HPGCL

HARYANA POWER GENERATION CORPORATION LIMITED

1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR, HARYANA

EPC PACKAGE TENDER SPECIFICATION

VOLUME - II

GENERAL & SCHEDULES

Job No	**D - 4041**	**Name / Sign**	**Date**	
Prepared By		**BHS/EVA/VNG/GR**	**24.12.2022**	
Checked By		**BHS/EVA**	**24.12.2022**	
Approved By		**BHS**	**04.01.2023**	
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SELF-RELIANCE IN ENGINEERING
DESEIN

DESEIN PRIVATE LIMITED
DESEIN HOUSE,
GREATER KAILASH – II.
NEW DELHI – 110 048

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PART A

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CONTENTS : GENERAL & SCHEDULES

PART - A

CHAPTER – 1

INTENT OF SPECIFICATION

1.0 Scope of the proposal

1.1 The scope of the proposal comprises of the design, engineering, manufacture, assembly, testing at manufacturer's works, packaging into properly sized units and shipping & marine insurance, custom clearance, port clearance & handling, satisfactory reconciliation with the custom authorities, inland transport, inland insurance from Ex-works/Ex-show room/Port of Entry up to completion of Final Taking Over, delivery to site, receipt, unloading, handling and storage at site, watch & ward, fabrication at site, erection, testing, supervision, pre-commissioning, and commissioning, performance & guarantee performance testing, putting into successful operation to the satisfaction of the Owner and Operation and Maintenance till Final Taking over of the 1 x 800 MW coal fired thermal power station consisting the following below listed system but not limited to the system and equipment and associated works as detailed in the accompanied Specification including supply of special tools & tackles, mandatory spares for three (3) years operation and maintenance & recommended spares for **"1X800 MW SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR"** Haryana, India on the basis of single point responsibility, completely covering the following activities and services in respect of Steam Generator, Steam Turbine Generator, SCR, FGD, all Balance of Plant (BOP) systems, all electrical systems including switchyard, complete control and instrumentation and complete Civil, structural and Architectural works specified including Railways Siding/Tracks) as covered under the specifications.

a) Basic Engineering of the plant including preparation of Plant Definition Manuals.

b) Detailed design of all the equipment and system(s) including civil, structural & architectural works included in bidder's scope..

c) Providing design basis reports, engineering drawings, equipment sizing & performance data, QAPs/FQPs, instruction manuals, As-Built drawings and other information.

d) Comply with statutory requirements and obtaining clearances from statutory authorities, wherever and whenever required.

e) Complete manufacturing and supply including shop testing / type testing of Supercritical Steam Generator and its Auxiliaries, Supercritical Steam Turbine, Generator & its Auxiliaries, SCR, Electrostatic Precipitator, HP/LP heaters & deaerator, Power cycle pumps, Condensate polishing unit, Chemical dozing system, Power cycle piping and valves including HP/LP bypass, FGD system, Coal Handling System including railway siding & railway tracks including track electrification, signaling etc., as per requirements of the Indian Railways, Ash Handling System, Raw Water System, Pre Treatment plant, service water system, potable water system, water storage and other auxiliaries systems, DM Water System, Cooling water & ACW system inclusive of Natural Draught Cooling Tower, Miscellaneous

Pumps etc., Chlorination Plant, Waste Water Treatment System, On line condenser cleaning system, Fire detection and protection system, Mill reject handling system, Ventilation and Air conditioning system, Compressed air system, Cranes & Hoists, Hydrogen generation plant along with nitrogen, carbon di-oxide and hydrogen storage, handling and distribution system, ammonia handling system, limestone handling and storage system, gypsum handling and storage system, cranes and hoists, Elevators, Clarified water System, Hot-well make Up System, Sewage Treatment Plant, Chemical lab equipment, Electronic weigh bridges, LDO system, LP Piping and other auxiliaries piping, Instrumentation and Control systems, Power Transformers viz. Generator Transformer, Station Transformers, interconnecting transformers and Unit Auxiliary Transformers, Generator Bus duct & other bus ducts as required, Protection system for generator, and generator synchronizing scheme, 11kV & 6.6 kV unit and station switchgears, 11kV and 6.6 kV segregated bus ducts, 415 Power supply system unit/station service transformers switchgears, PCCs, MCCs, ACDBS, Non segregated bus ducts, Lighting for the entire plant, Grounding resistors, Earthing and lightning protection, General metering for Station Auxiliaries, Medium & low Voltage Switch gears, MCC, Station service switchgear etc., Other electrical items like Motors, Actuators, DC Starter panel, Local Panels, Control panels, Electrical lab, testing equipment and other electrical auxiliaries including but not limited to HV cables, LV cables, control cables, battery and battery chargers, Emergency Diesel Generator, Instrumentation and Control systems for the system supplied under this scope, 400 kV Switch Yard equipment and auxiliaries and it's interconnection with existing switchyard, communication system, energy management system etc.

f) Complete Civil, structural and architectural works include topological survey, detailed geotechnical investigation, site leveling, construction power and construction water for plant area, labour colony, water supply, and sanitation, infrastructure works including roads & drainage for plant, sewage treatment plant, raw water reservoir modification, (or Optional New Raw Water Reservoir with applicable modifications in existing intake channel as described in Chapter 24 of Volume VI), main plant area structure and foundation including turbine building, bunker building, boiler structure, ESP structure, FGD tanks and buildings, service building, compressor house and air washer building, ammonia unloading, storage and forwarding system, coal handling plant and Ash handling plant, chimney, pipe/cable galleries and pipe/cable trenches, duct banks, pedestals, CW system structures and foundations including pump houses, CW ducts and natural draught cooling tower, make up water system, balance of plant buildings including PT,DM and ETP building and structures, offsite structures and buildings, transformer yard structures, switchyard building and structures, fuel oil handling system, fire protection system structures and foundations, railway siding and railway tracks, bridges and culverts for crossing of railways track inside plant area, landscaping and other miscellaneous buildings and structures.

g) Packing and transportation from the manufacturers' works to the site including logistic studies, customs clearance & port clearances, port Charges, local clearances if any.

h) Receipt, storage, preservation, handling and conservation of equipment at site.

i) Fabrication, preassembly, erection testing commissioning and completion of facilities including putting into satisfactory operation all the equipment including successful completion of initial operation.

j) Performance and guarantee tests after successful completion of initial operation.

k) Furnishing of spares on FOR site basis.

l) Reconciliation with customs authorities, as and when required.

m) Comprehensive insurance and other requirements of complete EPC package.

n) Satisfactory conclusion of the contract.

Land for labour colony, laydown area for storage of equipment, fabrication yard or any other construction related activities is not available within the plant boundary. Bidder has to make his own arrangement to have these facilities outside plant boundary.

Disposal and cleaning of all construction debris inside the plant boundary and facilities of bidder outside plant boundary are included in bidder's scope.

1.2 The requirements, conditions, appendices etc. given in Technical Specifications (Volume II to VII) shall apply to and shall be considered as a part of this document as completely as if bound herewith. The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices, etc., stated in GCC, which shall be considered as a part of the Technical Specification as completely as if bound herewith. The bidder shall be responsible for providing all material, equipment and service, which are required to fulfill the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. It is not the intent to specify herein all aspects of design and construction; nevertheless, the equipment and civil works shall conform in all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable to Indian/ International standards mentioned elsewhere in this specification.

1.3 Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Such clarifications shall be sought within the time period as stipulated in section ITB. Bidder's offer shall not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels

that, in his opinion, certain features brought out in his offer are superior to what has been specified, these may be highlighted separately.

1.4 Bidder may also make alternate offers provided such offers are superior, in his opinion, to the requirements of these specifications in which case adequate technical information, operating feedback, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumption, etc. shall be clearly brought out. In any case, the base offer shall necessarily be in line with the specifications. Under no circumstances the equipment/systems as specified herein shall be brought out as an alternative offer i.e. the system/equipment specified shall be made as a base offer. In case the above requirements are not complied with, the offers may be considered as incomplete and would become liable for rejection.

1.5 This enquiry concerns one (1) power generating unit having a rated output of 800 MW, including but not limited to:

- **Steam Generator and Auxiliaries including**,

  - Complete pressure parts, structures, platforms, stairs, piping, valves, supports etc.
  - Soot blowing system with piping, valves, controls etc.
  - Coal feeder and complete milling system (high performance coal mills) including mill reject system
  - Coal combustion system including coal (second generation low NOx)/oil burners & scanners.
  - SCR system along with ammonia unloading, storage & handling system, cyclone separators etc.,
  - Air and flue gas ductwork.
  - Primary air fans.
  - Forced draft fans.
  - Induced draft fans.
  - Aux PRDS and piping
  - Start up & circulation system
  - Air heaters & SCAPH
  - Chemical dosing systems as applicable.
  - Electrostatic Precipitators.
  - Fuel oil pressurizing system
  - Elevators for Steam generators
  - Other systems like tools & tackles etc., as specified
  - Wet limestone based FGD system
  - Limestone handling system
  - Gypsum handling system

- **Turbo Generator and Auxiliaries including,**

  - Steam turbine.
  - Condensing plant.
  - Complete Regenerative Feed system.
  - HP-LP Bypass system.
  - Low Pressure Chemical Dosing system.
  - Condensate Extraction Pumps.
  - Boiler Feed Pumps

- Condensate transfer pumps
- Turbine hall E.O.T. crane.
- Condenser On-load Tube Cleaning System
- Equipment cooling water system
- Boiler fill system

➢ **Power cycle piping**

➢ **Low pressure piping with Valves & Specialities**

➢ **Raw Water System**

- Raw water intake pumps (supply and erection)

- Raw Water pump house at reservoir

- Existing Raw Water Reservoir modification or Optional New Raw Water Reservoir with applicable modifications in existing intake channel.

➢ **Water Treatment Plant including,**

- DM plant
- CW chemical treatment.
- Pre treatment plant including filtration system
- Condensate polishing unit including regeneration facility
- Laboratory equipment
- Chlorination Plant
- Service water system
- Potable water system
- Reverse Osmosis plant for waste water system

➢ **Effluent Treatment Plant**

➢ **Sewage Treatment Plant**

➢ **Equipment cooling water system**

➢ **Cooling Water System including,**

- CW & ACW pumps with associated piping
- Natural Draught Cooling Tower
- DMCW System with PHEs

➢ **Plant Utilities including,**

- Compressed air system
- Air conditioning and ventilation system
- Fire detection and protection system

➢ **Material Handling System including,**

- Fuel Oil Handling System
- Coal Handling System,
- Mill Reject Handling system.
- Ash Handling system

- Ammonia & hydrogen handling systems
- Limestone & Gypsum handling systems

➢ **Elevators, Cranes and Hoisting equipment**

➢ **Electrical Equipment including,**

- Main generator and associated equipment.
- All Transformers.
- Bus ducts.
- 400 KV switchyard
- ICT & interconnection to existing switchyard
- Medium and low-voltage switchgear, motor control centres.
- Motors & Cables etc.
- Illumination, Earthing, Lightning protection, DG sets, Batteries, Battery chargers
- Overhead lines etc.
- Electrical systems as required.
- Solar PV plant

➢ **Control and Instrumentation system along with accessories & cables, surveillance system and complete Simulator system**

➢ **Civil, Structural and Architectural Works for the complete plant**

➢ **Solar PV plant**

2.0 **Additional Requirements**

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

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

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

2.4 In line with Gazette Notification on Ash Utilization issued by MoEF and its amendment thereafter, bidder shall use ash and ash based products in works as specified in these specifications, drawings and as per instructions of the

Owner. He shall also use ash and ash based products in construction of his offices, stores, staff quarters and labour huts etc. He shall furnish a compliance report along with all details of use of ash and ash based products along with each bill.

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

3.0 TENDER DRAWINGS

3.1 The tender drawings are enclosed along with the specification as Volume-VII and shall supplement the requirements specified in these technical specifications. The scope of the equipment to be furnished under the Turnkey package shall be as identified in these drawings read in conjunction with text of the specification.

4.0 GENERAL REQUIREMENTS

4.1 Items though not specifically mentioned in the specification but needed to complete the equipment/systems to meet the intent of specification, shall also be deemed to be included unless otherwise specifically mentioned in exclusions.

4.2 In addition to the scope of supply and services indicated in other chapters of the scope of supply and services, the other general requirements are covered in this chapter as part of the scope of the bidder.

4.3 Paints

4.3.1 The bidder's scope of work includes supply of paints and painting of all equipment and structures as per stipulated requirements and the standard colour coding scheme.

4.4 Pre-commissioning and commissioning activities

4.4.1 The bidder's scope shall include all pre-commissioning and commissioning activities, materials and services as detailed in technical specifications including supply of all consumables (except coal and fuel oil for firing), temporary equipment and piping, instruments, labour/skilled manpower etc. The scope includes complete requirement of flushing oils including fresh oil refilling during the pre-commissioning and commissioning activities and subsequent initial operation.

4.5 First Fill of Consumable, Oils & Lubricants

4.5.1 All the first fill and one year's topping requirements or 10% of first fill quantity, whichever is more, at the time of final taking over of the unit which includes but not limited to consumables such as greases, oil, lubricants, servo fluids/

control fluids, gases and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning/initial operation and to establish completion of facilities shall be furnished by the bidder. Suitable standard lubricants as available in India are desired. Efforts shall be made to limit the variety of lubricants to minimum.

4.5.2 Additional quantity as per Clause 4.5.1 above shall be supplied in separate containers.

4.5.3 Hydrogen, nitrogen and carbon dioxide as applicable for the generator shall be supplied by the bidder till final taking over of the plant by the Owner.

4.6 **Guarantee Tests**

4.6.1 The guarantee tests for various equipment and systems shall be carried out as specified under chapter of Function Guarantees and Liquidated damages, this part of technical specification. All special equipment, tools and tackles, instruments, measuring devices required for the successful conductance of Guarantee Tests shall be provided by the bidder, free of cost. All costs associated with the tests shall be included in bid price.

4.7 **Spares**

4.7.1 The scope of supply of bidder includes supply of mandatory spares, start-up and commissioning spares, recommended spares, consumable spares and other spares as required for plant erection, testing, commissioning, startup, initial operation etc.

4.8 **Special Tools & Tackles and Test/Measuring Equipment**

4.8.1 One set of all special tools and tackles including testing, calibrating and measuring instruments required for erection, assembly, disassembly and maintenance and testing of all equipment/systems covered under the scope of the bidder shall be supplied by the bidder as per relevant clause indicated in Volume-II Chapter 5 and as specified elsewhere in Scope of Supply, Volume-II of Technical Specifications. The bidder shall not use these special tools, tackles and testing/measuring equipment for erection/commissioning purposes and shall be in an unused and new condition, when they are handed over to the Owner. A list of all such special tools and tackles shall be submitted along with the offer.

4.9 The scope of the bidder includes complete design and engineering, technical co-ordination (including participation and arranging technical co-ordination meetings, review meetings etc), finalization of drawings/documents, submission of engineering drawing/documents and processing of their approvals by the Owner as per requirement indicated in Technical Specification and other relevant clauses given elsewhere in the Technical Specifications.

Further, the scope shall also include submission, in proper shape and format, of all types of manuals, handbooks and documents in requisite numbers to the Owner at different phases of the project as per the requirement of Owner.

4.10 All the plant layouts shall be made in computerized 3D modeling system as detailed in the Volume II, Chapter-05 of the Bidding Document. Bidder shall provide the completed plant documentation including integrated 3-D model with equipment drawings, data sheets, P&IDs, BOQ, schematics, logic

diagrams, test reports and quality plan, etc. attached to the respective equipment/systems in the 3D model, along with the design review software (network ready) which shall include interference check, walk-through animation, simulation, visual effect, photo realism etc. loaded on a server with 2 work stations (latest configuration for server & workstation) with one A-3 size coloured laser printer and one A-0 size coloured plotter. The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter/printer. The requisite hardware and software shall be supplied and commissioned. All soft wares provided shall necessarily include the cost for perpetual licenses for use on all the machines and an Annual Maintenance Contract (AMC) which shall include software upgrades as & when released by the software agency for a period of three (3) years after warranty/guarantee period.

5.0 GENERAL ENVIRONMENTAL REQUIREMENTS

5.1 The bidder shall execute all work at site as per the general environmental requirement and following the applicable codal provisions and local regulations in this respect. The bidder shall provide and install suitable safeguards and facilities as approved by the Owner for meeting general environment requirements given herein under.

5.2 Protect from damage and disturbance of the existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipe lines, drains, sewers, or other surface or sub-surface systems /facilities within or adjacent to the works being carried out given herein below.

5.3 Take all necessary precautions against soil erosion, water and environmental pollution and safe disposal of waste material.

5.4 Control the ground in the vicinity of all excavations, so that the surface of the ground is properly sloped or dyked to prevent surface water from running into the excavated areas, during construction.

5.5 All materials obtained from excavation shall remain Owner's property. All salvaged materials of archaeological importance or of value (in the opinion of the Owner) shall be segregated from the other materials and stacked separately at locations as indicated by the Owner.

5.6 The method and arrangement of blast cleaning shall conform to factory act, local laws and stipulations of pollution control board, if any.

5.7 a) Excavated earth shall be stockpiled properly at designated areas so as not to spread and cause air pollution (fugitive dust emission) and water pollution (suspended solids in run-off).Top soil (top 150 mm layer of the fertile soil) may be stored separately for future use in landscaping/revegetation/horticulture.

b) Solid wastes generated during construction such as construction debris, excess cement/concrete, wrapping materials (e.g. plastic packets and wrappers), timber, tins, cans and drums, wire, nails, glass etc., chemical wastes and hazardous wastes, food and domestic wastes etc., shall be properly disposed off so as not to cause any air / water pollution.

c) Potential pollutants (such as oils, chemicals) shall be kept, stored, and used in such a manner that any escape can be contained and the surface and ground water resources are not contaminated.

d) Water containing pollutants such as cement, concrete, lime, chemicals and oils shall be discharged through a temporary sedimentation and equalization tank.

e) The necessary precautions shall be taken to control emission of fugitive dust and suspended solids in effluents leading to sedimentation of receiving water bodies.

f) Provide necessary sanitation facilities to the labour camps.

g) All vehicles and equipment shall be kept in good working order and serviced regularly to maintain the exhaust emissions and noise levels within reasonable limits.

h) Control the movement of all vehicles so as to minimize disruption to regular users of the routes.

i) The speed of the vehicles on gravel or earth roads in and around site may be restricted to minimize the emission of fugitive dust. Further, the road surface of gravel or earth roads may be provided with suitable cover to reduce the emission of fugitive dust.

CHAPTER – 2

PROJECT INFORMATION

1.0 BACKGROUND AND SALIENT FEATURES

Introduction

Haryana Power Generation Corporation Ltd (HPGCL) came into existence in August 1998 on unbundling of erstwhile Haryana State Electricity Board into four (4) entities under the reform program.

The State of Haryana is rich in agricultural resources besides a large number of medium and small-scale industries. The Government of Haryana has taken strategic initiatives for development of industrial, commercial and agricultural sector for overall growth in the state. HPGCL is the nodal agency which is responsible for generating power and for coordinating the capacity addition program under the private and public sector in Haryana. HPGCL has proposed a 800 MW coal based thermal power Unit as expansion of 2x300 MW DCRTPP plant at DCRTPP, Yamuna Nagar in the state sector.

Location

The proposed site for this expansion Unit is in the already acquired premises of existing 2x300 MW Units at DCRTPP, Yamuna Nagar.

Type of Plant

The proposed 800 MW Coal Fired Power Unit consists of coal fired steam generator connected to a reheat type steam turbine generator along with all the required auxiliaries.

The description and salient technical data of the Steam Generator, Steam Turbine Generator, Auxiliary systems, Electrical, Control & Instrumentation, Civil etc. are explained elsewhere in the specification:

2.0 PROJECT INFORMATION

1.1	Owner	**HARYANA POWER GENERATION CORPORATION LIMITED, PANCHKULA, HARYANA**	
1.2	Project Title	Deen Bandhu Chhotu Ram Thermal Power Plant (1X800 MW Expansion Unit), Yamuna Nagar	
1.3	Owner's Consultant	**DESEIN PRIVATE LIMITED, NEW DELHI**	
1.4	Project Site Location	Place	Kalanaur
		District	Yamuna Nagar
		State	Haryana
		Country	India
1.5	Latitude & Longitude of project site	North	30^0 06' 34" N
		East	77^0 19' 43" E
1.6	Nearest Railway Station	Kalanaur	2 km

1.7	Nearest Town	Yamuna Nagar	8 km
1.8	Nearest Highway	National Highway - 344	
1.9	Nearest Airport	Chandigarh	110 km
1.10	Nearest Water Body	Western Yamuna Canal, adjacent to site	
1.11	Land	Land is in possession of HPGCL.	
1.12	Station Graded Level Elevation from Mean sea level (MSL)	Land Contour varies from RL Plant FGL 270.00 M Plant FFL 270.50 M	
1.13	Water		
1.13.1	Nearest Water Source	Western Yamuna Canal system running adjacent for project site	
1.13.2	Water Requirement for station	~ 2300 M^3/hr considering closed cooling cycle with NDCT. Additional 750m^3/hr for ash slurry preparation during emergency ash disposal and line flushing	
1.13.3	Raw Water Analysis	Refer Appendix - I	
1.14	Site Ambient Condition	Refer enclosed Climatological Table	
1.14.7	Basic Wind Speed	As per IS 875 latest revision For wind resistance design of structure & equipment refer relevant civil section	
1.14.8	Climatic condition	Refer enclosed Climatological Table	
1.15	Seismic data	Zone – IV as per IS: 1893 latest revision For earthquake resistance design of structure & equipment refer relevant civil section	
1.16	Fuel Data		
1.16.1	Coal Source		
1.16.2	Coal Transportation	Thru BOBR / BOXN wagons of Indian Railways System	
1.16.3	Coal Analysis	Refer Appendix – II	
1.16.4	Support Fuel (LDO) transportation	Support fuel will be transported by road tankers. Start-up/support fuel for the proposed project will be LDO.	
1.16.5	Support Fuel (LDO) analysis	Refer Appendix – III	
1.16.6	Lime stone for FGD	Refer Appendix - IV	

2.0 Access to Site

The nearest town Yamuna Nagar is about 8 km from site. It is easily accessible by Railway/Road.

Dedicated railway link is available for the transportation of coal for the power plant. No problem is envisaged in accessibility and transportation of heavy equipment to site by road.

3.0 Plant Rating, Capacity, Availability, PLF

Plant continuous rating will be 800 MW at generator terminals based on the following site conditions.

- Ambient air temperature

- Condenser cooling water inlet temperature of 33°C and 9°C temperature rise across the condenser.
- Generator power factor of 0.85 (zero point eight-five).
- Fuel specification as given in Appendix II & III.
- Design temperature for electrical equipment is 50°C.

The VWO capacity of the steam turbine 800 MW will be 105% or 840 MW and the Boiler maximum Continuous Rating (MCR) will be established to match the steam requirement at VWO conditions. The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

4.0 Power Evacuation

The power generated from the proposed 800 MW unit will be evacuated over the 400 KV through a 400 KV gas insulated switchyard. Further to Switchyard, distribution will be by others. Interconnection of proposed 400 KV Switchyard with existing 220 kV switchyard shall be done as specified in Volume IV.

5.0 General Information

Land for labour colony, laydown area for storage of equipment, fabrication yard or any other construction related activities is not available within the plant boundary. Bidder has to make his own arrangement to have these facilities outside plant boundary.

Disposal and cleaning of all construction debris inside the plant boundary and facilities of bidder outside plant boundary are included in bidder's scope.

APPENDIX – I

RAW WATER ANALYSIS

(Source - Western Yamuna Canal)

S. No.	Description	Unit	Parameter
1	**Physical characteristics**		
	pH	-	8.45
	Turbidity	NTU	5.7
	Conductivity at 25^0C	μmhos /cm	300
	Total Dissolved solids	Mg/l	220
	Colour	Hazen	<5.0
2	**Cations**		
	Calcium Hardness	mg/l	105
	Magnesium Hardness	mg/l	40
	Sodium (as Na)	mg/l	20
	Potassium (as K)		7
	Iron (as Fe)	mg/l	2
	Total Cations	mg/l	174
3	**Anions**		
	M-alkalinity (as $CaCO_3$)	mg/l	128
	Chlorides (as Cl)	mg/l	15
	Sulphate (as SO_4)	mg/l	26
	Nitrate (as NO_3)	mg/l	6.8
	Total Anions	mg/l	175.8
4	Total Hardness	mg/l	145
5	P-alkalinity	mg/l	3.9
6	Dissolved Silica	mg/l	6.4
7	Colloidal Silica	mg/l	4.2
8	Organic Matter	mg/l	4.8

APPENDIX – II

COAL QUALITY PARAMETERS

S.No.	Particulars	Unit	Worst Fuel	Performance/ Design Fuel
1.0.	**Proximate Analysis (As Received Basis)**	**By Weight**		
1.1.	Moisture	%	12.46	12
1.2.	Ash	%	44.00	41
1.3.	Volatile Matter	%	20.92	21
1.4.	Fixed Carbon	%	22.62	24
1.5.	**Total**	%	**100**	**100**
1.6.	**Gross Calorific Value**	**kcal/kg**	**3198**	**3600**
2.0.	**Ultimate Analysis (As Received Basis)**			
2.1.	Moisture	%	12.46	12
2.2.	Ash	%	44.00	41
2.3.	Carbon	%	35.5	38
2.4.	Hydrogen	%	2.91	2.73
2.5.	Nitrogen	%	0.43	0.83
2.6.	Sulfur	%	0.46	0.55
2.7.	Oxygen	%	4.24	4.89
2.8.	**Total**	%	**100**	100
3.0.	**Hard Groove Index**		**62**	**55**
4.0.	**Ash Fusion Range**			
a)	Initial Deformation Temperature	^{0}C	1025	1100
b)	Hemispherical Temperature	^{0}C	1304	1300
c)	Fusion Temperature	^{0}C	1318	

ASH ANALYSIS

Sl.No.	Ash Constituent's	% By Weight (**)		
		Worst Fuel		
1.	Silica (as SiO_2)	51.2		
2.	Aluminium (as Al_2O_3)	24.6		
3.	Iron Oxide (as Fe_2O_3)	3.78		
4.	Calcium Oxide (as CaO)	2.4		
5.	Magnesium (as MgO)	1.2		
6.	Sodium Oxide (Na_2O)	0.72		
7.	Potassium Oxide (K_2O)	1.11		
8.	Titanium Dioxide (TiO_2)	0.36		
9.	Sulphur Trioxide (SO_3)	0.22		
10.	Phosphorus Pentaoxide (P_2O_5)	0.07		

APPENDIX – III

LIGHT DIESEL OIL (LDO)

[As per IS: 15770-2008]

S.No.	Property	Unit	Value
1.0	Ash content (max)	% by mass	0.02
2.0	Carbon residue (Rams Bottom) max	% by mass	0.2
3.0	Cetane number (Min)	-	-
4.0	Pour Point (max) a) Winter b) Summer	°C	 12 21
5.0	Flash Point (min) a) Abel b) Pensky0Martens	°C	 -- 68
6.0	Kinematic Viscosity at 38 deg	Cst	2.5 to 15.7
7.0	Sediments (max)	% by mass	0.1
8.0	Sulphur Content (max)	% by mass	1.8
9.0	Water Content (max)	% by volume	---
10.0	Gross Calorific Value (GCV), approx	kCal/kg	10,000
11.0	Density at 15°C	Kg/m^3	850 to 870

APPENDIX - IV

DESIGN LIMESTONE ANALYSIS (TYPICAL)

S. No.	Constituents	Unit	% By weight	
			Analysis # 1	Analysis # 2
1.	Silica as SiO2		7.5	4-6
2.	Iron as Fe2O3		8.0	1.5-2.2
3.	Aluminium as Al2O3		1.0	1.8-2.8
4.	CaCO3		70.0	85-89
5.	MgCO3		3.4	
6.	Acid Insoluble		7.0	Below 1%
7.	Others		2.42	-
8.	Inherent Moisture Content		Max 0.5	-
9.	Bond Work index	KWH/T	11.61	13

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : अम्बाला — STATION : Ambala — अक्षांश LAT. 30° 23' — देशांतर LONG. 76° 46' — समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 272 METRES — प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1981-2010

माह / MONTH		स्टेशन का सतह दाब / STATION LEVEL PRESSURE एच.पी.ए hPa	वायु तापमान / AIR TEMPERATURE — माध्य / MEAN — शुष्क बल्ब DRY BULB डि. से °C	नम बल्ब WET BULB डि. से °C	दैनिक अधिक ताम DAILY MAX डि. से °C	दैनिक न्यून तम DAILY MIN डि. से °C	माह में उच्चतम HIGHEST IN THE MONTH डि. से °C	माह में निम्नतम LOWEST IN THE MONTH डि. से °C	चरम / EXTREMES — उच्चतम HIGHEST डि. से °C	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST डि. से °C	दिनांक और वर्ष DATE AND YEAR	आर्द्रता / HUMIDITY — सापेक्ष आर्द्रता RELATIVE HUMIDITY प्रतिशत %	वाष्प दाब VAPOUR PRESSURE एच.पी.ए hPa	मेघ की मात्रा / CLOUD AMOUNTS — समस्त मेघ ALL CLOUDS आकाश के अष्टमाश Oktas of sky	निम्न मेघ LOW CLOUDS आकाश के अष्टमाश Oktas of sky	मासिक योग MONTHLY TOTAL मि.मि. mm	वर्षा के दिनोंकी संख्या NO. OF RAINY DAYS	वर्षा / RAINFALL — वर्षसहित सबसे नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR मि.मि. mm	वर्षसहित शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR मि.मि. mm	24 घंटोंकी सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS मि.मि. mm	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED कि.मी. प्र. घं. Kmph
जनवरी JAN	I	984.6	8.6	7.7	18.9	6.4	24.1	2.7	29.1	29	-1.3	24	87	9.9	4.1	2.6	27.3	1.9	152.7	0	118.4	16	3.4
	II	982.8	16.5	12.7						1991		2008	63	11.8	3.1	1.3			1953			1953	
फरवरी FEB	I	982.2	11.7	10.1	22.4	9.1	27.3	5	33.9	28	-0.6	1	81	11.2	3.1	1.3	35.1	2.2	233.9	0	146.8	11	4.7
	II	980.3	20.2	14.9						1956		1905	54	12.8	3	1.1			1898			1898	
मार्च MAR	I	979.6	17.5	14.4	27.8	13.8	33	8.9	41.7	31	3.7	9	70	14	2.8	0.9	27.2	1.8	176	0	103.9	13	5.1
	II	977.3	25.6	18						1945		1979	45	14.7	3.1	1.1			1982			1956	
अप्रैल APR	I	975.8	24.6	18.2	34.9	19.1	40.1	13.7	45	28	9.4	6	51	15.8	2.2	0.6	12.3	1.2	174.4	0	82	6	4.9
	II	973.1	33	20.4						1941		1967	28	14	2.5	0.9			1983			1935	
मई MAY	I	972.2	29.1	21.6	36.1	23.4	42.6	18	47.8	29	13.9	1	50	19.9	1.8	0.6	31.5	2.7	146.7	0	85.1	20	5
	II	968.9	36.3	23.2						1944		2004	31	18	2	0.9			2008			1913	
जून JUN	I	968.6	30.1	24.3	38.1	25.4	42.8	20.3	47.8	17	17.8	5	62	25.9	2.9	1.4	86.6	4.5	291.3	0	121.8	20	5
	II	965.1	36.1	25.4						1923		2000	42	23.9	2.6	1.4			1913			1973	
जुलाई JUL	I	968.3	28.7	26.1	34.4	25.5	38.9	21.8	46.7	10	19.4	5	81	31.8	5.1	2.8	264.7	9.1	715	7.2	206.7	16	4.2
	II	965.5	32.5	27.2						1903		1956	67	31.9	5	3.1			2010	1967		2001	
अगस्त AUG	I	970.4	28	26	33.3	25	36.3	22.2	43.9	7	3.7	11	84	32.1	5.1	2.8	239.2	9	649	1.7	246.2	3	3.4
	II	967.6	31.4	27.3						1918		2010	72	32.9	5.1	3.3			2004	1993		2004	
सितम्बर SEP	I	974.5	26.4	24.2	33.1	23	35.7	19.3	40.6	6	15.6	22	82	28.6	3	1.7	134.8	4.8	661	0	224.8	26	3.5
	II	971.6	30.9	25.6						1951		1972	64	28.6	3	1.9			1962			1945	
अक्तूबर OCT	I	980	21.2	18.5	31.7	17.1	34.6	12.4	39.4	6	8.3	30	76	19.5	0.8	0.3	15.1	0.8	306.5	0	141.6	5	2.6
	II	977.2	28.5	21.5						1941		1898	51	20.1	1	0.4			1955			1973	
नवम्बर NOV	I	983.6	14.5	12.7	27.1	11.1	30.5	6.6	35.6	14	1.8	29	81	13.5	1.2	0.3	4.5	0.6	136.4	0	135.1	26	2.3
	II	981.1	23	17.2						1947		1966	53	15	1.3	0.2			1951			1951	
दिसम्बर DEC	I	985.3	9.5	8.5	21.7	7.1	25.5	3.3	29.4	5	-0.6	27	86	10.4	3	1.6	19.7	1	111.2	0	72.5	10	2.5
	II	983.2	18.1	13.8						1944		1913	60	12.4	2.5	0.8			1997			1997	
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	977.1	20.8	17.7	30.1	17.2	43.5	2.1	47.8	29	-1.3	24	74	19.4	2.9	1.4	898.2	39.6	2047.7	297.6	246.2	3	3.9
	II	974.5	27.7	20.6					5	1944	1	2008	52	19.7	2.9	1.4			1896	1918	8	2004	
वर्षोंकी सं NUMBER OF YEARS	I																						
	II	28	28	28	29	29	29	29	107		107		28	28	28	28	30	30	106	106	108		29

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : अम्बाला
STAION : Ambala

माह / MONTH		मौसम परिघटना: वर्षण 0.3 मि.मि.या अधिक	मौसम परिघटना: ओले	मौसम परिघटना: गर्जन	मौसम परिघटना: कुहरा	मौसम परिघटना: धूल भरी आँधी	मौसम परिघटना: बर्फ गलन	पवन: पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.) 62 या अधिक	20-61	1-19	0	पवन: पवन की दिशा के दिनों की संख्या का प्रतिशत उ	उ.पू.	पू.	द.पू.	द	द.प.	प	उ.प.	शांत	मेघ: मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश 0	से-2	3-5	6-7	8	मेघ: निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश 0	से-2	3-5	6-7	8	कुहरा 8	दृश्यता: दृश्यता सहित दिनों की संख्या 1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
		WEATHER PHENOMENA						WIND														CLOUD										VISIBILITY				
		No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p. h.)				PERCENTAGE No. OF DAYS WIND FROM										No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS					No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS						No. OF DAYS WITH VISIBILITY				
MONTH		PPT 0.5 mm Or more	HAIL	THUNDER	FOG	DUST STORM	SQUALL	61 Or more	20-61	1-19	C	N	NE	E	SE	S	SW	W	NW	CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	UP TO 1 Km.	1-4 Kms.	4-10 Kms.	10-20 Kms.	OVER 20 Kms.
जनवरी JAN	I II	3.3	0.1	1.6	9.6	0.1	0	0 0	0 0	12 20	19 11	2 3	0 0	1 1	5 6	0 0	1 0	5 10	22 46	64 34	9 12	3 4	4 6	5 6	10 3	16 21	3 3	4 5	1 1	7 1	0 0	8.6 1.4	15.6 7.7	6.8 21.9	0 0.1	0 0
फरवरी FEB	I II	4	0.3	2.1	1.8	0	0	0 0	0 0	14 23	14 5	3 2	1 0	2 1	8 9	1 2	0 2	4 15	29 50	52 19	10 9	4 5	6 6	5 7	3 1	18 17	3 5	5 5	1 1	1 0	0 0	1.6 0.1	12.6 2.4	13.9 25.5	0 0.1	0 0
मार्च MAR	I II	4.4	0.2	3.9	0.2	0.1	0	0 0	0 0	18 26	13 5	7 2	1 1	2 1	10 8	1 3	0 2	5 15	33 53	41 15	11 8	5 7	7 7	6 7	2 2	22 17	3 7	5 6	1 1	0 0	0 0	0.3 0	6.3 1.3	24.3 29.6	0 0.1	0.1 0
अप्रैल APR	I II	3.1	0.2	3	0	0.6	0	0 0	0 0	18 25	12 5	7 6	1 1	4 2	14 7	1 2	1 2	3 8	28 55	41 17	14 10	5 7	6 7	4 5	1 1	25 18	2 7	3 4	0 1	0 0	0 0	0 0.1	3.4 1.9	26.4 27.8	0.2 0.3	0 0
मई MAY	I II	5	0.2	6.8	0.1	1	0	0 0	0 0	21 24	10 7	4 6	1 1	5 2	35 16	2 4	0 2	3 8	17 39	33 22	17 13	4 7	5 6	4 4	1 1	24 19	3 7	4 4	0 1	0 0	0 0	0.1 0.2	5 2.8	25.8 27.9	0.1 0.2	0 0
जून JUN	I II	6.9	0	6.4	0.1	1.1	0	0 0	0 0	21 24	9 6	6 4	1 1	7 3	33 17	4 4	1 3	4 13	13 36	31 19	13 12	3 6	5 6	6 5	3 1	17 15	4 7	7 7	2 1	0 0	0 0	0.1 0.3	5.8 3.8	24.1 25.8	0 0.1	0 0
जुलाई JUL	I II	13.2	0	9.4	0	0.3	0	0 0	0 0	19 21	12 10	2 4	1 2	5 4	38 21	2 4	2 2	3 11	5 19	42 33	3 2	3 3	6 10	13 14	6 2	8 3	4 7	15 18	4 3	0 0	0 0	0.1 0.1	4.3 1.9	26.5 28.8	0.1 0.3	0 0
अगस्त AUG	I II	13	0	8.6	0.1	0	0	0 0	0 0	15 19	16 12	2 4	1 1	3 3	27 14	1 3	1 2	6 12	8 20	51 41	3 1	3 3	7 10	12 15	6 2	7 2	6 6	14 21	4 2	0 0	0 0	0.1 0	3 0.6	27.8 30.2	0.1 0.3	0 0
सितम्बर SEP	I II	7.1	0	4.9	0.4	0.1	0	0 0	0 0	14 21	16 9	5 3	1 1	3 1	17 7	1 1	1 2	3 16	15 40	54 29	11 8	4 7	6 8	6 6	3 1	17 10	4 9	7 10	2 1	0 0	0 0	0.1 0	4 0.9	25.7 29	0.2 0.2	0 0
अक्तूबर OCT	I II	1.8	0	1.3	0.4	0.1	0	0 0	0 0	9 12	22 19	3 2	1 0	2 1	11 3	1 0	0 1	1 2	10 31	71 60	25 22	2 4	2 3	1 2	1 0	29 26	1 3	1 2	0 0	0 0	0 0	0.3 0	11.4 4	19.3 27	0 0	0 0
नवम्बर NOV	I II	0.9	0	0.8	0.9	0	0	0 0	0 0	6 9	24 21	1 0	0 0	1 0	4 1	1 0	0 0	1 1	12 26	80 72	20 20	3 4	4 4	2 2	1 0	28 27	1 2	1 1	0 0	0 0	0 0	0.9 0	17.4 4.3	11.7 25.7	0 0	0 0
दिसम्बर DEC	I II	2	0.2	1.2	6.7	0	0	0 0	0 0	7 13	24 18	2 1	1 0	0 0	4 2	0 0	0 0	2 4	16 34	75 59	14 13	3 5	5 6	4 5	5 2	22 22	2 3	3 4	0 1	4 1	0 0	5.9 0.8	19.4 7.4	5.7 22.9	0 0	0 0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I II	64.7	1.2	50.1	20.3	3.2	0	0 0	0 1	170 238	195 126	4 3	1 1	3 2	17 9	1 2	1 2	3 10	17 36	53 35	155 129	43 64	64 81	64 75	39 16	233 199	38 66	67 87	16 11	13 2	0 0	17.9 2.8	108.4 38.9	239.9 321.8	0.8 1.5	0.1 0
वर्षोंकी सं NUMBER OF YEARS	I II	29						29				29									29					29						29				

CHAPTER – 3

OPERATING CAPABILITY OF PLANT

3.1 The operating capability of various systems, equipment and associated auxiliaries in the scope of the bidder is specified elsewhere in the Technical Specification.

