and Misc. pumps and equip-ment foundations will also be supported on RCC foundations.		
33	Volume-III	Part-D		9.06.02 ix)	In case of variable speed machines such as ID fan, one or more natural frequencies of the foundation may coincide with the operating frequency of the machine. If it is not possible to satisfy the codal frequency or amplitude criteria VIS with springs and viscous dampers shall be provided..... The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096.		

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34	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		1.16.01 v), page 5	A preliminary Geo-technical Investigation has been carried out by the Owner and report of the same is attached in Annexure – 5, Volume V. However this report along with the recommendation given there shall be considered by the Bidder for reference only.	It is observed that only bore logs are provided. Please furnish following additional details: 1. Existing ground level (EGL) of all bore holes. 2. Depth of ground water table in each bore hole 3. Laboratory test results of soil and rock samples of all bore holes. 4. Chemical analysis results of sub soil and water samples. 5. Electrical resistivity test results.	1. For EGL, please refer Topography survey rept. 2, 3, 4 and 5. The provided Geo-technical report is for reference/bidding purpose only. If any further details required, the Bidder can do the same for his Own cost.
35	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		2.05.02, Page 8	Site grading of the area as identified in the Property Plan.	1. Please provide/mark in plot plan the extent of grading required to be done by the bidder. 2. Provide the graded level required for chimney, FGD area . 3. Please furnish required graded level for all facilities within BTG package. 4. Bidder understand that micro grading within BTG area is only in bidders scope. Kindly confirm.	Bidder note that please refer Plot plan and topography survey report for all the details of FGL, NGL, terminal point, etc.
36	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		3.02.11, Page 10	 sewers, sewage pump house, sewage treatment plant	Sewage pump house, sewage treatment plant are not in bidders scope. Kindly Confirm.	STP is not in bidder's scope. Sewage transfer pumps, if required to send sewage collected in bidder's area/buildings, to STP will be in bidder's scope.
37	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		4.02.02,iii), page 13	Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 60.0 m or 5 m continuous into hard rock whichever is earlier.	Please specify the hard rock properties in terms of Core recovery and RQD for deciding termination depth of bore holes.	As per relevant IS codes
38	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.02.02, page 16	Site grading Fills shall normally be made up of Cohesive Non Swelling material capable of being compacted up to 95% Modified Proctor density. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the bidder himself.	Please allow use of excavated soil of proposed plant area in place of CNS material in filling during site grading as the same is suitable for filling purpose and is having similar properties like CNS material.	Excavated soil shall be tested in the laboratory. If it is suitable for backfilling, Bidder can use the same.
39	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		15.04.03, page 93	Site Levelling Filling shall be done in horizontal layers not exceeding 300 MM compacted thickness or as directed by the Engineer subjected to compaction test 95% M.D.D.	Please allow 95% standard Proctor density in place of Modified Proctor density.	Compaction of soil shall be 95% of M.D.D.
40	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.03.02, Page 16	Peripheral/patrolling roads inside boundary wall shall be 4 m wide Water bound macadam base (WBM) without bituminous topping	Peripheral/patrolling roads are not in bidder scope. Kindly confirm	Noted
41	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.03.01, Page 16	All roads in the power plant area of BTG island and main access road from gate.....	Main access road from gate is not in bidders scope. Roads within the BTG area only in bidders scope. Kindly confirm.	Noted
42	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.04.07, Page 17	The storm water drainage for the contaminated area such as coal stack pile etc., shall be designed separately and the discharge shall be led separately for treatment and disposal.	As per CI 3.02.03 (2) Section 2/Lead specification, drains within the BTG area are only in bidders scope. Hence Clause 6.04.07 shall not be applicable for this package and drainage for Coal stack pile not in the scope of BTG package. Pls. confirm.	Noted

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43	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.04.08, Page 17	Any existing nalla which is coming in the plant area shall be suitably diverted and connected to a permanent water course.	1. Please furnish the longitudinal and cross-sectional details of the existing nalla including discharge. 2. Please mark the existing and diverted route of nalla on plot plan.	Bidder shall visit the site and collect the necessary data.
44	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.04.01, Page 17	The drainage scheme shall be based on the detailed area drainage study being carried out by the Bidder.	Drains within BTG area are only in bidders scope, hence area drainage study is not in bidder scope. Kindly confirm.	Required study shall be done by the bidder, for the design of efficient drainage system, in the BTG area.
45	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.04.03, Page 17	Main drains shall be designed as a network covering total plant area and shall ultimately be disposed in the manner defined in the drainage studies.	As per CI 3.02.03 (2) Section 2/Lead specification, drains within the BTG area are only in bidders scope. Kindly confirm.	Noted
46	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.05.02, Page 17	Provision shall also be made for collection and disposal of solid waste.	1. Collection and disposal of solid waste is not in bidder scope. Kindly confirm. 2. Kindly provide the details of provision requirement.	Collection and transfer of effluent & sewage, up to common collection sump of ETP/STP (of BoP Package), will be bidder's scope.
47	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.02.02, Page 20	Over the TG Bay roof, monitor shall be provided with Exhaust system mounted on the side wall of the monitor.	Kindly clarify the followings : 1. What is monitor? 2. Is this civil structure or equipment? Kindly provide GA details.	TG bay roof Monitor is not envisaged
48	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.03.16, Page 23	ACP cladding shall be provided for walls inside and outside of PCR.	Please elaborate PCR. Also clarify where ACP cladding is to be provided.	PCR - Plant control room. Also called as Central control room (CCR). ACP cladding shall be provided for walls inside and outside of the control room.
49	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.04.01 Page 23	The TG foundation shall comprise of RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System)	It is requested to give the option for providing TG foundation without VIS.	TG foundation shall be rigid
50	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.04.02 Page 23	TDBFP&MDBFP foundations shall consist of RCC top deck supported on steel helical springs & viscous dampers	Requirement of VIS for BFP foundations shall be decided by bidder. Please confirm.	Bidder note that if the BFP foundations are resting over the building structure, the VIS shall be provided. If the foundation is resting at ground floor, it shall be rigid foundation.
51	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		2.02.00, Page 7	Bidder's scope shall also include excavation in soil and rock (if any, with/without blasting as per the site conditions), dewatering, dressing to required profile, sheet piling or shoring/strutting, backfilling with CNS soil with compaction as per IS code wherever required around completed structures and plinth filling, piling (if required), plinth protection, import soil from barrow pits, disposal of surplus earth and rock as directed by Engineer.		
52	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		6.02.02, Page 16	Fills shall normally be made up of Cohesive Non Swelling material capable of being compacted up to 95% Modified Proctor density.		

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53	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		15.06.01, Page 97	The excavated soils will be disposed off in any or all the following manners: i) By using it for backfilling straightway.	The referred clauses are contradictory. Bidder understand that excavated soil/rock/dismantled material from proposed plant area shall be used for filling/backfilling purposes. Kindly confirm.	Bidder note that if the excavated materials are suitable for backfilling, it can be used. If it is not suitable for backfilling, it should be disposed off.
54	VOLUME - II	SECTION - 2/LEAD TECHNICAL SPECIFICATION		2.13.13, page 45	v) Excavation in soil and rock (if any, with or without blasting as per the site conditions), dewatering, dressing to required profile, sheet piling or shoring/strutting, backfilling with CNS (Cohesive Non swelling soil) and compaction as per IS code		
55	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		15.04.05, page 94	BACKFILLING i) Select surplus soils from excavated materials shall be used as backfill. Fill material shall be free from lumps, salts, sulphates, organic or other foreign material. All fill material will be subject to Engineer's approval. The bidder shall remove fill material rejected by Engineer from the site at no extra cost to the Owner.		
56	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		15.04.05, page 94	(iii) All back filling shall be carried out with approved material in layers not exceeding 200mm, watered and compacted with mechanical compaction equipment. However, the.....	Bidder proposes that all backfilling shall be carried out with approved material in layers not exceeding 300mm compacted thickness and each layer shall be compacted so as to achieve atleast 90% Standard Proctor Density as per IS 2720 Part 7 in case of cohesive soil and 75% relative density in case of cohesionless soil. Please confirm.	Bid Specification Prevails
57	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.07.02, Page 25	Complete hopper (sloped portions) shall be provided with lining of at least 5mm thick SS 304M grade material.	1. Referred clauses are condtradiictory, please clarify about the SS lining material for coal bunkers . 2. Only hopper portion (sloped portion) shall be provided with SS Liner. Kindly confirm.	Fuel storage bunkers with supporting structure complete with emptying chute, poking holes. SS lining of 3mm thick shall be provided in bottom conical portion plus 3m in cylindrical portion as per specification of Volume-III, Part-A, Section-1, Clause no. 2.29.02.
58	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.18.02, Page 72	Coal Storage Bunkers shall be provided with 3.15 mm thick stainless steel lining conforming to ASI 409M, IS1570.		
59	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		18.04.09, Page 144	The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality.		
60	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		CI 7.14.00, Page 29	Cooling water pump house (CWPH) - Forebay	Pressure relief valves (PRV) shall be provided to prevent uplift of the forebay. Please confirm.	Bid Specification Prevails
61	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		CI 7.14.00, Page 29	Cooling water pump house (CWPH) - Channel	Pressure relief valves (PRV) shall be provided to prevent uplift of the channel. Please confirm.	Bid Specification Prevails
62	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.04, Page 36	ACP cladding shall be provided for inside partitions and front side elevation works.	Service building, wall finishing schedule for internal and external as per Clause No .7.20.08, ii) (a) shall be followed. Kindly confirm.	Bid Specification Prevails

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63	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.07, Page 36	Shaded car parking facility shall be provided as per requirement of the owner.	Please furnish number of two wheelers and cars.	Bidder shall consider for parking of 10 cars
64	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.08 (viii), Page 38	Numbers of store building required shall be decided during detail engineering.	Store building is not in bidder scope. Please confirm.	Store rooms required in service building shall be decided during detail engineering.
65	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.23.07, Page 40	The foundation of the Pipe/Cable Trestle shall be constructed at a distance of 4.0M from centre line of the plant building	The extent of foundation for Pipe/Cable Trestle shall be decided by bidder during detailed engineering after ensuring suitable clearance from nearby foundations. Pls. confirm.	Noted.
66	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.14.09, Page 30	The pump house structure shall be of R.C.C frame.	CI 7.14.09, CI 7.19.02, CI 7.21.02 are in contradiction to Clause No. 10.01.03. Kindly clarify which clause to be followed for Cooling Water PH, Fuel Oil Pump House and Fire water Pump House.	Pump houses shall have structural steel super structure with Galvalume sheet roofing.
67	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.19.02, Page 33	This building shall be a single storied framed superstructure with RCC columns, structural steel roof truss (with rafter and tie level plan bracings), purlins and roof slab. The roof slab shall comprise minimum 40 mm thick (above the crest of metal deck sheet) RCC slab supported on profiled metal deck sheet.		
68	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.21.02, Page 39	The fire water Pump House shall be single storied and single bay RCC superstructure provision for a structural steel monorail.		
69	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.01.03, Page 58	However, pump houses shall have structural steel super structure with Galvalume sheet roofing.		
70	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.23.03, Page 40	A walkway of minimum width 600mm shall be provided along the Cable Trays supporting floor of the gallery.	Bidder proposes to consider 600mm wide walkway for cable gallery. Please confirm.	Walkway of minimum 800mm width shall be provided along the cable / pipe galleries.
71	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.03.07, Page 61	All trestles shall be provided with continuous walkway of minimum 750mm width with handrails and toe-guards all along the length of the trestle		
72	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.03.09, Page 61	The storm water drainage shall cater to storm water runoff resulting from one hour rainfall intensity, with a return period of 100 years.	Please furnish design rainfall intensity in mm/hr for design of BTG area drainage.	Bidder to collect the data from Meteorological department
73	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		1.13.01 v), page 4	Rain fall a) Annual average rainfall : 1112.7mm b) Maximum rainfall in 24 hours : 315mm/day		