3.2 The plant/unit 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.

3.3 The major operating capabilities for the unit(s)/plant shall be as follows:

(a) Operate continuously with turbine under VWO condition with rated steam parameters, design condenser pressure and 1% cycle make up.

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

(c) The plant shall be designed to operate on FGMO/RGMO as per requirement of Indian Electricity Grid Code (IEGC).

(d) Operate continuously with HP heaters out of service with maximum 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 800 MW or output corresponding to design BMCR heat duty, whichever is lower.

(e) In case of sudden reduction in demand (load throw off), the unit shall 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

(f) HP-LP bypass operation under rated steam conditions with bypass valve open to full capacity and turbine on house load.

(g) Automatic run back capability of the unit load on loss of critical auxiliary equipment, ensuring smooth and stable runback of the Steam Generator, Steam Turbine Generator equipment and systems.

(h) Continuous TG output of 800 MW under rated steam conditions, worst condenser pressure, 1% cycle make-up and 47.5 Hz grid frequency.

(i) The equipment and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz.

(j) 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.

(k) Turbine Generator set shall be capable of continuous operation with HP heaters out of service with maximum output not less than 800 MW.

(l) Turbine shall be capable of operation on variable pressure mode during part load & start-up operation.

(m) 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 atleast for 1 hour.

(n) HP-LP Bypass should be capable of operation in parallel with turbine with all feed water heaters in service.

(o) Bidder shall furnish Pure sliding pressure & Modified sliding pressure operation curves.

(p) Plant shall be designed to give life of not less than 25 years. Further, expected numbers of Steam Turbine Generator startups during design life are as follows:

Type of starts	Number of starts
Hot Start	4000
Warm start	1000
Cold start	250

3.4 All the systems/equipment/auxiliaries under Bidder's scope shall be designed to cater to the above operating conditions envisaged for the unit/plant by the Owner. Unless specified otherwise in the Technical Specification, the design shall cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.

3.5 The plant shall be designed to operate as a base load station. However, continuous operation under two shift and cyclic modes during certain periods is also envisaged. The design would cover adequate provision for quick startup and loading of the unit to full load at a fast rate. The main plant and its auxiliaries with their controls would be designed to permit operation of the unit on house load without there being any necessity to shut down the unit in the event of sudden loss of total load due to tripping of transmission

lines or any other grid disturbances. The design of the plant equipment and control system would permit participation of the plant in automatic load frequency control.

3.6 Bidder shall design Turbine-Generator system meeting the load cycling conditions as indicated at relevant clause. In no case the design life of Turbine-Generator system shall be affected due to

1. '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.

2. 'Creep damage'

3. The combined creep fatigue damage shall lie within acceptable limits.

3.7 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.

3.8 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, super heater/reheater attachments, dissimilar weld joints etc.

The Bidder shall provide information to the process adopted and analysis carried out for the design and operational improvements. Following shall be necessarily included:

a) Header thickness reduction: the intervention may include improvement in proper-ties of materials or materials, increase in number of headers etc.
b) Use of full penetration welds for header/stub welds and header ligament de-sign improvements
c) Design improvement in the mechanical design of water walls
d) Design improvements to prevent economizer steaming
e) 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.
f) Water chemistry improvements
g) Vent/drain/spray system sizing improvements
h) Expansion joints design improvements and fatigue tests
i) Refractory improvements

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.

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.

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. 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).

Periodic inspection shall be carried out by the Contractor during the warranty period of all pre-identified areas with stress con-centration. 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 and/or trouble-shooting. Bidder shall recommend additional instrumentation that may be required for the purpose.

3.9 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.

3.10 Resulting Damage Factor due to Creep-Fatigue interaction shall be made available online (display in CCR) for Operating personnel.

CHAPTER – 4

PROVENNESS

4.1 Provenness of Turbine Set

4.1.1 The turbine set offered shall be built up using proven design modules of HP, IP (or Combined HP-IP, if applicable) and LP turbines of the Foreign / Indian Qualified Steam Turbine Manufacturer*. The offered HP turbine module should have been in successful operation with Super critical pressure and Main steam temperature of 593^0 C or higher for a period of not less than one (1) year as on the date of Tender opening. The offered IP turbine module should have been in successful operation with Reheat steam temperature of 593^0 C or higher for a period of not less than one (1) year as on the date of Tender opening. In case Combined HP-IP turbine module is offered it shall meet the respective requirements of HP turbine and IP turbine modules as above. The offered LP turbine module should have been in successful operation for a period of not less than one (1) year as on the date of Tender opening. The Bidder shall furnish experience list of HP, IP (or Combined HP-IP) and LP turbine modules offered to substantiate their provenness along with the techno commercial Bid as per the format enclosed in **Annexure I**.

4.1.2 The turbine to be supplied under this contract shall be manufactured, assembled and tested in a factory where turbines of at least 500 MW rating have been manufactured in the past. Alternatively the same can also be manufactured in the Indian Manufacturing Company under supervision of Qualified Steam Turbine Generator Manufacturer.

Note: * The Qualified Steam Turbine Manufacturer means

a) The Indian Qualified Steam Turbine Generator Manufacturer.

OR

b) Foreign Qualified Steam Turbine Manufacturer, with whom the Bidder / Associate is having the Technolog**y Transfer** Agreement OR with whose technology, support and strength, the Bidder / Associate/Indian Qualified Steam Turbine Generator Manufacturer have acquired technology for Supercritical Steam Turbine.

4.2 Provenness of Generator

4.2.1 The generator offered shall be of proven design of the Qualified Generator Manufacturer. At least one (1) number generator of 660MW or above rating made on the proven design should be in successful operation for a minimum period of one (1) year prior to the date of Techno-Commercial bid opening.

4.2.2 The offered generator shall be similar in design and construction to the above proven generator in respect of:

i. Cooling medium (e.g. water, Hydrogen etc) and number of shaft mounted fans.
ii. Thermal Class of Insulation for stator and rotor windings.
iii. Core support system (e.g. spring type, rigid type etc)
iv. Type of excitation system

4.2.3 The generator to be supplied under this contract shall be manufactured, assembled and tested in a factory where generator of at least 660MW rating have been manufactured in the past. Alternatively the same can also be manufactured in the Indian Manufacturing Company under supervision of Qualified Generator Manufacturer.

Note : * The Qualified Generator Manufacturer means the

a) Indian Qualified Steam Turbine Generator Manufacturer

OR

Qualified Generator Manufacturer with whom the Bidder / Associate is having the Technology Transfer Agreement OR with whose technology, support and strength, the Bidder/Associate/Indian Qualified Steam Turbine Generator Manufacturer have acquired technology for the Generator of the rating specified.

The Bidder shall furnish experience list for offered Generator to substantiate it's provenness along with the techno commercial bid.

4.3 **Provenness criteria for BTG critical equipment(s) and bought out items**

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

PA, ID, & FD Fans, Coal Pulverisers, Raw coal feeders, Boiler start up drain re-circulation pumps, Air pre-heaters, Condenser, Condensate Extraction Pumps (CEP), Condenser air evacuation pump, Feed Water Low Pressure Heaters, Feed water High Pressure Heaters, Deaerator, Boiler Feed Pumps (BFP), HP Bypass system and LP Bypass system offered by the Bidder shall be only from such manufacturer(s) who has previously designed (either by itself or under collaboration/licensing agreement), manufactured/got manufactured the respective equipment(s) of the type and minimum equipment rating as stipulated below such that the respective equipment(s) are in successful operation in at least one (1) plant for a period not less than one (1) year prior to the date of techno-commercial bid opening.

S No	Name of equipment	Type of equipment	Equipment rating
a.	PA Fans	Axial type (2 stage) with variable pitch control	Flow 210 M^3/Sec (minimum) with Head 1130 mm WC (minimum) & Fan Speed 1500 rpm (maximum)
b.	ID Fans	Axial type (2 Stage)with variable pitch control	Flow 525 M^3/Sec (minimum with Head 525 mm WC (minimum & Fan speed 900 rpm (maximum)
c.	FD Fans	Axial type with variable pitch control	Flow 365 M^3/Sec (minimum) with Head 350 mm WC (minimum) & fan Speed 1500 rpm (maximum).

S No	Name of equipment	Type of equipment	Equipment rating
d.	Coal Pulveriser	Bowl mill / Roller mill/Ball & Race mill/or approved equivalent	Minimum capacity -78 T/hr with: a) Coal pulverizing fineness not less than 70% through 200 mesh. b) Coal input size up to 50 mm. c) Total moisture in coal – 12% d) HGI of input coal - 55
e.	Raw coal feeders	Gravimetric, belt type with minimum size of 36 inch	Capacity not less than 95 T/hr.
f.	Boiler start up drain recirculation pumps	Glandless pump with submerged type wet motor with external high pressure cooler	Pump rating not less than that supplied for 800 MW or higher size super-critical unit.
g.	Air pre-heaters	Rotary regenerative (Lung storm or approved equivalent)- Bisector type or Trisector type with vertical axis of rotation.	Air pre-heater rating not less than that supplied for 800 MW or higher size unit.
h.	Condenser	Condenser of type as specified	Condenser of 800 MW or higher size unit.
i.	Condensate Extraction Pumps (CEP)	Vertical, canister with double suction first stage impeller for steam turbine generator sets.	Capacity not less than 1025 Ton/Hr and total developed Head not less than 30 $kg/cm^{2.}$
j.	Condenser Air Evacuation Pump	Liquid ring type for steam turbine generator sets	Free Dry air capacity 20 SCFM at 1" of Hg (abs) at 21.1^0 C.
k.	Feed Water Low Pressure Heaters	Horizontal, U-tube type having condensing and drain cooling zones for steam turbine generator sets	Feed Water Low Pressure Heater of 660 MW or higher size unit.

S No	Name of equipment	Type of equipment	Equipment rating
l.	Feed Water High Pressure Heaters	Horizontal, U-tube type, having integral de-super heating, condensing and drain cooling zones for steam turbine generator sets	Feed Water Low Pressure Heater of 800 MW or higher size unit
m.	Deaerator	Horizontal/ Vertical, direct contact, spray or spray cum tray design for steam turbine generator sets	Deaerator of 800 MW or higher size unit.
n.	Boiler Feed Pumps (BFP)	Horizontal, centrifugal, multistage, outer casing barrel type with end rotor removal for supercritical steam turbine generator sets	Capacity not less than 1250 Ton/hr and total developed Head not less than 320 $Kg/cm^{2.}$
o.	HP Bypass system	HP Bypass system for supercritical steam turbine generator sets	Capacity of each valve not less than 750 Ton/hr at rated steam parameters (i.e. pressure & temperature).
q.	LP Bypass System	LP Bypass system for steam turbine generator sets	Capacity of each valve not less than 750 Ton/hr at rated steam parameters (i.e. pressure & temperature)

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

Triple redundancy for sensors and transmitters will be used for critical Control & Protection applications. Where correction / compensation for the measured signal are involved, the computed signal shall be the one transferred for control purposes. The measured value indicated shall be the duly corrected/ compensated signal. Redundancy of all components employed for measuring and control BTG equipment shall guarantee the system availability of 99.7%, as well as safety considerations in critical applications should be fully met by OEM.

Turbine controls viz. DEHC, ATT, TSC and Main Turbine Protection system shall be designed and supplied complying the TMR–Triple modular redundant

philosophy and same shall be SIL3 certified via TUV, Rheinland-Germany. Bidder to note that OEM for TMR system shall preferably be same as selected for Main plant DDCMIS.

Triple Modular Redundant (TMR) TUV & SIL 3 processors for BMS (FSSS) & Boiler protection with fail safe design cards shall also be supplied by Bidder.

Sensor redundancy required (2 out of 3 or 1 out of 2) requirement have been specified in respective control system specifications. However, sensor utilization will be decided during detailed engineering. It is mandatory to use sensors with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application /service.

The provenness criteria for equipment (PA fans, ID fans and FD fans) stipulated at (a), (b) & (c) above shall also be considered acceptable provided the rating parameters (i.e., flow, head and rated rpm) is covered within the operating regime of the respective fan performance curve of the reference plant equipment.

4.3.2 In case the Bidder or the proposed sub-vendor(s) is not manufacturer of proven equipment(s) as per clause 4.3.1 above but is a manufacturer for such equipment(s), for units of at least 500 MW rating, the Bidder or the proposed sub vendor(s) can manufacture such equipment(s) for 800 MW supercritical unit also, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment(s) in India with such manufacturer(s) who meet the requirements stipulated at clause 4.3.1 above for the respective equipment.

4.3.3 AJV/Subsidiary Company formed for manufacturing and supply of equipment(s)as listed at clause no. 4.3.1above in India can also manufacture such equipment, provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at clause 4.3.1 above (or the technology provider of the qualified equipment manufacturer).Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/subsidiary company,atleast26%equityparticipationin the Indian Joint Venture Company/Subsidiary Company, which shall be maintained for a lock-in period of seven(7) years from the date of incorporation of such Joint Venture/ Subsidiary or up to the end of defect liability period of the contract , whichever is later. In addition, the sub-vendor along with the Indian Joint Venture Company/ Subsidiary Company, qualified equipment manufacturers and its holding/ subsidiary Company, as applicable, shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for a particular equipment. In case of award, each executant of the DJU be required to furnish a non demand bank guarantee for INR1.5 Million (Rupees One and Half Million) for each equipment.

4.3.4 Before taking up the manufacturing of such equipment(s) as per clause 4.3.2 and 4.3.3 above, the Bidder / its sub vendor(s) must create (or should have created) manufacturing and testing facilities at its works as per Collaborator /

licenser's design, manufacturing and quality control system for such equipment duly certified by the Collaborator / licensor.

Further, the Collaborator / Licenser shall provide (or should have provided) all design, design calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipment.

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

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

4.4 Provenness criteria for other equipment/ systems

4.4.1 Electrostatic Precipitator

Bidder/Bidder's sub-vendor should meet the qualifying requirement here under in clauses 4.4.1.1 or 4.4.1.2 or 4.4.1.3 as the case may be.

4.4.1.1 The Bidder/Bidder's sub-vendor should have designed, supplied, erected/ supervised erection and commissioned/supervised commissioning rigid discharge framework Electrostatic Precipitators (of the type offered), having a designed efficiency of not less than 99%, operating in conjunction with pulverized coal fired steam generating units, rated for a minimum of 500 MW unit size or minimum 1500 T/hr steaming capacity, which should have been in successful operation in at least one installation for a period not less than one (1) year prior to the date of Techno-Commercial bid opening.

4.4.1.2 (a) (i) The Bidder/Bidder's sub-vendor should be an Engineering, Procurement and Construction (EPC) organization executing contracts for setting up of coal fired power plants and shall have experience of supplying at least one (1) no. coal fired power plant of 200 MW capacity or above comprising of Electrostatic Precipitators, which has been in successful operation for a period of not less than one (1) year prior to the date of Techno-Commercial bid opening.

Alternatively

(a) (ii) The Bidder/ Bidder's sub-vendor should be an Engineering, Procurement and Construction (EPC) organization and should have executed, in the last 10 years, large industrial projects on EPC basis (with or without civil works) in the area of power,steel, oil & gas, petro-chemical, fertilizer and/or any other process industry with the total value of such projects being **INR 5,000 million or more**. Atleast one of such projects should have a contract value of **INR 2,000 million** or more. These projects shall be in successful operation for a period of not less than one (1) year prior to the date of Techno-Commercial bid opening.

(b) The Bidder/Bidder's sub-vendor who fulfill the requirements as per clause 4.4.1.2 (a) (i) or 4.4.1.2 (a) (ii) above shall Associate/ Collaborate with a Electrostatic Precipitator manufacturer who meets the requirements of 4.4.1.1 above on its own. The Bidder/Bidder's sub-vendor shall either source the Electrostatic Precipitator from such manufacturer or manufacture the Electrostatic Precipitator as per the design and manufacturing drawings of such manufacturer under an on-going Collaboration agreement/ Technology Licensing Agreement. **The Bidder shall be required to furnish an undertaking jointly executed by the Bidder**, its Sub-vendor (if applicable) and the Electrostatic Precipitator manufacturer for the successful performance of Electrostatic Precipitator, in which the Electrostatic Precipitator manufacturer and the Bidder and its sub-vendor (if applicable) are jointly and severally liable to the Owner to perform all the contractual obligations including the technical guarantees for the complete Electrostatic Precipitator. The Deed of Joint Undertaking (DJU) shall be **submitted prior to the placement of order on the approved sub-vendor.** In case of award, the Electrostatic Precipitator manufacturer and Bidder's sub-vendor (if applicable) shall each be required to furnish an on demand bank guarantee for **INR 15 Million (Rupees fifteen Million)** in addition to the contract performance security to be furnished by the bidder.

4.4.1.3 (a) The Bidder/Bidder's sub-vendor should have designed, supplied, erected/**supervised erection** and commissioned/**supervised commissioning** rigid discharge framework Electrostatic Precipitators (of the type offered), having a designed efficiency of not less than 99%, operating in conjunction with pulverized coal fired steam generating units, in at least one installation rated for a minimum of 600 MW unit size or minimum 1800T/hr steaming capacity, which **should** have been in successful operation for a period not less than one (1) year prior to the date of Techno-Commercial bid opening.

(b) The Bidder/ Bidder's sub-vendor who fulfill the requirements at clause 4.4.1.3 (a) above, shall also have an on-going Collaboration Agreement / Technology Licensing agreement **prior to the date of submission of proposal** for sub-vendor with such a manufacturer of Electrostatic Precipitators, who meets the requirements of clause 4.4.1.1 above. In such an event, the Bidder/ Bidder's sub-vendor shall furnish an undertaking jointly executed by him and the Electrostatic Precipitator manufacturer as per the format enclosed with the bidding documents, in which the Electrostatic Precipitator manufacturer, the Bidder and its Sub-vendor (if applicable) are jointly and severally liable to the Owner to perform all the contractual obligations including the technical guarantees for complete Electrostatic Precipitator. The Deed of Joint Undertaking (DJU) shall be submitted **prior to the placement of order on the approved sub-vendor.**

In case of award, the Electrostatic Precipitator manufacturer and Bidder's sub-vendor (if applicable) shall each be required to furnish an on demand bank guarantee for **INR 15 Million (Rupees fifteen Million)** in addition to the contract performance security to be furnished by the Bidder.

Note

(1) "Qualified Electrostatic Precipitator Manufacturer" means a manufacturer meeting requirements stipulated at 4.4.1.1.

(2) The Bidder/ Bidder's sub-vendor shall also be considered qualified, in case the award for executing the reference works (Electrostatic Precipitator set) has been received by the Bidder/ Bidder's sub-vendor either directly from owner of plant or any other intermediary organization. However, a certificate from such owner of plant or any other intermediary organization shall be required to be furnished by the Bidder/ its sub- vendor along with its Techno-Commercial bid in support of Bidder/ Bidder's sub-vendor claim of meeting the qualification requirement as per 4.4.1.1 or 4.4.1.2 or 4.4.1.3 above. Further, certificate from owner of the plant shall also be furnished by the Bidder/ Bidder's sub-vendor for the successful operation of the Electrostatic Precipitator as specified at clause 4.4.1.1 and 4.4.1.2 above.

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

4.4.2 **Natural Draught Cooling Tower**

4.4.2.1 The Bidder/its sub-vendor should have designed, constructed and commissioned at least one (1) number of Natural Draft Cooling tower in RCC construction with splash type fill, of capacity not less than 60,000 M^3/hr or 80% of offered capacity whichever is lower and which should have been in successful operation for at least one (1) year prior to the date of Techno Commercial bid opening. The reference cooling tower should be of the same type, as is being offered by the Bidder/ sub vendor.

4.4.2.2 Bidder/its sub-vendor who do not fulfil the requirement in clause 4.4.2.1 above can also participate provided the Bidder/sub-vendor has designed, constructed and commissioned at least one (1) number Natural Draught Cooling Tower having film/splash/grid type fill, of capacity not less than 80,000 M^3/hr or 80% of offered capacity whichever is lower and associates with a party fully meeting the requirements of clause 4.4.2.1 above. The Associate will be responsible for design, erection, commissioning and satisfactory performance of the equipment/system. The EPC contractor shall arrange a letter of undertaking to this effect from such Associate to the Owner prior to placement of order for the said equipment/system.

4.4.2.3 In case the reference cooling tower was designed by a party other than the Bidder himself /its sub vendor, the Bidder/ its sub vendor shall employ a cooling tower designer/ supplier who has independently designed an natural Draft Cooling Tower of same type as being offered of capacity not less than 80,000 M^3/hr or 80% of offered capacity whichever is lower in RCC construction with film/splash/grid type fill which should have been in successful operation for at least one (1) year prior to the date of Techno-Commercial bid opening.

4.4.3 **CW Pumps**

The Bidder/its Sub-vendor should meet the qualifying requirements of any one of the qualifying routes stipulated under clause 4.4.3.1 or 4.4.3.2 or 4.4.3.3 for the type of CW pump specified in the Technical Specification.

4.4.3.1 The Bidder/its sub-vendor should have designed either by itself or through its Collaborator/Associate, manufactured/got manufactured, supplied, erected/ supervised erection, and commissioned/supervised commissioning of at least two (2) nos. of vertical wet pit pumps, each of capacity 36,000 M^3/hr or offered capacity whichever is lower, having specific speed in the range of 4000–7000 (*) (US units) which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

4.4.3.2 Bidder/its sub-vendor who has designed by itself, manufactured/got manufactured, supplied, erected/supervised erection, and commissioned/ supervised commissioning of at least two (2) nos. of vertical wet pit pumps, each of capacity 36,000 M^3/hr or more, having a specific speed in the range of 4000–7000 (*) (US units) which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening can also participate, provided it associates/ collaborates with a firm who in turn meets the requirements of 4.4.3.1 above.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking(s) (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator(s)/Associate(s) and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of CW pumps , as per the format enclosed with the bidding documents. The Deed of Joint Undertaking(s) (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, the Collaborator(s)/Associate(s) shall be required to furnish an on demand bank guarantee for INR 10 Million (Rupees Ten Million).

4.4.3.3 a) The Bidder/its sub-vendor should be a wholly or partially (with minimum 51% holding) held Indian subsidiary of a firm who in turn meets the requirements of clause 4.4.3.1. Further, the Bidder/its sub-vendor should have executed/be executing at least one (1) Contract involving design, manufacture/got manufactured, supply, erection/supervision of erection, and commissioning/ supervision of commissioning of at least two (2) nos. vertical wet pit pumps, each of capacity 36,000 cum/hr or more.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking(s) (DJU) jointly executed by the Bidder, its sub-vendor and the Holding company and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of CW pumps. The Deed of Joint Undertaking(s) (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, the Holding company shall be required to furnish an on demand bank guarantee for INR 15 Million (Rupees Fifteen Million).

Note

(i) For qualification under clause 4.4.3.1, a firm can meet the requirements stipulated under clause 4.4.3.1 above either singularly or collectively along with its Subsidiaries.

In such a case the Bidder shall be required to furnish a Deed of Joint Undertaking(s) (DJU) jointly executed by the Bidder, its sub-vendor, Associate or collaborator, the Holding company along with all its subsidiaries extending support to the holding company/ Associate or collaborator for complying requirements of clause 4.4.3.1 and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of CW pumps, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking(s) (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, the Holding company/ Associate or collaborator along with all its subsidiaries extending support to the holding company/ Associate or collaborator for complying requirements of clause 4.4.3.1 shall be required to furnish an on demand bank guarantee for INR 10 Million (Rupees Ten Million) equally divided amongst them.

(ii) (*)Specific speed as stipulated above is the specific speed calculated at the best efficiency point of the pumps as defined in Hydraulic Institute Standards (HIS).

4.4.4 **Chemical Treatment (system) Programme for CW System**

The Bidder/its sub-vendor should have executed contracts for cooling water treatment program of at least two (2) different cooling water systems each having a flow rate not less than 36,000 M^3/hr operating in alkaline pH range and both the treatment programs should have been in successful operation for at least one (1) year prior to the date of Techno-Commercial bid opening. These contracts should include supply of chemicals, operation and maintenance of the system. The Chemicals used in these programme should have been organic polymers/ organic phosphorous compounds/ organic phosphates based chemicals.

4.4.5 **Fire Detection and Protection System:**

The bidder/its sub-vendor should have designed, supplied, erected and commissioned at least two (2) numbers of Fire protection Systems, each of contract value not less than INR 50 million or equivalent in foreign currency (exchange rate applicable as on date of Techno-commercial bid opening), in thermal power plant installations. Each of the above fire protection systems should have comprised of:

a) Fire hydrant system.

b) High velocity water (HVW) spray or medium velocity water (MVW) spray or sprinkler system.

c) Firewater pumping and pressurizing arrangement.

The systems mentioned above should have been designed to the recommendations of Tariff Advisory Committee of India or Oil industry safety directorate (OISD) or any other International reputed authority (like LPC-UK or NFPA, USA) and these systems should have been in successful operation for atleast two (2) years prior to the date of techno- commercial bid opening.

In addition, the analogue addressable type fire alarm system proposed to be supplied shall be sourced from a firm who has supplied atleast two (2) similar

systems which have been approved or listed by UL-USA/ FM-USA/ LPC-UK/ Similar agency and should have been in successful operation for atleast two (2) years prior to the date of techno- commercial bid opening. Further, the Inert gas fire extinguishing system shall be sourced from an agency who has designed and supplied atleast two (2) inert gas total flooding fire extinguishing system each having a total risk volume of atleast 1000 cum. These systems must have been designed to the recommendation of Tariff advisory committee of India or any other International reputed authority (like LPC-UK or NFPA, USA) and should have been in successful operation for atleast two (2) years prior to the date of techno- commercial bid opening.

4.4.6 Air Conditioning System

The bidder/its sub-vendor should have designed, supplied, erected and commissioned atleast two (2) numbers of Air conditioning systems each having a total installed capacity of 300 TR or more, which should have included atleast one chilling unit with a minimum capacity of 60 TR at each reference system in Industrial/Commercial installations. The systems should have been in successful operation for atleast two (2) years prior to the date of techno-commercial bid opening.

In addition, the chiller unit(s) proposed to be supplied for this package shall be sourced from the manufacturer(s) who have manufactured and supplied atleast two (2) nos. of similar type of chiller units each having a capacity of not less than 150 TR, which should have been in successful operation for atleast two (2) years prior to the date of techno- commercial bid opening.

4.4.7 Ventilation System

The bidder/ its sub-vendor should have designed, supplied, erected, and commissioned atleast two (2) numbers ventilation systems including air washer units having individual fan capacity of 1,25,000 Cum./Hr. or more at each ventilation system, in Industrial/ Commercial installations. The systems should have been in successful operation for atleast two (2) years prior to the date of techno- commercial bid opening.

4.4.8 Compressed Air System

a) The bidder/ its sub-vendor should have designed, manufactured, supplied, erected/supervised erection and commissioned/supervised commissioning of atleast two (2) numbers non-lubricated oil free screw type air compressor of minimum capacity 40 NM^3/min each or atleast two(2) numbers centrifugal air compressors of minimum capacity 50 NM^3/min each and at rated discharge pressure of 8 kg/cm^2 (g) which should have been in successful operation for atleast two (2) years prior to the date of techno-commercial bid opening. Bidder/its sub-vendor shall offer only the type of compressors for which he is qualified.

b) The Air Drying Plant (A.D.P) shall be supplied from such manufacturers who have manufactured and supplied atleast two (2) numbers Air Drying Plant each of capacity 40 NM3/min or more and the type same as offered, which should have been in successful operation prior to the date of techno- commercial bid opening

4.4.9 **Water Pre-treatment Plant & Liquid Effluent Treatment Plant**

The Bidder/its sub-vendor should have designed, supplied, erected and commissioned at least two (2) numbers water/waste water treatment plants, each with a capacity of not less than 1500 M^3/hr, comprising of clarifiers/tube settlers/ thickeners or a combination thereof including civil works. The plants should have been in successful operation for at least two (2) years prior to the date of Techno- Commercial bid opening.

4.4.10 **Ion Exchange Demineralization Plant**

The Bidder /its sub-vendor should have designed, supplied, erected and commissioned at least one (1) number of ion exchange based demineralising plant, consisting of at least two (2) streams each of minimum 40 M^3/hr capacity, capable of producing outlet water quality of silica and conductivity not more than 0.01 ppm as SiO_2 and 0.1 micromho/cm respectively, which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

4.4.11 **Mill Reject Handling System**

4.4.11.1 Mill reject handling system offered by the Bidder shall be only from such manufacturer who has previous experience of manufacturing and supplying pneumatic type coal mill rejects handling systems of capacity 5 TPH or higher which are in successful operation in at least one (1) plant for a period not less than one (1) year prior to the date of Techno-Commercial bid opening.

4.4.11.2 In case the Bidder or the sub vendor is not a manufacturer of proven equipment as per clause 4.4.11.1 above but is a manufacturer of pneumatic conveying systems and has manufactured and supplied pressure type pneumatic conveying systems of capacity 5 MTPH or higher for any material which are in successful operation in at least one (1) plant for a period not less than one (1) year prior to the date of Techno- Commercial bid opening , the Bidder/sub vendor can manufacture such equipment for mill rejects handling also provided he has valid collaboration or licensing agreement for design, engineering, manufacture, and supply of such equipment in India with a manufacturer who meets the requirements of clause 4.4.11.1above.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator/ Associate and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of the system, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, the Collaborator/ Associate shall be required to furnish an on demand bank guarantee for INR 2 Million (Rupees Two Million).

4.4.11.3 JV Company / Subsidiary Company formed by one of the promoters of the Indian JV/Subsidiary Company formed for manufacturing of steam generator sets, can also manufacture Mill Reject Handling System for 800 MW supercritical units provided one of its promoters meets the requirements of clause 4.4.11.1 above. However, in such a case, the JV Company/ Subsidiary Company formed should have collaboration or valid licensing agreement for design, engineering, manufacturing of Mill Reject Handling System in India,

with the JV promoter who meets the requirements stipulated at clause 4.4.11.1 above.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking (DJU) jointly executed by the Bidder and the Collaborator/ Associate and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of the system, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) should be submitted at the time of placement of order. In such a case, the Collaborator/ Associate shall be required to furnish an on demand bank guarantee for INR 2 Million (Rupees Two Million).

4.4.12 **Condensate Polishing Plant**

a) The Bidder/its Sub-vendor should have designed, supplied, erected and commissioned at least one (1) Condensate Polishing Plant of mixed bed, deep bed type consisting of service vessel of minimum capacity of 500 M^3/hr. The plant shall have external regeneration system, incorporating the same resin separation and regeneration process as proposed by the Bidder / its Sub-vendor for this package. The above plant should have been in successful operation for a period of at least one (1) year prior to the date of Techno-Commercial bid opening.

b) The Bidder/its Sub-vendor who do not meet the qualification requirements stipulated at 4.4.12 (a) above, may also participate provided the Bidder/its Sub-vendor is a Contractor in water treatment plant and has executed at least one (1) number ion exchange based demineralising plant of minimum capacity of 30 M^3/hr consisting of maximum two (2) streams and associates for this bid with an Associate who in turn fully meets the requirements stipulated at 4.4.12 (a) above.

In such case, the Bidder shall be required to furnish a Deed of Joint Undertaking(s) (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator/Associate and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of Condensate Polishing Plant, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking(s) (DJU) should be submitted at the time of placement of order on approved vendor. In such a case, the Collaborator /Associate shall be required to furnish an on demand bank guarantee for INR 3 Million (Rupees Three Million).

4.4.13 **Turbine Hall EOT Crane**

The Bidder/its sub-vendor should have designed, manufactured, erected and commissioned EOT cranes of capacity 100T or more with minimum crane span of 28 meters, which is in successful operation in at least two (2) power stations for a minimum period of one (1) year prior to the date of Techno-Commercial bid opening.

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

The Bidder/its sub-vendor should have designed, manufactured, erected and commissioned COLTCS with ball collecting strainer having diameter of not less than 2100 mm, which is in successful operation in at least one (1) station for a minimum period of one (1) year prior to the date of Techno-Commercial bid opening.

4.4.15 **Ash Handling System**

Ash Slurry Disposal Pumps:-

The ash slurry pumps to be supplied shall be from such manufacturers who have in the past supplied and installed ash slurry pumps for similar duty applications and have at least two (2) nos. pumps of same models that are being offered having capacity not less than 1000 cubic meters per hour at each of the two (2) different stations which are in successful operation for at least two (2) years.

4.4.15.1 The Bidder/ its Sub-vendor should be a manufacturer of ash handling systems and should have executed ash handling system involving design, engineering, manufacture, supply, erection and commissioning of

(a) Bottom Ash handling system comprising a jet pump system in conjunction with water impounded Bottom Ash Hopper designed for the following conveying capacities for pulverized coal fired boilers:

Jet Pump : 3 x 65 TPH (dry ash basis)

The reference Bottom Ash Handling systems should be of the same type i.e. jet pump system, as is being offered by the Bidder/ its Sub- vendor.

(b) Pneumatic fly ash handling system for conveying fly ash from ESPs of a single pulverized coal fired boiler unit by Vacuum conveying system designed for 45 TPH or more conveying capacity per vacuum extractor.

The reference fly ash handling systems should be of vacuum system and pressure system, as is being offered by the Bidder/ its Sub-vendor.

(c) Pneumatic pressure conveying Fly Ash Transportation System for transporting fly ash through conveying air blowers from pulverised coal fired boiler having capacity of not less than 80 TPH for a conveying distance of not less than 200 M.

(d) Complete ash slurry disposal system for handling not less than 150 tonnes of ash per hour for pulverised coal fired power stations which includes, among others, ash slurry pumps & piping system with associated controls.

The systems mentioned at 4.4.15.1(a), (b) & (c) above should have been in successful operation in at least two (2) plants for at least two (2) years prior to date of Techno-Commercial bid opening. For the purpose of qualification, the experience as at (a), (b) & (c) above in separate plants also is permissible.

An individual boiler unit having its own independent bottom ash handling system of either the jet pump system type can be considered as a plant for meeting the requirement of 4.4.15.1 (a) above.

An individual boiler unit having its own independent fly ash handling system up to wetting units/ dry dust collection buffer hoppers which includes, among others, independent fly ash handling equipment below ESP hoppers, independent ash conveying piping up to wetting units/ dry dust collection buffer hoppers can be considered as a plant for meeting the requirement of 4.4.15.1(b) above. Further, a transportation system provided for an individual boiler unit having dedicated ash vessels below buffer hoppers and dedicated

piping from buffer hoppers to storage silos can be considered as a plant for meeting the requirement of 4.4.15.1(c) above.

For reference fly ash handling systems, the design capacity of conveying from ESPs to buffer hoppers and of transportation from buffer hoppers to storage silos will be the capacity which the client (of the reference plant against which the Bidder / its Sub- vendor is seeking qualification) must have specified in its contract documents.

4.4.15.2 The Bidder/ its Sub-vendor who is a supplier of ash handling systems but does not meet the requirements under clause 4.4.15.1 in part or in full can also participate provided it has executed at least the following systems of ash handling plant involving design, engineering, manufacture, supply, erection and commissioning:

a) Bottom ash handling system comprising jet pump system in conjunction with water impounded Bottom Ash Hopper.

b) Fly Ash Handling System for conveying fly ash from ESPs in dry form (involving pneumatic conveying systems of vacuum & pressure type) and in wet (slurry) form

The systems mentioned at 4.4.15.2 (a) and (b) above in India should have been in successful operation in at least two (2) plants for two (2) years prior to the date of Techno-Commercial bid opening and should have been installed for pulverized coal fired boiler units generating not less than 150 TPH of ash per boiler.

And

collaborates/ associates with party(ies) who meet(s) either the total requirement or the balance part under 4.4.15.1 (a),(b),(c) above which the Bidder/ its Sub- vendor itself is not able to meet.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator(s)/ Associate(s) and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of the relevant system, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, each Collaborator/ Associate shall be required to furnish an on demand bank guarantee as follows:

i) INR 2 Million (Rupees Two Million) for Collaborator/ Associate for Bottom Ash Handling System

(ii) INR 2 Million (Rupees Two Million) for Collaborator/ Associate for Vacuum Conveying System

(iii) INR 4 Million (Rupees Four Million) for Collaborator/ Associate for Vacuum Conveying System

(iv) INR 6 Million (Rupees Six Million) for Collaborator/ Associate for Pressure Conveying System.