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74	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		8.03.00, Page 44	2 Power House Building (iii) Other Areas in Turbine Hall -25 kN/Sq.m plus hung loads	Imposed load of 10 kN/Sq.m plus hung loads shall be considered. Please confirm.	Bid Specification Prevails
75	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		8.03.00, Page 45	3 Mill Building (b) Feeder Floor - 25 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)	10 kN/Sq.m + hung loads kN/sq.m (dust load) shall be considered. Please confirm.	3 Mill Building (b) Feeder Floor - 15 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)
76	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.01.02, Page 58	The main plant building, Control Room building, de-aerator supporting structures and Bunker building shall have structural steel framed super structure, with metal cladding on exterior face.	Clause 7.02.04 for TG Bay, Clause 7.03.04 for Control room, Electrical bay & heater bay, and Clause 7.0712 for mill and bunker bay shall be followed. Kindly confirm.	The clause no. 10.01.02 is design concept/design criteria for the building.
77	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.01.21, page 59	Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures	Plasticiser/ super-plasticiser cum water proofing compound shall be added in concrete as per specification. No separate water treatment is required. Kindly confirm.	The clause no. 10.01.02 is design concept/design criteria for the building. Separate details for waterproofing of underground structures is provided.
78	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.03.05, Page 61	All roads shall be of flexible pavements except as otherwise specified.	Flexible pavement roads are not specified in the specification for BTG package. Kindly confirm.	All roads in the BTG package shall be rigid pavement.
79	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.17.05, Page 72	Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used.	Referred clauses are contradictory, please clarify about the cement sand mortar for one brick thick wall (outer as well as internal).	All internal walls shall be with one brick thick in cement mortar (1:6). However, internal partition walls for office area and toilets shall be with half brick masonry thick with cement mortar (1:4).
80	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		21.01.02, Page 158	All internal walls shall be with one brick thick in cement mortar (1:4). However, internal partition walls for office area and toilets shall be with half brick masonry thick with cement mortar (1:4).		
81	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		CI 11.22.05, Page 76	TEMPERATURE CONTROL OF CONCRETE i) The temperature of fresh concrete shall not exceed 23°C + 2°C when placed. ii) For maintaining the temperature of 25°C in the machine foundations, crushed ice shall be used in mixing water.	Temperature control of concrete is required only for TG foundation (deck). Kindly confirm.	Noted.
82	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.24.02, Page 77	No pressure relieving devices shall be permitted in underground structures.	Pressure relief valves (PRV) shall be permitted to prevent uplift of the cooling water channel and forebay. Please confirm.	Bid Specification Prevails
83	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		14.00.00, Page 91	The Bidder shall carry out the work as per the drawings issued to him and/or Bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.	Micro-grading of area within the BTG Package is only in Bidders scope. Kindly confirm.	Bid Specification Prevails
84	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		38.01.03, Page 231	The scope of work shall also include the patrol road around the plant area and parallel to boundary wall. The patrol road will be 4m wide	Patrol roads are not in bidder scope. Kindly confirm.	Noted.

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85	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		37.02.00, Page 231	This shall include ground water recharging with clean water collected from roof of buildings like Administration Building and collection of clean rain water from other areas in a pond.	1. Ground water recharge (refer clause 37.01.00) is envisaged as per specification, hence there shall not be any roof water collection pond. Kindly confirm. 2. Scope of rain water harvesting is applicable for BTG package only. Kindly confirm.	Providing rain water harvesting system, for individual buildings (BTG package), along with sump, is in bidder's scope.
86	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		38.02.00, Page 232	Roads – Bitumen Roads [Part – A]	1. Kindly clarify what is Part-A and Part-B w.r.to Roads. 2. Kindly clarify is their any bitumen road in scope of BTG Package . Bidder understand that Bitumen roads are not in bidders scope. Only internal roads within BTG package area are in bidders scope. Kindly confirm.	1. It is the detailed specification for Bituminous road and concrete road. 2. All roads in the BTG area shall be rigid pavements. BTG roads with in the terminal points marked in the Plot plan is in the scope of Bidder.
87	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.14.01, Page 170	The elastomeric membrane for the raft	1. Bidder proposes to follow Clause No 10.01.05, page 58 for below ground RCC structures in contact with soil. Kindly confirm. 2. Above ground RCC superstructure, RCC substructure which is not in contact with soil, inside surface of RCC tanks and walls - Surface treatment/coating is not required. Kindly confirm.	It should be used for all underground like tunnel/basement floor or water retaining structures.
88	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.15.00, Page 172	Bituminous or Tar Coating on External Surface		It should be used for all concrete surfaces of structures/foundations which are contact with soil or ground water.
89	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.16.00, Page 173	Protective Coating on Inside Surface		It should be used for internal surface of concrete walls for all underground or water retaining structures.
90	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.17.00, Page 173	Bitumen Felt: Application for Tanking		It should be used for base of below MS tanks.
91	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.18.00, Page 173	Polyethylene Films: Application in Walls or base of Structures		Not applicable.
92	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.19.01, Page 174	Protective Coating on Concrete Surface ON FOUNDATION		Not applicable.
93	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.01.05, Page 58	The concrete surface wherever contacts with soil or ground water shall be provided Bitumen painting/Bitumen felt for all areas/structures shall provide if required as per soil condition.		Bid Specification Prevails
94	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.02.07, Page 21	elastomeric membrane type waterproofing system as per specifications.....		
95	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.03.12, Page 23	Elastomeric membrane type Waterproofing system as per specifications shall be provided over the roof.		

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96	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.10.04, Page 27	Roof shall be given Heavy duty water proofing with Bitumen felt.	There is contradiction in roof water proofing requirement in different clauses of the specification. Bidder proposes to follow 23.04.00 for roof water proofing system. Kindly confirm.	Clause no. 23.04.00 shall be followed for roof water proofing.
97	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.14.10, Page 30	Review for providing elastomeric compound as per roof treatment done in other major plant building.		
98	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.14.11, Page 30	To protect water proofing courses, a screed layer of concrete grade M20 using 10 mm downgraded aggregate, of average thickness 40 mm shall be provided.		
99	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.02.00, Page 165	MATERIALS High solids content Polyurethane based cold liquid applied coatings shall be as per ASTM C836-89		
100	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.04.03, Page 166	roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-836 & 898.....		
101	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.05.00, Page 167	Expanded Polystyrene Blocks		
102	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.05.04, Page 167	Either of above items can be adopted subject to approval of engineer.		
103	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.07.00, Page 167	Water proofing by epoxy resin based application		
104	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.09.00, Page 168	Waterproofing with app modified bituminous membrane.		
105	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.10.00. Page 168	Surface finish		
106	IV-PART D	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		31.03.06, Page 204	Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This under deck insulation shall consist of Glass insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.	1) Bidder understands that underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements of HVAC. Please confirm. 2) Areas such as cable vault etc. which are coming below the air conditioning area shall not be provided with under deck insulation (below floor) due to practical constraints. Please confirm.	Noted

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107	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		32.01.06, Page 205	Vitrified ceramic tiles of size 400mm x 400mm or 600mm x 600mm (Mat or Mirror Polished) and of specified thickness from reputed manufacturer shall be used.	Please provide the thickness of the floor tile.	Minimum thickness required for Vitrified tiles is 12mm.
108	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 81	Colour coated Metal cladding on A-row & Gable end.	Bidder understabd that only external cladding is required on A Row and Gable end. Kindly confirm.	Noted.
109	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 81	ACP cladding works	Scope not clear, please clarify	ACP cladding will provide over the wall surface.
110	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page82	Aluminium composite panel cladding on walls and columns upto false ceiling level	1. ACP pannel in SWAS room/UPS battery charger room is not required. Kindly confirm. 2. Please furnish painting schdeule.	Bid Specification Prevails
111	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 82	Aluminium Composite panel cladding for columns and walls	1. ACP pannel in Conference room, senior executive room, Computer Room, Office room and staff room is not required. Kindly confirm. 2. Please furnish painting schdeule.	Bid Specification Prevails
112	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01 Page 82	Digitally glazed ceramic wall tiles up to False Ceiling Height	Please confirm which clause (i.e. 12.02.01 page 82 or 32.01.02 page 204) is to be followed.	Both the clauses are different. Bid Specification Prevails
113	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		32.01.02, Page 204	Sunken RCC slab shall be provided in false flooring area and all toilet areas so as to keep the finished floor level of these areas 12 mm below as that of the surrounding area. For toilet area, sunken slabs shall be made water tight by suitable water proofing treatment.		
114	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 83	INTERIOR FINISH SCHEDULE 2)Service building a) Entrance Lobbies and Lift areas/ Foyer /Exhibition space. b) Conference room, senior executive room. Page-84 INTERIOR FINISH SCHEDULE 4)ESP Control building c) Control room area	ACP cladding on internal wall is not required. Kindly confirm. 1. ACP pannel in Entrance Lobbies and Lift areas/ Foyer /Exhibition space, Conference room, senior executive room, ESP Control room, control room ares is not required. Kindly confirm. 2. Please furnish internal painting schdeule for above mentioned area.	Bid Specification Prevails
115	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 82/83	INTERIOR FINISH SCHEDULE Service building Conference room, senior executive room - 11 mm thk. Laminated wooden flooring INTERIOR FINISH SCHEDULE, STG Building k) Conference room, senior executive room, Computer Room, Office room and staff room - Matt finished Vitrified ceramic tiles.	1) Bidder proposes vitrified tiles instead of wooden flooring as this type of flooring is not advisable in dusty environment. Please confirm.	Bid Specification Prevails

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116	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.02, Page 87	Toilet & pantry doors shall be wooden panel door. EXTERIOR FINISH SCHEDULE 5. Doors f) Toilet / Pantry area Brief technical specifications of different items to be used for the area as follows:	Bidder proposes to provide wooden panel door with steel frame in toilets and pantry. Kindly confirm.	Bid Specification Prevails
117	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.08 Page 38	iv) DOORS		
118	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.02, Page 87	EXTERIOR FINISH SCHEDULE 6. Windows d) Toilet / Pantry area	Bidder suggest to use Aluminium framed glazed windows in toilet and pantry. Kindly confirm.	Noted
119	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.08 Page 37	i-c) For staircase and Corridors: Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble.	Clause 7.20.08 and 12.02.01 for flooring in RCC stairs are contracditory. Kindly clarify which is to be followed.	20mm thick Granite flooring
120	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, Page 83	Service building d) RCC Stair case - 20mm thick Granite flooring.		
121	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.02.10/ 11.02.00	For Control Rooms, CER, UPS Charger Room area in MPH/turbine building. Dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall panelling for housing LVS.	Clause 7.02.04 for TG Bay, Clause 7.03.04 for Control room, Electrical bay & heater bay shall be followed. Kindly confirm.	Bid Specification Prevails
122	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.10.02, Page 69	ii) Rain water down comers shall be of uPVC Pipe conforming to IS 4985:2021.	There is contradiction in specification for rain water downtake pipe material. Bidder proposes to follow uPVC Pipe for rain water downtake pipe. Kindly confirm.	Noted. Rain water down comers shall be of uPVC Pipe conforming to IS 4985:2021
123	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		35.03.01, Page 222	Rainwater down comers shall be standard Cast Iron Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted.....		
124	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		10.01.08, Page 58	Welding shall be used for fabrication and erection. Site connections shall generally be with welding/bolts.	Bidder proposes that primer coat shall be applied at shop, Intermediate coat and final coat shall be applied at site after erection for welded construction of structural steel works. Kindly confirm.	Noted
125	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		13.03.00, Page 88	Painting of Steel Surfaces (Other Than Those Embedded In Concrete)		
126	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.02, Page 45	Exposed Metal Work		

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127	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		24.04.01, Page 175	Permanent Colour Coated Aluminium Cladding System	The referred clauses are in contradiction for side cladding/roof sheeting requirement in the specification. Bidder proposes to follow clause 12.02.02 for side cladding/roof sheeting. Kindly confirm.	Noted.
128	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		24.06.01 iii), Page 175	Troughed galvanized M.S. sheets having 0.6 mm minimum base metal thickness (bare material) with minimum rate of galvanization of 275 gms./sq.m. as per IS-277 of minimum yield strength of 250MPa		
129	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		24.06.02 iv), Page 176	Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm or as recommended by manufacturer to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel.....		
130	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		24.07.00, Page 176	Double skin insulated metal cladding		
131	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		24.06.02 v), Page 175	Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet.	Bidder proposes 50 mm thick insulation sandwiched between two sheets. Kindly confirm.	Bid Specification Prevails
132	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.01.06, Page 45	External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium / C-276 sheet over insulation.	In case of borosilicate glass block lining system is envisaged on inner surface of flue can, there shall be no requirement of insulation on outer surface of flue can. External surface of chimney flue liner projecting over the chimney roof shall be wrapped with 2 mm thick Titanium / C-276 sheet without insulation. Kindly confirm.	Noted.
133	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.01.12, Page 46	For Borosilicate lining, the top flue liner above the roof slab shall be made of C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 8 mm thickness with Borosilicate Glass Block Lining of minimum 38 mm thickness.	In case of borosilicate lining, for flue can projecting above the roof slab, bidder proposes to provide 8 mm thick (minimum) mild steel flue internally lined with borosilicate and external surface wrapped with 2 mm thick Titanium/C276 sheet. The same is as per latest specifications of most of the customers including NTPC and also inline with engineering done for various projects chimneys by bidder. This is to avoid joint between two type of materials for flue can. Kindly confirm.	Noted.
134	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.01.14, Page 46	For Borosilicate lining, top portion of the flue can shall be fitted with stop bar of 8 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining. The minimum length of the capping inside the chimney shall be atleast equal to 1/4th diameter of flue liner.	For Borosilicate lining, top portion of the flue can shall be fitted with stop bar of 2 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining. The minimum length of the capping inside the chimney shall be atleast equal to 150mm. Kindly confirm.	For Borosilicate lining, top portion of the flue can shall be fitted with stop bar of 3 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining. The minimum length of the capping inside the chimney shall be 100mm and the thickness shall be 2mm of Titanium / C-276 sheet.

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135	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.03, Page 49	Internal and external platforms shall be provided not more than 45 m intervals and shall satisfy the requirements of high intensity aviation obstruction lights as per IS 4998 / I.C.A.O. regulations, aviation lights are provided at three levels at 1 / 3, 2 / 3 and at top of Wind Shield.	External platform nowadays are obsolete due to high maintenance cost and delay in construction. Bidder proposes to remove the requirement of external platform. Aviation Warning lights (AWL) shall be fixed to openings in the chimney shell. The same is inline with detailed engineering done by bidder for various projects as a proven practice. Kindly confirm.	Noted.
136	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.13, Page 49	CHIMENY OPENING iii) Bidder shall consider not more than 45° as maximum angle subtended by single opening at the centre of the shell as per clause 7.0 of IS 4998:2015. iv) The maximum width of opening shall be limited to an angle of not more than 30 degree subtended at center of concrete shell.	Opening criteria mentioned in these clauses are contradictory. Bidder proposes to follow the opening criteria as per IS4998:2015 including its amendment. Kindly confirm.	Noted.
137	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.14 i) Page 50	The floor supporting beams shall take support on shell by making a pocket in the shell and elastomeric bearings shall be provided below the supporting beams.	Steel bearing plates shall be provided for supporting beams in shell pockets. The same is inline with detailed engineering done by bidder for various projects. Kindly confirm.	Noted.
138	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.17 vii) Page 51	Minimum factor of safety against 1.5 using unfactored loads	Values of Partial Safety Factor for Loads shall be aprovided as per IS 4998:2015 table-1. Kindly confirm.	Noted.
139	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.18 ii) Page 52	If the liner is supported by the shell, the shell shall be thickened for the liner support framing beam pockets, unless otherwise approved by the Owner.	Liner supporting beams shall be supported in recess provided in chimney shell. Thickening of shell may not be required. The same is inline with detailed engineering done by bidder for various projects. Kindly confirm.	Noted.
140	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.02.19 ii) Page 54	Use a response spectrum modal analysis with the design response spectrum for horizontal ground motion calculated by the general procedure in IS 4998 appropriate for the seismic conditions. A fixed base "stick" model, which couples the shell and liner behavior, shall be used. The liner stay rod system shall be included in such a manner as to produce a conservative design of the shell and liner. A sufficient number of modes shall be considered such that the stresses would not change by more than 10 percent if additional modes were included.	Chimney shall be designed fulfilling all the requirements of IS 4998:2015 (latest). Kindly confirm.	Noted.
141	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.03.00 Page 55	Painting i) The Chimney painting as per ICAO guidelines. External portion of the wind shield shall be coated with alternate bands of colours red and white to meet the aviation safety requirements. The mini-shell and the top few metres of the internal surface of the windshield shall be painted for acid and heat protection with bituminous paint.	Minishell shall be wrapped with titanium/C276 sheet. Please provide complete specification (type, DFT etc) for chimney RCC shell external surface and internal surface painting as the same is ambiguous.	Refer Addendum on Chimney Painting
142	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.05.06 Page 59	The top flue liner above the roof slab shall be made of solid C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 10 mm thickness.	In case of borosilicate lining, for top flue liner above the roof slab, bidder proposes to provide 8 mm thick (minimum) mild steel flue internally lined with borosilicate and external surface wrapped with 2 mm thick Titanium/C276 sheet. The same is as per latest specifications of most of the customers including NTPC and also inline with enginnering done for various projects chimneys by bidder. This is to avoid joint between two type of materials for flue can. Kindly confirm.	Noted.
143	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.05.10 Page 60	ALLOY CHIMNEY HOOD:	Chimney hood were required in case of brick flue chimney, to seal the gap between brick lining and RCC shell. For subject steel flue chimney, the same is not required. Kindly confirm.	Bidder note that it is coming at Chimney roof level for connection between Flue can and Roof slab.

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144	VOLUME - III	PART - A/SECTION - 4/FGD, Lime Handling & Chimney		4.06.01 iii) Page 63	Compressive strength of at least 1.38 Mpa as per ASTM C.165	Minimum compressive strength of 1.1 Mpa as per ASTM C165 is proposed by the bidder. The same is inline with other projects done by bidder. Kindly confirm.	Noted.
145	VOLUME - III	PART - D		8.17.01 ii) Page 51	R.C.C CHIMNEY a) Reference shall be made to IS: 4998 Part I (1992) – “criteria for design of Reinforced concrete chimneys – Part I, assessment of loads” for loading details. For wind loading IS: 875 and for seismic loading IS: 1893 shall be referred to. b) Wind load magnification on the Chimney induced by adjacent tall structures such as Cooling Towers/Boiler structures shall be included in model study conducted in wind tunnel, and necessary modification shall be made in the wind loading for design. c) Detailed design requirements in respect of the chimney have been described elsewhere in the specifications (Refer FGD Section Vol.-III, Part-A, Section-4).	Chimney shall be designed fulfilling all the requirements of IS 4998:2015 (latest). Kindly confirm.	Bid Specification prevail. However, the code IS 4998: 2015 instead of IS 4998: 1992 shall be followed
146	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.02.07, Page 21	Roof rain water pipe shall be of uPVC conforming to IS 4985:2021	The referred specification clauses are contradictory. Please clarify the type of rain water down take pipes to be used.	Roof rain water pipe shall be of uPVC.
147	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.07.14, Page 26	Rain water down take pipes shall be of uPVC pipe conforming to IS 4985:2021.		
148	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.10.04, Page 27	Adequate number of rain water down take pipe shall be provided using uPVC pipe conforming to IS 4985:2021.		
149	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.14.11, Page 30	Rain water down comers shall be of uPVC pipes conforming to IS 4985:2021.		
150	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.10.02 ii), page 69	Rain water down comers shall be of uPVC Pipe conforming to IS 4985:2021.		
151	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		23.04.05, Page 166	For all Buildings are envisaged uPVC pipes shall be provided to drain off rain water from the roof.		
152	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		35.03.01, Page 222	Rainwater down comers shall be standard Cast Iron Pipes.		

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153	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.24.14 ii), Page 42	interlocking concrete blocks of minimum M35 grade and minimum 80 mm thickness.....	The referred clauses are contradictory. Pls. clarify the grade of concrete and thickness of interlocking concrete blocks.	Clause no. 7.24.14 ii) shall be followed for interlocking concrete blocks.
154	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		32.01.08, Page 205	Inter locking concrete blocksn used for paving shall be of minimum M-30 grade of concrete, and of thickness 60 mm,.....		
155	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.24.14, Page 42	All facility/buildings shall be provided with 1000 mm wide plinth protection all around with garland drain. It consists of 100 mm thick P.C.C. M-20 grade.....	The referred clauses are contradictory. Pls. clarify the grade of concrete for plinth protection.	Clause no. 7.24.14 shall be followed for Plinth protection.
156	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.36.01, Page 80	All buildings will be provided with a width of 1000mm with plain cement concrete of M15 grade paving.....		
157	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.17.05, Page 72	Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used.	Referred clauses are condradictory, please clarify the following: 1. Proportion of cement mortar for external wall. 2. Proportion of cement mortar for internal wall one brick thick. 3. Proportion of cement mortar for internal wall half brick thick.	Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used.
158	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		21.01.02, Page 158	All internal walls shall be with one brick thick in cement mortar (1:4). However,internal partition walls for office area and toilets shall be with half brick masonrythick with cement mortar (1:4)		
159	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		21.02.06, Page 159	Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS:2250. Mix shall be in the proportion of 1:4.		
160	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		22.01.01, Page 162	Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.	Referred clauses are condradictory, please clarify the proportion of the cement mortar for plastering.	The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand).
161	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		22.02.01, Page 163	The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand).		
162	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.18.03 i), Page 72	Dry film thickness of each primer coat shall be 50 microns.	CI 11.18.03 i) & 13.03.00 are contradictory w.r. to requirement of primer coat DFT. Please clarify DFT for each primer coat.	Clause no 13.03.00 shall be followed for primer coat DFT.
163	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.18.04 ii), Page 72	Two coat of primer shall be provided.		