In case bidder/sub-vendor collaborates/associates for more than one system with a party, then the Collaborator/ Associate shall be required to furnish an on demand bank guarantee for an amount arrived at by adding up the amounts for the relevant systems as above.

4.4.15.3 The activity of design and engineering under 4.4.15.1 (a), (b) & (c) should have been carried out by the Bidder/ its Sub- vendor and not through any external design agency/agencies. The activity of design and engineering under 4.4.15.1 (d) should have been carried out by either the Bidder/ its Sub- vendor or through design agency/design agencies having experience for high concentration ash slurry disposal system.

For design and engineering activity referred under paras 4.4.15.2 the activity should have been carried out by either the Bidder/ its Sub- vendor or through design agency/agencies having experience for reference systems. In case of Collaborator(s)/associate(s) (meeting the balance part of total requirement under clause 4.4.15.1), the activity of design and engineering for the reference systems should have been carried out by them

4.4.16 **Coal Handling Plant**

4.4.16.1 The Bidder/ its Sub- vendor should have designed, manufactured/ got manufactured, erected and commissioned at least two (2) integrated bulk material handling plants (essentially comprising of conveying and crushing) including all associated structural steel works and electrical works of minimum 1000 TPH rated capacity or above for coal of equivalent volumetric capacity which should have been in successful operation in India for at least two (2) years prior to the date of Techno- Commercial bid opening. At least one (1) Wagon tippler and one (1) stacker cum reclaimer with 1000 TPH or more capacity should have been supplied and commissioned in the above bulk material handling plants.

And

The Bidder/ its Sub- vendor should have designed, manufactured, supplied, erected and commissioned including all associated structural steel works and electrical works at least two (2) number cantilever boom type, slewable and luffable, bucket wheel type travelling Stacker-cum-Reclaimer suitable for stacking and reclaiming at a rated continuous capacity of 1000 TPH (or above) for coal or other mineral of equivalent volumetric capacity which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

And

4.4.16.3 The Bidder/ its Sub- vendor who meets the requirements of only para 4.4.16.1 above can also participate provided it collaborates / associates with a firm which fully meets the requirements specified at para 4.4.16.2 above.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator/ Associate and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of the system, as per the format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) should be submitted at the time of placement of order on approved sub-vendor. In such a case, the Collaborator/ Associate shall be

required to furnish an on demand bank guarantee for INR 5 Million (Rupees Five Million only).

4.4.16.4 **Coal Sampling System**

The Bidder/ its Sub-vendor shall source coal sampling system from a manufacturer/ supplier who has engineered and supplied minimum two (2) numbers of coal sampling systems for sampling coal /other bulk mineral from conveyor of 1000 MTPH or above and which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

4.4.17 **Fuel Oil System**

The Bidder/ its Sub-vendor, should have designed, supplied, erected and commissioned at least one (1) fuel oil handling installation consisting of:

a) Unloading facilities
b) One (1) Storage tank of capacity not less than 500 M^3.

The above system should have been in successful operation prior to the date of Techno-Commercial bid opening.

4.4.18 **Hydrogen Generation Plant**

The bidder/its sub-vendor should have designed and supplied at least one (1) hydrogen generation plant of the type specified, comprising of electrolyser(s) and gas compressor(s) to generate Hydrogen at 5 NM^3/hr (minimum) of 99.7% purity (minimum) at the main electrolyser outlet which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening. Bidder/its Sub-vendor shall offer only the type of hydrogen generation plant for which he is qualified

4.4.19 **Provenness criteria for critical equipment(s) and bought out items for SCR system**

4.4.19.1 **Ammonia handling and storage system for SCR**

The Bidder/Bidder's sub-vendor should have designed, engineered, manufactured/ got manufactured/ supplied, erected/ supervised erection and commissioned/ supervised commissioning of at least one (1) no. of anhydrous ammonia storage and handling system for SCR system operating in conjunction with coal fired steam generating units, rated for a minimum of 500 MW unit size or minimum 1500 T/hr steaming capacity. The above System should have been in successful operation for a period not less than one (1) year.

4.4.19.2 **Catalyst for SCR system**

Catalyst for SCR system shall be supplied only from such catalyst manufacturer who has designed, engineered, manufactured, supplied plate type catalyst for SCR system which is operating in conjunction with pulverised coal fired steam generator for 500 MW or higher capacity unit or with steam generator having minimum 1500T/hr steaming capacity. Further, such plate type catalyst in a SCR System should have been in successful operation for a period of at least 16000 hours without any replacement during this period.

Note:

A) Notes to Clauses 4.4.19.1 and 4.4.19.2

(1) "Qualified Selective Catalytic Reduction system Manufacturer (QSCRM)" means a manufacturer meeting requirements stipulated.

(2) The Bidder/ Bidder's sub-vendor shall also be considered qualified, in case the award for executing the reference works (SCR system) has been received by the Bidder/ Bidder's sub-vendor either directly from owner of plant or any other intermediary organization. However, a certificate from such owner of plant or any other intermediary organization shall be required to be furnished by the Bidder/its sub-vendor in support of Bidder/ Bidder's sub vendor claim of meeting the qualification requirement as per 4.4.19.1 or 4.4.19.2 above. Further, certificate from owner of the plant shall also be furnished by the Bidder/ Bidder's sub-vendor for the successful operation of the SCR System as specified at clause 4.4.19.1 or 4.4.19.2 above, whichever is applicable.

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

(4) Holding Company as a Qualified Selective Catalytic Reduction system Manufacturer (QSCRM).

(i) A Holding Company, singularly or collectively along with its Subsidiaries (held either directly or indirectly), meeting the requirements of clause 4.4.19.1 above shall also be considered as QSCRM.

(ii) In such a case, if the Holding Company is an Associate/ Collaborator for Bidder or Bidder's sub-vendor as a QSCRM, the Holding Company and all such subsidiaries lending strength / experience to the Holding Company for meeting the requirements of clause 4.4.19.1 above should necessarily be part of the DJU being submitted by the Bidder for successful performance of the contract as per format enclosed with the bidding documents. The Deed of Joint Undertaking (DJU) shall be submitted prior to the placement of order on the approved vendor. Further, in such a case the Holding Company and all such entities lending strength / experience to the Holding Company for meeting the requirements of clause 4.4.19.1 above shall each be required to furnish separate on demand bank guarantees for INR 30 Million (Indian Rupees Thirty Million only) divided equally among them, in addition to the contract performance security to be furnished by the Bidder. This bank guarantee requirement shall supersede bank guarantee requirement stipulated at clause & for the QSCRM.

(iii) In case the Holding Company itself is the Sub-Vendor as a QSCRM as per clause 4.4.19.1, the Holding Company shall submit its board resolution stating that in case of any likely change of management control of any of these subsidiaries lending strength/experience to the Holding Company for meeting the requirements of clause above, the Sub-Vendor shall arrange for separate on demand bank guarantees as per the format

enclosed with the bidding documents from all such entities lending strength/experience to the Holding Company for fulfilment of requirement of clause, above for an amount aggregating INR 30 Million (Indian Rupees Thirty Million only) before the change in management control actually occurs.

B) Technology Transfer Agreement

The technology transfer agreement shall necessarily cover transfer of technological know-how for SCR System in the form of complete transfer of design dossier, design software's, drawings and documentation, quality system manuals and imparting relevant personnel training to the Indian Manufacturing Company.

4.4.20 **Provenness criteria for critical equipment, auxiliaries, systems and bought out items for Flue Gas Desulphurisation System**:

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

Slurry Recirculation Pumps, Oxidation Blowers, Wet Limestone Grinding Mills, Slurry Pumps, Agitators & Vacuum Belt Filters for the Wet Limestone based Flue Gas Desulphurisation (FGD) System offered by the Bidder shall be only from such manufacturer(s) who has previously designed (either by itself or under collaboration / licensing agreement), manufactured / got manufactured the respective equipment(s) of the type, application and minimum equipment rating as stipulated below such that the respective equipment(s) should have been in successful operation in at least one (1) plant for a period not less than one(1) year prior to techno commercial bid opening:

S No	Name of Equipment	Type of equipment	Application	Equipment rating
a.	Slurry Recirculation Pumps	Centrifugal type	Wet Limestone based FGD application in Coal fired power plant	80% of the flow & 100% of the head of the offered Slurry Recirculation Pump
b.	Oxidation Blowers	Centrifugal/ positive displacement type blower	Wet Limestone based FGD application in Coal fired power plant	80% of the flow & 100% of the head of the offered Oxidation Blower
c.	Wet limestone Grinding mills	Horizontal Wet Ball mill	Wet Limestone based FGD application in Coal fired power plant	80% of offered ball mill capacity With pulverising finesse not less than 90% thru 325 mess.
d.	Slurry Pumps	Centrifugal type	Wet Limestone based FGD application or similar	Flow 50 m^3/hr (minimum) with Head 30 Meters of Liquid Column (minimum)

			process/duty application	
e.	Agitators	Vertical/ Horizont al	Wet Limestone based FGD application in Coal fired power plant	Agitator rating not less than that supplied for 500 MW or higher size unit for similar application
f.	Vacuum Belt filters	Belt type	Wet Limestone based FGD application in Coal fired power plant	80% of the offered Vacuum Belt filter capacity

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

4.4.20.2 A JV/Subsidiary Company formed for manufacturing and supply of equipment(s) as listed at clause no 4.4.20.1 above in India can also manufacture such equipment, provided that it has a valid collaboration or licensing agreement for design, engineering, manufacturing of such equipment(s) in India with a qualified equipment manufacturer who meets the requirements stipulated at clause 4.4.20.1 above (or the technology provider of the qualified equipment manufacturer) for the respective equipment(s). However, in this case, the proposed JV/Subsidiary Company before resorting to design, engineering, manufacturing of such proven equipment(s) listed at clause no. 4.4.20.1 above by himself should have sourced / shall source such proven equipment(s) for at least one first 660 MW unit completely from such qualified manufacturer. For subsequent units before taking up the manufacturing of such equipment(s), the bidder/his sub-vendor(s) must create/have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for such equipment(s).

Further, in such a case, such qualified equipment manufacturers should have, directly or indirectly through its holding company/ subsidiary company, at least 26% equity participation in the Indian Joint Venture Company/ Subsidiary Company, which shall be maintained for a lock-in period of seven (7) years from the date of incorporation of such Joint Venture/Subsidiary or up to the end of defect liability period of the contract, whichever is later. In addition, the Bidder along with the Indian Joint Venture Company/Subsidiary Company, qualified equipment manufacturers and its holding/ subsidiary Company, as applicable, shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for a particular equipment. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on demand bank guarantee for INR 2.5 Million (Indian Rupees Two and Half Million only) for each equipment.

4.4.20.3 In case the Bidder or the proposed sub-vendor is not manufacturer of proven Oxidation Blowers as per clause 4.4.20.1 (b) above but is a manufacturer of Blowers/compressors for minimum 90 NM^3/min capacity, the Bidder or the proposed sub-vendor can also manufacture Oxidation Blowers, provided it has

collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Oxidation Blowers in India with such manufacturer who meet the requirements stipulated at clause 4.4.20.1 (b) above for the Oxidation Blowers. However, in this case, Bidder or the proposed sub-vendor before resorting to design, engineering, manufacturing of such proven equipment by himself should have sourced/shall source such proven equipment for at least the first 660 MW unit completely from such qualified manufacturer. For subsequent units before taking up the manufacturing of such equipment, the bidder/his sub-vendor must create/have created manufacturing facilities at his works as per collaborator's/licenser's design, manufacturing and quality control system for such equipment.

In addition, the Bidder along with the qualified equipment manufacturer shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for Oxidation Blowers. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on demand bank guarantee for INR 2.5 Million (Indian Rupees Two and Half Million only).

4.4.20.4 In case the Bidder or the proposed sub-vendor is not manufacturer of proven Wet limestone Grinding mills as per clause 4.4.20.1 (c) above but is a manufacturer of dry Grinding mills for power or cement industry of minimum 20 T/PH capacity, the Bidder or the proposed sub-vendor can also manufacture Wet limestone Grinding mills, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Wet limestone Grinding mills in India with such manufacturer who meet the requirements stipulated at clause 4.4.20.1 (c) above for the Wet limestone Grinding mills. However, in this case, Bidder or the proposed sub-vendor before resorting to design, engineering, manufacturing of such proven equipment by himself should have sourced / shall source such proven equipment for at least the first 660 MW unit completely from such qualified manufacturer. For subsequent units before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.

In addition, the Bidder along with the qualified equipment manufacturer shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for Wet limestone Grinding mills. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on demand bank guarantee for INR 2.5 Million (Indian Rupees Two and Half Million only).

4.4.20.5 In case the Bidder or the proposed sub-vendor is not manufacturer of proven Agitators as per clause 4.4.20.1 (e) above but is a manufacturer of Agitators for similar process/duty application in petrochemical or metals and mining industry, the Bidder or the proposed sub-vendor can also manufacture Agitators, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such Agitators in India with such manufacturer who meet the requirements stipulated at clause 4.4.20.1 (e) above for the Agitators. However, in this case, Bidder or the proposed sub-vendor before resorting to design, engineering, manufacturing of such proven

equipment by himself should have sourced / shall source such proven equipment for at least the first 660 MW unit completely from such qualified manufacturer. For subsequent units before taking up the manufacturing of such equipment, the bidder/ his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.

In addition, the Bidder along with the qualified equipment manufacturer shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for Agitators. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on demand bank guarantee for INR 1.5 Million (Indian Rupees One and Half Million only).

4.4.20.6 In case the Bidder or the proposed sub-vendor is a manufacturer of Slurry Pumps who meets the requirements stipulated at clause 4.4.20.1 (d) above, the Bidder or the proposed sub-vendor can also manufacture Slurry Recirculation Pumps, provided it has collaboration or valid licensing agreement for design, engineering, manufacturing, supply of such equipment in India with such manufacturer who meet the requirements stipulated at clause 4.4.20.1 (a) above for the Slurry Recirculation Pumps. However, in this case, Bidder or the proposed sub-vendor before resorting to design, engineering, manufacturing of such proven equipment by himself should have sourced / shall source such proven equipment for at least the first 660 MW unit completely from such qualified manufacturer. For subsequent units before taking up the manufacturing of such equipment, the bidder/his sub-vendor must create /have created manufacturing facilities at his works as per collaborator's /licenser's design, manufacturing and quality control system for such equipment.

In addition, the Bidder along with the qualified equipment manufacturer shall furnish DJU in which executant of the DJU shall be jointly and severally liable for the successful performance of the equipment as per the format enclosed in the bidding document. The DJU shall be submitted prior to the placement of order on the approved sub-vendor for Slurry Recirculation Pumps. In case of award, each executant of the DJU except the Bidder shall be required to furnish an on demand bank guarantee for INR 4 Million (Indian Rupees Four Million only).

4.4.20.7 Before taking up the manufacturing of such equipment(s) as per clause 4.4.20.2, 4.4.20.3, 4.4.20.4, 4.4.20.5 & 4.4.20.6 above, the Bidder/its sub vendor(s) must create (or should have created) manufacturing and testing facilities at its works as per Collaborator / licenser's design, manufacturing and quality control system for such equipment duly certified by the Collaborator/licensor. Further, the Collaborator / Licenser shall provide (or should have provided) all design, design calculation, manufacturing drawings and must provide (or should have provided) technical and quality surveillance assistance and supervision during manufacturing, erection, testing, commissioning of equipment.

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

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

4.5.0.0 Sewage Treatment Plant

The Bidder /Sub-Contractor should have supplied, erected and commissioned a Sewage Treatment Plant based on FAB/MBBR technology during the last ten years with a minimum capacity of 1 cum/hour and the plant should have been in successful operation for at least one year as on date of LOA.

4.6.0.0 Effluent Treatment Plant

The Bidder /Sub- Contractor should have designed , supplied, erected and commissioned during the last ten years at least one number sea water reverse osmosis plant with a permeate water capacity of minimum 30 m^3 / hour. which should have been in successful operation for a period of not less than one year as on date of LOA.

4.7.0.0 Hydrogen Generation Plant

The Bidder /Sub-Contractor should have supplied, erected / supervised erection and commissioned / supervised commissioning a Hydrogen Generation Plant based on Proton Exchange Membrane (PEM) technology during the last ten years with a minimum capacity of 8 Nm3 /hour and the plant should have been in successful operation for at least one year as on date of LOA.

4.8.0.0 Sub-contractor for Erection Works

In case the Bidder / sub-Contractor wants to engage any Erection Contractor, such sub-contractor for erection of the particular sub package shall satisfy the following Qualification Requirement.

(i) **For Mechanical works:**

Bidder to furnish documentary evidence to prove that similar mechanical erection as the case may be and installation work in 500MW unit capacity or above had been carried out by the Sub-contractor.

(ii) **For Electrical works:**

Bidder to furnish documentary evidence to prove that similar electrical erection as the case may be and installation work **in 500 MW unit capacity or above** had been carried out by the Sub-contractor.

(iii) **For Control and Instrumentation items:**

In case the main Contractor is engaging a sub-contractor for C&I works, Documentation proof shall be furnished in the form of Bid award copy of C&I erection & installation activities along with Commissioning /handing over protocols mentioning the project name from end user/main Contractor/DCS Vendor for minimum 500 MW or above capacity power plant.

5.0 PROVENNESS CRITERIA FOR ELECTRICAL EQUIPMENTS

5.1 ISOLATED PHASE BUSDUCT

5.1.1 Bidder/Sub Vendor should have designed, manufactured, type tested, supplied, erected/ supervised erection and commissioned/supervised commissioning of Isolated Phase Bus duct for a turbo-generator of at least 500MW, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening.

OR

5.1.2 (i) Bidder/Sub Vendor should have designed, manufactured, type tested, supplied, erected/supervised erection and commissioned/ supervised commissioning of Isolated Phase Busduct for a turbo-generator of at least 200MW, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening.

(ii) Bidder/Sub Vendor has an on-going technical collaboration agreement with a party who in turn meets the requirements of 5.1.1 above. Further in such an event the Bidder should furnish an undertaking jointly executed by it and its Associate or Collaborator, as per format, enclosed in the bidding document for the successful performance of the equipment. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder /Sub Vendor (as applicable) will be required to furnish an on demand Bank Guarantee for INR 1.5 Million (Indian Rupees One and a half Million only).

5.2 POWER TRANSFORMERS

5.2.1 Bidder/Sub Vendor should have designed, manufactured, installed/ supervised installation and commissioned/supervised commissioning of at least two (2) nos. (one each at two different installations) of 400 KV or above class Generator transformers of at least 200 MVA capacity (single phase transformer) which should be in successful operation for at least two(2) years prior to the date of Techno-Commercial bid opening.

OR

5.2.2 Bidder/Sub Vendor who have designed, manufactured, installed/supervised installation and commissioned/supervised commissioning of at least two (2) no. 220 KV or above class transformer which are in successful operation for two (2) years prior to the date of Techno-Commercial bid opening and have established manufacturing facilities for 400 KV class transformers based on technological support of its Associate or Collaborator, can also be considered Qualified provided its Associate or Collaborator meets the qualifying requirement stipulated at 5.2.1 above and Bidder furnishes an undertaking jointly executed by it and its Associate or Collaborator, as per the format, enclosed in the bidding document for the successful performance of the equipment. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 22 Million (Indian Rupees Twenty Two Million only).

Transformer shall be of Collaborator's/Associate's/Technology provider's/Licensor's design. Transformer shall be manufactured in line with manufacturing & assembly drawings of Collaborator/ Associate/Technology provider/Licensor.

Core coil assembly and final testing of the transformer shall be under the supervision of Collaborator/Associate/Technology provider/Licensor.

5.3 **AUXILIARY OIL FILLED/ DRY TYPE TRANSFORMERS**

5.3.1 Bidder/Sub Vendor should have manufactured & supplied at least two numbers (one each at two different installations) of at least highest offered rating oil filled/ dry type transformers which should have been in successful operation for a period of at least two (2) years prior to the date of Techno-Commercial bid opening.

5.3.2 Bidder/Sub Vendor should have his own facilities for conducting all routine and type tests as per IS: 2026 (except short circuit test).

5.3.3 The transformer considered for the above (5.3.1) should have been successfully short circuit tested.

Note (applicable for clauses 5.2 & 5.3):

Two different installations means two different projects or two different contracts.

5.4 **LT SWITCHGEAR**

Route 1

5.4.1 Bidder/ Sub-vendor should have manufactured and supplied at least a total of four hundred & fifty (450) Nos. draw out type Air Circuit Breaker Panels and / or draw out Motor Control Centre Panels complete in all respects with fault rating of at least 50kA for 1 sec. and 105kA (peak) under a single order and these panels should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening.

5.4.2 Bidder/ Sub-vendor should have manufactured and supplied at least one hundred & fifty (150) Nos. draw out Circuit Breaker Panels with Air Circuit Breakers having fault rating of at least 50kA for 1 second, 105kA MAKING and 50kA BREAKING, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening.

Note: Each Single Front Panel shall be counted as one (1) Panel, Double Front Panel as one (1) Panel and Air Circuit Breaker Panel as one (1) Vertical Panel.

Route 2

Bidder/ Sub Vendor based on technological support of its Associate or Collaborator, can also participate provided

5.4.3 Bidder/ Sub Vendor should have manufactured and supplied at least a total of two hundred & twenty-five (225) numbers of draw out type Air Circuit Breaker

Panels and / or draw out type Motor Control Centre Panels with fault rating of at least 45kA for one (1) second and 105kA peak under a single order and these panels should have been in successful operation for at least two (2) years.

And

Bidder/ Sub Vendor should have manufactured and supplied at least seventy-five (75) numbers of draw out type Air Circuit Breaker panels having fault rating of at least 45kA for one (1) second and 105kA peak, which should have been in successful operation for at least two (2) years.

And

Bidder/Sub Vendor shall be considered qualified provided its Associate or Collaborator or Technology Provider or Licensor meets the requirement stipulated in Route-1 for sourcing of Air Circuit Breakers. The Associate or Collaborator or Technology Provider or Licensor shall provide a letter of technical support for successful performance of the Air Circuit Breakers, as per the format, given in the bidding document. This letter of technical support should be submitted at the time of placement of order on the Sub Vendor.

And

Bidder/ Sub Vendor should have established manufacturing facility for draw out type Air Circuit Breaker Panels and draw out type Motor Control Centre Panels in India. Further, all the panels for this project shall be manufactured and supplied from the Indian manufacturing facility.

5.5.4 Bidder/ Sub Vendor shall furnish a Deed of Joint Undertaking jointly executed by it and its Associate/ Collaborator as per format enclosed in the bidding document in which the Bidder/ Sub Vendor and its Associate/ Collaborator are jointly and severally liable to the Owner for successful performance of the LT Switchgears. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 6 Million (Indian Rupees Six Million only).

5.5 11 KV/6.6 KV SWITCHGEARS

Route 1

5.5.1 The Bidder/ Sub Vendor should have designed, manufactured and supplied at least one hundred (100) 11kV and /or 6.6kV Switchgear panels complete in all respects with fault rating of at least 40 kA for one (1) second and 100kA (peak), which should have been in successful operation for a period of at least two (2) years prior to the date of Techno-Commercial bid opening.

5.5.2 The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) Vacuum Circuit Breakers for 11kV and /or 6.6kV panels with a rating of 40 kA rms BREAKING, 100kA peak MAKING and 40kA withstand for one (1) second, which should have been in successful operation in 6.6kV or higher voltage application for a period of at least two years prior to the date of Techno-Commercial bid opening.

Route 2

Bidder/ Sub Vendor based on technological support of its Associate or Collaborator, can also participate provided

5.5.3 The Bidder/ Sub Vendor should have manufactured and supplied on an average one hundred (100) 11kV and /or 6.6kV Switchgear panels per annum during the last three years prior to the date of Techno-Commercial bid opening.

5.5.4 The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) 11kV and /or 6.6kV Switchgear panels complete in all respects with fault rating of at least 40kA for one (1) second and 100kA (peak which should have been in successful operation for a period of at least two (2) years prior to the date of Techno-Commercial bid opening. The Bidder/ Sub Vendor should have type tested the offered type of panels as specified.

5.5.5 The Bidder/ Sub Vendor should have manufactured and supplied at least one hundred (100) Vacuum Circuit Breakers for 11kV and /or 6.6kV panels with a rating of 40kA rms BREAKING, 100kA peak MAKING and 40kA withstand for one (1) second which should have been in successful operation in 6.6kV or higher voltage application for a period of at least two years prior to the date of Techno-Commercial bid opening.

5.5.6 Bidder's/ Sub Vendor's Associate or Collaborator meets the qualifying requirement stipulated at 5.5.2 & 5.5.3 stipulated under Route 1.

5.5.7 Bidder/ Sub Vendor furnishes a Deed of Joint Undertaking jointly executed by it and its Associate/ Collaborator as per format enclosed in the bidding document in which the Bidder/ Sub Vendor and its Associate/ Collaborator are jointly and severally liable to the Owner for successful performance of the MV Switchgears. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 6 Million (Indian Rupees Six Million only).

5.6 NUMERICAL RELAYS & NETWORKING

5.6.1 Numerical Relays shall be offered from a Manufacturer who has manufactured and supplied and successfully configured at least 100 Nos. of Numerical Relays with IEC 61850 used for application in Feeder Protections /Transformer Protections/ Motor Protections for 500MW unit or above/ atleast for 220kV substation. These relays should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

5.6.2 The Numerical Relay Network system shall be offered from an Integrator/ Manufacturer who has designed and successfully done SAT for a network on IEC 61850 with least 100 Communicable Numerical Relays prior to the date of Techno-Commercial bid opening.

5.7 HT MOTORS

a) CW MOTOR

The CW pump drive motors should be sourced from a Manufacturer who have supplied at least two nos. of 6.6KV or above, vertical, DOL started

squirrel cage induction motors of cooling type specified having rating 2000 KW or more and motor speed not exceeding 500 rpm synchronous, which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

b) BFP MOTOR

The offered Squirrel cage Induction motor shall be from such a Manufacturer who has manufactured and supplied motor of 10 MW or above rating, which should have been in successful operation in at least one (1) plant for a period not less than two (2) years prior to the date of Techno-Commercial bid opening.

c) ID FAN MOTOR

The offered Squirrel cage Induction motor shall be from such a Manufacturer who has manufactured and supplied motor of 8 MW or above rating, which should have been in successful operation in at least one (1) plant for a period not less than two (2) years prior to the date of Techno-Commercial bid opening.

5.8 CONTROL CABLES

The Bidder/ Sub Vendor should have manufactured and supplied prior to the date of Techno-Commercial bid opening the following:

(a) At least 300 km of PVC insulated, PVC sheathed stranded copper conductor 1.1kV grade cables in one single contract

(b) At least one (1) km of Flame retardant low smoke cables.

5.9 1.1 KV POWER CABLES

The Bidder/ Sub Vendor should have manufactured and supplied prior to the date of Techno-Commercial bid opening the following:

(a) At least 100 km of aluminium conductor, XLPE insulated, PVC sheathed power cables of 1.1kV or higher grade in one single contract

(b) At least 100 km of aluminium conductor, PVC insulated, PVC sheathed power cables of 1.1kV or higher grade in one single contract

(c) At least one (1) km of flame retardant low smoke cables.

(d) 1.1kV or higher grade power cable of minimum 630sq.mm conductor size.

5.10 HT POWER CABLES

The Bidder/ Sub Vendor should have manufactured and supplied following cables, prior to the date of Techno-Commercial bid opening

(a) At least 50kms of XLPE insulated power cables of 6.35/11 KV or higher voltage grade, executed in one or more orders.

(b) At least one (1) km of flame retardant low smoke cables of any voltage level.

5.11 **DG SETS**

The Bidder/ Sub Vendor should have supplied at least two (2) numbers of DG sets of rating not less than 1500 kVA, at least one (1) each at two (2) different installations, which is in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening. The offered make of the DG sets (Alternator and Engine) shall be same as that of reference plant DG sets.

Note: Two different installations mean two different project sites.

5.12 **DC BATTERIES**

The Bidder / Sub Vendor should have manufactured and supplied at least two (2) numbers of highest offered rating or above of High Discharge type Plante type (in case bidder offers Lead Acid Plante type battery) or High Discharge type Nickel Cadmium battery (in case bidder offers Nickel Cadmium battery), at least one (1) each at two (2) different industrial installations, which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

Note: Two different installations mean two different project sites or two different contracts

5.13 **BATTERY CHARGER**

The Bidder/Sub Vendor should have manufactured and supplied at least two (2) numbers of Static Automatic Voltage Regulator type Battery Chargers of highest offered rating or above, at least one (1) each at two (2) different industrial installations, which should have been in successful operation for at least two (2) years prior to the date of Techno-Commercial bid opening.

Note: Two different installations mean two different project sites or two different contracts

5.14 **400 KV SWITCHYARD**

5.14.1 The Vendor/his Group Company should have Designed, Manufactured, Supplied, Erected/Supervised erection, Commissioned/Supervised Commissioning of one (1) Gas Insulated Switchgear (GIS) Installation having at least Six (6) bays of 400 kV or above voltage class with a short circuit rating of not less than 50 kA for 1 second, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening.

AND

The above Vendor should have established manufacturing facilities in India and should have supplied atleast Four (4) GIS bays of 400 kV or above from their Indian manufacturing facility.

Documentary evidence meeting the above requirement shall be submitted to the Owner.

Note: For the purpose of qualifying requirement, one no. of bay shall be considered as comprising of at least one circuit breaker, two disconnectors and single phase current transformers.

5.14.2 **400 kV AIS INSTRUMENT TRANSFORMERS**
(Current Transformer/ Capacitor Voltage Transformer as applicable)

400 kV Instrument Transformers being offered should be from Manufacturer who have manufactured and supplied at least fifteen (15) Nos. of single phase Instrument Transformers suitable for Switchyard of 400 kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.14.5 **400 kV AIS SURGE ARRESTORS**

400kV Surge Arrestors being offered should be from Manufacturer who have manufactured and supplied at least fifteen (15) Nos. of single phase Surge Arrestors suitable for Switchyard of 400kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.14.6 **220 kV CIRCUIT BREAKERS**

220kV Circuit Breakers being offered should be from Manufacturer who have manufactured and supplied at least five (5) three phase circuit breakers suitable for Gas Insulated Substation/ Switchyard of 220 kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.14.7 **220 kV INSTRUMENT TRANSFORMERS**
(Current Transformer/ Capacitor Voltage Transformer as applicable)

220 kV Instrument Transformers being offered should be from Manufacturer who have manufactured and supplied at least fifteen (15) single phase Instrument Transformers suitable for gas Insulated Substation/ Switchyard of 220 kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.14.8 **220 kV DISCONNECTORS**

220kV Disconnectors being offered should be from Manufacturer who have manufactured and supplied at least five (5) three phase Disconnectors suitable for gas Insulated Substation/Switchyard of 220kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno- Commercial bid opening.

5.14.9 **220 kV SURGE ARRESTORS**

220kV Surge Arrestors being offered should be from Manufacturer who have manufactured and supplied at least fifteen (15) single phase Surge Arrestors suitable for gas Insulated Substation/ Switchyard of 220kV or above class which should have been in successful operation for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.15 **Substation Automation System & Protective Relays**

The Substation Automation System offered with distributed architecture should have been in successful operation in at least one (1) Substation/Switchyard of not less than 220 kV class for minimum two (2) years prior to the date of Techno-Commercial bid opening.

The Generator Protection Relays, Transformer protection, Line Protection, the Bay Protection Units including the Bus bar protection and the energy metering System offered should be from manufacturer(s) who have manufactured and supplied the offered type of devices for respective equipment, which should have been in successful operation in a 500 MW or above unit/ 220 kV class or above Substation/Switchyard for minimum two (2) years prior to the date of Techno-Commercial bid opening.

5.16 **Provenness criteria for Solar PV rooftop on plant buildings:**

Solar PV rooftop EPC contractor: The Bidder or its Sub-vendor should have designed, supplied, erected/supervised erection and commissioned/supervised commissioning of SPV based grid-connected power plant of at least one plant of 40 kWp or above. The reference plant of 40 kWp or above capacity must have been in successful operation for at least six months.

Solar PV module The bidder/sub-contractor shall meet the requirements as stipulated in para (a) and (b) below for supply of solar PV modules:

a) The Bidder / sub-contractor should have manufactured and supplied the solar PV modules of cumulative installed capacity of 1MWp or above using any rating of modules and any source of indigenous or imported PV cells in any one financial year.

b) The Bidder / sub-contractor should have manufactured and supplied solar PV modules built up using indigenous and/or imported PV cells of power rating 300Wp or above which must have been in successful operation for at least six months.

6.0 **Provenness of I & C Equipment/Systems**

6.1 The Distributed Digital Control, Monitoring and Information System (DDCMIS) supplier(s) of SG C&I, TG C&I and BOP C&I, should have engineered, supplied, and commissioned their respective sub-systems in at least one (1) unit of a power station having unit rating 660 MW or above. It is not essential that all the three sub-systems are implemented in a single unit i.e., SG C&I, TG C&I and BOP C&I DDCMIS supplier(s) may supply even if their respective sub-systems have been implemented in three different units/ power station.

The BOP C&I DDCMIS/ supplier who fully meet the above requirement for BOP C&I but does not meet the requirement of SG C&I and/or TG C&I DDCMIS, may also supply SG C&I and/or TG C&I DDCMIS provided he collaborates /associates with DDCMIS/ DCS manufacturer(s) who fully meets the above requirement for SG C&I and/or TG C&I DDCMIS respectively. In such case, the Bidder shall be required to furnish a Deed of Joint Undertaking(s) (DJU) jointly executed by the Bidder, its sub-vendor (if applicable) and the Collaborator(s)/Associate(s) for the successful performance of Distributed Digital Control, Monitoring and Information System (DDCMIS) , as per the format enclosed with the bidding documents in which the

Collaborator(s)/Associate(s) and the Bidder, its sub-vendor (if applicable) are jointly and severally liable to the Employer to perform all the contractual obligations including the technical guarantees for the complete DDCMIS. The Deed of Joint Undertaking(s) (DJU) shall be submitted at the time of placement of order on approved vendor. In such a case, the Collaborator(s)/Associate(s) and the Bidder's sub-vendor (if applicable) shall each be required to furnish an on demand bank guarantee for INR 30 Million (Rupees Thirty Million) in addition to the contract performance security to be furnished by the bidder.

6.2 The respective DDCMIS offered for BOP C&I, SG C&I and TG C&I application(s) shall be same or of same series which

a) is operating successfully with control system (s) for any of the above application for a period of not less than one (1) year prior to the date of Techno-Commercial Bid opening in at least one (1) unit of a power station having rating of 660 MW or above

and

b) has been commissioned in at least one (1) unit of a power station having unit rating 660 MW or above for respective application(s).

6.3 Measuring instruments (primary & secondary), SWAS equipment offered for this package shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in one power station having unit rating of 660 MW or above.

6.4 The 24 V DC modular charger offered for this package shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in any industry or telecommunication application with a rating of 500 A or above.

6.5 The UPS system offered for this project, shall have atleast one(1) year's satisfactory operation prior to the date of Techno-Commercial bid opening, in one(1) power station for a rating of 105 KVA or above.

6.6 All other C&I equipment/ C&I system/Control systems/Sub systems and accessories etc., offered for this project shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in one power station having unit rating of 660 MW or shall meet the provenness criteria/qualifying requirements indicated elsewhere in the specification.

6.7 The Plant Security and Surveillance System offered by the Bidder shall be from reputed manufacturer, who should have designed, manufactured, tested and commissioned a distributed type Plant Security and Surveillance systems having minimum installation of total forty (40) nos. cameras in single thermal power plant or single large industrial installation and which is in successful operation for a minimum period of one (1) year prior to the date of Techno-commercial bid opening.

6.8 The offered combination of camera types and video management software, for CCTV system, shall have at least one year's satisfactory operation prior to the date of Techno-Commercial bid opening in a large industrial setup viz power plant, cement plant, petroleum refinery, steel plants or coal mine, having minimum installation of total forty(40) nos. cameras.

6.9 The Bidder should have carried out Engineering of Control and Instrumentation System of the complete plant including offsite plants of at least one (1) unit of a coal fired power station having unit rating 660 MW or above which is in successful operation for a period of not less than one (1) year prior to the date of Techno-Commercial Bid opening. In case the Bidder does not have the engineering experience of the complete plant as described above, then the Bidder shall get the Control and Instrumentation engineering of the remaining plant area (s) done through any of its sub vendor(s) / supplier(s) or through Engineering firm(s) who meets the above requirement for the respective plant area(s).

6.10 Bidder shall furnish the required information / details / PTR to fully satisfy the owner regarding successful operation and high reliability of products/systems offered / furnished.

6.11 The bidder shall obtain & furnish the certification from his tie-up partners (as consortium or otherwise) that their design, engineering, procurement, manufacturing, erection, commissioning and shop test facility are adequate to meet the specified technical & performance/quality requirements for execution & commissioning of the package offered to the satisfaction of owner.

Notes:

A. BOP C&I referred in Para 6.1 and 6.2 means the following sub-systems of a coal fired units:-

(i) Modulating control for Steam Generator (SG)

(ii) Modulating control for feed water / Condensate Cycle

(iii) Binary Control of the auxiliaries for Steam Generator SG)

(iv) Binary Control of the auxiliaries for Turbine generator (TG)

B. SG C&I referred in Para 6.1 and 6.2 means Burner Management System & Boiler Protection of coal fired units.

C. TG C&I referred in Para 6.1 and 6.2 means Steam Turbine Electro-hydraulic control & Turbine Protection system.

D. Engineering referred in Para 6.11 above shall include the followings as a minimum.

a) Preparation of basic logic/loop diagrams (not just the implementations), I/O List, Drive list, Instrument list etc for each of the plant areas of the complete plant including offsite systems based upon Flow schemes / Write ups by the OEM(s)

b) Engineering of power supply system for DDCMIS, Process connection and piping, SWAS, Control Valves.

c) Instrumentation, cable engineering including preparation of Interconnection Cable Diagram, Cable schedule etc.