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164	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		13.03.00, Page 88	All steel surfaces shall be provided with two component moisture curing zinc (ethyl) silicate primer coat (having minimum 80% of metallic Zinc content in dry film, solid by volume minimum 60% ±2%) of minimum 70 micron DFT to be applied over blast cleaned surface.....		
165	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.08 i) b), Page 37	For Entry cum reception lounge, VIP lounge, Main meeting/ conference room: Suitable and approved combination shed of marble slab and strips shall be used.	1. Please clarify thickness of marble slab for flooring, wall, staircase tread/riser. 2. Please provide details of strip?	For marble, 20mm thick shall be provided.
166	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		7.20.08 i) c), Page 37	For staircase and Corridors: Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble.		For staircase and corridors, 20mm thick granite shall be provided.
167	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 1), Page 81	STG building d) General circulation area like lift entrance area, office area and laboratory - 25mm thick Granite flooring.	Bidder proposes to provide 18-20 mm thk. Granite flooring. Please confirm.	Strips for design/border shall be same as that of floor material.
168	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 1), Page 81	STG building e) Operating floor - 25mm thick Granite flooring.		
169	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 1), Page 82	STG building n) RCC Stair case - 20mm thick Granite flooring.		
170	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 1), Page 82	STG building l) Record room - ceramic tiles	Bidder proposes to provide vitrified ceramic tiles in place of ceramic tiles for the referred clauses. Please confirm.	Noted.
171	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 2), Page 83	Service building f) Pantry/ Kitchen - ceramic tiles		
172	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 1), Page 82	STG building m) Toilet area- Ceramic (anti-skid) tiles	Bidder proposes to provide vitrified ceramic (anti-skid) tiles in place of ceramic(anti-skid) tiles for the referred clauses. Please confirm.	Noted.
173	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.02.01, 2), Page 83	Service building e) Toilet - Ceramic (anti-skid) tiles		
174	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		11.02.01, Page 66	All the Architectural design works shall be carried out by professionally qualified architects having adequate experience (minimum five years) in the design and detailing of architectural work of power plant buildings. Bidder may have inhouse Architects with the required experience for the above or engage Architect Consultant having similar experience.	Referred clauses are condradictory, please confirm the following: Bidder proposes to follow Clause No. 11.02.01, page 66 for architectural design and detailing aspects of all the buildings. All the Architectural design works shall be carried out by in-house Architects having adequate	Noted. However Bidder to submit atleast three number of design options for owner's

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175	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS		12.01.04, Page 81	Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements may be required to be met with, wherever essential. The Architect Consultant shall be of National/International repute having experience in similar kind of works. The consultant shall evolve the design philosophy based on Owner/Engineer's guidelines and shall present it in the form of presentation drawings, Perspective views, 3-D Models and detail drawings.	experience (more than five years) in the design and detailing of architectural work of power plant buildings. Also, in-house Architects shall evolve the design philosophy based on Owner/Engineer's guidelines and shall present it in the form of presentation drawings, Perspective views, 3-D Models and detail drawings. Kindly confirm.	approval DDE. In-house Architect having minimum 10 yrs experience is accepted.
176	III	PART - D		10.01.07	Design detailing and fabrication of steel structures shall be done as per provisions of IS: 800 with updated version.	Design boiler structures will be as per IS 800 latest using working stress method.	Noted
177	III	Part-D		(Page 88) 13.02.00	Painting of steel surfaces embedded in concrete Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Pri-mer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).	<i>No painting is required for embedded surfaces, as paint will hinder adhesion.</i> <i>Temporary rust preventive fluid can be applied to protect these surfaces until erection.</i>	Noted
178	Volume III - Part D Civil		15	5.04.02	Face of the buildings and facilities are located in such a way so as to have an offset of minimum 15 to 20m with respect to centre line of road	The minimum requirement given is stringent considering the available space. Building offset shall be finalised based on available space in plot during detail design. Owner to please confirm.	Face of building and facility should be maintained at a distance of minimum 3 mtr with respect to edge of right of way
179	Volume III - Part D Civil		22	7.03.08	All partitions wall for Control room area shall be of aluminium glazed partition up to roof level, on either side of air lock	Bidder understands glazed partition to be provided till False ceiling level. Owner to please confirm.	Bid Specifications prevails and glazed partition to be provided till False ceiling level.
180	Volume III - Part D Civil		22	7.03.09	Battery room shall be provided with PVC doors in PVC framing.	Bidder recommends to provide steel door for battery room as per standard practice. Owner to please confirm.	2 Hr fire rating MS Steel fire proof door in MS frame shall be provided.
181	Volume III - Part D Civil		23	7.03.11	Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling	Bidder understands that under deck insulation shall be provided as per functional requirement for Air conditioned rooms. Owner to please confirm.	Bid Specifications prevails.
182	Volume III - Part D Civil		23	7.03.12	Roof shall be given a fall of about 300 mm for proper drainage.	Specification requirement is not clear. Owner to elaborate the requirement.	Roof shall be given a projection of 300 mm from outer face of wall for proper drainage.
183	Volume III - Part D Civil		37	7.20.08.i.a	Total thickness of the flooring shall be 40 mm thick including the thickness of the tiles, under bed	Total flooring thickness for service building shall be 75 mm considering cable raceway under flooring for working cubicles. Owner to please confirm	Total thickness of 40 mm mentioned in bid is minimum. As per functional requirement thickness may increase.
184	Volume III - Part D Civil		37	7.20.08.iii	It shall be of aluminium linear acoustic false ceiling with glass wool insulation on top having approved colour with stove enamel finish,	For AC area under deck insulation is provided as per HVAC requirement. Bidder understand additional insulation above false ceiling is not envisaged. Owner to please confirm.	Noted
185	Volume III - Part D Civil		38	7.20.08.v	GLAZED PANELS The glazed panels shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling and maximum available width. Insulating glass shall consist of 2 nos. 6 mm thick clear float glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer.	Bidder understand that the clause is for internal partitions, not the external glazing. Generally internal partition does not require Double glazed glass. Generally double glazed is used to segregate between AC and Non AC area, but here the Service building is centrally AC, hence this may not be required. Owner to check and confirm.	Noted. However, for main entrance double glazed partition shall be provided.

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186	Volume III - Part D Civil		66	11.02.11 7.03.04	For Control Rooms, CER, UPS Charger Room area in MPH/turbine build. dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall panelling for housing LVS. Cladding shall be of brick walls	There is a discrepancy in 2 clauses for cladding for control room. Owner is requested to check and clarify.	There is no discrepancy. The building shall be cladded with Brick wall (as per clause no. 7.03.04). In addition to Brick wall, the inside control room shall be cladded / decorated with ACP panels (as per clause no. 11.02.11).
187	Volume III - Part D Civil		66	11.02.10	For Control Rooms, CER, UPS Charger Room area in MPH/turbine build. dry wall construction technology shall be incorporated. Control room shall be designed as designer control room with ACP Cladded wall panelling for housing LVS	Owner to please clarify the type of DRY WALL to be used if not brick.	Bidder note that the drywall means no Brick wall. It means Aluminium parrtition, ACP partition, etc.
188	Volume III - Part D Civil		67	11.02.12	All control room shall be provided with air lock lobby having double glass door	Bidder understand this shall be considered only for MPH main Control room.	Noted
189	Volume III - Part D Civil		67	11.03.01	All roofs shall be provided with access thorough a staircase/cage ladder	Bidder understands that wherever equipment handling is required, staircase shall be provided. Otherwise ladder or cage ladder to be provided.	Noted.
190	Volume III - Part D Civil		68	11.05.03	All stairs normally shall have not more than 15 risers in one flight.	As per NBC only 12 risers in one flight is allowed. Owner to confirm on providing 15 risers in one flight.	Noted and maximum 12 risers in one flight may be provided
191	Volume III - Part D Civil		81	12.01.04	The consultant shall evolve the design philosophy based on Owner/Engineer's guidelines and shall present it in the form of presentation drawings, Perspective views, 3-D Models and detail drawing	Bidder understands and request to provide 3D Perspective view of important buildings like Service building and MPH only. Rest other buildings shall not be submitted with 3D perspective views. Owner to confirm.	Noted
192	Volume III - Part D Civil		81	12.02.00	FINISH SCHEDULE- Aluminium False ceiling	Bidder understands that Aluminium False ceiling here means Lineal pattern as mentioned in clause 31.00.00 on page 203 of Volume III- Part D civil and not a Grid type aluminium panel ceiling. Owner to please confirm	Bidder's understanding is correct.
193	Volume III - Part D Civil		158	21.01.01	All walls shall be non-load bearing infill panel walls. For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever Aluminium cladding is specified.	As per this clause wherever ACP (aluminium cladding) is coming, external wall shall be of 3mt high and rest area shall be ACP. As per finishing schedule Service building is to be provided with ACP on external face. Owner to please check and clarify the clause to be followed.	Bidder note that this clause is only specification of Brick work. For initial height up to 3 metres from ground floor one brick thick masonry wall shall be provided wherever Aluminium cladding is specified. It is for Steel building wherever sheet cladding will come. The ACP cladding on external face for Service building shall be as per tender requirements.
194	Volume III - Part D Civil		162	22.01.02	Plaster of Paris (Gypsum Anhydrous) shall be used for plaster of paris punning over cement plastered surfaces for inside wall of all buildings. The finish surface shall be smooth and shall be of 2 mm nominal thickness	POP Punning shall be provided only for important areas and buildings like Service building and control rooms only. Rest of the areas shall be cement base putty over plaster before painting. Owner to please confirm	Noted.
195	Volume III - Part D Civil		188	27.03.09	All inaccessible (where regular maintenance is not feasible) ventilators and windows shall be provided with 6mm thick Multiwall Polycarbonate plain or tinted sheet for preventing solar radiations.	Bidder recommends to provide 4mm thick ground glass or 6 mm thick wired glass for inaccessible windows instead of Polycarbonate sheet for better durability in weather effect. Owner to please reconsider.	6mm thick wired glass shall be provided instead of multiwall polycarbonate plain or tinted sheet.