Documents in support of the above shall be submitted along with the Bid.

7.0 PROVENNESS CRITERIA FOR CIVIL WORKS

7.1 Bidder or his agency should have in past executed civil and structural works for 500 MW or higher capacity thermal power plant including Coal handling plant, Ash handling plant, DM/PT plant, Main power house building, Chimney, Foundation for Turbo generator, all types of other foundations, water retaining structures, like CW pump house, Raw water pump house etc. Piling, CW steel liners, steel and concrete buildings, underground structures and any other civil and structural works required for 500 MW unit or higher capacity thermal power plant.

7.2 Bidder shall engage one agency, in case the bidder himself is not able to meet the requirement. The agency being engaged for a particular work must have in the past executed such works.

7.3 Bidder or his agency should have the capability of executing such works in the past and the rate of execution of the reference work should not be less than eighty percent (80%) of the asking rate of such works, for which he is being engaged, in a year. In case of separate agencies engaged for each unit, the cumulative rate of execution shall be considered for comparison with the asking rate of works.

7.4 Bidder or his design agency should have carried out the design and detail engineering of Main Plant Building, Coal handling plant, Ash handling plant, C W System, Turbo Generator foundation of 500MW unit or higher capacity thermal power plant (with or without VIS system as offered by the bidder) including at least one reinforced concrete chimney of minimum 220 M height.

7.5 Notwithstanding anything stated above, the Owner reserves the right to assess the bidder's or his agencies capabilities and capacity to perform the contract, should the circumstances warrant such assessment in the overall interest of the Owner.

7.6 The Main Contractor shall engage one or two sub-contractors for carrying out civil & Structural works excluding Chimney and natural draught Cooling Tower. However, the Civil & Structural sub-Contractors shall have the following qualifying requirements.

a) Civil works(except construction of Chimney) :

i) Bidder/Sub - Contractor shall have experience in carrying out civil engineering works for Industrial buildings/ equipment foundations/high-rise buildings (three storied and more) etc.

ii) Bidder/Sub - Contractor should have executed not less than 20,000 m^3 of R.C.C work in a single agreement in a year.

iii) The work in S No. i) & ii) should have been completed within the past seven (7) years, as on date of LOA.

iv) Bidder to furnish necessary fool proof crystal clear documentary evidence without any ambiguity and interpretation to prove the above requirements and get approval from the Owner, prior to engaging them for civil works.

b) Structural steel works(for buildings and structures under the scope of civil):

- **For structural steel fabrication works:**

  i) Bidder/Sub - Contractor shall have experience in carrying out structural fabrication works for Industrial buildings/ Power plant structures / high-rise buildings (three storied and more) etc.

  ii) Any structural steel fabrication works of quantity not less than 2500 MT in a single agreement in a year.

  iii) The work in SNos. i) & ii) should have been completed within the past seven (7) years, as on date of LOA.

  iv) Bidder to furnish necessary fool proof crystal clear documentary evidence without any ambiguity and interpretation to prove the above requirements and get approval from the Owner, prior to engaging them for structural fabrication works.

- **For Structural steel Erection Works:**

  i) Bidder/Sub - Contractor shall have experience in carrying out structural steel erection works for Industrial buildings/ Power plant structures / high-rise buildings etc.

  ii) Any structural steel erection works of quantity not less than 2500 MT in a single agreement in a year.

  iii) The work in S No. i) & ii) should have been completed within the past seven (7) years, as on date of LOA.

  iv) Bidder to furnish necessary fool proof crystal clear documentary evidence without any ambiguity and interpretation to prove the above requirements and get approval from the Owner, prior to engaging them for structural erection works.

8.0 **BALANCE EQUIPMENT/ SYSTEMS**

The Bidder at its option can source the balance of plant equipment/systems not covered in clause 4.0, 5.0, 6.0 & 7.0 above. However for such balance of plant equipment/systems, the Owner reserves the rights to satisfy himself on the provenness of the equipment and capability and capacity of the manufacturers.

9.0 Notwithstanding anything stated above, the Owner reserves the right to assess the capabilities and capacity of the Bidder/its Collaborators/ licenser/ its sub-contractors to perform the contract, should the circumstances warrant such assessment in the overall interest of the Owner.

10.0 To enable the approval of sub-vendors, the Bidder shall provide all necessary data such as type, design, make, capacity, duty conditions, date of commissioning/ operation etc.

11.0 **Bidder shall submit the list of proposed sub-vendors/sub-contractors along with their credentials as per format of Attachment-3K duly filled for each equipment and system proposed for the EPC package for consideration/approval of the Owner within 90 days from issue of Letter of Intent.**

Annexure I

EPC PACKAGE FOR 1 x 800 MW DEEN BANDHU CHOTU RAM THERMAL POWER PLANT, YAMUNANAGAR

BIDDING DOCUMENT NO. : .....

(Experience Details - Applicable to all the Bidders)

Bidder's Name and Address :			**To HPGCL, Panchkula.**

Details of Provenness for the offered Steam Turbine.

S No	**Item Description**	**Plant Name**	**Module No.**	**Operating Steam Parameters (MS Pressure, MS Temp & RH Steam Temp)**	**Date of Commencement of Successful operation**	**Offered Module Same as Reference Module? Bidder to Confirm (Yes /No)**
1.	Provenness of HP Turbine Module					
2.	Provenness of IP Turbine Module					
3.	Provenness of Combined HP and IP Turbine Module (if applicable)					
4.	Provenness of LP Turbine(s) Module					

Certified that the offered Steam Turbine Set shall be built up using above proven HP, IP and LP turbine modules of M/s..... (Name of Steam Turbine Manufacturer).

The Turbine to be supplied under this contract shall be manufactured assembled and tested at ..... (Name of the Factory) where turbine of at least 500 MW rating have been manufactured in past/the Indian manufacturing company under supervision of ..... (Qualified Steam Turbine Manufacturer).

Certificate(s) from Owner that the aforesaid Steam Turbine Modules are in successful operation for atleast one (1) year as on the date of Tender opening and caused no serious problem in past, are furnished along with techno-commercial Bid at Annexure.. to this **Attachment-**…..

Date :

Signature……..

Place :

Printed Name …….

Designation ……

Common Seal ……

Annexure II

EPC PACKAGE FOR 1 x 800 MW DEEN BANDHU CHOTU RAM THERMAL POWER PLANT , YAMUNANAGAR

BIDDING DOCUMENT NO. : .....

(Experience Details - Applicable to all the Bidders)

Details of Provenness for the offered Generator.

Bidder's Name and Address :		**To** **HPGCL** **Panchkula**	
S No	**Item Description**	**Details**	**Offered Design and Construction is similar to Reference Design? Bidder to Confirm (Yes /No)**
1.	Name of the Station and its Location		
2.	Client Name and its Address, Fax and Tel. No.		
3.	Name and Designation of the responsible person in Client's Organisation		
4.	Date of commencement of successful operation		
5.	Generator Make		
6.	Model No.		
7.	MVA Rating		
8.	MW Rating		
9.	Compliance to IS/IEC Standard		
10.	Cooling medium (e.g. Water, Hydrogen etc.) (i) Stator Core (ii) Stator Winding (iii) Rotor		
11.	Number of shaft mounted fans		
12.	Thermal Class of Insulation (i) Stator (ii) Rotor		
13.	Details of Core & Core support system (e.g. Spring type/ Rigid type etc.)		
14.	Type of Excitation system		
15.	Factory /Works where the Generator rating equal to 500MW or more was Manufactured, assembled & tested		

16.	Factory/works where the offered Generator is proposed to be Manufactured, assembled and tested		

Certificate(s) from Owner that the Generator with above mentioned technical parameters is in successful operation for a minimum period of two (2) years prior to the date of Techno-Commercial bid opening and caused no serious problem in past, are furnished along with techno-commercial Bid at Annexure… to this **Attachment-**…..

Date :

Signature……..

Place :

Printed Name …….

Designation ……

Common Seal ……

LETTER OF SUPPORT FOR SATISFACTORY PERFORMANCE OF FGD SYSTEM FOR EPC PACKAGE

FOR 1 x 800 MW DEEN BANDHU CHOTU RAM THERMAL POWER PLANT, YAMUNANAGAR

TO:

[***Employer's Name & Address***]

Sub: Letter of Support submitted From …….... (name of the collaborator*/Technology provider*/Licensor*) undertaking the responsibility for satisfactory performance of FGD SYSTEM

Dear Sirs,

1. In accordance with the Award of Contract by…… (Name of the Contractor) to M/s ……. (Name of the sub-vendor), We the aforesaid collaborator*/Technology provider*/Licensor*, M/s (……..) shall be fully responsible for the satisfactory performance of FGD system.

2. Further, the manner of achieving the objective set forth in point 1. Above shall be as follows:

   For FGD system

   (a) We shall provide design, manufacturing and assembly drawing of FGD system. FGD system shall be manufactured and supplied as per above design provided by us and the drawings approved by Employer.

   (b) We shall depute technical experts to Bidder's/Sub-vendor's works for supervision during manufacturing, assembly, erection, commissioning and final testing (as and when necessary) of FGD system.

   (c) We shall promptly carry out all the corrective measures and shall promptly provide corrected design and shall undertake replacements, rectifications or modifications to the equipment as required incase the equipment fails to demonstrate successful performance as per contract at site

3. We, the Collaborator*/Technology provider*/Licensor* do hereby undertake and confirm that this Letter of Support shall valid till the end of warranty period of the contract.

Signature of the Authorized Representative:

For M/s…….

(Collaborator*/Technology provider*/Licensor*)

Name ……

Designation ……..

Date ……..……

Common Seal of the Company

*: Strike off whichever is not applicable.

CHAPTER - 5

GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

This chapter covers technical requirements, which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.

2.0 BRAND NAME

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Owner to determine that the products proposed are equivalent or superior to those named.

3.0 BASE OFFER & ALTERNATE PROPOSALS

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technicalspecifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Owner. Sufficient amountof information for justifying such proposals shall be furnished to Owner along with the bid to enable the Owner to determine the acceptability of these proposals.

4.0 ALL THE FACILITIES COMPLETED BEFORE FTO

4.1 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.

4.2 All equipment furnished by the Bidder shall be complete in every respect, withall mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operatingpersonnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

4.3 All similar standard components/ parts of similar standard equipment provided shall be interchangeable with one another.

4.4 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Owner.

5.0 CODES & STANDARDS

5.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

a) Bureau of Indian Standards (BIS).
b) Indian Boiler Act, 1923, and Rules and Regulations specified thereunder./GCC
c) Indian Factory Act, 1948, and Rules and Regulations specified thereunder. /GCC.
d) Indian Explosives Act, 1884, and Rules and Regulations specified thereunder. /GCC.
e) Indian Petroleum Act, 1934, and Rules and Regulations specified thereunder. /GCC.
f) ASME Test Codes./GCC
g) AIEE Test Codes./GCC
h) IEEE 122./GCC
i) IEC 34.1, 34.3./GCC
j) American Society of Materials Testing Codes./GCC
k) Bureau of the Indian Standards (BIS) ./GCC
l) Indian Electricity Act (2003)
m) Indian Electricity Rules
n) Indian Explosives Act
o) Indian Factories Act and State Factories Act
p) Indian Boiler Regulations (IBR)
q) Regulation of Central Electricity Authority
r) Regulations of the Central Pollution Control Board, India
s) Regulations of the Ministry of Environment & Forest (MOEF),
t) Pollution Control Regulations by Department of Environment, Government of India
State Pollution Control Board.
u) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
v) Explosive Rules, 1983
w) Petroleum Rules, 1976,
x) Gas Cylinder Rules, 1981
y) Static and Mobile Pressure Vessels (Unified) Rules, 1981
z) Workmen's Compensation Rules, 1924
aa) Rules for Electrical installation by Tariff Advisory Committee (TAC) and appropriate Electrical Inspectorate.
bb) Owner’s Safety Policy
cc) Any other statutory codes / standards / regulations, as may beapplicable.

5.2 Unless covered otherwise by Indian codes & standards and in case nothing tothe contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

a. British Standards (BS)
b. Japanese Industrial Standards (JIS)
c. American National Standards Institute (ANSI)
d. American Society of Testing and Materials (ASTM)

e. American Society of Mechanical Engineers (ASME)
f. American Petroleum Institute (API)
g. Standards of the Hydraulic Institute, U.S.A.
h. International Organization for Standardization (ISO)
i. Tubular Exchanger Manufacturer's Association (TEMA)
j. American Welding Society (AWS)
k. Cooling Tower Institute (CTI)
l. National Electrical Manufacturers Association (NEMA)
m. National Fire Protection Association (NFPA)
n. International Electro-Technical Commission (IEC)
o. Expansion Joint Manufacturers Association (EJMA)
p. Heat Exchange Institute (HEI)
q. IEEE standard
r. JEC standard

5.3 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superiorto the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to wordtranslation of the standard that is normally not published in English.

5.4 As regards highly standardized equipment such as Steam Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL,SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design,Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National/International standards, established and proven standards of manufacturers shall also be considered.

5.5 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

5.6 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Owner shall have the option to incorporate the changed requirements or to retain theoriginal standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

5.7 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Owner within two calendar months from the date of the Notification of Award

6.0 EQUIPMENT FUNCTIONAL GUARANTEE

Please refer Chapter 8, Volume II

7.0 DESIGN OF FACILITIES/MAINTENANCE AND AVAILABILITYCONSIDERATIONS

7.1 Design of Facilities

7.1.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

7.1.2 The Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.2 Maintenance and Availability Considerations

7.2.1 Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

7.2.2 Bidder shall state in his offer, various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.

7.2.3 Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist /crane shall be provided by the Bidder for lifting the equipment and accessories covered under the specification.

7.2.4 Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities

8.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED

8.1 Plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

8.2 The Contractor shall furnish engineering data/drawings in accordance with the schedule of information as specified in Technical Specification and data sheets.

8.3 A comprehensive engineering and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this

section of specifications.

8.4 Each main and auxiliary equipment/item of the plant including instruments shall be assigned a unique tag number. The assignment of tag numbers shall be in accordance with KKS system. In all drawings/documents/data sheet etc. KKS tag number of the equipment/item/instrument etc. shall be indicated.

8.5 The number of copies/prints/manuals to be furnished for various types of documents is given in Volume II, Chapter 5, Annexure-VI.

8.6 The documentation that shall be provided by the Bidder is indicated in various chapters of specification. The documentation shall include but not be limited tothe following:

8.6.1 **Basic Engineering Documentation**

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Plant Definition Manual within 4-6 weeks from the date of the LOI. This manual shall contain the following as a minimum.

1) System description of all the mechanical, electrical, control & instrumentation & civil systems.

2) Technology scans for each system / sub-system & equipment.

3) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

4) Optimization studies including thermal cycle optimization.

5) Sizing criteria of all the systems, sub-systems including various piping systems/ equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

6) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

7) Operation Philosophy and the control philosophy of the Main Plant and other plants.

8) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Owner's scope. This drawing shall also be furnished in the form of CD discs to the Owner for engineering of areas not included in Bidder's scope.

9) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the Bidder.

10) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of LOI, a list of contents of the Plant Definition Manual (PDMs)including techno-economic studies, which shall then be mutually discussed & finalised with the Owner.

After approval of Plant Definition Manual / Design Basis Report, Bidder shall furnish detailed technical specification of all system / packages of the Plant.

8.6.2 **Detailed Engineering Documentation**

1) Layouts, general arrangements, elevations and cross-sections drawingsfor all the equipment and facilities of the plant.

2) The Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the LOI.

3) This manual shall contain the following as a minimum:

- Water Balance diagram.
- Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.
- Start-up curves for turbine, boiler and both turbine and boiler combined together as a unit for various start-ups, viz. cold, warm and hot start- up.
- Piping isometric, composite layout and fabrication drawings.
- Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.
- Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.
- Detailed design calculations for components, system/sub-system, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.
- Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.
- Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.
- Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).
- Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for condensers & heaters.
- Model Studies for ESP & CW System.
- Characteristic Curves/ Performance Correction Curves and thermal design calculations for Cooling Tower.
- Composite Water Balance for total Plant.
- Hydraulic calculation/profile for Water Treatment Plant.
- Comprehensive list of all terminal points which interface with Owner's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
- Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- Protection systems diagrams and relay settings.
- Interconnection diagrams.
- Cable routing plan.
- Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups and installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
- Alarm and annunciation list and alarms & trip set points.
- Sequence and protection interlock schemes.

- Type test reports and power system stability study report.
- Control system configuration diagrams and card circuit diagrams and maintenance details.
- Detailed software manuals & source software listing.
- Detailed flow chart for digital control system.
- Mimic diagram layout.
- Civil Task drawings, Design and Drawings for the Civil & Structural works in the scope of the Bidder.
- Model study reports wherever applicable.
- Functional & guarantee test procedures and test reports.
- Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- Documentation in respect of commissioning as listed out elsewhere in this specification.

The Bidder while submitting the above documents/drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.6.3 **Instruction Manuals**

As per GCC

A Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

1) Erection strategy.
2) Sequence of erection.
3) Erection instructions.
4) Critical checks and permissible deviation/tolerances.
5) List of tool, tackles, heavy equipment like cranes, dozers, etc.
6) Bill of Materials
7) Procedure for erection.
8) General safety procedures to follow during erection/installation.
9) Procedure for initial checking after erection.
10) Procedure for testing and acceptance norms.
11) Procedure / Check list for pre-commissioning activities.
12) Procedure / Check list for commissioning of the system.
13) Safety precautions to be followed in electrical supply distribution during erection

B Operation & Maintenance Manuals

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and

Volume/Book number. Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O&M manuals shall be as follows :

Chapter 1 - Plant Description

To contain the following sections specific to the equipment/system supplied

i. Description of operating principle of equipment / system with schematic drawing / layouts.

ii. Functional description of associated accessories / controls. Control interlock protection writes up.

iii. Integrated operation of the equipment along with the intended system. (This to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

iv. Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment along with its accessories and auxiliaries.

v. Design data against which the plant performance will be compared.

vi. Master list of equipment, Technical specification of the equipment/system and approved data sheets.

vii. Identification system adopted for the various components, (it will be of a simple process linked tagging system).

viii. Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

Chapter 2 - Plant Operation:

To contain the following sections specific to the equipment supplied

i. Protection logics provided for the equipment along with brief philosophy behind the logic, Drawings etc.

ii. Limiting values of all protection settings.

iii. Various settings of annunciation/interlocks provided.

iv. Start-up and shut down procedure for equipment along with the associated systems in step mode.

v. Do's and Don'ts related to operation of the equipment

vi. Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/ lubrication failure/any other conditions.

vii. Parameters to be monitored with normal value and limiting values.

viii. Equipment isolating procedures.

ix. Trouble shooting with causes and remedial measures.

x. Routine testing procedure to ascertain healthiness of the safety devices along with schedule of testing.

xi. Routine Operational Checks, Recommended Logs and Records

xii. Change over schedule if more than one auxiliary for the same purpose is given.

xiii. System/plant commissioning procedure.

xiv. Preservation procedure on long shut down.

Chapter 3 - Plant Maintenance

To contain the following sections specific to the equipment supplied

i. Exploded view of each of the equipment. Drawings along with bill of materials including name, code no. & population.

ii. Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment

iii. List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.,

iv. Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

v. Preventive Maintenance schedules linked with running hours/calendar period along with checks to be carried out

vi. Overhauling schedules linked with running hours/calendar period along with checks to be done

vii. Long term maintenance schedules

viii. Consumables list along with the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling

ix. List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement

x. Tolerance for fitment of various components

xi. Details of sub vendors with their part no. in case of bought out items

xii. List of spare parts with their Part No, total population, life expediency & their interchange ability with already supplied spares to OWNER.

xiii. List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

xiv. Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares

xv. General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country/foreign country and list of utilities where similar equipment have been supplied.

After finalization and approval of the Owner, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Owner.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O&M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Owner for records and number of copies shall be as mentioned in Annexure-VI.

8.6.4 **Plant Handbook and Project Completion Report**

8.6.4.1 **Plant Handbook**

The Bidder shall submit to the Owner a preliminary plant hand book preferablyin A-4 size sheets which shall contain the design and performance data of various plants, equipment and systems covering the complete project including

1) Design and performance data.
2) Process & Instrumentation diagrams.
3) Single line diagrams.
4) Sequence & Protection Interlock Schemes.
5) Alarm and trip values.
6) Performance Curves.
7) General layout plan, layout of main plant building, auxiliary buildings.
8) Important Do's & Dont's

The plant handbook shall be submitted within twelve (12) months from the date of LOI. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted Six(6) months before start-up and commissioning activities.

8.6.4.2 Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant. (before Trial operation)

8.6.5 **Drawings**

a) i) All the plant layouts shall be made in computerized 3D modelling system. The Owner reserves the right to review the 3D model at

different stages during the progress of engineering. The layout drawings submitted for Owner's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisitenumber of hard copies shall be submitted as per Annexure-VI.

b) All documents/text information shall be in latest version of MS Office orMS Excel as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment andmaterials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of sub vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) Contractor shall prepare the model of all the facilities located within plant boundary covering facilities in Main Plant Block area and Balance of plant (BOP) area in an integrated & intelligent 3D software solution. Main Plant Block area shall include Transformer Yard, TG building (including all facilities), Boiler area, ESP area, chimney area, FGD area and any other facility located in main plant block. BOP area shall include all facilities pertaining to AHP, CHP, LHP, GHP, DM PT plant, pipe & cable racks and any other facility located within plant boundary.

All piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings and RCC layout of major buildings and structural arrangement drawings shall necessarily be extracted from the aforesaid 3D model.

Contractor shall prepare and provide 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc.), which is extracted from intelligent 3D model and shall make a presentation of the same every 3 months from LOA to enable OWNERS ENGINEERING to review the progress of engineering or as & when required by Owner.

f) The drawings submitted by the Contractor (or their sub-vendor) shall bear Owner's drawing number in addition to contractor's (their sub- vendor's)

own drawing number.

g) The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Owner. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

h) Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall beidentified on each drawing for Approval stamp and electronic signature.

i) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/drawings/documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Owner/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

j) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Owner.

k) All manufacturing, fabrication and execution of work in connection with the equipment/system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Owner.

l) However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Owner indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

m) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/approval of Owner prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Owner based on requirements of such piping indicated in approved / finalized Flow Scheme/Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

n) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent systemcharging and its effective draining & venting arrangement as per site suitability.

o) **As Built Drawings**

After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions in requisite number.

p) Drawings must be checked by the Bidder in terms of its completeness,data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering.The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner's scope and submit all necessary drawings/ documents for the same.

q) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

r) All engineering data submitted by the Bidder after final process including review and approval by the Project Manager/Owner shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technicalspecifications unless otherwise expressly requested by the ProjectManager in writing.

8.7 Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Owner. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. This list would be a comprehensive one including all engineering data /drawings/information for all bought out items and manufactured items. The information shall be categorized into the following parts.

a) Information that shall be submitted for the approval of the Owner before proceeding further, and

b) Information that would be submitted for Owner's information only.

The Master Drawing List (MDL) shall be updated periodically and submitted tothe Owner, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.8 **Engineering Progress and Exception Report**

8.8.1 Report giving the status of each engineering information including

a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

b) Drawings which were not submitted as per agreed schedule.

8.8.2 The draft format for this report shall be furnished to the Owner within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the Owner.

8.8.3 Provision for Fail Safe operation of vital Equipment

All the Plant and equipment/Systems supplied under the contract shall be designed following "Fail Safe" concept. In case of failure of Power supply like Electric power, Hydraulic pressure, Pneumatic pressure, Vacuum etc. the system should be designed in such a way that the equipment/Valves/dampers etc. shall always move/remains (as applicable) to safest position as per system requirement to ensure safety of Man and Machinery.

8.9 **Engineering Co-ordination Procedure**

8.9.1 The following principal coordinators will be identified by respective organizations at time of award of contract:

Project Manager (HPGCL CE-TD)

Name :
Designation :
Address
a) Postal :
b) Telegraphic /e-Mail :
c) FAX/TELEPHONE :

Project Consultant (Desein)

Name :
Designation :
Address
a) Postal :
b) Telegraphic /e-Mail :
c) FAX/TELEPHONE :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :
Designation :
Address :
a) Postal :
b) Telegraphic /e-Mail :
c) FAX/TELEPHONE :

8.9.2 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.9.3 Contractor's/Vendor's Drawing Submission and Approval Procedure:

a. All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for OWNER'S information/ interface and or review and approval are referred by the general term "drawings".

b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalized mutually between Contractor and Owner before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c. All drawings (including those of sub vendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in.The Contractor shall furnish this format to his sub vendor along with hispurchase order for sub vendor's compliance.

d. Owner and contractor shall follow their own numbering systems for the drawings. However, Owner shall intimate the contractor, OWNER drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate OWNER drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.

e. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data /drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities,equipment & works under Owner's scope and submit all necessary drawings/ documents for the same.

f. Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.

g. The Contractor shall submit adequate prints of drawing/data/documentfor Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNER and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories:

The Contractor shall submit drawing / data / document for Owner's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by OWNERS ENGINEERING and their comments shall be forwarded within three (3) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories:

CATEGORY A : Approved

CATEGORY B : Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments

CATEGORY C : See MEMO & COMMENTS

CATEGORY D : Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.

CATEGORY E : For information and records.

After **Rev 0** comments, the drawing will be locked in the system. Contractor will review the Rev 0 comments within 7 days & furnish the Comment Reply Sheet (CRS) to OWNERS ENGINEERING as an agenda point for TCM. TCM shall be conducted with Contractor on non-agreed comments of CRS.

System will not allow Contractor to submit approval category drawings before the scheduled submission date. However, documents may be unlocked on case to case basis. Based on resolution of all comments and agreements, the document will be approved in TCM itself. The contractor will revise the document based on the resolutions and certify that all the resolutions has been taken care of. Based on this certification, the document will be opened and submitted by contractor in the system for approval as Rev 1 within 10 days of TCM.

1. Contractor shall resubmit the drawings marked/stamped under Category B, C & D within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (e.g. 1, 2, 3 etc.,). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in theportions already approved, the Contractor shall resubmit the drawing identifying the changes for Owner's review and approval. **Drawings resubmitted shall show clearly the portions where the same arerevised marking the relevant revision numbers and Owner shall review only such revised portion of documents**.

2. In case, the Contractor/ Vendor does not agree with any specificcomment, he shall furnish the explanation for the same to OWNER for consideration. In all such cases, the Contractor shall necessarily encloseexplanations along

with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

3. It shall be the responsibility of the Contractor/ Vendor to get all the drawings approved as the case may be and complete the engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

4. If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried outon the basis of comments furnished on previous issues of the drawing.

5. These comments will be taken care by the contractor while submitting the revised drawing.

6. The contractor shall use a single transmittal for drawings Submission. This shall include transmittal numbers and date, number of copies beingsent, names of the agencies to whom copies being sent, drawing numberand titles, remarks or special notes if any etc.

9.0 TECHNICAL CO-ORDINATION MEETINGS

9.1 The Bidder shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings with the Owner / Owner's representatives/OWNER Consultant during the period of contract. The Bidder shall attend suchmeetings at his own cost at mutually agreed venue as and when required andfully co-operate with such persons and agencies involved during the discussions.

9.2 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the Owneras far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Owner shall then be discussed across the tableduring the above co-ordination Meetings wherein best efforts shall be made byboth sides to ensure the approval of the drawing.

9.3 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

9.2.2 Should any drawing remain unapproved for more than four (4) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

9.3 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completiondate.

10.0 DESIGN IMPROVEMENTS

The Owner or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.0 EQUIPMENT BASES

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Owner. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.0 LUBRICANTS, SERVO FLUIDS AND CHEMICALS

As per **Clause 28.10, Section V - E**CC **of Volume I**.

14.0 LUBRICATION & CHEMICALS

Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

14.1 Chemicals for Water System

Bidder's scope shall include chemicals required for complete water system up to final handing over EPC package and further two (2) months plant operational requirement.

15.0 MATERIAL OF CONSTRUCTION

All materials used for the construction of the equipment shall be new and shallbe in accordance with the requirements of this specification. Materials utilizedfor various components shall be those which have established themselves for use in such applications.

16.0 RATING PLATES, NAME PLATES & LABELS

16.1 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.

16.2 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.

16.3 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

16.4 Items of plant such as valves, which are subject to handling, shall be provided with engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

16.5 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

16.6 Valves, steam traps and strainers shall be identified by tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

16.7 Safety and relief valves shall be provided with the following:

a) Manufacturer's identification.

b) Nominal inlet and outlet sizes in mm.

c) Set pressure in Kg/cm^2 (abs).

d) Blow down and accumulation as percentage of set pressure.

e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in liters of water per minute.

16.8 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

16.9 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

17.0 TOOLS AND TACKLES

As per Erection Conditions of Contract

18.0 WELDING

As per Erection Conditions of Contract

19.0 COLOUR CODE FOR ALL EQUIPMENT/PIPING/PIPE SERVICES

19.1 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

20.0 PROTECTION AND PRESERVATIVE SHOP COATING

20.1 Protection

As per Erection Conditions of Contract

20.2 Preservative Shop Coating

20.2.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.

20.2.2 Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colours shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

20.3 Shop primer for all steel surfaces which will be exposed to operating temperature below 950 C shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 950 C and such primer shall also be subject to the approval of the Owner.

20.4 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

20.5 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

20.6 Painting for Civil structures shall be done as per relevant part of technical specification.

21.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Owner's site or at any other place of workare in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points, as necessary. Such programs shall be outlined by the Contractor and shall be finally accepted by the Owner /authorized representative after discussions before the award of the contract. The QA program shall be generally in line with ISO-9001/IS- 14001. A quality assurance program of the contractor shall generally cover thefollowing:

a) His organization structure for the management and implementation of the proposed quality assurance program.

b) Quality System Manual

c) Design Control System

d) Documentation and Data Control System

e) Qualification data for bidder's key personnel.

f) The procedure for purchase of materials, parts, components and selection of sub-vendor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

g) System for shop manufacturing and site erection controls including process, fabrication and assembly.

h) Control of non-conforming items and system for corrective actions and resolution of deviations.

i) Inspection and test procedure both for manufacture and field activities.

j) Control of calibration and testing of measuring testing equipment.

k) System for Quality Audits.

l) System for identification and appraisal of inspection status.

m) System for authorizing release of manufactured product to the Owner.

n) System for handling, storage and delivery.

o) System for maintenance of records, and

p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as Annexure-I and Annexure-II respectively.

22.0 **General Requirements - Quality Assurance**

22.1 All materials, components and equipment covered under this specification shallbe procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Program. An indicative program of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however,not intended to form a comprehensive program as it is the Bidder's responsibility to draw up and implement such program duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and shall be submitted to Owner for approval. Schedule of finalisation of such quality plans shall be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

22.2 Manufacturing Quality Plan shall detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-vendor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval. After approval, the same shall be submitted in compiled form on CD-ROM.

22.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.

22.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorized representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.

22.5 No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to pre dispatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/ Authorized representative and duly authorized for dispatch by issuance of Material Dispatch Clearance Certificate (MDCC).

22.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

22.7 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format enclosed at Annexure-V. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at leastninety days before schedule start of erection work at site.

22.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.

22.9 All welding/brazing procedures shall be submitted to the Owner or its authorized representative for approval prior to carrying out the welding/brazing.

22.10 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-vendor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.

22.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorized representative.

22.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds

MPI/LPI shall be carried before seal welding.

22.13 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

22.14 No welding shall be carried out on cast iron components for repair.

22.15 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

22.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

22.17 All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

22.18 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-vendor proposed by the Bidder for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalized with the Owner, shall be subject to Owner's approval. The Bidder's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-vendor detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.

22.19 For components/equipment procured by the contractor for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-vendor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organization, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalized with the Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-vendor. Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.

22.20 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-vendor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

22.21 The Bidder shall carry out an inspection and testing program during manufacture in his work and that of his sub-vendor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/ equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorized representative.

22.25 **Environmental Stress Screening**

Environmental stress screening test process / procedure for eliminating infant mortile components for DDCMIS / PLC based system & for other systems having substantial electronics components (as determined by Owner) like Electronic transmitter, CCTV components, PA systems etc. shall be furnished for OWNERS ENGINEERING acceptance.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by Owner shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

22.25.1 All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following

22.25.2 The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

OR

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two number or 10% whichever is less, most densely populated Panels shall be tested for ElevatedTemperature Cycle Test as per the following procedure.

23.0 **Software Reliability / Quality Certification**

Certification from OEM's authorized signatory that software offered with DDCMIS, PLC, CCTV, PA, Pyrometer, CEMS, AAQMS, EQMS, BHMS etc. declaring that the all the offered software(s) had gone through the established software quality test and offered software is not of β-version and offered software is also free from all known bugs as on date of approval of systems documents by OWNERS ENGINEERING as a part of quality documentation review and approval process during detail engineering.

24.0 **QA Documentation Package**

24.1 The Bidder shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark.

24.2 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

24.3 The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

24.4 The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

24.5 Typical contents of QA Documentation are as below:-

a) Quality Plan
b) Material mill test reports on components as specified by thespecification and approved Quality Plans.
c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
e) Heat Treatment Certificate/Record (Time- temperature Chart)
f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
g) CHP / Inspection reports duly signed by the Inspector of the Owner and Bidder for the agreed Customer Hold Points.
h) Certificate of Conformance (COC) wherever applicable.
i) MDCC

24.6 Similarly, the Bidder shall be required to submit two sets (two hard copies andtwo CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, priorto commissioning of individual system.

24.7 Before dispatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file iscompleted. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

c) If a decision is made dispatch, whereas all outstanding actions cannotbe readily cleared for the release of the quality document by that time.The supplier shall immediately, upon shipment of the equipment, senda copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

24.8 **Transmission of QA Documentation**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department (@ Head Office) and otherset to respective Project Site of Owner.

For the particular case of phased deliveries, the complete quality document tothe Owner shall be issued not later than 3 weeks after the date of the last delivery of equipment.

25.0 **PROJECT MANAGER'S SUPERVISION**

25.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

25.2 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

a) Interpretation of all the terms and conditions of these documents and specifications:

b) Review and interpretation of all the Bidder's drawing, engineering data, etc.,

c) Witness or his authorized representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

d) Inspect, accept or reject any equipment, material and work under the contract.

e) Issue certificate of acceptance and/or progressive payment and final payment certificates

f) Review and suggest modifications and improvement in completion schedules from time to time, and

g) Supervise Quality Assurance Program implementation at all stages of the works.

26.0 INSPECTION, TESTING AND INSPECTION CERTIFICATES

As per SCC

26.1 Associated document for quality assurance program:

26.1.1 List of items requiring quality plan and sub supplier approval. (Annexure-III).

26.1.2 Status of items requiring Quality Plan and sub supplier approval (Annexure-IV)

26.1.3 Field Welding Schedule (Annexure-V).

26.1.4 Manufacturing Quality Plan (Annexure-I).

25.1.5 Field Quality Plan (Annexure-II).

26.2 Testing Of Major Design Features Of I&C System

The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within four months from the date of LOA. These are the system function tests,which have a major impact on the detailed system design & finalization of important engineering documents like configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features & include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before a w a r d . The developments and any augmentation of standard features undertaken by the Bidder to fulfil the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following

A) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.
B) Loop reaction time for sample loops/ logics
C) SOE functionality tests
D) Server changeover
E) Various response times, having serious implication on operation & maintenance philosophy
F) Duty cycle of controller/ HMIPIS with simulated load, representativeof

the final engineered load.

G) Unified HMI for DDCMIS

The results of the above tests, after its acceptance by the Owner, shall be properly documented and submitted to Owner.

26.2 **Demonstration of Application Engineering**

26.2.1 Based on Owner's inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following

i) Logics/Loops:

a) Drive logics implementation for each type of binary drive alongwith its display in HMI.

b) Sequence implementation along with its display in HMI.

c) Single non-cascade controller implementation.

d) Cascade loop implementation.

e) Master slave implementation with different slave combination.

f) Temperature & pressure compensation for flow signals &pressure compensation for level signals as applicable

ii) HMI Functions:

a) LVS Annunciation.
b) Graphics.
c) HSR
d) Logs/Reports.
e) Calculations (Basic & Performance Calculations).

26.2.2 The above typical cases shall be finalized with the Owner through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on OWNER's inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by theOwner and demonstrate to Owner at Owner premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Ownerpremises & the results shall be documented as part of test report.

26.2.3 During the integrated testing at the Contractor's works, only sample checks shall be done by the Owner for the items covered in above application engineering demonstration.

27.0 PRE-COMMISSIONING, COMMISSIONING, TRIAL OPERATION, PERFORMANCE TEST

As per Section VI-SCC of Volume I.

27.1 Initial Operation/Trail Operation Test

As per Section VI-SCC of Volume I.

27.2 Guarantee Tests

As per Chapter 8, Volume II.

28.0 FINAL TAKING OVER

As per Section VI-SCC of Volume I.

29.0 TRAINING OF OWNER'S PERSONNEL

The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance. Total period for above training shall not be less than sixty (60) man-months at manufacturers' works & facilities.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:

a) Training for Steam Generator & ESP Equipment, TG & Auxiliaries and related equipment.

b) Training for Electric Systems including VFD and Electric power supply system.

c) Training for other SG/TG related C&I systems/equipment including training on Flame Monitoring System, Furnace and Flame Viewing System, Turbine Supervisory System (TSS) including vibration analyzer, vibration monitoring system axial shift, eccentricity measurements etc. for Main Turbine, BFP Turbine etc. Burner management study, control loop study, misc system for SG C&I, EHTC, Turbine stress control system, Turbine protection system, ATRS, instrumentation etc.

d) Training for special packages for various PC based systems.

e) Training for various C&I systems/equipment supplied includes the following:

i. DDCMIS - Human Machine Interface – Hardware & Operating System
ii. DDCMIS-Human Machine Interface System Engineering & Application Software.
iii. DDCMIS – Control System Hardware and Control system Application Software.
iv. DDCMIS – Operator Training: Use of the system at Works + at site.
v. DDCMIS – Specialized Network security.

f) Training for power cycle piping/critical piping.

g) Training for UPS systems Annunciation system, SWAS, PA system, flue gas analysers, CCTV and 24 VDC systems.

h) Training for numerical relays & networking systems supplied under MV & LT switchgear system.

i) Details of training modules for Mechanical, Electrical and C&I systems are given at Annexure – VII,

The exact details, extent and schedule for training shall be as finalized during detailed engineering and shall be subject to Owner's approval.