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196	Volume III - Part D Civil		205	32.03.03	The total thickness of glazed tile finish including the bedding mortar shall be 20mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work	As per clause 32.00.01 nominal total flooring thickness is 50 mm, but here it is mentioned 20 mm. Bidder understands it shall be 50 mm for all buildings Owner to please confirm.	Minimum total thickness of glazed tile in dado/skirting is 20mm.
197	Volume III - Part D Civil		208	32.04.02.ii.a	The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified	As per clause 32.00.01 nominal total flooring thickness is 50 mm, but in this clause it is mentioned 40 mm. Bidder understands it shall be 50 mm for all flooring. Owner to please confirm.	Thickness of flooring shall be 50mm.
198	Volume III - Part D Civil		222	35.03.01 11.11.02	Rainwater down comers shall be standard Cast Iron Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer. Rain water down comers shall be of uPVC Pipe conforming to IS 4985:2021	There is a discrepancy in 2 clauses for Rain water down comer. Bidder understands that uPVC pipes as Rain water down comers shall be considered. Owner is requested confirm.	uPVC Pipe conforming to IS 4985:2021 shall be used for rain water down-comers.
199	Volume III - Part D Civil			10.03.09 36.00.00	These values shall be based on the recommendations of the Meteorological Department. The maximum velocity for pipe drains and open drains shall be limited to max. 1m/sec. The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8 m/sec. respectively	There is a discrepancy in 2 clauses for Maximum Velocity in drain. Owner is requested to check and clarify.	Clause no. 36.01.00 shall be followed.
200	Volume III - Part D Civil			36.03.00 6.03.03	The drain shall be minimum 300mm wide at the base. Drains shall be designed during detailed engineering; however minimum clear width of the drain shall be 450mm.	There is a discrepancy in 2 clauses for Drain Width. Owner is requested to check and clarify.	Minimum width of drain shall be 450 mm.
201	Volume III - Part D Civil			36.05.00 10.06.03	Similarly all artery drains and the drains along the periphery of building shall also have perforated precast RCC covers of minimum 50 mm thickness with provision of openable galvanized steel grating covers at about 4.0 m intervals. Drains outside building (Garland drains) will have perforated pre-cast RCC covers of minimum 75mm thickness	There is a discrepancy in 2 clauses for Precast RC Cover. Owner is requested to check and clarify.	Perforated precast RCC covers of minimum 75 mm thickness with provision of openable galvanized steel grating covers at about 4.0 m intervals shall be provided.
202	Volume III - Part D Civil		61	10.03.09	The storm water drainage shall cater to storm water runoff resulting from one hour rainfall intensity, with a return period of 100 years. These values shall be based on the recommendations of the Meteorological Department.	Owner to specify the rainfall intensity for storm water drain design.	Bidder shall collect the data from Meteorological department
203	Volume III - Part D Civil		65	10.06.03	Runoff coefficient shall be taken as per IS 8835-1978.	Kindly note that IS 8835 is only for rural area and agriculture land. Coefficient for plant area, paving etc. are not provided in code. Hence owner is requested to specify the runoff coefficient for plant.	Run-off coefficient 1) Paved area - 1 2) Unpaved area - 0.6

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204	Volume III - Part D Civil		16 61 231	6.03.01 10.03.05 38.01.01	All roads in the power plant area of BTG island and main access road from gate shall be rigid pavement with RCC and all other roads shall be Bitumen top flexible pavement designed and constructed as per relevant IRC codes. All roads shall be of flexible pavements except as otherwise specified. Design of flexible pavement shall be carried out as IRC-37. The minimum requirements as specified in IRC-37 w.r.t. surfacing base and sub base shall be followed. All main plant roads (Part-B) will be in concrete rigid pavement with minimum 300 thick PQC as per IRC except patrolling roads.	a) There is a discrepancy in all 3 clauses for type of road. Owner is requested to specify whether road shall be flexible (Bitumen) or Concrete (RCC or PQC). Also, if Concrete road, then whether the concrete road will be with reinforcement (i.e. RCC Road) or without reinforcement (i.e. PQC road). Owner is requested to check and clarify. b) Also in case of PQC road, Owner is requested to allow bidder to design the PQC thickness of rigid pavement of road as per IRC. 300 mm thickness is too high which is generally not required as per design.	All main plant roads will be in concrete rigid pavement with minimum 300 thick PQC as per IRC.
205	Volume III - Part D Civil		17	6.04.08	Any existing nalla which is coming in the plant area shall be suitably diverted and connected to a permanent water course.	Bidder do not envisage any nalla diversion within the BTG battery limit. However in case the same is included in BTG package then Owner is requested to provide layout and terminal point of existing Nalla to be diverted.	Bidder visit the site and collect the necessary data.
206	Volume III - Part D Civil		17	6.05.01	For plant area sanitary sewage disposal, Effluent from the each building complex shall be connected to a common combined sewage treatment plant.	Bidder understand that Sewage treatment plant is existing or in others scope. For BTG package, Bidder needs to connect the pipe at terminal point. If this understanding is correct, Owner to provide terminal point location in the plot plan.	Sewage pipe line upto collection sump at STP is in bidder scope. Location of STP is marked in the plot plan.
207	Volume III - Part D Civil		23	7.04.01	The TG foundation shall comprise of RCC top deck supported on steel helical springs & viscous dampers (called herein as the Vibration Isolation System – VIS) and shall be located in the Turbine bay of Main Power House. The springs-cum-viscous dampers shall be placed on a group of RCC/ Structural Steel columns.	Owner is requested to also allow bidder to design STG without spring & dampers/VIS, as per OEM recommendation.	TG foundation shall be Rigid.
208	Volume III - Part D Civil		23	7.04.03	In case the MDBFP/TDBFP foundation is approved by owner & consultant to be located at ground floor of Main Power House, then these shall be designed as block foundations directly resting on soil / pile.	Bidder proposed to keep MDBFP and TDBFP on ground floor of Main Power House Building. Owner is requested to confirm the same to proceed with layout.	If BFP foundations rest over the floor beams, VIS shall be provided. If the BFP foundation rest on ground or on lower floors where rigid foundation can be used, the VIS may not be required & all stipulations given in the code shall be followed..
209	Volume III - Part D Civil		33 58	7.19.02 10.01.03	This building shall be a single storied framed superstructure with RCC columns, structural steel roof truss (with rafter and tie level plan bracings), purlins and roof slab. However, pump houses shall have structural steel super structure with Galvalume sheet roofing.	As per CI 10.01.03 all pump house shall be Steel superstructure. However Fuel Oil pump house has been specified with RCC superstructure with Steel. Owner is requested to check and clarify the requirement.	RCC pedestals, structural steel Columns and truss is envisaged for all the pump houses except Fuel oil pump house. Fuel oil PH shall be RCC framed structure.
210	Volume III - Part D Civil		53	9.03.02	The permissible differential settlement between two adjacent footings (in a framed configuration) shall not be more than 6mm.	Owner is requested to allow bidder to design the foundation as per codal requirement of differential settlement.	Bid Specifications prevails. However, bidder want to go as per codal requirement then bidder has to give detailed calculation of settlement, DDE

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211	Volume III - Part D Civil		59	10.01.20	All RCC liquid retaining/ conveying structure (except water storage tanks) shall be designed in accordance with IS: 3370 by the working stress method.	As per Latest IS 3370- 2021, Only Limit state method is available for liquid retaining structure design. Therefore Bidder shall follow the same. Owner to confirm.	All RCC liquid retaining/ conveying structure shall be designed in accordance with IS: 3370 by the working stress method. However, the water storage tanks shall be designed as per IS 3370-2021. It should be satisfied with crack width.
212	Volume III - Part D Civil		61	10.03.04	However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc.	Where Minor equipment supported on floor, if mass of concrete is 3 times of mass of equipment, No vibration isolation required. Owner to confirm.	Bid Specifications prevails, Further requirement of isolation/dynamic analysis can be decided during detail engineering.
213	Volume III - Part D Civil		61	10.03.03	Minimum Reinforcement in base raft in either direction shall be as follows: i) At bottom face - 0.2% of gross cross-sectional area	Owner to note that as per IS 2974 Part 3 ,0.12 % can be provided . Kindly confirm.	Minimum 0.12 % each on either direction can be provided.
214	Volume III - Part D Civil		60	10.03.02	Transient analysis shall be carried out for the short circuit condition with an appropriate force function.	For Short circuit condition, loading and analysis will be carried out as per machine manufacturer requirement. Owner to confirm.	Noted
215	Volume III Part D Civil		10	3.02.00	General plant layout drawing with coordinates of roads, buildings and facilities, piping / cable trenches, pipe and cable racks, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc	Bidder understand that, Landscaping and Green belt development will be done by Owner. Please confirm.	Development of landscaping in the BTG area as per specification shall be in Bidder's scope. However, Green belt development is not in Bidder's scope. Bidder has to plan the facilities leaving the space for green belt in the Layout Plan.
			6	1.18.02 / 11.02.13	The development of green belt is not in bidder scope. However, bidder has to plan the facilities leaving the space for green belt as indicated in "General Layout Plan". In addition to that lay-down areas and other vacant land of the plant will be used by owner for the development of green belt		
216	Volume III - Part D Civil		66	37.00.00	RAIN WATER HARVESTING	Bidder Understand that overall Rain water harvesting scheme development scope shall be with owner considering Split Packages. Any rain water collection from building in Bidder's scope shall be done by Bidder. Kindly Confirm.	Providing Rain water harvesting system to individual buildings with sump, is in bidder's scope.
217	III	Part D	88	13.03.00	Painting of Steel Surfaces (Other Than Those Embedded In Concrete)	a) The referred clause mentions two types of painting category based on classification of environment "C3 - medium" and "C5-very high". Bidder understands that "C3-medium" painting scheme shall be followed for this project. Please confirm. b)Also, Bidder understands that the referred "Annexure-8 - Painting specification" is applicable for technological structures and equipment. For Building structures such as Turbine Building, Pipe rack, Coal Handling Plant structures, other structural buildings etc. clause no. 13.03.00 shall be applicable. Please confirm Bidder's understanding.	Pl. refer cl. No. 4.08.00 page no 4 of bid specification, Vol-V, Annexure-8- "Painting system for the plant shall be selected for medium corrosivity category, i.e. C3 and medium durability category, i.e. 7-15 yrs, as per ISO 12944. However, a minimum requirement of the specification has to be met." Pl. refer cl. No. 4.09.00 page no 4 of bid specification, Vol-V, Annexure-8- "System specific requirement of painting may be mentioned in other part/section of the specification. If there is any contradiction between this section and the other, the better painting scheme should be implemented "
	V	Annexure - 8	17	Annexure - 8	Painting specification All auxiliary steel structural steel components (Outdoor)		

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218	Volume III - Part D Civil		15	5.04.05	Available Area for laydown, preassembly and batching plant have been earmarked on the General Layout Plan.	Laydown and preassembly area is not marked in the tender Plot Plan. Bidder request Owner to issue revised Plot Plan and earmark approx 100 acres of land for laydown and preassembly area.	Bidder to refer clause 9.01.02, vii, of Vol-II, Section-2. Available area within the plant area, will be marked in the Plot Plan & shared with bidders.
219	Volume III - Part D Civil		8	2.05.04	Tentative quantity of concrete/below ground structures and items to be dismantled is 5000m3.	Bidder requests Owner to furnish GPR survey report or drawing of underground facilities within the proposed BTG area.	Bidder to note that the proposed BTG plant is coming in the existing cooling tower area. The provided quantity is tentative. However Bidder can visit the site and collect if additional data is required.
220	Volume III - Part D Civil		8	2.05.01	Site clearance including diversion of existing services if any.	Owner to list out the facilities & earmark on the GLP which are fouling with the proposed BTG area and therefore requires rerouting. Also Owner to confirm that rerouting of such facilities shall be executed by Owner. For example - existing fuel oil lines, raw water pipeline, MCC Building of IDCT etc.	Bidder to visit the site and collect the necessary data. Tender terms and conditions prevail.
221	Volume III - Part D Civil		8	2.05.04	MAHAGENCO has dismantled the superstructure of all structures including cooling towers etc.	Bidder understands that the debris arising out of dismantling of superstructure (which is Owner' scope) shall be cleared before handover of site to EPC Contractor. Please confirm.	Noted
222	Volume III - Part D Civil		6	1.17.04	Site preparation including excavation and demolition of all underground structures, removal of all unwanted debris and transportation, procurement and transportation of suitable backfill material, backfilling, compaction, levelling, grading etc., is in bidder's scope.	As dismantling of substructure is included in EPC scope, Bidder requests Owner to specify the location wherein the debris and scrap material (substructure concrete, rebar etc.) shall be disposed.	Owner will provide the land for disposal of unused materials within 6 km from the plant boundary
223		ETG061-COM-GEN-PP-001			PLOT PLAN	During site visit, Bidder has observed that mill rejects are lying within the proposed BTG area. Bidder understands that the same shall be removed by Owner before handover of site to EPC Contractor. Please confirm.	Noted
224		Part A/ Section 5 Part D		4.11.09 7.15.08 7.14.15	600 NB size manholes, with 150 NB size vent valve shall be provided at 125 to 150m interval. Lifting lugs shall be provided to handle manholes. Manholes of minimum 1000mm clear opening shall be provided in each CW duct at a spacing of 200M (approx.) to facilitate maintenance / dewatering of CW ducts. At least one manhole shall be provided at the deepest point for both intake & discharge duct. Manholes shall be provided along the length of pipe at about 150 m centres and near locations of bend in each pipe.	Owner to clarify the manhole size required. Bidder proposes as a good industrial practice the size of 750 NB at spacing of 200 mtr. Owner to check and confirm.	Noted, however spacing can be finalized DDE.
225		Part A/ Section 5 Part D		4.04.16 7.14.01	Then pumps and equipment shall be designed for the tertiary treated sewage water as specified. Filtered / Clarified water shall be used for circulating water system	Owner is requested to confirm the water quality of the CW system. Bidder understand water quality is clarified water.	Filtered tertiary treated sewage water will be used for CW/ACW system.
226		Part D		7.14.04	Dimension of the pump sumps shall be so selected as to prevent dead water areas, reverse currents, flow separation and eddies. Recommendations of British Hydromechanics Research Association (BHRA) and Hydraulic Institute Standards shall be followed	Bidder will follow HIS recommendation for the CW sump design. Owner is requested to accept the same.	Noted