29.1 The scope of services under training shall also necessarily include training of Owner's personnel covering a training module as indicated in Annexure – VII. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design soft-wares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc.

29.2 Contractor shall also arrange for training of Owner's personnel in respect of fire detection and protection systems and other Balance of Plant equipment.

29.3 Four (4) man month and two (2) man month training for OWNER Engineering Personnel on the offered CFD modelling code for SG & ESP including alternative geometry modeling technique shall be provided.

29.4 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (Annexure – VII for O&M and Engineering) is indicative only. Owner reserves the right to re-appropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

29.5 Exact details, extent of training and the training schedule shall be finalized by the Owner based on the Bidder's proposal.

29.6 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's (within Owner’s Country) it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

29.7 In case the training of Owner's personnel is arranged at the works of the manufacturer's (outside Owner’s Country) it shall be noted that the all the expenses including travel, air fare, application processing fees, lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all **necessary arrangements towards the same.**

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

30.0 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

As per Section V- ECC, Volume I

31.0 **NOISE LEVEL**

As per Chapter 8, Volume II.

32.0 **PACKAGING AND TRANSPORTATION**

As per Section IV-GCC, Volume I

33.0 **ELECTRICAL EQUIPMENT/ENCLOSURES**

All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.

34.0 **INSTRUMENTATION AND CONTROL**

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

34.1 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm^2). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure.If nothing is there, that will mean that the indicated pressure is gauge pressure.
c)	Draught	-	Millimeters of water column (MMWC).
d)	Vacuum	-	Millimeters of mercury column (mm Hg) or water column (MMWC).
e)	Flow (Gas)	-	Tonnes/ hour
f)	Flow (Steam)	-	Tonnes/ hour
g)	Flow (Liquid)	-	Tonnes / hour
h)	Flow base	-	760 mm Hg. 15^0 C
i)	Density		Grams per cubic centimeter.

34.2 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

34.3 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalized & components shall be of industrial grade or better.

35.0 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniquesto eliminate measurement and control problems caused by electrical noise. Areas in Bidder's equipment, which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in theproposal. The equipment shall be protected against ESD as per IEC-801- 2./ IEC 61000-2 Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.

36.0 SURGE PROTECTIONS FOR SOLID STATE EQUIPMENT

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a powerplant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates etc. shall be submitted by the Bidder.

37.0 INSTRUMENT AIR SYSTEM

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, powercylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

38.0 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

a) Temperature test pockets with stub and thermowell.

b) Pressure test pockets

39.0 SYSTEM DOCUMENTATION (DDCIMS)

39.1 The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C&I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Owner during detailed engineering stage and to

provide information to plant personnel for operation& Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I "Technical DataSheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the TechnicalSpecification.

39.2 The exact format, submission schedule and contents of various documents shall be as finalized during detailed engineering stage.

39.3 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Owner.

40.0 MAINTENANCE MANUALS OF ELECTRONIC MODULES

The Contractor shall furnish 2 SETS OF all maintenance manuals of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make, model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

41.0 ENVIRONMENTAL MONITORING & CONTROL MEASURES

41.1 The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment,so that there are no adverse effects due to emissions, noise, and contaminationof soil, water and air.

41.2 One single flue stack of minimum 150 M will be provided for wider dispersion of pollutantas per environmental guidelines.

42.0 LIST OF CODES AND STANDARDS

Indian Standards	Title	Equivalent standards
IS: 277	Galvanised steel sheets (plain or corrugated)	
IS: 655	Specification for metal air duct	
IS: 800	Code of practice for	BS 449:1969
	use of structural	BS 5950
	steel in general	ASA A57,
	building construction 1-1952	
IS: 807	Code of practice for	Draft Revision,
	design, manufacture,	A.S. NO. CS.2
	erection and testing	SAA Crane and
	(Structural portion)	Hoist code
	of cranes and hoists	Doc:No. BU/4 Rev

	6588 (Issued by	
	Standards Association of	
	Australia) DIN 120:1936	
	(Sheet 1) DIN 120:1936	
	(Sheet 2) 327 part-I, 1951	
	BS 466 part-II, 1960 BS 644:1960BS 1757:1951BS 2573:part-I:1960	
IS:875	Code of practice for design loads (other than Canada earthquake) for buildings and structures Leading standards by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Buildingcode of (1953)-Part-IV Design section 4.1 (issued
IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957)(ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239	Mild steel tubulars and	BS 1387 : 1967
Part-II	other wrought steel pipe fittings	BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	

IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for performance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type	

	Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
IS:3354	Outline dimensions for electric lifts.	
IS:3401	Silica gel	
IS:3588	Specification for electrical axial flow fans	
IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)	
IS:3677	Unbonded rock and slag wool for thermal insulation	
IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)
IS:3895	Specification for monocrystallines semiconductor rectifier cells and stacks	
IS:3963	Roof extractor unit	
IS:3975	Mild steel wires, strips and tapes for armouring cables	
IS:4503	Shell and tube type heat Exchanger	
IS:4540	Specification for mono crystallinesrectifire assembly equipment	
IS:4671	Expanded polystyrene for thermal insulation purpose	
IS:4736	Hot dip zinc coating on steel tubes	
IS:4894	Centrifugal fans	

IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392	Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098	Cross linked Polyethylene PVC sheathed cables	Standard No. 1 to insulated IPCEA (USA) Pub. No. 5-66-524
IS:7373	Specification for wrought aluminium and aluminium sheet and strips	
IS:7938	Air receivers for compressed air installation	
ISO:1217	Displacement compressor-Acceptance test	
ASHRAE-33	Methods of testing for rating of forced circulation air cooling and air heating coils.	
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particulate matter	
ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.	
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.	
ARI-450-6	Standard for water cooled refrigerant condensers.	
ARI-550	Standard for centrifugal water chilling packages.	
ARI-410	Standard for forced circulation air cooling and air heating coils	
ARI-430/435 BS:848 (Part-1,2)	Central station AHU/Application of Central Station AHU Fans	
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.	
BS:401	Low carbon steel cylinders for the storage & transport of liquefied gases.	
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.	

ANSI-31.5	Refrigerant piping
ASME-PTC-23-1958	Atmospheric Water Cooling Equipment
AMCA A-21C	Test Code for air moving devices
API:618	Reciprocating Compressor for general refinery services.

HYDRAULIC INSTITUTE STANDARDS.

HYDRANT SYSTEM MANUALS OF TAC.

TAC MANUALS OF SPRAY SYSTEM

NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

CODE AND STANDARD FOR CIVIL WORKS

Some of the applicable Standards, Codes and references are as follows:

Excavation & Filling

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701	Code of practice for earth work on canals.
IS: 9758	Guide lines for Dewatering during construction.
IS: 10379	Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS: 269	Specification for ordinary Portland cement, 33 grade.
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete.
IS: 432	Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.
IS: 455	Specification for Portland slag cement.
IS: 702	Specification for Industrial bitumen.
IS: 712	Specification for building limes.

IS: 808	Rolled steel Beam channel and angle sections.
IS: 1077	Specification for common burnt clay building bricks.
IS: 1161	Specification of steel tubes for structural purposes.
IS: 1363	Hexagon head Bolts, Screws and nuts of production grade C.
IS: 1364	Hexagon head Bolts, Screws and Nuts of Production grade A & B.
IS: 1367	Technical supply conditions for Threaded fasteners.
IS: 1489	Specification for Portland-pozzolana cement:
(Part-I)	Fly ash based.
(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.
IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS:8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.
IS: 457	Code of practice for general construction of plain & reinforcedconcrete for dams & other massive structures.
IS: 516	Method of test for strength of concrete.
IS: 650	Specification for standard sand for testing of cement.
IS:1199	Methods of sampling and analysis of concrete.
IS: 1791	General requirements for batch type concrete mixers.
IS: 1838	Specification for preformed fillers for expansion joints in concrete (Part-I) pavements and structures (non-extruding and resilient type).
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2438	Specification for roller pan mixer.
	IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 2505	General requirements for concrete vibrators, immersion type.
IS: 2506	General requirements for concrete vibrators, screed board type.
IS: 2514	Specification for concrete vibrating tables.
IS: 2645	Specification for Integral cement water proofing compounds.
IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
IS: 2750	Specification for Steel scaffolding.
IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
IS: 3025	Methods of sampling and test waste water.
IS: 3366	Specification for Pan vibrators.
IS: 3370 (Part I to IV)	Code of practice for concrete structures for the storage of liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.

IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.
IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.
IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.

IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP: 23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/Sec.7)	National Building Code- Structural design of prefabrication and systems building.
IS: 10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS: 10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonary and Allied Works

IS: 1905	Code of Practice for Structural Safety of Buildings-Masonry walls.
IS: 2212	Code of Practice for Brickwork.
IS: 2250	Code of Practice for Preparation and use of Masonry Mortar.
SP: 20	Explanatory hand book on masonry code.

Sheeting Works

IS:277	Galvanised steel sheets (plain or corrugated).
IS: 459	Unreinforced corrugated and semi-corrugated asbestos cement sheets.
IS: 513	Cold-rolled carbon steel sheets.
IS: 730	Specification for fixing accessories for corrugated sheet roofing.
IS: 1626	Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.
IS: 2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS: 3007	Code of practice for laying of asbestos cement sheets.
IS: 5913	Methods of test for asbestos cement products.
IS: 7178	Technical supply conditions for tapping screw.

IS: 8183	Bonded mineral wool.
IS: 8869	Washers for corrugated sheet roofing.
IS: 12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
IS: 12866	Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced).
IS: 14246	Specification for continuously pre-painted galvanised steel sheets and coils.

Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.
IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
IS: 3502	Specifications for chequered plate.
IS: 6911	Specification for stainless steel plate, sheet and strip.
IS: 3757	Specification for high strength structural bolts
IS: 6623	Specification for high strength structural nuts.
IS: 6649	High Tensile friction grip washers.
IS: 800	Code of practice for use of structural steel in general building construction.
IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
IS: 9006	Recommended Practice for Welding of Clad Steel.
IS: 7215	Tolerances for fabrication steel structures.
IS: 12843	Tolerance for erection of structural steel.

IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.
IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.
IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.

IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars. Part I Silicate type Part II Resin type Part III Sulphur type
IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.

Water Supply, Drainage and Sanitation

IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copperalloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.
IS : 1172	Basic requirements for water supply, drainage and sanitation.
IS : 1230	Cast iron rain water pipes and fittings.
IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
IS : 1726	Cast iron manhole covers and frames.
IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.

IS : 1742	Code of practice for building drainage.
IS : 1795	Pillar taps for water supply purposes.
IS : 1879	Malleable cast iron pipe fittings.
IS : 2064	Code of practice for selection, installation and maintenance of sanitary appliances.
IS : 2065	Code of practice for water supply in building.
IS : 2326	Automatic flushing cisterns for urinals.
IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
IS : 2501	Copper tubes for general engineering purposes.
IS : 2548	Plastic seat and cover for water-closets.
IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
IS : 2963	Non-ferrous waste fittings for wash basins and sinks.
IS : 3114	Code of practice for laying of cast iron pipes.
IS : 3311	Waste plug and its accessories for sinks and wash basins.
IS : 3438	Silvered glass mirrors for general purposes.
IS : 3486	Cast iron spigot and socket drain pipes.
IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
IS : 4127	Code of practice for laying of glazed stone-ware pipes.
IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS : 5822	Code of practice for laying of welded steel pipes for water supply.

IS : 5961	Cast iron grating for drainage purpose.
IS : 7740	Code of practice for road gullies.
IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.
IS : 8934	Cast copper alloy fancy pillar taps for water services.
IS : 9762	Polyethylene floats for ball valves.
IS : 10446	Glossary of terms for water supply and sanitation.
IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.

IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels
IS:2209	Mortice locks (vertical type).
IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

Roof Water Proofing and Allied Works

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.
IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring

tiles.

IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white Portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.

Painting and Allied Works

IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship
Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.

IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint
IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.

Piling and Foundation

IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.
IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines withrotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines. Stop Log and Trash Rack
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.

IS:11855	General requirements for rubber seals for hydraulic gates. Roads
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.
IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.
IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Publication	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen

Loadings

IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.

Safety

IS:3696 (Part I & II)	Safety code for scaffolds and ladders.

IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Safety code for demolition of buildings.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.
-	Indian Explosives Act. 1940 as updated.

Architectural design of buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in (Relevant parts) overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Creteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes. Publication

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.

3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.

4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).

   b) Electonic transmitters BS:6447.

2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.

3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.

2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.

3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.

4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).

5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.

6. Printed circuit boards - IPC TM - 650, IEC 326 C.

7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.

8. Edge socket connectors - IEC 130-11.

9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.

10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).

11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).

12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.

13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.

14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.

15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232- D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.

2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.

3. Water and steam in power cycle - ASME PTC 19.11.

4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.

2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472

3. Damp heat cycling test - IS:2106

4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.

2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.

3. Turbine water damage prevention - ASME TDP-1-1980.

4. Boiler safety interlocks - NFPA Section 85 B - 1984, 85 C - 1991.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.

2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.

3. Surge withstand capability test - ANSI C 37.90 1 -1989.

4. Performance testing of UPS - IEC 146.

5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.

2. Seamless carbon steel pipe ASTM - A - 106.

3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.

4. Material for socket welded fittings - ASTM - A - 105.

5. Seamless ferritc alloy steep pipe - ASTM - A - 335.

6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.

7. Composition bronze of ounce metal castings - ASTM - B - 62.

8. Seamless Copper tube, bright annealed - ASTM - B - 168.

9. Seamless copper tube - ASTM - B - 75.

10. Dimension of fittings - ANSI - B - 16.11.

11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.

2. Material of socket weld fittings - ASTM - A105.

3. Dimensions of fittings - ANSI - B - 16.11.

4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.

2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.

3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.

4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).

5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.

6. Rules for Testing insulated cables and flexible cables : VVDE - 0472

7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)

8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.

9. Oxygen index and temperature index test - ASTM D - 2863.

10. Smoke density measurement test - ASTMD - 2843.

11. Acid gas generation test - IEC - 754 - 1.

12. Swedish Chimney test - SEN - 4241475 (F3).

13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.

14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.

15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.

2. -do- Test Standards. NEMA VE-1-1979.

3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

Public Address System

1. Specifications for lod speakers - IS:7741 (Part-I, II and III)

2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301

3. Specification for Public Address Amplifiers - IS:10426.

4. Code of practice for outdoor installation of PA system - IS:1982.

5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.

6. Basic environmental testing procedures for electronic and electrical items - IS:9000.

7. Characteristics and methods of measurements for sound system equipment - IS:9302

8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732

9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)

10. Fittings for rigid steel conduits for electrical wiring - IS:2667

11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

Vibration Monitoring System

1. API 670 - 1994

2. BS : 4675 Part-2

ANNEXURE - I

MFGR.'s LOGO	**MANUFACTURER'S NAME AND ADDRESS**	**MANUFACTURING QUALITY PLAN** **ITEM :** **SUB-SYSTEM:**	**QP NO.:** **REV.NO:** **DATE:** **PAGE: …. OF….**	**PROJECT :** **PACKAGE :** **CONTRACT NO. :** **MAIN-SUPPLIER :**

SL. NO	**COMPONENT & OPERATIONS**	**CHARACTERISTICS**	**CLASS**	**TYPE OF CHECK**	**QUANTUM OF CHECK**		**REFERENCE DOCUMENT**	**ACCEPTANCE NORMS**	**FORMAT OF RECORD**		**AGENCY**			**REMARKS**
					M	**C/N**					**M**	**C**	**N**	
1.	**2.**	**3.**	**4.**	**5.**	**6.**		**7.**	**8.**	**9.**	**D***	**** 10.**			**11.**

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (☐☐) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.** **M:** MANUFACTURER/SUB-SUPPLIER **C:** SUPPLIER/NOMINATED INSPECTION AGENCY, **N**: THE OWNER **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** THE OWNER SHALL IDENTIFIED IN COLUM "N"		**DOC. NO.:** **REV…… CAT…..**	
MANUFACTURER / SUB-SUPPLIER	**MAIN-SUPPLIER**		**FOR THE OWNER USE**		
SIGNATURE				**REVIEWEDBY**	**APPROVEDBY**	**APPROVAL SEAL**

ANNEXURE - II

<table>
<tr><td rowspan="2">SUPPLIER's LOGO</td><td colspan="2" rowspan="2">SUPPLIER'S NAME AND ADDRESS</td><td colspan="6">FIELD QUALITY PLAN</td><td colspan="3">PROJECT :
PACKAGE :
CONTRACT NO. :
MAIN-SUPPLIER :</td></tr>
<tr><td colspan="2">ITEM :

SUB-SYSTEM :</td><td colspan="4">QP NO.:
REV.NO.:
DATE:
PAGE: …. OF….</td></tr>
<tr><td>S. NO</td><td>ACTIVITY AND OPERATION</td><td>CHARACTERISTICS / INSTRUMENTS</td><td>CLASS# OF CHECK</td><td>TYPE OF CHECK</td><td>QUANTUM OF CHECK</td><td>REFERENCE DOCUMENT</td><td>ACCEPTANCE NORMS</td><td colspan="2">FORMAT OF RECORD</td><td>REMARKS</td></tr>
<tr><td>1.</td><td>2.</td><td>3.</td><td>4.</td><td>5.</td><td>6.</td><td>7.</td><td>8.</td><td>9.</td><td>D*</td><td>10.</td></tr>
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<tr><td colspan="2"></td><td></td><td colspan="3" rowspan="4">LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (☐) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR;
'A' SHALL BE WITNESSED BY THE OWNER, 'B' SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)</td><td colspan="2" rowspan="2"></td><td colspan="3">DOC. NO.:
REV……</td></tr>
<tr><td colspan="2">MANUFACTURER/ SUB-SUPPLIER</td><td>MAIN-SUPPLIER</td><td colspan="2" rowspan="2">FOR THE OWNER USE</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">SIGNATURE</td><td>REVIEWED BY</td><td>APPROVED BY</td><td>APPROVAL SEAL</td></tr>
</table>

ANNEXURE - III

	Project : **Stage : :** **Package :** **Supplier :** **Bidder No. :**			**LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL** **SUB-SYSTEM:**					**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**	
S. N.	**Item**	**QP/ Insp. Cat.**	**QP No.**	**QP Sub. Schedule**	**QP approval schedule**	**Proposed sub-supplier**	**Place**	**Sub-suppliers approval status / category**	**Sub-supplier Details submission schedule**	**Remarks**

LEGENDS

1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY the Owner)

A – For these items proposed vendor is acceptable to the Owner. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Details required" for the Owner review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by the Owner without specific vendor approval from the Owner. To be identified with "NOTED.'

2. QP/INSPN CATEGORY:

CAT-I: For these items the Quality Plans are approved by the Owner and the final acceptance will be on physical inspection witness by the Owner.

CAT-II: For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner shall be on the basis review of documents as per approved QP.

CAT-III: For these items Main Supplier approves the Quality Plans. The final acceptance by the Owner shall be on the basis certificate of conformance by the main supplier.

UNITS/WORKS: Place of manufacturing Place of Main Supplier of multi units/works.

ANNEXURE - IV

	Project : **Stage :** **Package :** **Bidder :** **Bidder No. :**	**STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

S. N.	Item / Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-mission	Date of comm t Appl.	Status Code C/II/I	Propose d Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

ANNEXURE - V

	Project : Stage : Bidder : Bidder No. : System :				FIELD WELDING SCHEDULE (To be raised by the Bidder) Welding Code:								DOC. NO.: REV. NO.: DATE : PAGE : OF			
Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method / Quantum	REF		Remarks
											Temp.	Holding time		Spec No.	ACC Norm Ref.	
NOTES:																
SIGNATURE																

ANNEXURE-VI

DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				HPGCL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	4*	1	-	-	2	1	-	-
2.	Final Approved Documents	1	1	1	1	1	1	4	1
3.	Drawings / Documents 'As Built'	1	1	1	1	2	1	4	1
4.	Type Test Reports (Initial)	4*	1	-	-	2	1	-	-
5.	Type Test Report (Final)	2**	1	1	1	2	1	4	1
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2**	1	-	-	2	1	2	1
8.	Erection Manual (Draft)	4*	1	-	-	1	1	-	-
9.	Erection Manual 'Final'	1	1	1	-	1	1	2	1
10.	O&M Manual 'Draft'	4*	1	1	-	1	1	-	-
11.	O&M Manual 'Final'	1	1	1	-	1	1	2	2
12.	Commissioning Procedure 'Draft'	4*	1	-	-	1	1	-	-
13.	Commissioning Procedure 'Final'	2**	1	1	-	1	1	2	1

S.No.	Description of Document	DESEIN				HPGCL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
14.	PG Test Procedure "Draft"	4*	1	-	-	1	1	-	-
15.	PG Test Procedure 'Final'	2**	1	1	-	2	1	2	1
16.	Progress Report	1	1	1	-	2	1	1	1
17.	PG Test Report for Approval	4*	1	-	-	2	1	-	-
18.	Approved PG Test Report	2**	1	1	-	2	1	4	1
19.	Project Completion Report	1	1	1	-	1	1	1	1
20.	Vendor Details in respect of proposed vendors including Contractor's evaluation Report	1	1	-	-	1	1	-	-
21.	Monthly Vendor / QP Approval Status	1	1	-	-	2	1	1	1
22.	Manufacturing QPs, Field QPs for review / comments	4*	1	-	-	2	1	-	-
23.	Manufacturing QPs, Field QP, Final	2**	1	1	-	2	1	2	1
24.	QA documents Package for equipment / field activities etc.	1	1	1	-	1	1	1	1

* - Consultant will return two (2) stamped document to CE (TD) HPGCL
** - Consultant will return one (1) stamped document to CE (TD) HPGCL
HC - Hard Copy
CC - Soft Copy thru e-mail
HO - Head Office of Consultant/HPGCL

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
STEAM GENERATOR	Thermal design and hydraulic circulation balance	Familiarization with various system and equipment	Manufacturing processes of pressure parts, and equipment	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues
	Combustion and Air & gas weight calculation	Performance data collect-ion analysis and review	Welding process	
	Pressure part calculation	O&M feed back	Testing facilities	Familiarization of special maintenance techniques.
	Pressure part and strength calculation	Operation history of various equipment and system	Product development in process	Special tool and tackles familiarization
	Tube metal temp. Calculation and selection.	Failure analysis	Future plan for technology induction	
	Performance calculation		R&D work in-progress	
	Duct design.			
	Pressure part			
	Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners start-up system, fuel firing system, draft plant			
	Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water.			
	Layout of overall plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker			

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
	arrangement, valves and damper, ESP area, cable & piping tressels etc.			
	Erection strategies, erection procedures			
	Performance and demonstration tests.			
MANDAYS	**120**	**20**	**20**	**20**
CFD model development and validation for Steam Generator	Familarisation of fundamentals and basis for the development of the CFD models.			
	Solving of set of simple problems by Owner's engineers with the help of trainer.			
	Hands on experience on the development of detailed/realistic CFD models for the steam generator and ESP. The Bidder/trainer shall develop CFD models for SG & ESPas per the Contract requirement with complete association of the Owner's engineers.			
	Validation of the above CFD model for SG & ESPby Bidder in association with the Owner's Engineers.			
MANDAYS	**120 for SG and 60 for ESP**	**-**	**-**	**-**

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
TURBINE GENERATOR AND IT'S INTEGRAL AUXILIARIES	Turbine cycle optimization and turbine performance in off design condition.	Familiarization of power plants of various makes of turbines for super critical units	Manufacturing processes of turbine	
	Rotor design and strength calculation	Collection of data for analysis of availability of turbines	Assembly of turbine	
	Rotor dynamic behaviour studies wrt natural frequency, critical speed, vibration etc.	Comparative studies for integral systems of turbine	Testing of turbines	
	Blade profile/root design and blade strength design, blade vibration analysis	O&M history/problems related to turbine	Product development in process	
	Casing & diaphragm design	Failure analysis	Future plan for technology induction	
	Labyrinth seal selection & design for different turbine configurations		R&D work in progress	
	Selection of turbine type (i.e. Tandem vs. cross compounding, separate HP/IP vs. combined HP/IP, material of construction etc.)			
	Design principle for Up rating/down rating of existing design/ modules for the specific project.			
	Selection of nos., type and arrangement of bearings, load calculation on bearings, bearing oil flow calculation			
	Selection, design and control principle for Turbine governing system			
	Performance calculation			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Steam path audit			
	Layout principle of various equipment's of TG and its integral system			
	Latest technological advancements			
MANDAYS	**45**	**10**	**10**	
Boiler Feed Pumps	Techno-economic studies for Selection of BFP Configuration and its drive	Familiarization of power plants of various makes of feed pumps	Manufacturing process of various components of BFP	
	Criteria for selection of boiler Feed Pump parameters	Data collection of BFP parameters and configur-ation	Assembly of BFP	
	Rotor design, strength calculation and rotor dynamic behavior studies wrt critical speed, vibration etc	Collection of data for analysis of availability of BFP	Testing, capabilities of BFP at works wrt performance, NPSH, thermal shock, dry run, visual cavitation, string test, axial thrust measurement	
	Impeller design and its hydraulic behavior	O&M history/problems related to BFP	Product development in process	
	Role of critical para- meters such as NPSH(R), Suction specific speed, running clearances, speed etc. in design of feed pumps	Comparative studies for various types of BFP& its features	Future plan for technology induction	
	Material selection of BFP components		R&D work in progress	
	Guiding factors for selection of BFP seals			
	Computation of axial thrust under various flows			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Performance calculation			
	Transient analysis in pump suction piping wrt NPSH margin			
	Latest technological trends in BFP design			
MANDAYS	**20**	**5**	**10**	
Condenser	Selection of condenser type and its optimization wrt temp rise across condenser, pressure drop in condenser, surface area etc.	Comparative studies of salient features	Manufacturing process of various components of condenser Assembly	
	Techno economic studies for Selection of condenser tube material and other parts depending on water quality	Collection of data for analysis of availability of Condenser	Testing capability at works	
	Condenser support selection & design	O&M history/problems related to condenser	Product development in process	
	Sizing of condenser w.r.t. super critical units		Future plan for technology induction	
	Latest technological trends in condenser arrangement and design		R&D work in progress	
	Condenser vacuum system design			
MANDAYS	**10**	**5**	**5**	
Feed Regene-rative Equipment's	Thermal and mechanical design calculation of heaters	Comparative studies of salient features	Manufacturing process of various components of heaters	
	Basis of selecting horizontal/vertical heaters	Analysis of data	Assembly	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Selection of TTD and DCAs for various heaters, and their effect on turbine heat rate	O&M history/problems related to heaters	Testing capability at works	
	Configuration of HP heaters (2x50% v/s100% capacity		Product development in process	
	Sizing criteria for De- aerator/Heaters		Future plan for technology induction	
	Selection of tube & tube sheet material of heaters		R&D work in progress	
	Latest technological trends in heaters design			
MANDAYS	**15**	**10**	**10**	
3-dimen-sional CFD modelling	CFD model develop ment and validation of design data for steam turbine, BFP, CEP, condenser, heaters etc.			
MANDAYS	**20**			
Training for Balance of Plant Equipment	**120**	**40**	**40**	**40**
	The details of training modules for various BoP equipment & systems shall be decided during detailed engineering.			
CONTROL & INSTRUMENTATION				
DDCMIS-Man Machine Interface - Hardware &	Hardware & Software organization of the system Basis of selection of H/W memory sizing	Operational feedback		

ANNEXURE-VII

PRODUCT	**AREAS OF TRAINING REQUIREMENT**			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Operating System	Operating system features, interface with other system, openness & inter-operability Upgradability System testing features			
MANDAYS	**16**	**6**		
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization Various system modules & interface with OS Database organization & development Development of mimics Other application like calculations, logs historical storage functionalities & use	Operation feedback		
MANDAYS	**40**	**6**		
DDCMIS - Control System Hardware	Basic design features for system & its modules System capabilities & system design techniques Communication with MMI & other system	Operation feedback	Manufacturing processes special attention to handling of the modules Maintenance facilities	
MANDAYS	**20**	**5**	**10**	
DDCMIS-Control system Application Software	Database structure Organisation & inter- face between application program & database Application for implementation of Control functions	Operational feedback	System integration & System capabilities testing	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	Study of standard algorithms & development of new algorithms			
MANDAYS	**12**	**4**	**4**	
DDCMIS - Control Loop Study	General description of closed loop controls of thermal power plant Critical analysis of few control loops e.g., TSCS Stress Control boiler start-up control etc.	Specific operational feedback		
MANDAYS	**4**	**2**		
DDCMIS- Burner Management System	Hardware logic, NFPA/ VDE requirements other safety standard Flame scanner location	Operational feedback	Manufacturing procedure& precautions for handling the system System testing facilities	
MANDAYS	**10**	**3**	**3**	
DDCMIS - EHTC, Turbine stress control system, Turbine protection system& ATRS	Basic design concept& features Logics of turbine stress control system Implementation of failsafe philosophy in turbine protection system	Operational feedback	Manufacturing procedure & precautions for handling for handling the system System testing facilities	
MANDAYS	**10**	**3**	**3**	
Furnace and Flame Viewing System.	Theory & principle of operation Details of software & methods of modification/ customisation	Operational feedback		

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Misc. systems for SG/TG C&I				
Electric Power Supply System	Theory & design features		Manufacturing/assembly process	
MANDAYS	**10**	**3**	**3**	
Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope.				
QUALITY ASSURANCE & INSPECTION **QA SYSTEM & PROGRAMME**	Integrated QA Management System for enhanced reliability of equipments QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems QA system for developing and establishing new processes and vendors.	Operational feedback Co-relationn of reliability and performance of the equipment with implementation of QA system. Appreciation of use of structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant	Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities. Appreciation of developmental activities for new processes and vendors. System of prequalification of special processes	

	System of structured documentation of Engg. And test records			

ANNEXURE-VII

PRODUCT	**AREAS OF TRAINING REQUIREMENT**			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
MANDAYS	**16**	**3**		
PLC	Hardware organization		Manufacturing process of PLC hardware	
	Operating system features		Integration & testing facilities	
	Data base organization			
	Logic/loop algorithm			
	Development of control logic & loop s/w & MMI application development			
MANDAYS	**16**	**-**	**2**	
Electric Power Supply System (UPS & 24 V DC system)	Theory & design features		Manufacturing/assembly process	
			Testing methodology	
MANDAYS	**10**	**2**		
PRODUCT	**AREAS OF TRAINING REQUIREMENT**			
(ELECTRICAL) GENERATOR	(a) Design aspects of the following areas	- Operational feed back	(a) Manufacturing process for	
	- Insulation system	- Familarisation with different sub-systems	- Core	
	- Cooling medium & arrangement		- Winding bars	
	- Winding & core support systems		- Assembly	
	b) Design aspects of other auxiliary systems		(b) Testing facilities	
MANDAYS	**30**	**15**	**15**	
	Design features of various sub-systems	- Operational feed back		

ANNEXURE-VII

PRODUCT	**AREAS OF TRAINING REQUIREMENT**			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Generator Excitation System including AVR.	Excitor PMG Transformer Controllers & different limiters etc. PSS & associated system studies	- Familiarisation with various equipment functioning at reference plants	- Manufacturing process& testing facilities for various equipment of excitation system	
MANDAYS	**30**	**15**	**15**	
400 KV Switchyard Equipments			Concepts and operational aspects for the offered equipments	
Substation Automation System				Training for site personnel for operation, maintenance & troubleshooting of total system for 5 working days at UPRVUNL site
MANDAYS	**30**	**15**	**15**	
MV AND LT Switchgear: Numerical relays & Switchgear SCADA system	Numerical relay engineering & associated training for relay software & O&M SCADA system design, engineering & associated training for SCADA & O&M			

MANDAYS	**30**			
MDBFP motor CW motor & BWCP motor	Design criteria for the stator core and winding, rotor core & winding, Insulation system & Cooling arrangement Study of forces & vibration Diagnostic & testing of large Electrical machines	Operational feedback	Manufacturing process & testing facilities	
MANDAYS	**30**	**15**	**15**	

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
Boiler Feed pump H.T. Motor	Design Criteria for the Stator core & wdg Rotor core & wdg Insulation system Cooling arrangement	Operational feed back	Manufacturing process & test facilities	
MANDAYS	**10**	**5**	**5**	
CRITICAL PIPING & POWER CYCLE PIPING	Design familiarization for critical piping of supercritical Plant	Familiarization with feedback (in super critical plant) on failure analysis and vibration analysis of piping.	Cold Setting of spring hanger	
	Optimization study for sizing including pressure drop calculation and selection of single or double lead together with Owner's engineers	Study of Feed back regarding hanger setting strategies and practice	Cyclic tests carried on spring hangers.	
	Design and stress analysis of lines with Expansion Joints together with Owner's engineers		Cyclic tests carried on expansion joints	
	Design and stress analysis of piping systems with two phase flow involving Owner's engineers		Manufacturing process of critical piping components and appreciation of their testing facilities at shop	
	Transient analysis and optimum sizing of feed suction piping together with Owner's engineers.			
	Static and dynamic analysis of critical piping including siesmic and other occassional load analysis (safety valve			

ANNEXURE-VII

PRODUCT	AREAS OF TRAINING REQUIREMENT			
	Product Design	**Plant Visit**	**Visit To Manufacturer's Work**	**Operation & Maintenance Of Plant**
	blowing condition). A joint activity together with Owner's engineers.			
	Study and collection of data pertaining to special welding requirements (pre and post weld heat treat ment and electrode selection criteria etc.) of materials used in high temp piping system.			
	Study and collection of data on special requirements in case of welding dissimilar metals and electrode selection criteria			
MANDAYS	**45**	**10**	**10**	

ANNEXURE - VII

Area	Topics	Mandays
DDCMIS-Man Machine Interface-Hardware & Operating System	Hardware & Software organization of the system	20
	Basis of selection of H/W memory sizing	
	Operating system features, interface with other system, openness & inter-operability	
	Upgradeability	
	System testing Features	
	Trouble shooting & fault analysis	
DDCMIS-Man Machine Interface System Engineering & Application Software	Specific system customization	40
	Various system modules & interface with OS	
	Database organisation & development	
	Development of mimics	
	Other application like calculation, logs historical storage functionalities & use	
	Trouble shooting & fault analysis	
DDCMIS-Control System Hardware & Control System Application Software	Basic design features for system & its modules Manufacturing process with special attention to handling of the modules Maintenance facilities	50
	System capabilities & system design techniques System integration & system capabilities testing	
	Communication with MMI & other system	
	Database structure Organisation & inter-face between application program & database	
	Application for implementation of Control functions Study of standard algorithms & development of new algorithms	
	Trouble shooting & fault analysis	

DDCMIS- Operator Training	Use of the system at Works + at Site	20+100
DDCMIS- Specialized Network security training	To be finalized during detailed engineering.	15
UPS system	Theory & design features Manufacturing/assembly process Testing methodology	5
	Trouble shooting and fault analysis.	
24 V DC system	Theory & design features Manufacturing/assembly process	5
	Testing methodology	
	Trouble shooting and fault analysis	
SWAS	Theory & design features	5
	Trouble shooting and fault analysis	
Communication System	Theory & design features	4
	Trouble shooting and fault analysis	
PSSS System	Theory & design features	5
	Trouble shooting and fault analysis	
QA SYSTEM & PROGRAMME	Integrated QA Management system for enhanced reliability of equipment	10
	QA system in design, procurement, manufacturing, installation and operation of the equipment/ systems	
	QA system for developing and establishing new processes and vendors	
	System of structured documentation of Engg and test records	
	Appreciation of implementation of QA Program in various manufacturing, assembly and testing activities	
	Appreciation of develop-mental activities for new processes and vendors	
	System of pre-qualification of special processes	

Controls & Instruments	Familiarization with control system and instrumentation	20
	QA System for manufacture of reliable components. Manufacturing activities for critical instruments/items	
	Implementation of testing program to ensure reliability	
Simulator	a. System design structure and basis of design b. Hardware components and their configuration c. System Software and Simulation Software Tools d. Plant process modelling and DCS emulation e. Project specific application development, configuration and modifications including equipment modelling and interconnections of models, graphics development , configuring equations etc, f. Maintenance and troubleshooting of hardware and software components	24
PADO	Theory & design features	**10**
	Trouble shooting and fault analysis	
CEMS	Theory & design features	5
	Trouble shooting and fault analysis	
AAQMS	Theory & design features	5
	Trouble shooting and fault analysis	
C&I Lab Instruments	Theory & design features	6
	Trouble shooting and fault analysis	
DMS	Theory & design features	5
	Trouble shooting and fault analysis	
Station LAN & MIS	Theory & design features	5
	Trouble shooting and fault analysis	
Note	**One week shall constitute of five (5) man days.**	

CHAPTER – 6

NOT UDED

CHAPTER – 7

PAINTING

1.0 SCOPE

1.1 This section covers the painting requirements for the power plant equipment, structures, piping etc. and any other surface required to be painted. The painting system should ensure optimal protection of the installation with minimum need for maintenance, environmental friendly & easy to apply.

2.0 CODES AND STANDARDS

2.1 Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS contract for the material and workmanship.