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227		Part D		10.05.01 7.14.16	ii) Earth pressure with surcharge of 2.5 t / m2 and ground water table up to FGL outside and no water inside. iii) The conduit shall be designed for surcharge of 2t/m2.	We understand for CW conduit, the surcharge pressure to be considered is 2 t/m2. Owner is requested to confirm.	Noted
228	Volume III, Part-D, Lead Technical Specification Civil, Structural and architectural works		6.06.03		The bidder shall provide for a temporary workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities.	Since, Workshop building is excluded from bidder scope, Bidder understand that all workshop equipment shall also not in bidder scope. Owner is requested to confirm bidder's understanding.	Bidder note that the specification clearly mentioned that "...the <u>temporary</u> workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities". Bid specification prevail.
229	Volume-III	PART-D		11.35.01	Roof water tank of adequate capacity depending on the number of users and minimum 8 hours requirement shall be provided for each building and pump house. Separate tanks shall be provided for potable water and service water.	Tank capacity will be decided based on the number of users and requirement of national building code (NBC). Also, Bidder will provide the water requirement and pressure for both potable and service water at given terminal point during engineering. Kindly confirm	Noted. However, minimum capacities mentioned in the specification should be considered. Noted
230	VOLUME - III PART - D 3/ Sec 7/ Part A	CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS ETG106-EPC-ME-FGD-TS	Page 151 68	18.08.05 4.08.11	18.08.05 The Bidder will provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Owner / consultant. In addition, the Bidder, at its expense, shall have the option of taking one radiograph per day per welder at a location selected by the Bidder.	Bidder will perform NDT as per FQAP requirement, in case of additional NDT to be performed, same shall be subject to extra time and cost. Please confirm.	Bid Specification Prevails
231	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 59	10.01.21	Design Concepts Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures (requiring dry working condition). Dense and durable concrete with water cement ratio not more than 0.45 shall be used. Plasticiser/ super-plasticiser cum water proofing compound shall be added to the concrete. All the onstruction/expansion joints shall be properly treated with Copper strip water bar and/or chemical injection grouting after leak proof test as per IS:3370 standards	Bidder would like to request for consideration as below; All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC Water stops. In case of any leakage found during leak test pressure grouting shall be done with fixing grouting nozzles and suitable materials.	Bid Specification Prevails
232	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 69	11.09.01	Expansion /Construction Joints 11.09.01 Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using Copper strip water bars and Grouting nozzles for pressure grouting shall be provided. The minimum thickness of Copper strip water bars shall be 2 mm and minimum width 250 mm.	Bidder would like to request for consideration as below; All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC Water stops. In case of any leakage found during leak test pressure grouting shall be done with fixing grouting nozzles and suitable materials.	Bid Specification Prevails
233	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 71	11.17.04	M-sand shall be used for construction of brick works and river/natural sand shall be used for plastering and finishing works.	Bidder would like to consider M-sand/river/natural sand for construction of brick masonry, plastering and finishing works. This is acceptable as per IS codes.	Bid Specification Prevails

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234	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 75	11.22.03	11.22.03 NOMINAL COVER TO REINFORCEMENT The nominal cover to the reinforcement considering severe exposure as per IS 456: 2000 for all the structures, unless otherwise specified, shall be as follows:	As severe exposure condition is specified for nominal cover to reinforcement, Bidder understands the same is also applicable for mix design. Please confirm.	Noted
235	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 76	11.22.08	ULTRASONIC TESTING i) Ultrasonic pulse velocity test shall be carried out for Top Deck of TG to ascertain the homogeneity and integrity of concrete. ii) Testing shall be done as per IS: 1331 (Part-1). The defects shall be rectified by using cement / epoxy grout etc.	ULTRASONIC TESTING UPV testing shall be conducted as per IS: 13311 (Part-1). Defects shall be rectified using suitable materials as per rectification methodology. Please confirm.	Noted
236	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 127	17.23.02	CEMENT iii) No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known.	Bidder would like to clarify that, cement will be received in bags or in bulkers along with manufacturing test certificate from source. Requisite sample testing will be done at site laboratory. However, cement bags will be kept at store whereas bulkers will be directly unloaded in cement silos. Same could not be kept hold until 7days. Therefore, bidder would like to request to kindly allow the cement usage after meeting requirement of consistency and setting time as per relevant standards.	Noted. However Bidder shall take responsibility for rectification works if the cement compressive strength fails in test result.
237	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 158	21.02.01	Bricks used in the works shall conform to the requirements laid down in IS:13757. Flyash bricks shall be used. The class of the bricks shall be as specified. The nominal size of the traditional bricks is 230mm x 110mm x 70mm with tolerance upto +3 mm in each dimension,one brick and half brick walls shall be considered as 230mm and 115mm respectively.	Bidder understand that use of fly ash bricks as per IS: 13757 or IS: 12894 is depend upon availability of fly ash bricks. However, in case fly ash bricks are not available in the vicinity area, burnt clay bricks meeting requirement of compressive strength 75kg/cm2 an as per IS: 1077 shall be allowed for use. Owner is requested to confirm acceptance.	Noted
238	VOLUME - III	PART - D TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	Page 267	38.03.03	CEMENT CONCRETE (PLAIN AND REINFORCED) (c) Concrete : 1) Mix: The following concrete mixes shall be used for concrete roads. 2) Grade M15 with minimum cement content of 325 kg/cum shall be used for DLC layer below PQC and minimum grade of M35 with minimum cement content of 360 kg/cum shall be used for PQC.	Bidder would like to consider the minimum cement content shall be as per Concrete mix design as per IS 456 and IRC specifications	Bid Specification Prevails
239	Vol-III	Part-D		8.17.01	ii) R.C.C CHIMNEY Reference shall be made to IS: 4998 Part I (1992)....	The bidder understands that IS 4998 (Latest) is updated to limit state method. Therefore, chimney shell shall be designed as per IS 4998 : 2015. Kindly confirm.	Noted
240	Vol-III	Part-D		7.11.02	The height of Chimney/ stack height shall be 140m.	There is a ambiguity in the clauses. The bidder request owner to confirm Minimum Height to be provided for the Twin Flue RCC chimney.	The top of Chimney for Flue can projection over the roof slab including the lightening arrester top shall be 140m only.
241	Vol-II	Section-1		3.11.02	Chimney of adequate height(150m) along with ESP,FGD & SCR is considered....		
242	Vol-III	Part-A / Section - 4		4.01.07	Bidder shall consider the stack height is 140m.		
243	Vol-III	Part-A / Section - 4		4.01.12	For Borosilicate lining, the top flue liner above the roof slab shall be made of C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 8 mm thickness with Borosilicate Glass Block Lining of minimum 38 mm thickness.	For Borosilicate lining, bidder proposes to provide 8mm thick (minimum) mild steel flue with Borosilicate Glass Block Lining for the top flue liner above the roof slab . This is proposed to avoid creation of welding joint between two different materials. It is not feasible to weld MS liner with solid titanium due to non-availability of suitable electrode for welding. Kindly confirm.	For flue can projecting above the roof slab, provide 8 mm thick (minimum) mild steel flue internally lined with borosilicate minimum 38mm thick and external surface wrapped with 2 mm thick Titanium/C276 sheet.

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244	Vol-III	Part-A / Section - 4		4.01.14	For Borosilicate lining, top portion of the flue can shall be fitted with stop bar of 8 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining	The bidder would like to propose 2 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining.	For Borosilicate lining, top portion of the flue can shall be fitted with stop bar of 3 mm thick capping of Titanium / C-276 sheet to avoid any damage in between flue can and borosilicate lining. The minimum length of the capping inside the chimney shall be 150mm and the thickness shall be 2mm of Titanium / C-276 sheet.
245	Vol-III	Part-A / Section - 4		4.01.19	However, minimum inside diameter of flue liner shall not be less than 8000 mm.	Bidder request owner allow to consider minimum inside diameter as per process requirement.	Bid Specification Prevails
246	Vol-III	Part-A / Section - 4		4.02.03	Internal and external platforms shall be provided not more than 45 m intervals and shall satisfy the requirements of high intensity aviation obstruction lights as per IS 4998 / I.C.A.O. regulations, aviation lights are provided at three levels at 1 / 3, 2 / 3 and at top of Wind Shield.	External platforms are obsolete these days. Moreover, DARA circulars are superseded by DGCA/ICAO guidelines. Also, external platforms have schedule and safety concerns. Therefore, bidder request Owner to remove this clause.	Noted.
247	Vol-III	Part-A / Section - 4		4.02.13	Bidder shall consider not more than 45° as maximum angle subtended by single opening at the centre of the shell as per clause 7.0 of IS 4998:2015.	There is a ambiguity in the clauses. Bidder request Owner to consider opening requirements as per clause 7 of IS 4998 : 2015(AMENDMENT NO. 1 ,JULY 2022) as following:	The single opening at the centre of the shell shall be as per clause 7.0 of IS 4998: 2015 and latest amendment.
248	Vol-III	Part-A / Section - 4		4.02.13	The maximum width of opening shall be limited to an angle of not more than 30 degree subtended at center of concrete shell.	The one-half opening angle of any opening shall not exceed 30° (Total = 2* 30 = 60 degrees). Therefore bidder would like to consider 60 degrees opening angle in place of 45 degrees. Please confirm. .	
249	Vol-III	Part-A / Section - 4		4.02.17	Concrete reinforcing steel Fe 550	Bidder would like to consider Fe500 for concrete reinforcing steel in line with ongoing FGD projects by NTPC/DVC.	Noted.
250	Vol-III	Part-A / Section - 4		4.02.17	Minimum factor of safety against - 1.5 using unfactored loads	The bidder understands that chimney shell shall be design as per IS 4998 : 2015 (Design of Reinforced Concrete Chimneys - Criteria, 3rd revision) with Limit State method of design. Similarly, loads and load combinations shall be taken as Table 1 of IS 4998 : 2015. <u>Please confirm.</u>	Noted
251	Vol-III	Part-A / Section - 4		4.02.18	The design shall be in accordance with IS 4998 for the following design conditions:	The bidder understands that wind shield shall be designed as per IS 4998 : 2015 using limit state method of design. Kindly confirm.	Noted
252	Vol-III	Part-A / Section - 4		4.02.18	Design basis concrete 28 day compressive strength for shell and other superstructure - f c ' = 35 Mpa	Bidder would like to propose Fc' = 30 Mpa for the Shell & other superstructure in line with ongoing FGD projects by NTPC/DVC	Minimum grade of concrete for RCC shell shall be M30.
253	Vol-III	Part-A / Section - 4		4.05.06	The top flue liner above the roof slab shall be made of solid C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 10 mm thickness	There is a ambiguity in the clauses. For Borosilicate lining, bidder proposes to provide 8mm thick (minimum) mild steel flue with Borosilicate Glass Block Lining for the top flue liner above the roof slab. This is proposed to avoid creation of welding joint between two different materials. It is not feasible to weld MS liner with solid titanium due to non-availability of suitable electrode for welding. Kindly confirm.	Clause no. 4.01.12 - For Borosilicate lining, flue can projecting above the roof slab, provide 8 mm thick (minimum) mild steel flue internally lined with borosilicate minimum 38mm thick and external surface wrapped with 2 mm thick Titanium/C276 sheet.
254	Vol-III	Part-A / Section - 4		4.01.12	For Titanium/C-276 lining, the top flue liner above the roof slab shall be made of solid C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 10 mm thickness. For Borosilicate lining, the top flue liner above the roof slab shall be made of C276 (ASTM B575, UNS N10276) / Titanium (Grade 2 as per ASME SB265) of minimum 8 mm thickness with Borosilicate Glass Block Lining of minimum 38 mm thickness.		

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255	Vol-III	Part-A / Section - 4		4.05.10	The hood shall slope toward the outside of the concrete shell. The hood shall be fabricated from Alloy C276 or C2000 material in sections arranged for attachment to the liner.	The bidder would like to propose 2 mm thick Titanium hood in line with ongoing FGD projects by NTPC/DVC	Noted
256	Vol-III	Part-A / Section - 4		4.05.15	The drain line shall be of 150 mm diameter solid Alloy C276 or C2000 material.	Bidder request Owner to allow use of Alloy C276 or SS316L material as Material for condensate collection drains / pipes for flue can/ outlet ducts.	Bid Specification Prevails
257	Vol-III	Part-A / Section - 4		4.06.05	The lining system shall, through documented testing, have been proven resistant to thermal shock, for a minimum of 1000 cycles, where each cycle results in the lining surface temperature to rise from ambient temperature to 180 °C, and back to ambient temperature.	Bidder request Owner to specify the ASTM Test Standard, which shall be followed to perform this study.	Five days cyclic test as per Manufacturer's recommendation shall be carried out.
258	Vol-III	Part-A / Section - 4		3.22.10	Ductwork for wet dry interface from ½ meter before quenching spray up to absorber	The extent to wet-dry interface shall be as per the recommendations from QFGDM. This extent has been similar to installation at NTPC projects. Kindly confirm.	Bid Specification Prevails
259	Vol-III	Part - D		7.24.04	Limestone Grinding System building/Ball Mill building: This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or brickwork/concrete block work with plastering on both sides.	Bidder request to MSPGCL/STEAG to allow Bidder to have a flexibility to consider framing structure i.e. RCC or Structural steel based on construction schedule / layout etc. However, the floor and roof slabs shall be RCC.Kindly confirm.	Bid Specification Prevails
260	Vol-III	Part - D		7.24.09	Gypsum Dewatering Building: This shall be steel framed building with R. C. C. roof and floor. For steel building roof /floors shall comprise of RCC slab over profiled metal deck sheets (to be used as permanent shuttering only over structural beams). Cladding shall be of single skin metal sheeting or brickwork/concrete block work with plastering on both sides.	Bidder request to MSPGCL/STEAG to allow Bidder to have a flexibility to consider framing structure i.e. RCC or Structural steel based on construction schedule / layout etc. However, the floor and roof slabs shall be RCC. Kindly confirm.	Bid Specification Prevails
261	Vol-III	Part - D		7.10.00	ESP Control Room	Bidder has considered a combined building for ESP and FGD control room building (unit wise). Owner is requested to confirm	Noted
262	Vol-II	Section-2		2.13.13	XXII) L - ESP & FGD Control / Switchgear Rooms		
263	Vol-III	Part - D		1.16.01	A preliminary Geo-technical Investigation has been carried out by the Owner and report of the same is attached in Annexure – 5, Volume-V.	Bidder requests to provide ground level in borelogs provided in geotechnical investigation report.	Bidder can check the tentative level of ground level from the topography survey report . Bidder shall visit the site and collect the necessary data.
264	Vol-III	Part - D		1.17.01	Owner has carried out the topography survey work and the drawing is attached in Annexure– 6, Volume-V.	As can be seen in Google earth, a conveyor is crossing from the CHP area. The same has not been marked in the surveyed drawing. Bidder requests to provide the details of same in survey drawing to check the interface with proposed CHP structures.	Bidder shall visit the site and collect the necessary data.
265	Vol-III	Part - D		1.17.02	The proposed plant will be established mainly at the land retrieved by demolishing the existing structures of retired units of 4X120MW units. The power block/main plant area of the proposed plant has to be constructed after demolishing the auxiliary structures like cooling towers.	Bidder requests to provide the foundation drawings of the retired units of 4x210 MW units, which are already demolished and / or which needs to be demolished.	Bidder shall visit the site and collect the necessary data.

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266	Vol-III	Part - D		4.02.02 ii)	Following field tests shall be conducted: a) Bore holes b) Static Plate load tests c) Cyclic Plate load test d) Field Permeability tests e) Field Density tests f) Vane Shear tests g) Static Cone Penetration tests h) Electric resistivity tests. i) Pressure meter test i) Block vibration test	Following field tests shall be conducted: a) Bore holes b) Cyclic Plate load test c) Field Permeability tests d) Field Density tests e) Static Cone Penetration tests f) Electric resistivity tests. g) Block vibration test	Bid Specification Prevails
267	Vol-III	Part - D		4.02.02 iii)	Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 60.0 m or 5 m continuous into hard rock whichever is earlier.	Bore holes shall be located to cover the entire area. Bore holes for major structures shall be sunk up to a depth of 40.0 m or 5 m continuous into rock with Core Recovery more than 20 %, whichever is earlier and for other structures the bore holes shall be sunk up to a depth of 30.0 m or 5 m continuous into rock with Core Recovery more than 20%, whichever is earlier.	Noted.
268	Vol-III	Part - D		4.02.02 vii) k)	k) Triaxial Compressive Strength Tests: 1) Unconsolidated Undrained Test 2) Consolidated Undrained Test 3) Consolidated Drained Test	k) Triaxial Compressive Strength Tests: 1) Unconsolidated Undrained Test	Bid Specification Prevails
269	Vol-III	Part - D		9.07.01 vi)	Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under: Vertical Lateral Uplift } Minimum of 3 Nos. in each mode or as per provision of IS:2911.	Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under: Vertical Lateral Uplift } Minimum of 2 Nos. in each mode as per provision of IS:2911 This is because, 2 nos. of tests are sufficient for one type of pile (i.e. dia, length and capacity) as per IS:2911, if the number of piles of specific type are less than 1000. The same has been considered for ongoing projects with NTPC. Kindly confirm.	Bid Specification Prevails
270	Vol-III	Part - D		9.07.01 ix) & x)	ix) Vertical- 1.0 % of the total number of piles provided. x) Lateral -1.0 % of the total number of piles provided.	ix) Vertical- 0.5 % of the total number of piles provided. x) Lateral -0.5 % of the total number of piles provided. Bidder would like to consider above mentioned frequency for routine load test as per IS:2911. Kindly confirm.	Bid Specification Prevails
271	Vol-III	Part - D		7.24.01	The civil works for FGD system shall comprise of civil, structural and architectural works below and above ground level of Ball mill building, Ball mill foundations, FGD control room building, slurry re-circulating pumps & oxidation blowers building, tank foundations, absorber tower foundation, MCC building, gypsum dewatering building, transformer foundation, equipment foundations, storage shed for Gypsum, lime storage silo, Truck tippler with shed	Building description for gypsum storage shed is not mentioned, Bidder requests to consider the following building configuration of gypsum storage shed. RCC framed structure with RCC/brick masonry wall (up to Tripper floor) and structural steel shed with permanently colour coated profiled steel sheet roof and side cladding (above Tripper floor). Roof shall be provided with troughed profile permanently colour coated sheet with slope. Kindly confirm.	Noted
272	VOLUME - III	PART D	10	3.02.09	Design calculations and drawings for foundations/ substructure and superstructure of all buildings including pump houses and other structures.	As per Bidder practice, Mill Building is an integral part of Boiler Structure. Boiler Structure along with Back End Duct supporting structure comes under Technological category & Proprietary in nature. Hence Design calculations & Drawings will not be part of submission.	Noted. However, if the Mill building is not integral part of Boiler structure, all the design calculations and drawing shall be submitted for approval.'

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273	VOLUME - III	PART D	11	3.02.22	Shop drawings / fabrications of all structural steel works (only for reference) and design calculations for important joint connections.	As per Bidder practice, Mill Building is an integral part of Boiler Structure. Boiler Structure along with Back End Duct supporting structure comes under Technological category & Proprietary in nature. Hence Shop drawings / fabrications of all structural steel works and design calculations for important joint connections will not be part of submission.	Noted. However, if the Mill building is not integral part of Boiler structure, all the drawings shall be submitted.'
274	VOLUME - III	PART D	11	3.02.27	Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.	As per Bidder practice, Mill Building is an integral part of Boiler Structure. Boiler Structure along with Back End Duct supporting structure comes under Technological category & Proprietary in nature. Soft copies of all design calculation and drawings will not be submitted.	Noted. However, if the Mill building is not integral part of Boiler structure, all the design calculations and drawing shall be submitted for approval.'
275	VOLUME - III	PART D	11	3.02.29	Wherever possible mechanical bolts shall be cast in situ with sleeve for future minor rectification instead of providing pockets this will avoid cutting of main reinforcement for provision of pockets.	As per Bidder practice, For Boiler Structure, Anchor Bolts are cast in situ along with Anchor Frames. Sleeve pipes will not be provided for Anchor Bolts. Seeking deviation for this clause.	Noted.
276	VOLUME - III	PART D	25	7.07.02	Complete hopper (sloped portions) shall be provided with lining of at least 5mm thick SS 304M grade material.	As per Bidder practice & Ongoing Projects / Proposals, For Coal Silo Hopper, Lining material of 4mm thick SS 304 plate will be provide. Seeking deviation for this clause.	Fuel storage bunkers with supporting structure complete with emptying chute, poking holes. SS lining of 3mm thick SS 304 plate shall be provided in bottom conical portion plus 3m in cylindrical portion as per specification of Volume-III, Part-A, Section-1, Clause no. 2.29.02.
277	VOLUME - III	PART D	72	11.18.02	ii) Coal Storage Bunkers shall be provided with 3.15 mm thick stainless steel lining conforming to ASI 409M, IS1570.	As per Bidder practice & Ongoing Projects / Proposals, For Coal Silo Hopper, Lining material of 4mm thick SS 304 plate will be provide. Seeking deviation for this clause.	Fuel storage bunkers with supporting structure complete with emptying chute, poking holes. SS lining of 3mm thick SS 304 plate shall be provided in bottom conical portion plus 3m in cylindrical portion as per specification of Volume-III, Part-A, Section-1, Clause no. 2.29.02.
278	VOLUME - III	PART D	144	18.04.09	i) The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness.	As per Bidder practice & Ongoing Projects / Proposals, For Coal Silo Hopper, Lining material of 4mm thick SS 304 plate will be provide. Seeking deviation for this clause.	Fuel storage bunkers with supporting structure complete with emptying chute, poking holes. SS lining of 3mm thick SS 304 plate shall be provided in bottom conical portion plus 3m in cylindrical portion as per specification of Volume-III, Part-A, Section-1, Clause no. 2.29.02.
279	VOLUME - III	PART D	144	18.04.09	ii) Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways.	As per Bidder practice, plug welding shall be done by drilling 20mm dia holes. Seeking deviation for this clause.	Noted
280	VOLUME - III	PART D	26	7.08.02	Elevator shaft shall be constructed with colour coated insulated metal cladding system supported on structural steel work.	As per Bidder practice & as per clause 7.06.02 of Volume III Part D Page 25, Cladding for Elevator Shaft (Elevator Enclosure) shall be by single skin troughed profile permanently colour coated sheet. Seeking deviation for this clause.	Bid Specification Prevails
281	VOLUME - III	PART D	45	8.03.00	Imposed Loads: 3. Mill Building: b) Feeder Floor - 25 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)	As per Bidder practice & Ongoing Projects / Proposals, Imposed load for Mill Building Feeder floor shall be 5kN/Sq.m (including Dust Load) + Actual equipment loads. Seeking deviation for this clause.	3 Mill Building (b) Feeder Floor - 15 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)