2.2 The following Indian Standards may be referred to for carrying out the painting job:

IS: 5	:	Colours for ready mixed paints and enamels
IS: 101	:	All Parts and Sections for paint testing
IS: 1303	:	Glossary of terms relating to paints
IS: 2379	:	Colour code for identification of pipelines
IS: 1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS: 2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS: 6278	:	Code of practice for white washing and colour Washing
IS: 13183	:	Aluminium Paint, heat Resistant specification
IS: 158	:	Ready mixed paint, brushing, bituminous, black, Lead free, acid, alkali, water and heat resisting
IS: 2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS: 104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS: 2932	:	Enamel, synthetic, exterior (a) undercoating (b) finishing.
IS: 2629	:	Recommended Practice for Hot Dip Galvanising
BS EN ISO 14713	:	Code of practice for protection of iron & steel structure against corrosion
ISO 8501-1	:	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 8502-3	:	Assessment of dust on steel surface prepared for painting (Pressure sensitive tape method)
ISO 12944 (Part 1 to 7)		Corrosion protection of steel structures by Protective paint systems
SSPC	:	US Specifications of Steel Structures Painting Council, SSPC Volumes I and II
SSPC-SP-08	:	Surface preparation by Pickling
NORSOK M-501	:	Surface preparation & Protective coating

IS0 20340	:	Pre-Qualification test
ASTM	:	American Standard Test Method for paints and coatings
AWWA	:	American Water Works Association
SIS: 55900	:	Swedish standard for blasting

In the event of conflict between the Codes and Standards referred to in the specification and the requirement of this specification, the latter shall govern. Statutory and Local regulations shall be strictly followed in selection and application of paint.

3.0 GENERAL

3.1 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).

3.2 Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

3.3 The paint to be applied shall be approved by Owner / Engineer.

3.4 All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.

3.5 The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information:

1. Surface preparations
2. Film thickness (min and max)
3. Min and max recoating intervals at relevant temperatures
4. Mixing ratio, thinner details and coating repair systems

3.6 The sample for testing the paint being used may be taken by the Owner at any time.

3.7 In general 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.

3.8 For equipment that has received shop prime coat, touch-up prime coat and additional coats 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.

3.9 Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and

spatter. Damage to other surfaces or equipment shall be repaired by the vendor.

3.10 The Contractor shall submit the following for review and approval by the Owner:

1. Manufacturer's recommended paint scheme for the project
2. Latest published product & instructions for application data,
3. Procedures for surface preparation and application.
4. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
5. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

3.11 The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.

3.12 Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.

3.13 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.

3.14 It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

4.0 PREPARATION OF SURFACES

4.1 All surfaces to be painted shall be thoroughly cleaned of all grease, oil, loose mill scale, dust, rust, weld spatters, sharp edges and any other foreign matter. Removal of grease and oil contamination shall be in accordance with SSPC-SP1 prior to cleaning process described below.

4.2 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. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Engineer.

4.3 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/m^2. Surfaces that do not meet these criteria shall be reprocessed.

4.4 **Mechanical Cleaning:**

4.4.1 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 055900**	**SSPC**
Hand tool cleaning	Rusted	C St2	C St2	SP2
	Rusted and pitted	D St2	D St2	SP2
Power tool cleaning	Rusted	C St3	C St3	SP3
	Rusted and pitted	D St3	D St3	SP3

i) 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 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.

ii) 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.

4.5 **Blast cleaning:**

4.5.1 **Compressors:** Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air at 110^0 C. The blasting activity shall be performed at ambient temperatures above 5ºC and relative humidity less than 85%. Steel temperature shall be 3ºC above dew point. Necessary safety precautions for equipment and operator shall be adhered to.

4.5.2 **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.).

4.5.3 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.

4.5.4 Surfaces to be coated shall be free of all grease, oil, loose rust, and loose mill scale. Rust, mill scale, weld spatter, flux, shall be removed by the methods indicated in the Coating Schedule. Oil and grease shall be removed by solvent cleaning method as outlined in SSPC – SP-1 prior to blasting.

4.5.5 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.

4.5.6 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.

4.5.7 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 4 hours, but in any case must commence before signs of degradation occur).

4.5.8 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.

4.5.9 The grades of surface finish:

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

4.6 Paint Application

4.6.1 General:

Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. The surface preparation and painting system shall be as described in ANNEXURE with the following exceptions:

- Nameplates, code stampings and push buttons
- Concrete brickwork, tile, and glass unless specified by the Owner / Engineer
- Non-ferrous materials
- Austenitic stainless steel
- Plastic and / or plastic coated materials
- Insulated surface of equipment and pipes except colour coating wherever required
- Any surface specified by the Owner / Engineer not to be painted.

4.6.2 Paint Application Requirements

4.6.2.1 The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mix ratio, the method of application, and the use of thinners and over coating times.

4.6.2.2 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.

4.6.2.3 Painting shall be performed when the temperature of the surface is greater than 3ºC 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 Vendor.

4.6.2.4 In addition, paints shall not be applied under the following conditions:

- When the surface temperature is greater than 60 ºC unless a higher temperature is agreed by the paint manufacturer
- When the air temperature is less than approximately 5ºC, 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.

4.6.2.5 Paints shall not be applied within 50 mm of edges which will later have to be welded. Such weld areas shall be taped/one coat of weldable primer for distance of 50 mm either side of the weld line.

4.6.2.6 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.

4.6.2.7 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.

4.6.2.8 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.

4.6.2.9 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 being applied, to ensure uniformity over the surface area (e.g., zinc MIO's pigmented materials).

4.6.2.10 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.

4.6.3 **Spray Application**

4.6.3.1 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.

4.6.3.2 Approval of Owner / Engineer shall be obtained during spray painting which may cause interference to other works. If spray painting is to be carried out, the following shall be taken into account:

4.6.3.3 The correct spray tips, air pressures, etc, as recommended by the equipment supplier, shall be used.

4.6.3.4 Conventional air spray equipment is used, the correct combination of air volume, air pressure and fluid flow to give good atomisation to be ensured to get 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.

4.6.3.5 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.

4.6.3.6 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.

4.6.3.7 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.

4.6.3.8 Very complex structures should be painted by brush instead of spray gun to avoid overspray, dry spray and unacceptable paint losses.

4.6.4 **Brush application**

4.6.4.1 Brush application may be used under the following circumstances:

- 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
- Where the paint manufacturer considers the coating material suitable for brush application.

4.6.4.2 Brushes shall be of a style and quality that will permit the proper application of paint.

4.6.4.3 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.

4.6.4.4 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.

4.6.5 **Roller application**

Roller application shall only be used on relatively large surface areas and only if spraying is not on option. Roller application shall only be used if the first or priming coat of paint has been applied by brush. Roller application shall be in accordance with the paint Manufacturer's instructions.

4.6.6 **Coating materials**

4.6.6.1 The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- Corrosion protective properties
- Requirements to health, safety and environment
- Properties related to application conditions, equipment and personnel
- Experience with the coating materials and coating system.

4.6.6.2 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. Performance standard as listed below shall be established by paint manufacturer the records shall be submitted for review.

- Adhesion test (pull off test)
- Flexibility test
- Salt spray test (min 1000 Hrs)
- Water absorption test
- UV resistance test (external coating)
- Cathodic dis bonding test (internal coating)
- Abrasion test (internal coating)
- Impact resistance test

4.6.6.3 Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet. All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions.

4.6.6.4 The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of, State or Local regulatory bodies for the products. All vehicle components for use in the manufacture of paints and enamels shall meet the ASTM/ ISO Specification except as otherwise stated coating systems shall be selected as per corrosivity category listed in the table below. Coating systems are tabulated in ANNEXURE and shall be pre-qualified in accordance with specification. Coating systems/ alternative coating systems may be re-subjected to pre-qualification, at the discretion of OWNER/ ENGINEER. The specified coating systems, the number of coats and the coating film thicknesses given in

Annexure are minimum requirements Top coat colors should be in accordance with Annexure.

4.6.7 **Gratings and 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/m^2.

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.

CORROSIVITY OF ENVIRONMENTS

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/m²	Thickness loss µm
C2	Low	>10 to 200	>1.30 to 25
C3	Medium	200-400 g/m^2	(25-50µm)
C4	High	400-650 g/m^2	(50-80µm)
C5	Very High Industrial & marine	650-1500g/m^2	(80-200µm)

Tests required for evaluation of acceptance of coating materials:

TABLE -1

PERFORMANCE TEST OF PAINT

SL. No.	**Test**	**ASTM TEST METHOD**
1.0	Abrasion Resistance: (topcoat only)	ASTM D4060
2.0	Adhesion:	ASTM D4541
3.0	Dry Heat Resistance:	ASTM D2485
4.0	Flexibility: (topcoat only)	ASTM D522, 180° bend
5.0	Pencil Hardness: (topcoat only)	ASTM D3363
6.0	Salt Fog Resistance:	ASTM B117, 1000 hours
7.0	Weather Resistance:	ASTMG23 Type D
8.0	Test	ASTM Test Method
9.0	Density	D 1475
10.0	Dipping properties	D 823
11.0	Drying time	D 1640
12.0	Flexibility	D 1737/D 522
13.0	Hardness	D 3363
14.0	Adhesion (pull off test)	D 4541
15.0	Abrasion resistance	D 968/D 4060
16.0	DFT/Coat	As per SSPC Guidelines
17.0	Storage Stability	D 1849
18.0	Resistance to	

	i) Humidity for 2000 hrs.	D 2247
	ii) Salt Spray for 2000 hrs.	B 117
	iii) Accelerated Weathering	D 822

5.0 **INSPECTION:**

5.1 Inspection will be performed by an inspector authorised by Owner / Engineer. 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.

5.2 The painting work shall be subjected to inspection by Owner / engineer at all times. The vendor shall offer following stage of inspection:

- Surface preparation
- Primer application
- Subsequent coats
- Paint qualification test

5.3 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.

5.4 The following coating inspection & test shall be carried out:

1. Ambient and steel temperature, relative humidity and dew point min twice in a shift.
2. Surface finish & profile check each component or once per 10 m2 after surface preparation.
3. Salt contamination test - Free from salt contamination.
4. Dry Film Thickness as per ISO 2808 No.6.
5. Holiday Test as per ASTM D 5162/ NACE RP 0188.
6. Adhesion Test as per ISO 2409 for cross-cut test, or a pull-off test as per ISO 4624/ ASTM D 4541.

6.0 **SUGGESTED COLOUR CODES FOR PAINTING:**

S No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
1.0	Structures, platforms, ladders and handrails	Dark Admiralty Grey	632		
2.0	Boiler casing, ESP and ducting	Nut Brown	413		
3.0	Fans, pumps, motors,	Light Grey	631		
4.0	Tanks (without insulation and cladding)				
4.1	Outdoor	Aluminium			
4.2	Indoor	Light grey	631		

S No.	Item/Service	Colour	IS-5	Colour (Band)	IS-5
5.0	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631		
6.0	Switchgear	Light grey	631		
7.0	Control & relay panels	Light grey	631 78 of IS1650		
8.0	Turbine	Golden Yellow	356		
9.0	Generator & exciter	Light grey	631		
10.0	Transformers	Aluminium			
11.0	Machinery guards	Signal red	537		
12.0	Crane				
12.1	Crane structure	Golden Yellow	356		
12.2	Trolley and hook	Crimson	540		
13.0	Piping (without insulation and cladding)				
13.1	Water System				
13.1.1	Boiler feed	Sea green	217		
13.1.2	Condensate	Sea green	217	Light brown	410
13.1.3	Bearing cooling water	Sea green	217	French blue	166

Notes:

1. This colour code basically refers to IS: 2379 for piping with necessary modifications.

2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

PAINTING SCHEME FOR C2 AMD C3 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120^{0}C	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2		260µ
2.	Indoor structure	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	--	--	--	260µ
3.	Insulated parts exposed to temp >120^{0}C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Aliphatic poly eurethene	2	80 µ	360µ
5.	Coal Handling Plant	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	poly eurethene	2	60 µ	260µ
6.	Fuel pipings	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
7.	Un insulated silencer, steel stacks >120^{0}C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
8.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
9.	Burried piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre									4.0mm
10.	Burried piping (Internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
11.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
13.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn	2	80	HB MIO	1	150	HB coal tar epoxy	1	150	380µ

			silicate		µ	epoxy		µ			µ	
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
16.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	250 µ							250µ
17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
19.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising 80µ									80µ

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance

PAINTING SCHEME FOR C4 AMD C5 ENVIRONMENT

S. No	Description	Surface Preparation	Primer			Intermediate paint			Finish coat			Total DFT
			Paint	No. of coats	DFT	Paint	No. of coats	DFT	Paint	No. of coats	DFT	Min.
1.	Boiler structure, un-insulated ducts, suspensions, hangers temperature <120^{0}C	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
2.	Indoor structure	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
3.	Insulated parts exposed to temp >120^{0}C	Sa 2 ½	In organic Zn silicate	2	60 µ							60µ
4.	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80 µ	HB MIO epoxy	2	200 µ	Epoxy PU HB	2	80 µ	360µ
5.	Coal Handling Plant	Sa 2 ½	HB Zn Phospate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
6.	Coal Fuel piping	Sa 2	Ehthy Zn silicate	1	40 µ				HR aluminium paint	2	40 µ	80µ
7.	Un insulated silencer, steel stacks >120^{0}C	Sa 2 ½	Ehthy Zn Silicate	1	40 µ				HR silicone aluminium paint	2	40 µ	80µ
8.	Above ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120 µ	Poly eurethene	2	60 µ	260µ
9.	Buried piping (external)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel									4.0 mm
10.	Buried piping (internal)	Sa 2 ½	Solid rigid poly eurethene 500 µ									500µ
11.	Storage tanks (external)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	2	200 µ	Poly eurethene	2	60 µ	340µ
12.	Storage tanks (internal)	Sa 2 ½	3 coats of amine adducts									400µ
13.	DM water tank (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ

14.	Fuel oil tanks (internal)	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	150 µ	HB coal tar epoxy	1	150 µ	380µ
15.	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ							75µ
16.	For insulted piping <125^{0}C	Sa 2 ½	Polyamide cured epoxy coasting	2	250 µ							250µ
17.	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	80 µ	160µ
18.	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				Chlorinated rubber	2	100 µ	180µ
19.	Switch yard, floor grills walk ways	Sa 2 ½	Hot dip galvanising coating Wt. 610 gms/M^2 (coating thickness of 80µ)									80µ

*** Note:** Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance.

CHAPTER – 8

FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS

1.0 General

1.1 The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

1.2 The term "BMCR" (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator ("As guaranteed") at super heater outlet at rated parameters.

1.3 The term "TMCR" (Turbine Maximum Continuous Rating) appearing in the Technical Specification shall mean 800 MW electrical power output at generator terminals (power at generator terminals) under 0% cycle make-up and guaranteed condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure

2.0 Performance Guarantees/Performance Tests

2.1 General Requirements

1. The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

2. The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

3. The Bidder shall conduct performance test and demonstrate all the guarantees covered herein under Category I, II & III. Various tests which are to be carried out during performance guarantee tests are listed in this chapter. The guarantee tests shall be conducted by the Bidder at site in presence of OWNER.

4. 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.

5. It is the responsibility of the Bidder to perform the Performance Guarantee/Acceptance test as specified in this chapter.. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

6. It shall be responsibility of the Bidder to make the plant ready for the performance guarantee tests. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

7. The Bidder shall make the plant ready for the performance guarantee tests.

8. All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Bidder shall get these instruments calibrated in an independent test Institute approved by the Owner. All test instrumentation required for performance tests shall be supplied by the Bidder and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

9. 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 free of cost.

10. The Performance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days from the date of letter of intent and finalization of the PG test procedure shall be done within 180 days from the date of Letter of Intent. After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Owner after completing each test run.

    The final tests to prove the guaranteed performance parameters shall be conducted at site by the Bidder in presence of the Owner on the Unit. The Bidder's commissioning/start-up Engineer shall make the unit ready to conduct such tests. The Performance Guarantee Tests shall commence within 45 days after the successful completion of Trial Operation. The PG test shall conclude within 50 months from date of LOI Any extension of time beyond the above time shall be mutually agreed upon. These tests shall be binding on both the parties of the contract to determine compliance of the equipment with the guaranteed performance parameters.

11. The P&G test procedures shall be submitted for equipment/ system & subsystem under Bidder's scope for all Guarantees under category I, II & III as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

12. The Bidder shall submit for Owner's approval the detailed Performance Test procedure containing the following:

    a) Object of the test
    b) Various guaranteed parameters & tests as per contract.
    c) Method of conductance of test and test code.
    d) Duration of test, frequency of readings & number of test runs.
    e) Method of calculation.
    f) Correction calculations & curves.

g) Instrument list consisting of range, accuracy, least count, and location of instruments.
h) Scheme showing measuring points.
i) Sample calculation
j) Acceptance criteria.
k) Any other information required for conducting the test.

13. **Test Reports**

After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.

14. In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Owner and re-conduct the performance guarantee test(s) with Owner's consent. In case the specified performance guarantee(s) are still not met by the Bidder even after modification and/or replacement but are achieved within the Acceptable Shortfall Limit as specified at clause 3.2 of this Chapter, Owner will accept the equipment/system/plant after levying liquidated damages as per clause 3.2 of this Chapter. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications / replacements within ninety (90) days or a reasonable period allowed by the Owner, after the tests have been completed, the Owner will have the right to either of the following:

A.) **For Category-I Guarantees**

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 indicated in clause 3.2 of this chapter shall be levied separately. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called `Category - I' Guarantees.

B.) **For Category-II Guarantees**

Reject the equipment/system/plant and recover from the Bidder, the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

C.) **For Category-III Guarantees**

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 from the contract price an amount equivalent to the damages as determined by the Owner. 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.

3.0 Guarantees Under Category-I

3.1 The Performance Guarantees which attract Liquidated Damages (LD) are as follows:

i. **Turbine Cycle Heat Rate**

a) Turbine Cycle heat rate in kcal/kWhr under rated steam conditions at guaranteed condenser pressure with zero make up at 440 MW unit load (i.e. 55% of rated load).

b) Turbine Cycle heat rate in kcal/kWhr under rated steam conditions at guaranteed condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load).

ii. **Steam Generator Efficiency**

a) Efficiency of the steam generator at 105% TMCR (840 MW unit load) with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.

b) Efficiency of the steam generator at 100% TMCR (800 MW unit load) with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.

Note for (i) & (ii)

- Turbine Heat rate and Steam Generator efficiency shall be computed as per clause 3.4 and 3.7 respectively as under.
- PG test for Turbine cycle Heat Rate & Steam Generator Efficiency shall be conducted simultaneously.

iii. **Turbine Generator Output**

Continuous TG output of 800 MW unit load (i.e. 100% of rated load) under rated steam conditions at guaranteed condenser pressure with 0% make-up.

The performance & acceptance of turbine generator shall be conducted in line with the requirement stipulated under clause 6.0 of this chapter.

iv. **Condenser pressure in mm Hg (abs)**

Condenser Pressure in mm Hg (abs) measured at 300mm above the top row of condenser tubes at 800 MW unit Load, 1% make up, design CW inlet temperature and design CW flow.

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.

The tube plug margin of 5%, as per design condition, shall be considered for condenser performance calculation at design condition.

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 on sidering the aspect of actual tube cleaning prior to conducting the test.

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

v. **Steam Generator Capacity**

Steam generating capacity in T/hr of steam at rated steam parameters at super heater 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 in Chapter 2 – Project Information, Volume-II.

vi. **Particulate Emission/ESP Efficiency**

Bidder's design shall ensure that the particulate emission from ESP(s) shall not be more than 17 mg/ Nm3 under guarantee point (refer clause 11.0, Chapter 1, Volume-III related to ESP sizing criteria) condition at 100% TMCR i.e. at 800 MW unit load with design coal firing and field in service.

The corresponding ESP efficiency shall be worked out as per the procedure outlined in clause 3.8 of this Chapter.

vii. **Auxiliary Power Consumption**

Unit Auxiliary Power Consumption comprising of auxiliaries required for continuous unit operation at 800 MW (i.e. 100% of rated load) under rated steam conditions and at guaranteed condenser pressure with 0% make up shall be guaranteed in line with the requirement stipulated in clause 3.9.

viii. **Solar PV cell capacity test**

Monthly performance ratio for solar voltaic project shall be guaranteed as indicated below:

The performance Guarantee (PG) Test shall be carried out after successful commissioning of all solar rooftop locations. PG Test shall be carried out on any rooftop location by measuring Performance Ratio (PR) and comparing to the Guaranteed PR. The test shall be repeated for each location having different type of inverter.

$$PR\ (\%) = \frac{AC\ Yield\ (KWh) x 100}{\text{Installed capacity (KWp)} x\ Global\ Inclined\ Insolation\ (\frac{KWh}{m2})}$$

For the purpose of measuring Global Inclined Insolation (GII), pyranometer shall be installed by the Bidder.

The assumption for calculating PG Tests are as follow

- Temperature as per latest version from PVSyst
- Soiling loss=3%
- LID=2%
- Cable loss=1.5%
- Thermal Loss Factor (Uc, Uv)= Uc-24 Watts/m2-K Uv-2.0 Watts/m2-K
- PAN and OND file has to be furnished by the bidder. In case same is not available, PAN and OND file of equivalent product may be taken.

1. For the purpose of measuring Global horizontal Insolation (GHI), pyranometer shall be installed on returnable basis, mounted at the plane of the module, free of cost.

2. Bidder also install Single Quadrant type of 1.0 accuracy energy meter on all the location(s) based on mutual understanding.

3. In case 1.0 class energy meter is available in inverter, same shall also be accepted.

4. Both the additional supplied items i.e. pyranometer and energy meter shall be returnable basis and free of cost.

5. Measuring instruments to record on site data will include a pyranometers with sensitivity of 7μV/(W/m2), temperature sensor, signal converter.

6. The Bidder will be responsible to conduct the PG test only after achieving the physical completion and synchronization of the plant and complying the relevant requirements from utility.

7. If failed to achieve the guaranteed performance levels, the Bidder will at its own cost rectify all the defects identified during the test and take necessary steps/efforts to pass the PR test within the stipulated time span. Subsequent to rectification the PR will be restarted.

8. The test shall be conducted for a period of 60 minutes having GHI more than 600 W/m2 and the Measured PR shall be determined as per the actual generation.

   In case the measured PR is less than target PR, then

   1. Bidder has to install additional module string equivalent to the percentage shortfall of PR.

      Or

   2. In case there is no scope of any additional of module string, equivalent amount shall be adjusted from the contract value as
   3. Contract Value means total contract value for "Solar PV Portion".

The mathematical formula for calculating PR is given below:

$$\text{Applicable LD} = \text{Target PR of the Month} - \frac{\text{Measured PR} \times \text{Contract Value}}{\text{(Target PR of the month)}}$$

ix. **SCR Efficiency for Control of NOx emission**

Bidder shall guarantee and demonstrate that at the end of 16000 hrs of operation and with the originally installed catalyst (i.e. without the use of future layer of catalyst) the SCR efficiency for control of NOx emission (from thermal as well as fuel) shall not be less than 80% at 6% oxygen (O_2) content in flue gas on dry gas basis and ammonia slip not exceeding 3ppm at 100% TMCR load condition, when firing any coal from the range of coal(s) specified.

The SCR efficiency test for control of NOx emission shall be conducted at the end of 16000 hrs of operation or as and when SCR efficiency for control of NOx emission based on online measurements available in the control room reaches to the level of 70%, whichever is earlier. The catalyst will be deemed to have exhausted its life as and when SCR efficiency for control of NOx emission reaches to the level of 70%.

x. **Catalyst Life**

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/ Hybrid (SCR+SNCR) 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.

xii. **Ammonia Consumption Rate**

Guaranteed Ammonia consumption rate (in Kg/hr/unit, 99.5 wt %) at 100% TMCR for firing coal from the range of coal(s) specified shall be demonstrated. The ammonia consumption rate shall be measured during the test for SCR efficiency for control of NOx emission.

xiii. **FGD SO_2 Removal Efficiency**

Bidder's design shall ensure that the SO_2 removal efficiency from FGD shall not be more than 80 mg/nm^3 (6% O_2 dry basis) under guarantee point condition. The corresponding SO_2 removal efficiency from FGD shall be worked out.

xiv. **Limestone Consumption Rate**

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

xv **Cooling Tower**

The cold-water temperature of 33^0 C shall be guaranteed for the design conditions of CW flow, range, ambient WBT and RH as per the performance test procedure of cooling tower elaborated elsewhere in the specification. "Predicted cold water temperature" shall be arrived from the guaranteed cold-water temperature by correcting the same for the test conditions of range, ambient conditions and circulating water flow using the performance curves furnished by the Bidder. In case the "Test cold water temperature" is higher than the Predicted cold water temperature", Owner reserves the right to accept the tower after assessing the liquidated damages. The liquidated damages for shortfall in cold water temperature shall be worked out for cooling tower as per relevant clause & Chapter.

xvi **Transformer Losses**

The transformer losses shall be guaranteed by bidder as per list attached in clause 3.2 of this chapter. The LD shall be levied as specified separately. This LD shall be over and above the LD for auxiliary power consumption.

3.2 Amount of Liquidated Damages (LD) Applicable Under Category-I Guarantees

If the performance guarantee(s) specified at clause 3.1 are not met by the Bidder even after the modifications and/or replacements mentioned at clause 2.1 of this chapter, but are achieved within the stipulated Acceptable Shortfall Limit as indicated in this clause, Owner will accept the equipment/system/plant after levying liquidated damages as indicated hereunder. However, if the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, the Owner may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages against the Bidder, at the rates listed herein, and such liquidated damages shall be deducted from the Contract Price:

S. No.	Guarantee	Rate of Liquidation Damage (LD)	Acceptable Shortfall Limit with LD
i)	For increase in the guaranteed Turbine heat rate		
i) (a)	At 55% TMCR (440 MW) Turbine heat rate under rated steam conditions at guaranteed optimized condenser pressure with zero make-up	INR 18,000,000/- (INR Eighteen Million only) or equivalent foreign currency for per 1 Kcal/Kwhr increase in heat rate	(+) 2.5% of the guaranteed turbine heat rate.
i)(b)	At 100% TMCR (800MW) Turbine heat rate under rated steam conditions at guaranteed optimized condenser pressure with zero make-up	INR 107,000,000/- (INR One Hundred Seven Million only) or equivalent foreign currency for per 1 Kcal/Kwhr increase in heat rate	(+) 2.5% of the guaranteed turbine heat rate.
ii)	For decrease in steam generator efficiency		
ii)(a)	At 105% TMCR (840MW) Steam Generator efficiency with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.	INR 31,100,000/- (INR Thirty one Million one Hundred Thousand only) or equivalent foreign currency for per 0.1% decrease in Steam Generator efficiency.	(-) 1% of the guaranteed efficiency.
ii)(b)	At 100% TMCR (800MW) Steam Generator Efficiency with zero make up while firing the design coal at rated steam parameters, rated coal fineness and rated excess air at economizer outlet.	INR 118,500,000/- (INR One Hundred Eighteen Million Five Hundred Thousand only) or equivalent foreign currency for per 0.1% decrease in Steam Generator efficiency.	(-) 1% of the guaranteed efficiency.
iii)	For deficiency in Turbine Generator Output of 800 MW (100% rated load) under rated steam conditions, 70 mm Hg (abs) condenser pressure with 0% makeup.	INR 150,000/-(INR One Hundred Fifty Thousand only) per 1 KW shortfall in TG output	(-) 2.0% of the guaranteed turbine generator output.
iv)	For deficiency in	INR 118,000,000/- (INR	(+) 2.5% of the

S. No.	Guarantee	Rate of Liquidation Damage (LD)	Acceptable Shortfall Limit with LD
	condenser pressure measured at 300 mm above top row of condenser tube at 840 MW of unit load, 1% make up, design CW inlet temperature & design CW flow	One Hundred Eighteen Million only) (or equivalent foreign currency) per 1 mmHg increase in condenser pressure	guaranteed condenser pressure
v)	Steam generator capacity For shortfall in the guaranteed steam generating capacity in T/hr at rated steam parameters at super heater outlet & rated steam temperature at reheater outlet (with any combination of mills working as per Owner's choice) with the coal being fired from within the range specified	INR 35,000,000/-(INR Thirty Five Million only) (or equivalent foreign currency) for every 1 T/hr short fall in steam output from the guaranteed value.	(-) 1.0% of the guaranteed steam generator capacity
vi)	**ESP efficiency** For shortfall in guaranteed ESP efficiency in percentage points under conditions specified in clause # 3.1 in this chapter and elsewhere in this Specification.	INR 120,000,000/- (INR One Hundred Twenty Million only) (or equivalent foreign currency) for every 0.01% point shortfall in ESP Efficiency from the guaranteed value.	(-) 0.05% point from the guaranteed ESP efficiency.
vii)	**Unit Auxiliary Power Consumption** For increase in the auxiliary power consumption in KW guaranteed as per the requirements of clause 3.9 (including unit auxiliaries & station auxiliaries)	INR 550,000/- (INR Five Hundred and fifty thousand only) (or equivalent foreign currency) per 1 KW increase in Auxiliary Power Consumption.	(+) 1% of the guaranteed auxiliary power consumption.
viii)	Shortfall in guaranteed monthly performance ratio of solar photo voltaic (PV) Project.	To be calculated as per clause 3.1 (viii) in this chapter.	
ix)	**SCR Efficiency for**	INR 95,24,000/- (INR	(-)10% points

S. No.	Guarantee	Rate of Liquidation Damage (LD)	Acceptable Shortfall Limit with LD
	Control of NO_X emission For shortfall in SCR efficiency for control of NO_X emission in percentage point under condition stipulated in clause 3.1(ix)	Nine Million Five Hundred Twenty Four Thousand only) (or equivalent foreign currency) for every 1% point shortfall in SCR efficiency from the guaranteed value	from the guaranteed value
xi)	**Shortfall in Catalyst Life** For shortfall in catalyst life in hrs under condition stipulated in clause 3.1 (x))	INR 3,161,000/- (INR Three Million One Hundred One Thousand only) (or equivalent foreign currency) for every 100 hours shortfall in catalyst life from the guaranteed value	(-) 15% from the guaranteed value
xii)	**Ammonia Consumption Rate** For increase in ammonia consumption rate (in Kg/hr/unit, 99.5wt %) under condition stipulated in clause 3.1 (xi)	INR 7,600,000/- (INR Seven Million Six Hundred Thousand only) (or equivalent foreign currency) for every 1 Kg/hr increase in ammonia consumption rate from the guaranteed value	(+) 10% of the guaranteed ammonia consumption
xiii)	**FGD SO_2 Removal Efficiency** For shortfall in guaranteed SO_2 removal efficiency in percentage points under condition stipulated in clause 3.1 (xii)	INR 26,000,000/- (INR Twenty Six Million only) (or equivalent foreign currency) for every 0.1% point shortfall in guaranteed SO_2 removal efficiency	(-) 0.25% from the guaranteed SO_2 removal efficiency
xiv)	**Limestone Consumption Rate** For increase in limestone consumption of FGD system in kg/hr/unit under condition stipulated in clause 3.1 (xiii)	INR /- 27,000,000/- (INR Twenty Seven Million only) (or equivalent foreign currency) for every 100kg/hr increase in limestone consumption rate from the guaranteed value	(+) 10% of the guaranteed limestone consumption
xv)	**Cooling Tower** – For every 0.2^0 C rise in cold water temperature stipulated	112,000,000/- (INR One hundred and Twelve million only) (or equivalent foreign	(+) 1^0 C of the guaranteed value

S. No.	Guarantee	Rate of Liquidation Damage (LD)	Acceptable Shortfall Limit with LD
	in clause 3.1 (xiv)	currency)	
xvi)	**Transformer Losses (**Refer table below for list of transformers)**		
	a). Iron Losses For every kW increase or part thereof from the Guaranteed value	Rs. 1,94,000/-(Rupees One hundred Ninety four thousand only)	(+) 1% of the guaranteed losses
	b). Copper Losses. For every kW increase or part thereof from the Guaranteed value	Rs. 1,48,000/- (Rupees One hundred forty eight thousand only)	(+) 1% of the guaranteed losses
	c). Cooler Losses For every kW increase or part thereof from the Guaranteed value	Rs. 78,000/- (Rupees seventy eight thousand only)	(+) 1% of the guaranteed losses

S. No.	Transformer Losses (as per list below) **							
	Transformer	Quantity (Nos.)	Iron Losses (max)		Copper Losses (max) at 75 °C & Full Load including IS tolerance		Cooler Losses (max) including IS tolerance	
			for One (1) trans-former	For all trans-formers	for One (1) trans-former	For all trans-formers	for One (1) trans-former	For all trans-formers
a.	Generator Transformer (GT)	**4**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
b.	Station Transformer (ST)	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
c.	Unit Transformer (UT)	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
d.	Interconnecting Transformer	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
e)	Excitation Transformer (if applicable)	**1**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
f)	Auxiliary Power Transformers 11/6.9 KV							
i	UAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
ii	SAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
iii	CHPAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
iv	AHPAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
v	BKTAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
vi	FGDAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
Vii	DMPAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
viii	BWAT	**2**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
g	Service Transformer	**Lot**	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote	Bidder to quote
	Total Losses							

NOTE:

a) Each of the liquidated damages specified above shall be independent and these liquidated damages shall be levied concurrently as applicable.

b) If the contract currency is other than INR, then the liquidated damages shall be in equivalent amount in contract currency based on Bill selling exchange rate of State Bank of India prevailing on the date of its deduction.

c) All these liquidated damages for short fall in performance shall be deducted from the contract price as detailed in accompanying General Condition of Contract (GCC) / Special Conditions of Contract (SCC).

d) Bidder's aggregate liability to pay Liquidated Damages (LD) for failure to attain the functional guarantee shall not exceed twenty (20) percent of the Contract Price.

e) The LD values and acceptable shortfall limits are applicable except for the value indicated for auxiliary power consumption for station auxiliaries, which is on station basis.

3.3 **Unit Heat Rate**

Tests for Turbine Cycle Heat Rate and Efficiency of Steam Generator shall be conducted simultaneously but independently and Unit Heat Rate is to be computed as follows:

To be arrived in line with 55%

Unit Heat rate in kcal/kW hr under rated steam conditions at at guaranteed Condenser pressure with zero make up at 440 MW unit load (i.e. 55% of rated load):

$$\textit{Unit Heat Rate (55\%)} = \frac{\text{THR (55\%)}}{\text{SG\_EFF (55\%)}}$$

Unit Heat rate in kcal/kW hr under rated steam conditions at guaranteed Condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load):

$$\text{Unit Heat Rate (100\%)} = \frac{\text{THR (100\%)}}{\text{SG\_EFF (100\%)}}$$

Where

THR (55%) : Turbine Cycle Heat rate in kcal/kW hr under rated steam conditions at guaranteed Condenser pressure with zero make up at 440 MW unit load (i.e. 55% of rated load). (To be calculated as per clause 3.4 of this section)

SG_EFF(55%) : Efficiency of the Steam Generator at 440 MW unit load (i.e. 55% of rated load) with 270 C ambient temperature and 60% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be calculated as per clause 3.7 of this sub-section). The efficiency shall be based on Heat

Input GCV of coal.

THR (100%) : Turbine Cycle Heat rate in kcal/kWhr under rated steam conditions at guaranteed Condenser pressure with zero make up at 800 MW unit load (i.e. 100% of rated load). (To be calculated as per clause 3.4 of this section)

SG_EFF(100%): Efficiency of the Steam Generator at 800 MW unit load (i.e. 100% of rated load) with 27^0 C ambient temperature and 60% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be calculated as per clause 3.7). The efficiency shall be based on Heat Input GCV of coal.

3.4 Turbine Cycle Heat Rate

Turbine Cycle Heat Rate shall be calculated as follows & indicated in all computed heat balance diagrams:

$$\text{HEAT RATE} = \frac{M1\,(H1 - h1) + M2\,(H3 - H2) + Mis\,(h1 - his) + Mir\,(H3 - hir)}{Pg}$$

Where,

M1 - Quantity of live steam entering the turbine stop valve including any live steam supplied to valve stems, or glands etc. in Kg/hr.

M2 - Quantity of steam from turbine to reheater in Kg/hr.

Mir - Quantity of desuperheating water flowing into reheater system for regulation of steam temperature in Kg/hr.

H1 - Enthalpy in kcal/kg of live steam.

H2 - Enthalpy in kcal/kg of steam to reheat.

H3 - Enthalpy in kcal/kg of reheated steam.

h1 - Enthalpy of feed water in kcal/kg at the downstream of the junction of feed flow and bypass flow of HP heaters.

hir - Enthalpy of desuperheating water flowing into reheat system in Kcal/Kg.

Pg - Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 840MW and 800MW respectively for 105%, and 100% TMCR unit load:

(a) Power taken by Excitation system (KW) including excitation 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).

(b) Power required for ventilation of oil and control fluid tanks, if ventilating fans are separately driven (KW).

(c) Power required for lubrication, if lubricating pumps are separately driven (KW).

(d) Power required for control fluid pumps, if control fluid pumps are separately driven (KW).

(e) Power required for hydrogen, seal oil auxiliaries, if separately driven (KW).

(f) Power required for stator water cooling system, if cooling pumps are driven separately (KW).

(g) Power required for Gland Steam Exhauster (GSC) if GSC Exhausters are separately driven

(h) Power required for any other continuously operating integral auxiliary. These need to be specified during bidding stage.

3.5 Applicable corrections for Heat Rate, Output and Condenser Pressure

(i) Corrections Applicable for Turbine Cycle Heat rate & Turbine Generator Output tests

Based on cycle condition & covering entire range of operation for Turbine following correction curves for variation in Turbine Cycle Heat rate & Turbine Generator output (55% & 100%) to be furnished:

(a) Variation in main steam pressure.

(b) Variation in main steam temperature.

(c) Variation in reheater steam temperature.

(d) Correction Curves, if applicable, due to change in reheater spray quantities with respect to coal properties.

(e) Variation in condenser pressure for main condenser.

(f) Variation in power factor, frequency, generator hydrogen pressure and voltage.

(g) Change in system water storage.

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, the amount shall be decided by the Owner.

(ii) Corrections Applicable for Condenser pressure Guarantee

(a) Variation in Ambient Wet Bulb Temperature (WBT).

(b) Variation in Ambient Relative Humidity (RH).

It may be noted that the heat balance diagrams and guarantees shall be furnished considering the quantities of water for reheater sprays with any mill combination in service to the Owner's choice. For reheater, the spray quantities used shall not exceed the limits specified elsewhere in the specification. During Performance Guarantee 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.

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.

The above list of correction curves is conclusive & curves in addition to above shall not be applied.

3.6 **Specific and Limiting Requirements for Steam Generator Efficiency**

(i) Guaranteed Steam generator efficiency shall be calculated as per the requirements of PTC 4 and as per stipulations of Clause 3.7 of this section.

(ii) The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing:

a.	Excess air at economizer outlet at 105% & 100% TMCR load	20% (min.)
b.	Corrected flue gas temperature at air preheater outlet (at 55% & 100% TMCR)	115^0 C or as predicted by the Bidder whichever is higher
c.	Unburnt fuel at all efficiency load at 105% & 100% TMCR load	1.0 % (min)

(iii) 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 parameters indicated at (a), (b) & (c) above are lower than those specified above.

(iv) For the purposes of guarantees the ambient air temperature and relative humidity shall be taken as 270 C and 60% respectively.

(v) Unless otherwise specified, the guarantees shall be based on design coal firing with coal/ash analysis as given in Volume II, Chapter 2 Project Information.

(vi) The performance guarantee test will be carried out within three months after the successful completion of Initial Operation of facilities 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

3.7 MAJOR REQUIREMNTS/ METHOD OF STEAM GENERATOR EFFICIENCY TESTS

a)	**Test Code**	**As per ASME PTC 4**
b)	**Test Loads**	55% TMCR (440 MW unit Load) 100% TMCR (800 MW unit Load)
c)	**Test Conditions**	Boiler operating with rated excess air at economizer outlet, coal fineness and firing design coal.
d)	**Ambient air condition**	27^0 C temperature (Dry bulb) and 60% relative humidity. The reference air temperature for the **Steam Generator** efficiency guarantee/ testing shall be taken as the temperature of air (i.e., 27^0 C) entering APH.
e)	**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.
f)	**Measurement and computation of heat losses: As Per ASME PTC 4** **Heat Losses to be measured :-** 1. Dry gas loss. 2. Loss due to hydrogen in fuel. 3. Loss due to moisture in fuel. 4. Loss due to moisture in air. 5. Loss due to unburnt carbon. 6. Loss due to carbon monoxide. 7. Loss due to sensible heat in fly ash. 8. Loss due to sensible heat in bottom ash. 9. Loss due to mill rejects. 10. Loss due to surface radiation & convection.	
g)	The guaranteed steam generator efficiency shall be without any heat credit.	
h)	The Steam Generator efficiency shall be guaranteed based on ambient air temperature of 27 degree Celsius and relative humidity of 60%.	
i)	Correction to tested efficiency shall be applicable for variation in following parameter only:	
	(a) Ambient air temperature.	
	(b) Relative humidity of ambient air.	
	(c) Hydrogen in coal.	
	(d) Moisture in coal.	
	(e) GCV of coal.	
	(f) Percentage of ash in coal.	

j)	The duration of the test shall be at least four hours. No soot blowing shall be allowed during the test period or during stabilization period of four hours prior to commencement of the test.
k)	The Bidder shall furnish the correction curves, for Owner's approval covering the expected ranges of variations for all these parameters for the range of coal specified. These curves shall be submitted along with Techo-commercial bid.
l)	For all other aspects, not spelt out above, or in the specifications, where code stipulates the agreement between the parties concerned before commencement of the test, 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.
m)	The number, location, type and accuracy of the test grade thermocouples and pressure gauges shall be to Owner's approval
n)	The Steam Generator efficiency testing shall be carried out with any combination of mills in operation to Owner's choice, with fineness of pulverized coal not exceeding 70% through 200 mesh.
o)	Steam generator efficiency shall be with guaranteed or actual air heater leakages, whichever is higher.

3.8 METHOD OF COMPUTING TEST EFFICIENCY OF ESP & SUSPENDED PARTICULATE MATTER EMISSION OF ESP.

3.8.1 The performance test on electrostatic precipitator will commence after trial operation. During the interval between the completion 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 permitted during this period or immediately before the conductance of the performance tests.

3.8.2 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.

The overall test efficiency and test temperature/inlet dust burden for one set of ESP passes (stream) serving the Steam Generator shall be worked out as follows:-

a) Vm (guarantee point test flow) shall be the total of inlet gas flows to the six gas streams at the time of test.

b) Test inlet dust burden (Di) shall be weighted mean of the inlet dust burdens for the individual streams i.e.:

$$Di = \frac{(Vm1 \times Di1) + (Vm2 \times Di2) + (Vm3 \times Di3) + (Vm4 \times Di4) + (Vm5 \times Di5) + (Vm6 \times Di6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

Where suffix 1, 2, 3, 4, 5 & 6 are representing the six gas streams.

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

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

$$Ti = \frac{(Ti1 \times Vm1) + (Ti2 \times Vm2) + (Ti3 \times Vm3) + (Ti4 \times Vm4) + (Ti5 \times Vm5) + (Ti6 \times Vm6)}{(Vm1 + Vm2 + Vm3 + Vm4 + Vm5 + Vm6)}$$

d) The measured test efficiency shall be:

$$Em = \frac{Di - Do}{Di} \times 100(\%)$$

e) The corrections for the flue gas flow and ESP inlet flue gas temperature in excess of the values for these parameters under guarantee point conditions, shall be allowed only in case and to the extent such variations are caused solely due to changes in specified coal properties and ambient conditions. Further, the corrections for the flue gas flow and temperature lower than the guarantee point values shall be applied based on actually measured test values. Subject to the above, the corrections for the variation in flue gas flow, inlet dust burden and ESP inlet flue gas temperature shall be based on the above computed test values and the procedure indicated in the next para.

3.8.3 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 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:

1. $Ec = 1 - e^{Z}$

Where

Ec = Corrected test efficiency to guarantee point conditions.

$$Z = C.Ln.(1 - Eg)$$

$$C = \frac{1}{Ca.Cb.Cc \ldots etc}$$

Ca. Cb. Cc are Correction factors for flue gas at temperature, ESP inlet dust loading & sulphur based on correction curves furnished by the Bidder and approved by the Owner.

2. $Eg = 1 - e^{Y}$

Where

$$Y = (Vm/Vg)^{0.5}.Ln.(1 - Em)$$

Eg = Measured test efficiency corrected to the specified guarantee point flow.

Vg = Specified Guarantee point gas flow (m3/sec).

Vm = Measured gas flow (m3/sec)

Em = Measured test efficiency

Ln = Logarithm, natural base.

The correction curves should be realistic for expected range of operation and variation in characteristics specified.

The test efficiency shall be the average of at least three corrected test efficiencies.

However, method & detail procedure shall be subjected to Owner's approval.

3.8.4 The Performance 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

3.9 AUXILIARY POWER CONSUMPTION

3.9.1 Unit Auxiliary Power Consumption

The unit auxiliary power consumption shall be calculated using the following relationship.

Pau = Pu + TL (Unit)
Pau = Guaranteed Unit Auxiliary Power Consumption.
Pu = Power consumed by the auxiliaries of the unit under test.
TL = Losses of the transformers supplied by bidder based on works test reports for unit.

The power consumption (Pu) 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.

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries. The auxiliaries to be considered shall include but not be limited to the following:

(i) Turbine Unit Oil purifier.

(ii) Turbine Unit control oil purifier.

(iii) Electric oil heaters for turbine lube oil (if applicable).

(iv) Feed and discharge pumps of turbine oil purification system.

(v) Main turbine Condenser air evacuation pumps.

(vi) BFP drive turbine Condenser air evacuation pumps (if envisaged).

(vii) BFP drive turbine Condensate extraction pumps (if envisaged).

(viii) Main turbine Condenser tube cleaning system pumps.

(ix) Debris filter flushing pumps (if envisaged)

(x) BFP drive turbine Condenser tube cleaning system pumps (if envisaged).

(xi) Condensate extraction pumps.

(xii) Drip pump (if envisaged).

(xiii) COLTCS

(xiv) BFP drive turbine Condensate extraction pumps (if envisaged).

(xv) Hydrazine dosing pumps (if required).

(xvi) Ammonia dosing pumps (if required).

(xvii) Oil purifiers of 2x50% TDBFPs and their feed and discharge pumps.

(xviii) Lube oil pumps of 2x50% TDBFPs and the electrical oil heater for lube oil.

(xix) Auxiliary oil pump for MDBFP.

(xx) Oil pumps for HP-LP bypass system.

(xxi) Motor Driven Boiler Feed Pump
(For this purpose only 15% of the deemed power consumed by the MDBFP at 100% TMCR unit load shall be considered).

(xxii) BFP Booster pumps (if applicable)

(xxiii) Auxiliary Cooling (normally working) water pumps to supply cooling water on the secondary side of the plate type heat exchangers in the closed loop Equipment cooling (unit auxiliary) water system.

(xxiv) DM Cooling (normally working) Water 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.

(xxv) Mills.

(xxvi) PA Fans.

(xxvii) FD Fans.

(xxviii) ID Fans.

(xxix) Air Heaters.

(xxx) Coal Feeders.

(xxxi) Steam Generator Start up drain recirculation Pumps (If required).

(xxxii) Seal Air Fans.

(xxxiii) Lube oil pumps for fans/ Air heaters & mill system etc

(xxxiv) Scanner air fans.

(xxxv) Electrostatic Precipitator 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. (Refer Note 4 below).

(xxxvi) Gas Recirculation Fan (if applicable)

(xxxvii) Circulating Water Pumps

(xxxviii) Power consumption of fans, water pumps, exhausters of Air washer units for TG building and whole main plant area at its rated duty point.

(xxxix) Power consumption of any other continuously operating BOP Packages viz., SCR, FGD, coal handling system, ash handling system, raw water system, water treatment plant, DM Plant, ETP, etc., for unit operation at 100% TMCR.

(xl) Pressurising pumps of fuel oil system.

(xli) Air conditioning and ventilation system

(xlii) Battery charger and UPS

(xliii) Limestone flow path and Duty factor for limestone handling plant shall be 0.2

(xliv) Gypsum flow path and Duty factor for gypsum handling plant shall be 1.0.

Note:

1. The bidder shall furnish a list of equipment to be covered under auxiliary power consumption, which shall be subject to Owner's approval.

2. The bidder shall ensure that power supply to all such equipment to be covered under auxiliary power consumption is fed from unit board.

3. Number of coal mill and coal feeders shall be corresponding to the design coal.

4. Method of Computation of Auxiliary Power consumption for ESP:-

   For guarantee purpose, total maximum continuous Auxiliary power consumption will be the power consumption of corona power (Excluding power consumption by hopper heaters, insulator heaters, rapping system, ventilation fans etc.) of all fields of all passes of ESP. Corona power of TR sets will be computed at the input terminals of the TR sets when all ESP fields of all ESP passes are working and rapping system is in normal operation at the guarantee point condition as

specified. The measurement for guaranteed auxiliary power consumption shall be carried out during ESP collection efficiency test. The method for computing the corona power shall be as described below:-

a) Power consumption of TR sets will be measured pass wise and for one pass (Say ESP-A) at a time with the help of energy meter in ESP MCC.

b) Energy meter reading will be taken before starting the collection efficiency test and after completion of collection efficiency test.

c) 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 W2=E2/t1.

d) 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 degree Celsius above the flue gas temperature.

e) Measured corona power consumption for one pass (say ESP-A) = (W2-W1)

f) Measured corona power = Corona power of (ESP-A + ESP-B + ESP-C + ESP-D + ESP-E + ESP-F).

g) Guaranteed Unit Auxiliary Power Consumption of FGD system shall be taken by considering the additional pressure drop in FGD system during FGD SO_2 removal efficiency test at specified guarantee point conditions. For this purpose, difference of FGD system pressure drop during FGD SO_2 removal efficiency test and that at Unit Auxiliary Power Consumption test shall be loaded as additional Auxiliary Power Consumption.

h) Number of fields shall be as per the PG test of ESP as detailed elsewhere.

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

3.9.2 **Station Auxiliary Power Consumption**

The station auxiliary power consumption shall be calculated using the following relationship.

P_Stn = Pau_Stn + TL_Stn

Pau_Stn = SUM (Pi x Di)

Where,

P_Stn = Power consumed by the station auxiliaries

Pau_Stn = Total Power Consumption, while running at 100% design load for all the auxiliaries of the station supplied by bidder.

Pi = Power consumed by each station auxiliary.

Di = Duty factor to be considered for each station auxiliary

TL_Stn = Transformer Losses of the station / standby / start-up transformers for meeting the station auxiliary power supply and that of any other transformer supplied by the bidder based on work test report.

NOTE: Transformer losses (TL) shall be considered as per following (as applicable)-

- GT - 100% no load loss, 54% of Copper losses & 100% Cooler Loss.
- ICT – 100% no load loss, 30% of Copper losses & 67% 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

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 at the ensuing para of this chapter.

The station auxiliaries that shall be running during the guarantee test for calculating "Pau Stn " shall include but not be limited to the following:

(Where duty factor is not indicated the same is to be considered as 1.0)

a) **Plant & Instrument Air Compressors & Air Drying plant**

Power consumption of:

i.) Instrument Air compressor
- All Normally running — Duty Factor = 0.6

ii.) Plant Air compressor
- All Normally running — Duty Factor = 0.33

iii.) Air Drying plant (Heaters) (if applicable)
- All normally running — Duty Factor = 0.6

iv.) Air Drying plant (Blowers) (if applicable)
- All normally running — Duty Factor =1.0

b) **Air Conditioning & Ventilation System - Duty Factor 1.0**

Power consumption at motor input terminals of working units (i.e., excluding stand-by) at its rated duty point of Chilling machines, Chilled water Pumps, Condenser water Pumps, Air handling unit (AHU) fans, for the Air conditioning system of main plant building, FGD control room, ESP control room of unit, 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 water system control building, switchyard control building and canteen building. Power consumption at motor input terminals of centrifugal fans of mechanical ventilation system of GIS building.

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.

(Duty factor for power consumption of A/C equipment of service building shall be 0.5)

c) **Water System Pumps (Working Pumps) - Duty Factor 1.0**

i.) Raw Water Pumps for PT Plant
ii.) AHP Make up pumps
iii.) AC & Ventilation system make-up pumps
iv.) DM water make up pump
v.) Potable water pumps
vi.) Service water pumps.
vii.) Clarified water feed pumps for DM plant
viii.) Degassed water pump
ix.) Waste water transfer pumps
x.) Jockey Pumps for fire-fighting system
xi.) CT makeup pumps
xii.) CW and ACW pumps
xiii.) CW treatment system & Chlorination plant
xiv.) Sludge transfer pumps in PT Plant, Centrifuge and thickened sludge transfer pumps
xv.) Pumps (for ETP system, zero discharge system)
xvi.) Any other pump/drive required for continuous running of the station.

d) **Ash Handling System**

List of drives with corresponding weight age factors thereof for which power consumption (at reference design condition) is to be guaranteed shall be as follows:

S No.	Drive	Weightage Factor
1.	Bottom Ash Clinker Grinders	0.3125 for jet pump system
2.	BA Water Pumps	0.625
3.	Eco water Pumps	1.0
4.	L.P. Water Pumps	1.0
5.	FA water pumps	1.0
6.	HP Seal water pumps	1.0
7.	LP Seal water pumps	1.0
8.	Fluidizing air blowers	1.0
9.	Conveying air blowers	1.0
10.	Vacuum pumps	1.0
11.	Coarse ash slurry pumps	0.1875
12.	Ash Slurry pumps	1.0
13.	Instrument air compressors with air drying plant (ADP)	1.0

e) **Mill Reject System**

Compressor : Duty Factor 1.0

f) **Coal Handling System**

Total power consumption for all the equipment including auxiliaries with single stream operation at its guaranteed flow path capacity except:-

- Lighting
- Hoists
- Coal sampling unit
- Sump Pumps
- Elevators
- DS, DE, Ventilation, SW System, Potable water system

Duty factor for coal handling system shall be 0.5

Coal & Biomass Handling plant

Total power consumption for all the equipments including auxiliaries with single stream operation at its guaranteed capacity for:

Coal flow path (Direct stream) and one no. stacker-reclaimer, one no of yard conveyor (maximum of stacking / reclaiming modes) except the following:

Lighting
Hoists
Coal/ sampling unit
DS, DE, Ventilation,
SW System,
Potable water system.

Duty factor for coal and Biomass handling plant shall be 0.5

The above list is not comprehensive and only indicative. Bidder shall furnish a list of equipment to be covered under station auxiliary system, which is to be considered under station auxiliary power consumption. These are subject to Employer's approvals.

g) **Fuel Oil system Duty Factor 0.5**

- LDO booster pumps

h) **SCR and FGD Packages**

- All operating equipment, blowers, compressors and pumps. **Duty factor: 1.0**

i) **Plant Illumination System**

- Indoor Lighting : Duty Factor 1.0
- Outdoor Lighting : Duty Factor 0.4

The above list is not comprehensive and only indicative. Bidder shall furnish a list of equipment to be covered under station auxiliary system, which is to be considered under station auxiliary power consumption. These are subject to Owner's approvals.

4.0 GUARANTEES UNDER CATEGORY-II

4.1 The Performance Guarantees, conformances to which are mandatory are as follows:

4.1.1 NOx emission

Bidder shall guarantee that maximum total NOx emission from the unit shall not be more than 100 grams of NOx (from thermal as well as fuel) per giga joule of heat input (at 6% O_2 level and as per equivalent NO_2) to the boiler during the entire operating range of steam generator for the range of coals specified.

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.

4.1.2 SO_X Emission

Bidder's design shall ensure that the SO_x emission from FGD shall not exceed 80 mg/NM^3 (6% O_2 dry basis) under guarantee point condition.

5.0 GUARANTEES UNDER CATEGORY-III

The parameters/capabilities to be demonstrated for various systems/ equipment shall include but not be limited to the following:

5.1 Noise

5.1.1 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.

5.1.2 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 IEC 651 or BS 5969 or IS 9779.

5.1.3 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.

5.1.4 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

5.2 Start-up time

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.

5.3 Performance characteristics of fans

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.

5.4 Steam temperature imbalance

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 10^0 C under all load conditions.

5.5 SH and RH tube metal temperature

It shall be demonstrated that superheater and reheater tube metal temperature at critical locations remain within maximum tube metal temperature limits as

per design of the OEM under various load conditions (i.e. 100%, 80%, 60% & 50%).

5.6 Super heater and reheater attemperation system

It shall be demonstrate that the spray water flow of SH attemperation system does not exceed 8% of main steam flow, at super heater outlet, while firing any coal from within the range specified with HP heaters in service while maintaining the rated SH outlet steam temperature at all loads up to and including BMCR. It shall also be demonstrate that the RH temperature is maintained at the rated value without any spray water requirement under normal operating conditions.

5.7 DM Cooling Water System

a) Parallel operation of pumps without undue noise & vibration to be demonstrated at site.

b) Pressure drop across the heat exchanger on the primary & secondary water circuit to be demonstrated at site.

c) 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.

5.8 Generator excitation system

The performance of generator excitation system as specified shall be demonstrated.

5.9 Steam condensing plant

i. Temperature of condensate, at outlet of condenser, shall be demonstrated to be near to saturation temperature corresponding to the condenser pressure at all loads.

ii. Oxygen content in condensate at hot well outlet shall not exceed 0.015 cc/litre over 50-100 % load range and shall be determined according to calorimetric Indigo-Carmine method.

iii. 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.

iv. When one half of the condenser is isolated, condenser shall be capable of taking at least 60% T.G. load under TMCR conditions.

v. The design 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 4.170 C below the temperature corresponding to absolute suction pressure shall be demonstrated. Correction curves for establishing the capacity at site conditions shall also be furnished.

vi. The air and vapour mixture from air cooling zone of condenser shall be 4.170 C below the saturation temperature corresponding to 25.4 mm Hg (abs) suction pressure. Correction curves for establishing the same at site conditions shall also be furnished.

vii. Pressure drop across of condenser cooling system with COLTCS in operation

5.10 **Rate of change of load and sudden load change withstand capability**

The Bidder shall demonstrate capability of boiler-turbine-generator in regards to ramp rate and step load change as specified and sudden load change withstand capability.

5.11 **No fuel oil support shall be required above 40 % BMCR**

Bidder shall guarantee that oil support for flame stabilization shall not be required beyond 40% of BMCR load when firing 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 any oil firing for stable and efficient boiler operation at and above 40% BMCR loads.

5.12 **Ammonia slippage in De-NOx system**

It shall be demonstrated that the Ammonia slippage in De-NOx system (after last layer of catalyst) for entire range of operation from 40% BMCR to 100% BMCR shall be less than 2.5 ppm (at 6% O_2 on dry basis) for the range of coal specified for an operation period of minimum 16,000 hrs without further catalyst addition or replacement.

5.13 **SO_2 to SO_3 conversion in De-NOx system**

Bidder shall demonstrate that SO_2 to SO_3 conversion in De-NOx system shall be within 1% (maximum) at all operating conditions for entire range of operation from 40% BMCR to 100% BMCR against range of coal(s) specified for an operation period of minimum 16,000 hrs without further catalyst addition or replacement.

5.14 **Catalyst Life**

The Bidder shall demonstrate NOx emission outlet at SCR shall not exceed 80 mg/Nm^3 @ 6% O_2 dry basis (with ammonia slip less than 2.5 ppm at 6% O_2 dry basis) at the end of 16000 operation hours for range of coal(s) specified from 40% BMCR to 100% BMCR.

Note: The 16000 hours as mentioned above for SCR catalyst life, shall be based on actual running hours of operation of SCR system counted from the date of successful completion of 'Initial Operation' of unit.

5.15 **Pressure drop across the SCR Reactor**

Bidder shall specify guarantee value and demonstrate the pressure drop across the SCR Reactor with operating catalyst rows (except spare row considered) at 100% TMCR load condition with design Coal and shall not exceed the guaranteed value.

5.16 **Air Preheater air in leakage**

Bidder shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or the value specified in technical specification (whichever is lower), as specified at 100% TMCR load condition

with design coal.

5.17 **ESP Air in Leakage**

Bidder shall guarantee that ESP air in leakage shall be limited to 1% of the total gas flow under guarantee point conditions.

5.18 **Pressure Drop across ESP**

Bidder shall guarantee that the maximum flue gas pressure drop across the ESP under specified guarantee point conditions shall not exceed 20 MMWC for base offer ESP.

5.19 **Feed Water Heaters and Deaerator**

The following parameters shall be demonstrated:

a) TTDs and DCAs of feed water heaters shall be demonstrated as per guaranteed heat balance diagram for 100% TMCR condition.

b) Outlet temperature from final feed water heater(s).

c) 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.

d) Free carbon dioxide in deaerator effluent shall be non-traceable at all loads from zero to VWO with 1% cycle make up.

e) Continuous and efficient operation and performance of feed heating plant without undue noise and vibrations at all loads and duty conditions

5.20 **HP/LP Bypass capabilities**

The HP/LP Bypass system shall satisfy the following functional requirements under automatic interlock action. It shall come into operation automatically under the following conditions:

(a) Generator Transformer Circuit breaker opening

(b) HP/IP stop valves closing due to turbine tripping.

(c) Sudden reduction in demand to house load

Under all these conditions while passing the required steam flows as per the relevant heat balances, the condenser shall 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

5.21 **Power cycle pumps**

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.

5.22 **Condenser on load tube cleaning system**

Life of sponge rubber balls and number of balls lost during 1000 hours of plant operation as agreed in contract shall be demonstrated.

5.23 **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 shall be demonstrated.

5.24 **Steam Generator and Auxiliaries**

Category-III Guarantees of this sub-section for various systems/ equipment for steam generator and auxiliaries shall be based on and demonstrated corresponding to ambient air condition of 27^0 C temperature & 60% RH.

(i) Coal Pulveriser capacity at rated fineness

Performance testing shall be conducted on coal pulverisers toward establishing their guaranteed capacity meeting the specification requirement. Corrections may be applied for the variation in coal characteristics i.e. HGI & Total Moisture of test coal with respect to specified design coal.

Capacity demonstration test shall be carried out for the following conditions:

(a) The Bidder shall demonstrate capacity output on one coal pulveriser (of Owner's choice) of Steam Generator for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.

(b) Further, Bidder shall also demonstrate capacity output on four coal pulverisers (of Owner's choice) of Steam Generator, not less than the 85% of guaranteed value of (a) 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.

Capacity test as mentioned at a & b above shall be demonstrated at the following conditions occurring simultaneously during testing:

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

In case the Bidder successfully demonstrates the guaranteed capacity of coal pulverisers as stated above, remaining coal pulverisers of corresponding steam generator will also be considered to have successfully met the 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 by the Bidder to demonstrate guaranteed capacity.

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.
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 upto a value above which the capacity remain constant.

In case the Bidder successfully demonstrates the guaranteed capacity of coal pulverisers as stated above, remaining coal pulverisers of corresponding steam generator will also be considered to have successfully met the 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 by the Bidder to demonstrate guaranteed capacity.

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.

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 upto a value above which the capacity remain constant.

(ii) Furnace Exit Gas Temperature (FEGT)

The Bidder shall conduct a comprehensive thermal performance test (TPT). Through such TPT the Bidder, by indirect measurement, shall demonstrate that the Furnace Exit Gas Temperature (FEGT) does not exceed the specified maximum temperature limit, with coal pulverizer combinations to Owner's choice and all other requirement in line with Section 2, Chapter 1 of Volume III (Mechanical) of Technical Specifications. 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. 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:

(a) 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.

(b) 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 ±5%) for all tests.

(c) Using above SEFs, for each heat transfer bank Bidder's original boiler design model will be changed to make it project specific to this EPC Package.

(d) 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 "(Project Name) TPS Specific" model as per step-(c) above. 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'.

(e) The validated "(Project Name) TPS Specific" 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 Owner.

(f) Having established and demonstrated FUEL SWITCHING capability, the contractual FEGT can be demonstrated by using the SITE SPECIFC calibrated model as per step-(d) and plugging in the specified coal(s).

The detailed procedure and the correction curves for the above test shall be to Owner's approval.

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 (800 MW).

(iii) Run back capability

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/ BFP etc.) shall be demonstrated ensuring smooth and stable runback operation.

For Details refer Volume II, Chapter-3.

(iii) Air Preheater Air in Leakage

Bidder shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or specified value (whichever is lower) as per indicated in the Technical specifications. Above requirement needs to be complied with recirculation of flue gas (if applicable) from downstream of ESP.

5.25 **Power Cycle Piping**

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.

5.26 **Air Conditioning & Ventilation System**

A. Following shall be demonstrated at Shop

1) Capacity and discharge pressure of chilled water pumps, condenser water pumps and pumps of air washer and unitary air filtration units at its rated duty point of Air conditioning and Ventilation system.

2) Capacity and static pressure of air washer unit fans, Unitary air filtration unit fans, roof exhausters of TG building and AHU fans at its rated duty point of Air conditioning and Ventilation system.

B. Following shall be demonstrated at Site

1) AC plant capacity of each area and guaranteed room conditions during summer for all the Air conditioned areas.

2) Parallel operation, Vibration & Noise level of all rotating equipment.

5.27 **Fuel Oil Handling System**

a) All pumps shall be guaranteed for capacity, total dynamic head either in isolation or during parallel operation.

b) Each storage tank shall be guaranteed for capacity and stability.

c) Entire piping and supports for smooth operation.

5.28 **Water System Pumps & other Misc. Pumps**

Capacity and 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).

Vibration, noise level and parallel operation of all the pumps at the rated duty point shall be demonstrated at site.

5.29 The parameters/capabilities to be demonstrated for following systems/ equipment shall be:

5.29.1 **Turbine hall EOT Crane:**

Over load test, travel & hoist speed checks etc., shall be demonstrated as per IS: 3177 (latest edition).

5.29.2 **EOT Cranes:** Over load tests, travel and hoist speed checks etc. as per relevant Indian standards IS (latest edition).

5.29.3 **HOT Cranes, Monorails etc.: Over** load test, Travel and speed checks, functional and performance tests as per relevant Indian standards IS (latest edition).

5.30 **COAL HANDLING SYSTEM**

5.30.1 **System Facilities**

In accordance to the Chapter – 4, GTR, after commissioning and before handing over, the entire Coal Handling Plant shall be subjected to System Trial Operations.

The duration of Trial Operations of the complete equipment shall be thirty (30) days with minimum twelve hours daily operation. For successful Trial Operation, the trial shall necessarily include steady operation of the plant at its rated flow path capacity for at least one hour duration per day on an average.

Major Equipment Capacity:-

Guaranteed capacity in T/Hr of the following:-

- Wagon Tipplers.
- Crushers (Coal & Limestone)
- Stacker cum Reclaimer.
- Vibrating Screening feeders (Limestone) & Vibrating feeder (Coal & Limestone)
- Travelling Tripper (Coal and gypsum)
- Performance tests and the procedure for performance testing of complete coal.

5.30.2 **Performance Requirements**

The Bidder shall furnish a declaration in the manner prescribed and included in the relevant Attachment of Section-VI for the following guaranteed parameters which shall attract levy of liquidated damages for shortfall in Performance.

The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in the technical specifications.

5.30.3 **Guarantees To Be Demonstrated**

Capacity in tonne/hr (equivalent to 100% of rated) of conveyor system including the intermediate equipments for each of the two parallel conveyor streams separately or any combination thereof to be tested in the following flow path operations.

A.) **Flow Path D-1 (Direct Stream)**

Apron feeders #AF-1A/1B taking feed of incoming coal from wagon tipplers #WT-1A & #WT-1B and discharging crushed coal into Coal Bunker through traveling tripper mounted on bunker feeding tripper conveyor #TBC-1A/#TBC-1B & #TBC-2A/#TBC-2B including all intermediate conveyors and equipment.

B.) **Flow Path S-1 (Stacking Stream)**

Apron feeders #AF-1A/1B taking feed of incoming coal from wagon tipplers #WT-1A & #WT-1B and stacking crushed coal in stockyard using yard conveyor with stacker/reclaimer #SR-1 stationed farthest from yard conveyor tail end and boom conveyor at highest angle including all intermediate conveyors and equipment.

C.) **Flow Path R-1 (Reclaiming Stream)**

Reclaiming coal from stockyard using yard conveyor with stacker reclaimer #SR-1 at farthest position from yard conveyor head end with boom conveyor at its lowest position and discharging crushed coal into Coal Bunker through traveling tripper mounted on bunker feeding tripper conveyor #TBC-1A/#TBC-1B & #TBC-2A/#TBC-2B including all intermediate conveyors and equipment.

D.) **Flow Path R-2 (Reclaiming Stream)**

Reclaiming coal from stockyard using Reclaim Hopper Complex #ERH-1 and discharging crushed coal into Coal Bunker of Units # 1 & 2 through traveling tripper mounted on bunker feeding tripper conveyor #TBC-1A /#TBC-1B & #TBC-2A/#TBC-2B including all intermediate conveyors and equipment.

E.) Further for the purpose of Guarantee tests all left out conveyors not appearing above along with all associated equipment shall also be considered.

5.31 MILL REJECT SYSTEM

5.31.1 Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.

5.31.2 Power consumption, Capacity and discharge pressure shall be demonstrated for each air compressor

5.31.3 Following shall be demonstrated at site for compressor,

- Parallel Operation of air compressor, if applicable
- Vibration and noise level of air compressors

5.32 ASH HANDLING SYSTEM

S. No.	DESCRPTION	PERFORMANCE GUARANTEE PARAMETERS	REMARKS
A.	Bottom ash system	Continuous effective extraction, crushing and conveying of bottom ash generated during various modes of boiler operation to the ash slurry sump and the continuous effective pumping of combined slurry from this sump to the ash disposal area. The extraction of bottom ash shall be done once in every shift of eight (8) hours. Ash from each individual hopper section shall be removed in parallel. The total time for evacuating eight (8) hour collection of bottom ash from a unit corresponding to collection rates specified shall not exceed 135 minutes including time required for starting, stopping, and water flushing of the system for the following condition and with 25mm wear on the diameter of the throat section of the jet pumps: 1) Complete draw down mode by totally emptying the hopper of all water and ash with the make-up valve closed	Continuous effective mixing and sluicing shall be established by no stagnation of ash or slurry at any point in the complete system
B.	Economizer ash handling system	The ash collected in economizer and SCR hoppers will drop continuously into bottom ash hopper through vertical pipes, flushing connection, flushing equipment in form of slurry. From bottom ash hopper and economizer hoppers shall be evacuated and transported to ash slurry pump along with bottom ash.	The continuous effective conveying of ash as stated above shall be established by no stagnation of ash or slurry at any point in the complete system and with all interlocks, protections working satisfactorily
C.	Coarse Ash Handling system	The ash collected in SCR hoppers, APH hoppers and duct hoppers shall be evacuated through feeder ejectors and transported to ash slurry pump. The total time for evacuating eight (8) hour collection of coarse ash from a unit corresponding to collection rates specified shall not exceed 60 minutes	The continuous effective conveying of ash as stated above shall be established by no stagnation of ash or slurry at any point in the complete

S. No.	DESCRPTION	PERFORMANCE GUARANTEE PARAMETERS	REMARKS
			system and with all interlocks, protections working satisfactorily
D.	Fly ash extraction & conveying system	1) Continuous effective conveying of fly ash from all ESP hoppers generated during various modes of boiler operation up to buffer hoppers **and** continuous effective transportation of fly ash from buffer hoppers to main ash storage silos **and** The fly ash collected in in every shift of eight (8) hours corresponding to specified ash collection rates shall be removed in five (5) hours. 2) Parameters of fluidizing/conveying blowers/ instrument air compressors /vacuum pumps including power consumption when operating at the rated capacity and pressure corresponding to the above conditions (shop test).	Continuous effective extraction and conveying system shall be established by no stagnation of ash or slurry at any point in the complete system.
E.	Water pumps for ash handling (BAHP, FAHP,LP, seal water, ash conditioning, drain pumps, etc.).	Rated capacity, head and power consumption at motor input terminal of each pump to be tested and proved	
F.	Ash slurry disposal system and ash slurry pump	Rated capacity, head and power consumption at motor input terminal of each bottom ash slurry disposal pump to be tested and proved applying correction for slurry density.	
G.	Weigh bridge near Storage silos	Bidder to demonstrate weighment loaded ash truck / Wagons	
H.	Classifiers (if applicable)	Bidder to demonstrate efficiency of the classification system. The classified fine ash shall have a	

S. No.	DESCRPTION	PERFORMANCE GUARANTEE PARAMETERS	REMARKS
		size of (-) 45 microns (95%).	

5.33 **FIRE DETECTION AND PROTECTION SYSTEM**

a) Following shall be demonstrated at Shop

- Capacity, Head & Power consumption of fire water pumps.

b) Following shall be demonstrated at Site

- Vibration & Noise level of fire water pumps.
- Performance test of each of systems such as Hydrant, HVW Spray, MVW Spray, Foam Injection system, Inert gas extinguishing system of control room and control equipment rooms, fire detection and alarm system, Fire extinguishers and Fire monitors as per the design parameters/ standards/TAC.
- Parallel Operation, vibration & noise level of the fire water pumps and diesel engines.

c) All tests as required by the TAC/ TAC accredited agency.

5.34 **WATER TREATMENT PLANT**

a) Clarification Plant (PT-system)

1. Each clarifier unit for PT system shall be guaranteed for an effluent capacity of not less than 2200 m3/hr.
2. Outlet water from clarifiers shall be guaranteed for the following:
   - Organic Matter Less than 0.05 mg/litre (see note below)
   - Iron Content Less than 0.3 mg/litre
   - Turbidity Less than 10 NTU
3. Each clarifier shall be tested to demonstrate the above mentioned Guarantees at site under PG test. In addition, demonstration of satisfactory working of all the clarifiers, its drives, scrapper mechanism, operation of sludge blow-off etc, shall be demonstrated.

Note: Organic matter shall be tested as per KMnO4 method.

b) Filtration Plant

1. Each filter for DM system, ETP-RO DM, PT-Potable system shall be guaranteed for design capacity meeting the effluent quality as mentioned below with one (1) backwash and air scouring in not less than 24 hours or more and backwash water requirement not to exceed 2% of the water treated between two successive backwashes.

2. Turbidity at outlet of each filter system shall not exceed 2 NTU with inlet turbidity of 10 NTU.

3. Each filter shall be tested to demonstrate the above mentioned Guarantees at site under PG test. In addition, demonstration of satisfactory working of all the filters, its backwashing operation, operation of various valves etc shall be demonstrated by Bidder.

c) Chlorine Dioxide System

1. Chlorine Doxide System for CW-Chlorination, Raw water chlorination and PT-Chlorination system shall be guaranteed for the design capacity.

d) Zero Discharge ETP

1. Ultra Filtration plant - Recovery 90% minimum.
2. RO permeate - Overall recovery > 80%,
   TDS < 200
   pH - 6.8 - 7.8

5.35 **DM PLANT (ION EXCHANGE)**

a) Activated Carbon Filters

1. Each filter shall be guaranteed for the design capacity. A.C. filter shall be backwashed once in 24 hours.

2. Free chlorine content in effluent water shall not be detectable as per latest ASTM procedure.

3. Organic matter below detectable level.

4. Turbidity in the effluent water shall be less than 0.5 NTU.

b) Ion Exchange Units

1. Each ion exchange unit shall be guaranteed for a design flow (net) 50 m^3/hr (min.) after meeting the water requirement for various regeneration steps. Net output from each cation-anion unit between two regenerations shall not be less than 1000 m^3/hr (min.) and for mixed bed 7000 m^3/hr (min.) of treated water.

2. Chemical consumption of the ion exchange units shall be guaranteed against the regeneration level employed and resin volume provided. Stream cycle time shall be as guaranteed in Tech spec. Total time requirement for regeneration and backwash operation for each stream (AC filter, cation, and anion) shall not exceed four (4) hours. With mixed bed in regeneration, total time of regeneration of stream shall not exceed six (6) hours. The guaranteed values of chemical consumption shall hold good for chemical conforming to following:

   i. HCL - As per IS: 265 Tech. Grade

   ii. NaOH - As per IS: 252 Rayon Grade available in Flakes or lye

form

3. Effluent from the mixed bed unit shall be guaranteed to meet the following requirements, at rated capacity, throughout the period between two successive regenerations:

   i.) Reactive Silica not to exceed - 0.01 ppm as SiO2
   ii.) Iron as Fe - Not detectable as per ASTM-D-1068
   iii.) Total Hardness - Not detectable
   iv.) pH Value - 6.8 - 7.3
   v.) Conductivity - Not more than 0.1 micromhos/cm at 250C.

4. Effluent from the anion exchanger shall be guaranteed as follows at rated capacity throughout the period between two regenerations:

   i.) Reactive silica not to exceed: 0.2 ppm as SiO2
   ii.) Conductivity at 250C: Not more than 10 micro mhos/cm
   iii.) Sodium leakage through cation shall not exceed 2 ppm as CaCO3 throughout the period between two regenerations.