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282	VOLUME - III	PART D	45	8.03.00	Imposed Loads: 3. Mill Building: c) Tripper Floor - 15 kN/Sq.m + hung loads + 0.5 kN/sq.m (dust load)	As per Bidder practice & Ongoing Projects / Proposals, Imposed load for Mill Building Tripper Floor shall be 5kN/Sq.m (including Dust Load) + Actual equipment loads. Seeking deviation for this clause.	Bid Specification Prevails
283	VOLUME - III	PART D	73	11.19.01	Handrails and Gratings and Other Requirements: In such a case spacing shall be constructed with kick plates at bottom. It shall consist of 100 mm wide 8mm thick steel plate.	As per Bidder practice & Ongoing Projects / Proposals, Toe guard (Kick Plate) thickness shall be 6mm. Seeking deviation for this clause.	Noted
284	VOLUME - III	PART D	73	11.19.02	Steel grating shall be Black Bitumen Painted to match with specifications. Pressure locked grating.	As per Bidder practice, as per clause 7.07.15 of Volume III Part D Page 26 and as per clause 13.05.01 of Volume III Part D Page 90, Grating shall be galvanised. Also Grating shall be of 32mm thick Electroforged type. Seeking deviation for this clause.	Noted.
285	VOLUME - III	PART D	87	13.01.03	Minimum thickness of metal for any structural steel elements shall be not less than 6 mm where steel is fully accessible for cleaning and repainting and where it is feasible to follow design criteria given in ISO: 12944 part 3.	Minimum thickness of structural steel shall be 4.5mm for the web of ISMB & ISMC sections. Seeking deviation for this clause.	Bid Specification Prevails
286	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.05.02	PA/ FD/ ID Fan and Mill foundations shall be RCC block foundation directly resting on virgin soil/ pile below Ground level.	Bidder observed difference in requirement of foundation type for ID fan Bidder propose block type RCC foundation for ID fans considering existing practice in similar capacity executed project. Please confirm.	Bid Specification Prevails; it is self explanatory
287	VOLUME-III, TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART-D		11.05.01 STEEL STAIRS	All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and inclination with horizontal shall not be more than 35 deg. However, in case of space restriction, minimum clear width up to 750 mm and slope up to 450 may be provided	Bidder understand that staircase angle shall be provided between 35 deg. to 45 deg. and clear width shall be between 750mm to 1000mm. Please confirm.	All steel staircases except SG & Aux. shall normally have minimum clear width (back to back of stringer) of 1000 mm and inclination with horizontal shall not be more than 35 deg. However, in case of space restriction, minimum clear width up to 750 mm and slope up to 45 degrees may be provided
288	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		6.03.03	Drains shall be designed during detailed engineering. Minimum clear width of the drain shall be 450mm.	Drain width shall be as per layout feasibility. However, minimum 300mm shall be considered. Please confirm.	Bid Specification Prevails
289	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.01.02	Mill Bay 12.5 X 44	Mill bay dimension will be considered as per bidder's bunker design. However, bidder understand that the provided dimensions are minimum for the complete mill bay (WxL) which is considering CHP tripper conveyor (Not in bidder scope). Please confirm.	Bidder note that the provided dimension is minimum. Tender conditions prevail. However, it can be discussed DDE, if there is any space constraint

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290	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.07.03	Mills are to be located on the ground floor. Mill foundations are to be designed with conventional block/frame type RCC foundation. In addition to Mill foundations provision has to be made in the Mill bay ground floor for trenches accommodating Mill reject system conveyors.	Bidder understand that trenches to be considered for chain conveyor only if required . However, bucket elevator will be located inside the pit as per OEM design. Please confirm.	Noted.
291	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.07.05	A steel stair case shall be provided for access to feeder floor from ground floor.	Bidder propose to consider approach to feeder floor through interconnection platform from boiler . Hence, separate staircase is not considered as per the practice in similar capacity project. Please confirm.	Bid Specification Prevails
292	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.07.10	In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air cannons .	Air cannons are not considered as per OEM design , Please confirm.	Noted
293	VOLUME-III/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PART - D		7.08.02	Lift pit shall be of RCC construction. Ground floor entry shall be kept about 500 mm above general graded / paved level with a ramp for approach.	Ramp of 200mm from paving level will be sufficient for elevator entry for ease of material movement. Please confirm.	Bid Specification Prevails
294	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS			General	As per site visit, it is observed that CW channels are located in the existing pond (water body) area. Bidder understand that MAHAGENCO will be providing levelled ground upto FGL clear of vegetation, bushes, buildings,trees, structures, debris, sheds etc. for entire scope in this package. Please confirm.	Minimum disturbance of the water body should be done for construction of Channel. Channel through the water body should be constructed on Pillars. However, any area leveling/grading/clearing etc required, shall be bidder's scope.
295	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS			General	As per site visit, it is observed that debris, vegetation, bushes, trees, buildings, boundary wall, storage shed, piping, other misc buildings and RCC structures, tanks etc. are existing in BTG area. Bidder understand that MAHAGENCO will be providing levelled ground upto FGL clear of vegetation, bushes, buildings,trees, structures, debris, sheds etc. for entire scope in this package.Please confirm.	Bid Specification Prevails
296	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS			General	As per site visit, it is observed that mill reject stone heaves are present in the BTG area. Please confirm that the same will be removed by MAHAGENCO and levelled ground upto FGL shall be provided to bidder. Please confirm.	Mill reject materials which are lying in the proposed BTG area will be removed by owner.
297	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS			General	At some places water pounding is observed in the BTG area. Please confirm that the levelled ground upto FGL shall be provided to bidder for entire area in the scope of this package.	Bid Specification Prevails

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298	VOLUME - III	Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS			General	As per site visit, it is observed that some area of BTG is filled with water. Please confirm that the levelled ground upto FGL shall be provided to bidder for entire area in this scope.	Bid Specification Prevails
299					General	Please furnish the Highest Flood Level of the for the proposed plant.	Refer Vol-II, Section-2, Clause 3.01.00, "The high flood level of nearest Kolar river at a distance 2 km. from plant area, is 292.5 m above M.S.L."
300					General	Please mark the co-ordinate and Finished graded level for terminal points of roads, drains, sewage in plot plan.	Please refer plot plan.
301					General	In case of ambiguity between 'VOLUME - II/SECTION - 2/LEAD TECHNICAL SPECIFICATION' and 'VOLUME - III/Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS', please clarify which of the two will take precedence.	For scope of work, VOLUME - II/SECTION - 2/LEAD TECHNICAL SPECIFICATION will follow. All other technical specification VOLUME - III/Part-D/TECHNICAL SPECIFICATION CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS will follow.

VOLUME - VI

ADDENDUMS & AMENDMENTS

LIST OF ADDENDUMS & AMENDMENTS

PREPARED BY



(An ISO 9001:2015 certified Company)

STEAG Energy Services India Pvt. Ltd.
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A-29, Sector-16, NOIDA - 201301, India

JUNE, 2024


MAHARASHTRA STATE POWER GENERATION CO. LTD.

VOLUME - VI

**KORADI THERMAL POWER STATION
2X660 MW UNITS - 11 & 12 PROJECT**

Date:21.06.2024

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**ADDENDUMS &
AMENDMENTS**
LIST OF ADDENDUMS & AMENDMENTS

REV. - 0

5.00.00 LIST OF ADDENDUMS AND AMENDMENTS
5.01.00 List of Amendments

Sr. No.	VOLUME	PART	SECTION	CLAUSE	PAGE	EXISTING	AMENDMENT
1.	Volume-I					Commercial Specification	Refer Amendment - 1
2.	Volume-I		Section-1	Schedule-7	173	GUARANTEE DECLARATION	SCHEDULE-7 - Refer Amendment – 2
3.	Volume-I		Section-1	6.3	389	Liquidated Damages For failure to meet Performance Guarantees	LIQUIDATED DAMAGES (PG) – Refer Amendment – 3
4.	Volume III	Part B				Electrical Specification	Refer Amendment - 4
5.	Volume-II		Section-2	11.30.00 to 11.35.00	175 to 213	Performance Guarantees	PERFORMANCE GUARANTEES - Refer - Amendment – 5
6.	Volume-II		Section-1	3.05.03	4	PRIMARY FUEL (COAL)	FUEL ANALYSIS – Refer Amendment – 6
7.	Volume III	Part C				C&I Specification	Refer Amendment - 7

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Sr. No.	VOLUME	PART	SECTION	CLAUSE	PAGE	EXISTING	AMENDMENT
8	Volume III	Part-A	Section-4	3.06.00	4	FGD Design & Guarantee	Refer Amendment - 8
9	Volume-II & III		Section-1/2			Coal Mill, Ramp rate, Limestone analysis	Refer Amendment - 9

5.02.00 List of Addendums

Sr. No.	VOLUME	PART	SECTION	CLAUSE	PAGE	EXISTING	ADDENDUM
1.	Volume-III	Part-A	Section-1	7.00.00		-	BOTTOM ASH HOPPER – Refer Addendum - 1
2.	Volume-III	Part-A	Section-4	4.03.00	55	-	CHIMENY PAINTING – Refer Addendum - 2
3.	Volume-III	Part-A	Section-5	4.11.13	21	Pipe Protection	Option of PU COATING as Alternative to GLASS FLAKE COATING - Refer Addendum - 3
4.	Volume-III	Part-C		15.08.00	270	-	CCTV for SAFETY CONTROL ROOM - Refer Addendum – 4
5.	Volume-III	Part-C					CENTRAL CONTROL ROOM

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Sr. No.	VOLUME	PART	SECTION	CLAUSE	PAGE	EXISTING	ADDENDUM
							INTERIOR - Refer Addendum – 5
6.	Volume-III	Part-A					GAS CYLINDERS SPECIFICATION – Refer Addendum-6