5. Effluent from degassifier should not have CO2 content more than 5 ppm.

6. Life of cation resin shall be minimum five (5) years and life of anion resin shall be minimum three (3) years

5.36 CONDENSATE POLISHING UNIT

Effluent quality at the outlet of each vessel at its rated design flow and design service length between two regenerations (as defined elsewhere).

Pressure drop across polisher vessel in clean & dirty condition.

5.37 COMPRESSED AIR SYSTEM

a) Following shall be demonstrated at shop:

   Capacity and discharge pressure of each air compressor.

b) Following shall be demonstrated at site:

   i.) Parallel operation of air compressors
   ii.) Dew point of air at the outlet of air drying plants of instrument air compressor.
   iii.) Pressure drop across the air drying plants of air compressors.
   iv.) Vibration and noise level of air compressors, blowers of air drying plant.

5.38 CW / ACW PUMPS

a) Each pump shall be tested at shop/ site (as applicable) for capacity, head and power consumption. Satisfactory operation of CW/ACW pumps without undue noise and vibration while operating in isolation or in parallel with other pumps shall be demonstrated at site.

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 otherat the rated duty point of pumps shall be demonstrated at site as a part of Performance Guarantee test.

Note: The points mentioned at (a & b) are applicable to all the pumps viz Equipment Cooling Water system, Auxiliary Water system, Make-up water system, Pre-treatment plant, DM Plant & Condensate Polishing Plant and all other miscellaneous pumps.

5.39 COOLING TOWER

Performance test of Cooling Tower as per the approved test procedure for demonstration of Cold Water Temperature at design conditions shall be carried out at site. The cold water temperature as specified shall be guaranteed by the bidder for the design condition of CW flow, range, ambient wet bulb temperature specified.

5.40 CW Chemical Treatment Plant

1. 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.

2. 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 the condenser of 800 MW unit. The fouling factor shall also demonstrate the cleanliness of condenser tubes by visual examination of the same.

3. 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

4. For the purpose of verifying bio fouling in circulating water system, a bio fouling monitor or bio film activity monitor shall be provided by the bidder. The bio fouling shall be determined based on observation on monthly basis and after completion of six months.

5. The bidder shall guarantee the following values of Scale, Corrosion, Fouling & Bio Fouling in circulating water system

   a) Cumulative Corrosion Rate on Mild Steel < 3 mils/year

   b) Cumulative Corrosion Rate on Stainless Steel< 0.1mils/year

c) Cumulative Corrosion Rate on Cu/Ni < 0.3 mils/year.

d) Cumulative Scaling Rate of Internal Tube Surface Area of Condenser <15mg/dm2/year

e) Fouling Factor: Deterioration in Heat Transfer Coefficient shall not be more than 5% of the original value just before commencement of the treatment programme.

f) TVC (Total Viable Count) (Micro Biological Counts) < 1.2 x 100000 counts/ml of circulating water.

g) SRB (Sulphate Reducing Bacteria) <100 organisms/100 ml of circulating water.

5.41 **PASSENGER & GOODS LIFT OF VARIOUS AREAS**

Over load tests, travel and hoist speed checks, functional & performance tests.

5.42 **i) Performance Guarantee on Steel Helical Springs and Viscous Dampers for Machine Foundations**

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

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.

5.43 For all other equipment included in the scope of supply of the bidder but not covered above, the demonstration tests to be carried out shall be mutually finalised between Bidder & Owner after award of contract.

5.44 FLUE GAS DESULPHURISATION SYSTEM

(i) Wet ball Mill capacity at rated fineness

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

i) 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).

ii) Limestone Quality: All available quality from the specified range. Bidder shall demonstrate the above capacity with the originally installed grinding elements in nearly worn-out condition as mutually agreed for the purpose of ascertaining wear life of any of the wear parts.

(ii) Wet ball Mill wear parts guarantee

Bidder shall demonstrate the life of wet ball Mill wear parts in line with requirements stipulated in Part B of 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.

(iii) Wet ball Mill ball consumption

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

(iv) Pressure Drop across FGD

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

(v) Vacuum Belt Filter Capacity

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 Part B of the Technical Specification.

(vi) Gypsum Purity

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.

(vii) Waste Water

The Bidder guarantees that the maximum purge flow rate to waste water treatment system from FGD system for the unit shall be less than $20m^3$/sec averaged over a 24 hour period for a the range of specified coal(s).

(viii) Mist Outlet Droplet Content

The mist eliminator outlet droplet content shall be guaranteed to be < 20 mg/Nm^3 at absorber outlet measured over a period of 24 hrs continuous operation. Mist outlet droplet content shall be measured as per applicable clauses in VDI Norm 3679 and the Bidder shall carry out the tests as per the test procedure approved by the Owner.

(ix) Limestone unloading stream:-

i. **Flow Path:-** Bulk receiving unit/Box Feeder/ Surface Feeder etc taking feed of incoming Limestone and discharging crushed Limestone into Limestone storage silos/storage shed which in turn feeds Limestone to Limestone Day Silo through Limestone

Conveyors, Bucket elevators, Diverter Plows including all intermediate equipments.

ii. Bidder shall also demonstrate the guaranteed tippling rate of Truck Tipplers

(X) Gypsum flow path:-

i. Gypsum conveyor taking feed from gypsum dewatering unit and feeding to gypsum storage shed through travelling tripper provided on last conveyor.

ii. Further for the purpose of Guarantee tests all left out Conveyors/bucket elevators not appearing above along with all associated equipments shall also be considered

5.45 **CONTROL & INSTRUMENTATION SYSTEM**
(DDCMIS System Guarantee Requirements)

5.45.1 The parameters/capabilities to be demonstrated for various systems/ equipment shall include but not be limited to the following:

5.45.2 Performance Requirement of the Closed Loop Control System

(i) The closed loop Control System shall provide automatic control of the plant for full applicable operating range of the unit and shall provide a unit operating turndown ratio of not less than six to one. The closed loop Control System shall permit the performance of the dynamic load tests (ramp test, steady state test & step tests) while maintaining safe furnace conditions, major process parameters and without endangering other equipment. All tests will be performed with the system in automatic mode:

(a) Drop 30 percent of maximum load capability from approximately full load at a rate of 10 percent per minute.

(b) Drop load from full rated output to the lowest runback limit, at a rate corresponding to the fastest run back rate.

During transient conditions causing deviation of process variables, the control system furnished under the specification shall not permit deviations, which exceed those permitted by the manufacturers of the controlled process equipment, for load changes as indicated above. SG and its auxiliaries along with its control system (SG C&I), TG and its auxiliaries along with its control system (TG C&I) when integrated with UNIT C&I systems shall meet the permissible limits for important parameters, under various operating conditions specified. The tentative parameters to be monitored for this test are given in the Table-1, given below and the exact parameters shall be as finalised by the boiler and turbine suppliers. The control loops shall perform to return the controlled variable to the set point in a stable manner without cycling in the shortest possible time and without any loop

interactions or cycling of generation when generation matches unit load demand.

(ii) The Bidder shall also guarantee that the control system provided by him will be responsive and stable and will maintain the deviation of controlled variables from set point within the limits specified so that the equipment being controlled will operate as specified over the range required. The controls shall operate automatically, with no assistance from the operator. The controller shall successfully demonstrate the performance of Closed Loop Control Systems before acceptance and taking over of this system by the Owner.

(iii) The control system including furnace draft & firing rate control shall also comply with all relevant requirements of NFPA code no. 85 'Standard for Prevention of Furnace Explosions in Pulveriser Fired Utility Stations' and other applicable codes regarding safety.

(iv) All runback conditions listed below shall be proved by the Bidder without any oil support.

- FD/ID/PA fan trip
- BFP/CEP/ trip
- One mill and two mill trip.
- Any other condition decided during detailed engineering.

PERFORMANCE REQUIREMENTS FOR CLOSED LOOP CONTROL SYSTEM

S No.	Load / Rated of load change (% of MCR per min.)	MAXIMUM DEVIATION OF PARAMETERS FROM SET POINT				
		Throttle Pressure Deviation (Kg/cm²)	Flue gas Oxygen Deviation (% O2)	Furnace Pressure Deviation (mmwcl)	S.H. Steam Temp. Deviation (Deg.C)	R.H. Steam Temp Deviation (Deg.C)
A.	**Steady State Condition**					
1	90% to 100%	±2.0	± 0.4	± 8.0	± 5.0	± 5.0
2	60%	±2.0	± 0.4	± 8.0	± 5.0	± 5.0
B.	**RAMP Test (Change For Max. Duration of Five Minutes for 3% & 5% ramp and Three minutes for 10% ramp)**					
3	± 3%	± 3.0	+0.6/-0.4	± 12.0	± 8.0	± 8.0
4	± 5%	± 3.0	+0.8/-0.4	± 12.0	± 10.0	± 10.0
5	± 10%	± 4.0	+1.0/-0.5	± 15.0	± 15.0	± 15.0
C	**Step Load Changes**					
6	From 100% to 80% at the rate of 10% per min.	± 5.0	+1.5/-0.5	± 20.0	± 15.0	± 15.0

Note:

1. Sufficient time shall be allowed as setting period between conducting the tests.

2. Plant operating condition, i.e. main equipment status, availability of auxiliaries, operational and equipment constraints, which can influence the test, shall also be recorded.

3. Control system shall be running in the CMC mode i.e. Boiler master, fuel flow, air flow, feed water and turbine load control shall be in automatic mode Load set point, maximum and minimum load set point, rate of raise/lower of load shall be set through the Operator Work Stations, Large Video Screen.

5.45.2.1 The following parametric tests shall also be conducted under worst case loading conditions as defined in Annexure-I to this sub-section – (details of which shall be as approved by Owner during detailed engineering.)

(i) For control system

- CPU loading, Cycle time/controller reaction time

(ii) For MMIPIS

- CPU loading, spare duty cycle, spare memory Capacity

(iii) Spare duty cycle for system bus

(iv) Various display response time

(v) System accuracy

(vi) Display update time

5.45.2.2 For the parametric test, the following requirements shall be met

(i) Processor Spare Duty Cycle (Free Time)

- Under worst case loading of MMIPIS and system bus each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one minute period.

- Under worst case loading conditions of control system control system processor shall have 20% free time when measured over any one minute period.

- The Bidder shall furnish all necessary data to fully satisfy the Owner that the processor spare duty cycle figures quoted by the Bidder are realistic and based on configuration and computation capability of the offered system and these shall be actually achieved in the fully implemented system as commissioned at project site.

(ii) System Bus Spare Duty Cycle (Free Time).

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system Bus, measured over any 2 seconds interval

(iii) Response Time

a) Display

The time from mouse click or last button pressed to the commencement of the requested display under the worst case loading conditions shall not be worse than the following:

- All control related displays 1 sec
- Point Details Display(single point) 1-2 secs
- Bar chart display (20 points, current data) 2-3 secs.
- Operator guide/plant start-up guide message display (full screen of alphanumeric information and a maximum of ten numbers of dynamic data items) 2-3 secs.
- Plant mimic display of fair complexity with a Minimum of 120 numbers of dynamic data Items e.g., values, macros, line segment, etc. 2-3 secs.
- Group review display (current values of twenty points) 2-3 secs.
- X-Y plot display (2 X-Y- plots and a single display requiring both historical as well as data) 3-4 secs.
- X-T plot display (Trend of 6 analog points and a single display requiring both historical as well as current data) 3-4 secs.
- Plant Summary display (e.g., bad point summary, limit check removed point summary. Assume the whole data base search is required and the summary display contains ten points only). 3-4 secs.

b) Command:

The response time for screen update, after the execution of the control command, from the time the command is issued (for example command to start a motor to the time the screen is updated) shall be within two seconds (excluding the drive actuation time).

(iv) System Accuracy Requirements

The overall system accuracy from signal input terminals to output presentation on display and printers for the least accurate input range and maximum scan rate shall be not worse than +/- 0.1% of full scale of the engineering process range +/- ½ LSB for 4-20 mA input. For this purpose, the number of decimal places on display for testing purpose shall be sufficient to cover 0.01% of full scale range. For temperature input modules, the sensor range as per relevant ASME/DIN standard or equivalent shall be used in place of process range.

(v) Display Updated Rates

All displays shall be updated at least every two seconds.

(vi) The spare capacities of working and bulk memory shall meet the requirements indicated in Section-VI, Part-B, Sub-section -DDCMIS.

5.45.3 **Sequence of Event**

The sequence of event in operating with 1 m sec. resolution as per DDCMIS Chapter, Volume V.

5.45.4 **Availability Tests**

5.45.4.1 The Bidder shall guarantee 99.7 percent system availability for a continuous period of 180 days. An availability guarantee test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 180 days, during availability test run, a new 180 days test run shall start at the time when the system becomes available again. Loss of availability (unavailable system) shall be defined as the loss of the system's guaranteed accuracy and repeat ability or of any system function, except however, that the loss of a function for not more than five percent of the points shall not be considered loss of availability. Loss of a function for more than five percent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to the function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeat ability and system parametric requirements specified in clauses on system parametric requirements shall be maintained for the entire 180 days run without any manual recalibration or any other changes made to the DDCMIS.

5.45.4.2 Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function. A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.

5.45.4.3 The Bidder shall submit the Availability Test procedure for Owner's approval. The details regarding outage time, weighing factors for various system functions equipment to calculate the down time, test duration etc., shall be discussed and finalised during detail engineering. After conductance of availability test, Bidder shall prepare report covering the methods followed, observations & submit to Owner.

5.45.4.4 If availability is lost due to reasons not attributed to the Bidder’s system or due to force majeure, then downtime shall not accrue & interrupted test resulting from the same shall be extended by an amount of time equal to the length of interruptions.

5.45.4.5 Loss of each of the following functions shall be treated as full system unavailability (i.e. factor of 1) and the downtime shall accrue individually for each of the following function:

(a) Interruption of control command communication between HMI and controllers for a period more than three seconds for any drive (i.e.

Unavailability of information in HMI for carrying out the control command shall also be treated as interruption of control commands).

(b) Permanent data loss in history functionality for a period more than three seconds for more than five percent of the history database.

(c) Delay in reporting of alarms in HMI for more than five percent of the alarms for more than three seconds.

If loss of function as described at (a) to (c) above is attributed to server changeover, due to system feature, then unavailability due to the above loss of function shall accrue even if the function is not specifically attempted by Owner during the server changeover period.

5.45.5 The performance & guarantee test for C&I system shall constitute verification of the parameter as mentioned above & shall be carried out as per agreed procedure. The PG test procedure shall be submitted within 90 days of the date of Notification of Award for Owner's review and approval. After the conductance of Performance test, the Bidder shall submit the test report to the Owner

5.45.6 The operating capabilities of the plant as listed out in Volume II, Chapter - 3, Operating Capability shall also be demonstrated along with other parameters/ capabilities specified under category-III guarantees. The treatment of these operating capabilities of compliance/ non-compliance shall be the same as given to other Cat.-III guarantees.

6.0 TURBINE GENERATOR PERFORMANCE/ ACCEPTANCE TEST

6.1 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 800 MW (100% TMCR) MW and 440 MW (55% TMCR) unit outputs corresponding to the conditions stipulated in Chapter-2: Turbine Generator and Auxiliaries, Volume-III. Power consumed by the auxiliaries mentioned in this chapter 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.

6.2 The essential mandatory requirements for instruments, methods and precautions to be employed shall be in accordance with the requirements specified in the respective codes. 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. Any advanced class instrument system such as those using electronic devices or mass flow technique shall be arranged by the Bidder, if required. For determination of primary flow to the turbine, a calibrated low Beta-ratio throat-tap nozzle assembly including required machined straight lengths meeting the requirement of ASME PTC-6 shall be provided. The test procedures, Calibration Standards, Calibration procedures etc., shall be subject to Owner's approval. All the instruments including the flow nozzle shall be calibrated by the Bidder before and after the test, in a reputed national (within India) institute / laboratories, international institute as approved by the Owner. However, post test calibration of flow nozzle shall not be mandatory. These calibrations shall be performed in the presence of the Owner. All calibrations shall be made 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. 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 downstream machined straight lengths, for main condensate flow measurements shall be as per ASME PTC6.

Secondary flow devices shall be calibrated flow nozzle/orifice plate as per ASME-PTC 19.5.

6.3 Corrections to the test results for steam turbine shall be applied as per the correction curves listed in detailed technical specification. When the system is properly isolated for a performance test, the unaccounted for leakages should not be more than 0.1% of the design throttle flow at that load. To achieve the above value of unaccounted for leakages, the Bidder shall prepare the unit during pretest available shutdown. However, during the test, if it is found that the unaccounted for leakage is more than 0.1% of design throttle flow at that load, then heat rate will be increased by an amount equal to half the difference between actual unaccounted for leakage expressed as percentage of design throttle flow at that load and 0.1% (allowed by the code).

6.4 The performance guarantee test will be carried out after successful completion of initial operation. Ageing allowance (beyond three months from the date of completion of initial operation) 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.

6.5 The tests shall be arranged in a manner that the OWNER's operation is not disrupted. Duplicate test runs shall be performed at 840 MW and 800 MW unit loads. The results of corrected heat rate shall agree within 0.25%. If they differ by more than 0.25%, additional test run(s) shall be made at the same point until corrected heat rates of at least two test runs agree within 0.25% and the achieved heat rate shall be calculated as average of test run points satisfying the above criterion.

6.6 During Performance/ Acceptance test, following tests shall be carried out for T.G. set with test grade instruments as per ASME code.

(i) Guarantee Turbine Cycle Heat rate test at 840MW (105% rated load) corresponding to the heat balance diagram specified in the tender specification.

(ii) Guarantee Turbine Cycle Heat rate test at 800MW (100% rated load) corresponding to the heat balance diagram specified in the tender specification.

(iii) Guarantee Output test of 840 MW (105% rated load) corresponding to the heat balance diagram specified in the tender specification.

(iv) Maximum continuous output corresponding to both strings of HP heaters out of operation, corresponding to the heat balance diagram specified in the tender specification.

(v) Turbine cycle Gross heat rate at 100% load on the unit/s corresponding to the heat balance diagram.

(vi) Output test of TMCR corresponding to the heat balance diagram.

(vii) Capability of unit/s at VWO conditions, corresponding to the heat balance diagrams with 3% make-up.

(viii) Auxiliary power consumption tests at 100% load on the unit/s at rated steam condition, 3% make-up and designed condenser pressure.

(ix) Maximum continuous output corresponding to one HP heaters out of operation, under rated steam conditions at a designed condenser pressure and 3% makeup.

(x) Maximum continuous output corresponding to both HP heaters out of operation, under rated steam conditions at a designed condenser pressure and 3% makeup.

(xi) Capability to operate under grid frequency variation.

(xii) Automatic voltage regulator test.

(xiii) Over-speed test.

(xiv) Minimum stable load capability.

(xv) Reactive power capability.

(xvi) Automatic start-up and loading times and rates from various initial conditions.

(xvii) Full load rejection.

(xviii) The inter-tripping circuit between the power plant and the grid system.

7.0 TEST REPORTS

7.1 The Bidder shall prepare test reports in which the methods followed, instrument readings, graphs, observations, final results obtained, etc., shall be recorded.

7.2 Four (4) hard copies and 2 soft copies on CD –ROM of each test report shall be submitted to OWNER for Approval.

7.3 Performance Guarantee/ Acceptance Tests on the equipment/systems not covered in this chapter shall be carried out as per the procedure/ test codes/ specified in respective detailed specifications/ Chapters in Volumes – III to VI.

8.0 LIQUIDATED DAMAGES FOR SHORT FALL IN EQUIPMENT PERFORMANCE

If the guarantees specified at clause 6.2 are not achieved by the Bidder in the performance guarantee test or within 90 days or a reasonable period thereof allowed by the Owner after notification by the Owner, the Owner may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages listed herein above against the Bidder and such amounts calculated at the rates specified in Cl.3.2 above for shortfall in performance shall be deducted from the contract price (provided the shortfall is less than or up to 25% of Contract Price) :

8.1 If the performance shortfall is such that the performance shortfall exceeds three (3) percent of the guaranteed value then the Owner will be entitled (at the Owner's sole discretion) to reject the works, terminate the Contract, and recover from the Bidder any loss the Owner has suffered up to the contract price. The Owner will give credit for any part of the works which he retains. In case, the

plant is rejected by the Owner, the price recovery from the Bidder will be done upto the whole contract price.

8.2 Failure to prove the performance of the plant/equipment as per guaranteed figures, which will lead to rejection as per clause 7.0 above, shall be treated as non-performance of the contract and in addition to the liquidated damages leviable for shortfall in the performance, the Owner will be entitled to revoke/invoke the contract performance security and realize the proceeds from the Bank without any demur, protest and/or objection by the Bidder.

9.0 LIQUIDATED DAMAGES FOR TIME DELAY

If the Bidder fails to successfully complete the Final Taking Over of the Unit by the Owner as specified in Special conditions of Contract, the Bidder shall pay to the Owner Liquidated damages for the delayed period at the rate as indicated in the GCC.

The total amount of Liquidated Damages for Delay shall be subject to a maximum of 10% (Ten percent) of the contract price.

ANNEXURE - I

1.0 Worst Case Loading Conditions for Control System (Definition)

The worst case loading conditions shall include the following tasks as a minimum:

1.1 All process inputs coming to Control System including SOE/annunciation inputs are being scanned, acquired, conditioned and processed.

1.2 All closed loop controls are in operation during a disturbed (non-steady) state of the process.

1.3 All open loop controls of DDCMIS are in operation during a disturbed (non-steady) state.

1.4 All data being transferred between control system, system bus and HMIPIS.

1.5. Three (3) alarms are being generated per second from each of the functional groups of Control System.

1.6 Twelve control commands from HMIPIS are being executed in one minute.

1.7 All processors (including hot standby) health being monitored.

1.8. All standby processors status being updated.

2.0 HMIPIS Worst Case Loading Conditions (See note below)

The worst case loading conditions shall include the following tasks as a minimum:

2.1 Continuous data transfer between System Bus & HMIPIS.

2.2 All calculations including performance calculations being performed at the specified rates.

2.3 Alarms being reported at the rate of three (3) alarms per second for each of the Control System functional groups.

2.4 Two control operator commands for control/ information within a base period of one minute from each OWS & each LVS.

2.5 Data collection for all logs/reports in progress.

2.6 OWS/LVS displays are in operation as follows:

LVS – 1, 4 - Sequence chain display with maximum number of dynamic data items.

LVS - 2, 5 - Individual display with maximum number of dynamic data items.

LVS – 3, 6 - Plant mimic display with one hundred and twenty (120) numbers of dynamic data items.

OWS - 1 - Overview display with max. no. of dynamic data items.

OWS - 2 - Group display (twenty points, current data).

OWS - 3 - Alarm display of twenty (20) points.

OWS – 4 - 4 Nos. Windows each running current trend.

Unit Incharge - Plant overview display

OWS

All PC Stations X-T plots are displayed & updated.

On Station WAN

And unit LAN

2.7 All printers connected to HMIPIS are in operation at rated speed.

2.8 HMIPIS processors and all peripherals health being monitored.

2.9 Data collection for trend function and historical data storage in progress.

2.10 Four alarm acknowledgements within a base period of one minute from each OWS & LVS.

2.11 Calculations for long term storage of data being performed.

2.12 SOE printing in progress.

2.13 Data transfer with other DDCMIS sub-systems, all PLCs and SG/TG C&I Systems in progress for controls (commands) as well as for information.

3.00 The Worst Case Loading Conditions For System Bus

The worst case loading condition shall mean continuous data transfer between the distributed modules (Control System/HMIPIS), at their individual worst case loading conditions defined at 1.0 & 2.0 above respectively.

Note: This clause is generally for the unit DDCMIS. This shall be suitably modified for other DDCMIS subsection depending or actual configuration.

CHAPTER – 9

MANDATORY SPARES

1.0 SPARES

Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spares is given below:-

1.1 MANDATORY SPARES

a) The list of mandatory spares considered essential is indicated in this Chapter. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Owner to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population of each item in the Bid Forms and Price Schedules.

Whenever the quantity is mentioned in "sets" the bidder has to give the item details and prices of each item.

b) Owner reserves the right to buy any or all the mandatory spares parts.

c) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

d) All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the Unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.

e) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.

f) Bidder shall clearly indicate either of the following against each spare specified in the list of mandatory spares.

1. Not applicable Equivalent Quoted
2. Not Required/ Not Applicable as per OEM Standard
3. Included

The above shall be indicated for each and every spare indicated in the specification. Bidder to note that in case spare is listed as 1 & 2 above and found to be required/ applicable in detailed engineering same shall be supplied without any implication.

1.2 **RECOMMENDED SPARES**

a) In addition to the spare parts mentioned above, the contractor shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list and total prices in relevant schedule of the Bid Form and Price Schedules. Owner reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least two months before the scheduled date of initial operation of the unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

b) Price of recommended spares will not be used for evaluation of the bids. The price of these spares shall remain valid up to 6 months after placement of Notification of Award for the main equipment. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares as desired by the Owner.

1.3 **START-UP & COMMISSIONING SPARES**

Start-up and commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the Owner shall come under this category. The Contractor shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipment are energized. The unused spares, if any, should be removed from site only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Contractor.

1.4 The Bidder shall include in his scope of supply all the necessary Mandatory spares, start up and commissioning spares and recommended spares and indicate these in the relevant schedules of the Bid Form and Price Schedules. The general requirements pertaining to the supply of these spars is given below.

1.5 The Contractor shall indicate the service expectancy period for the spares parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

1.6 All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.

1.7 All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

1.8 The contractor will provide Owner with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Owner to identify and finalize order for recommended spares.

1.9 Each spares part shall be clearly marked or labeled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

1.10 All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Owner.

1.11 The contractor will provide the Owner with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/ equipment covered under the contract and will further ensure with his vendors that the Owner, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

1.12 The Contractor shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.

1.13 In addition to the recommended spares listed by the contractor, if the Owner further identifies certain particular items of spares, the contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request with a validity period of 6 months for consideration by the Owner and placement of order for additional spares if the Owner so desires.

1.14 The Contractor shall guarantee the long term availability of spares to the Owner for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, He shall give the Owner at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub-contractors, Contractor will provide the Owners, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Owner for the purpose of manufacture/procurement of such items.

1.15 The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified. This would facilitate the Employer to assign a unique code to each of the mandatory spare as brought out in GCC. The bidder shall extend all necessary assistance in this regard.

NOTES:

1.0 Wherever quantity has been specified as percentage (%), it shall mean percentage (%) of the total population of the item in the station, unless specified otherwise and the fraction will be rounded off to the next higher whole number.

2.0 Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed and the break up for these shall be furnished in the bid.

3.0 In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed as per the list.

STEAM GENERATOR & ITS AUXILIARIES

S.No.	PARTICULARS	Spares
1	**PRESSURE PARTS**	
A	**ECONOMISER**	
a)	Economizer coils(the coils and panels are to be fabricated and supplied in dismantled condition)	25% of each size, type of coil of unit
b)	Straight Tube	250 Mtr. of each size, type, thickness & material
c)	Coil end bends	20 Nos. of each size, type, thickness, radius & material.
B	**WATER WALL/EVAPORATOR**	
a)	Straight tube/Spiral tube	200 m of each type, thickness, size and material
b)	Bends for Burner elevation	10 Nos. for each size, type, thickness, radius and material
c)	Screen water wall tube (if applicable)	100m including all types, size & Material
C	**LOW TEMPERATURE SUPER HEATER (LTSH)**	
a)	Straight tube of 8-10 m length	150 mtr. of each size, thickness, types & material
b)	Bends	20 Nos. (LOT) of each size, type, thickness, radius and material.
c)	Male & Female couplings spacers	1 Sets
D	**INTERMEDIATE TEMPERATURE SUPERHEATER (ITSH) /PLATEN SUPERHEATER**	
a)	Straight tube of 8-10 m length	100 m of each size, thickness, type & material
b)	Bends	20 nos. of each size, thickness, radius, type and material
c)	Male & Female couplings spacers	1 Sets
E	**HIGH TEMPERATURE SUPERHEATER(HTSH) / FINAL SUPERHEATER**	
a)	Straight tube of 8-10 m length	100 mtr. of each size, thickness, type & material
b)	Bends	20 nos. of each size, thickness, type, radius & material
c)	Male & Female couplings spacers	1 set
d)	Dissimilar metal weld joint spot pcs.	20 Nos. of each size, thickness, type, radius & material
F	**REHEATER**	
a)	Straight tube of 8-10 m length	200 m of each size, thickness, type & material
b)	Bends	20 Nos. of each size, thickness, type, radius & material
c)	Male & Female couplings spacer	1 set
d)	Dissimilar joint spot pcs	20 Nos. of each size, thickness, type, radius & material

2	**SPARES FOR HEADER**	
A	**Water wall Header**	
a)	Hand hole plate with cap	2 no's of each type
b)	Yoke plate with fasteners	2 sets* of each type
B	**Spares for Superheater Header**	
a)	Hand hole plate with cap	2 No's. of each type
b)	Radiographic plug	4 no's (wherever applicable)
C	**Spares for Reheater Header**	
a)	Hand hole plate assembly	2 no's of each type
b)	Radiographic plug	4 no's (wherever applicable)
3	**Superheater/ReheaterAttemperation System**	
a)	Desuperheater liner	1 set of each type
4	**Steam Generator startup re-circulation pump**	
a)	Journal bearing	1sets *
b)	Thrust bearing	1sets *
c)	Casing wear rings	2 sets *
d)	Impeller wear rings	2 sets *
e)	Set of gaskets (All gaskets including heat exchanger)	2 sets*
f)	Set of 'O' rings	2 sets*
g)	Gland packings	2 sets*
h)	Motor heat exchanger	1 set *
	*One set means one complete replacement for one equipment	
5	**Fans**	
A	**ID Fans**	
i	**Fan assembly (excluding fan body)**	**1 no.**
a)	Fan bearings	2 set
b)	ID fan motor bearings	1 set
ii	**Spares for blade bearing Assembly**	
a)	Bearings	2 sets
b)	'O' rings	2 sets
c)	Bushes	2 sets
d)	Metallic rings	2 sets
e)	Intermediate piece (if applicable)	2 sets
iii	**Lube Oil / Hydraulic Oil system**	
a)	Pump assembly	1 nos. of each type
b)	Pressure regulator	3 nos.
c)	Filters	8 nos.
d)	Coupling between oil pump & motor	4 nos.
e)	Fan Blades	2 sets
f)	Coupling between Fan & Motor	2 sets
g)	Hydraulic servomotor	1 no.
h)	ID fan impeller liner	2 sets
i)	ID fan casing liner	1 set
B	**FD Fans**	
i	Fan assembly (excluding fan body)	1 no.
ii	Fan bearings	2 set
iii	FD fan motor bearings	1 set

iv	**Spares for blade bearing Assembly**	
a)	Bearings	2 sets
b)	'O' rings	2 sets
c)	Bushes	2 sets
d)	Metallic rings	2 sets
e)	Intermediate piece (if applicable)	2 sets
v	**Lube Oil / Hydraulic Oil system**	
a)	Pump assembly	1 nos. of each type
b)	Pressure regulator	3 nos.
c)	Filters	8 nos.
d)	Coupling between oil pump & motor	4 nos.
e)	Fan Blade	2 sets
f)	Coupling between Fan & Motor	2 sets
g)	Hydraulic servomotor	1 no.
C	**PA Fan**	
I.	Fan assembly (excluding fan body)	1 no.
II.	Fan Bearings	2 set
III.	PA fan motor bearings	1 set
IV.	Coupling between fan & motor	2 no.
V.	Fan blades	2 set
VI.	**Spares for blade bearing Assembly**	
a)	Bushes	2 set
b)	Bearings	2 set
c)	'O' rings	2 set
d)	Metallic rings	2 set
e)	Intermediate piece (if applicable)	2 set
VII.	**Lube Oil / Hydraulic Oil System**	
a)	Pump assembly	1 nos. of each type
b)	Pressure regulator	3 set
c)	Filters	8 set
d)	Pump & motor coupling	2 set
e)	Hydraulic Servomotor	1 no.
	Note: One set means one complete replacement for one fan	
D	**Scanner Air Fan**	
a)	Fan assembly (excluding fan body)	1 No. of each type
E	**Seal Air Fan**	
a)	Fan assembly (excluding fan body)	2 no's
b)	Bearings & seals	2 sets *
c)	Motor bearing	1 set.
	* One set means complete replacement of one fan	
6	**Air and Gas Ducting**	
a)	Expansion joint for hot air duct (PA)	1 set consisting of each type size and material
b)	Expansion joint for hot air duct (SA)	1 set consisting of each type size and material
c)	Expansion joint for gas duct	1 set consisting of each type size and material
	Note: Set means requirement for complete replacement for Unit	

7	**Dampers (air and flue gas ducting)**	
a)	Bearings	1 set of each type
b)	Shaft	1 set of each type
c)	Sealing arrangement (if any)	1 set of each type
8	**Coal Pulverizers**	
i	**Grinding elements:**	
a)	Rollers/tyres/grinding balls.	6 sets*
b)	Bull ring segments/ bowl / rings	4 sets*
c)	Gear box internals (except bearings & seals)	4 sets*
d)	Complete Gear Box	2 sets*
e)	Bearings for mills	3 sets*
f)	Seals & rings for gear box	4 sets*
g)	Seals & rings for mills	4 sets*
h)	Pulverisers motor bearing	1 sets
i)	Liners with brackets & fasteners	4 sets*
j)	Discharge valve assembly	3 sets*
k)	Multiport outlet & liners	4 sets
l)	Mill main shaft/yoke	1 no.
m)	Journal & Spring	8 no's
n)	Hydraulic loading cylinder	3 no's
o)	Filter Cartridges	8 no's
p)	Actuators (pneumatic/hydraulic) (complete)	1 no. of each type
q)	Actuators (pneumatic/hydraulic) spare kits	1 set of each type*
r)	Mill Bottom	2 no's
s)	Bowl hub assembly/Ring seat	2 no.
ii	**Lube Oil System**	
a)	Pressure regulator	3 no's
b)	Filters	3 no's of each type
c)	Pump & Motor coupling	4 no's
d)	Oil cooler assy for coal mills	2 no's
e)	Bearings for gear box	4 sets*
	Note:* One set means one complete replacement of one mill	
9	**Coal Feeder**	
a)	Belt	8 sets*
b)	Belt drive reducer	3 no's
c)	Clean out conveyor reducer	2 no's
d)	Counter assembly (complete)	1 no.
e)	Head pulley assembly (complete)	1 no.
f)	Weight sensing system	
g)	Weighing roll	1 no.
h)	Weighing spare roller assembly	1 no.
i)	Drag link assembly	1 no.
j)	Tension roll	1 no.
k)	Worm	1 no.
l)	Worm wheel	1 no.
m)	Feeder gate	1 no.
n)	Actuator	1 no. of each type
o)	Rotary type feeder (if applicable)	
p)	Rotating tables	1 set
q)	Divider plates	1 set
r)	Speed reduction arrangement	1 set
s)	Speed sensing device	1 set

	Note: * One set means one complete replacement of one feeder	
10	**Coal Burners/Coal Pipe Bends**	
a)	Coal compartment assembly	1 set**
b)	Inter air compartments	1 set**
c)	End air compartment	1 set**
d)	Coal nozzle castings	1 set**
e)	Adjustable coal nozzle tips	1 set**
f)	Coal pipe bends with liners	50% of population for each type size, thickness & radius for unit.
g)	Victualic couplings	20 nos. of each size
h)	Victualic coupling gasket	50 nos. of each size
	** One set means one complete replacement for a unit	
11	**Regenerative Air Preheater (Primary & Secondary APH)**	
a)	APH Main drive Motor complete	1 No. each for APH
b)	Support Bearing	2 No. each APH
c)	Guide Bearing	2 no's APH
d)	Lubricating system of support & Guide Brg	
e)	Pump assembly	1 no. each for APH
f)	Pressure regulator	1 no. each for APH
g)	Filters	4 no's each for APH
h)	Pump Motor coupling	2 no's each for APH
i)	Radial seals	3 sets*
j)	Axial Seals	3 sets*
k)	Circumferential or bypass seals	3 sets*
l)	Rotor post seals	3 sets*
m)	Bearings & seals for air motor	2 sets*
n)	Complete Speed reducer	1 set*
o)	Speed reducer Gears, pinions & shaft	1 set*
p)	Speed reducer Bearings	1 set*
q)	Speed reducer Seals & gaskets	2 sets*
r)	Speed reducer Clutch assembly	2 nos. each for APH
s)	Fluid coupling	2 nos. of each for APH
t)	Other couplings with inserts & fasteners	2 nos. each for APH
u)	Solenoid valves	2 nos. of each for APH
12	**Spare for cleaning device**	
a)	Worm & worm wheel for gear reducer	1 set*
b)	Coupling	1 set
c)	Bearing & seals for spec reducer	1 set*
d)	Bearing for cleaning device	2 sets*
e)	Spare kit for rotor stoppage alarm	1 Set
f)	Spare kit for fire sensing device.	1 Set
g)	Bushings for worm gear reducer	1 set*
h)	Actuators (pneumatic/hydraulic)	One of each type
i)	Cold, intermediate & hot end baskets	2 set each type and size*
j)	Rack & pinion assembly	1 set
k)	Motor Bearing	1 set each for APH
l)	* One set means one complete replacement each for APH.	
13	**Fuel Oil System**	
a)	Light Oil gun	25% of population
b)	Oil gun nozzle (with back plate, mixing plate & capnut)	4 sets**

c)	Light oil pump	
d)	Complete cartridge assembly	2 sets*
e)	Bearings including that of motor	2 sets*
f)	Mech. Seals	4 sets*
g)	Set of 'O' rings & seals	2 sets*
h)	Set of all types of bushes & sleeves	2 sets*
i)	Set of gaskets	2 sets*
	* One set means one complete replacement of one pump	
	** One set means one complete replacement of Unit	
14	**HEA Ignitors**	
a)	HEA retractor	2 sets*
b)	HEA spark rod	2 sets*
c)	HEA spark tip	3 sets*
d)	HEA exciter	4 no's of each type and rating
e)	Solenoid valves	-do-
f)	Limit switch	4 no's of each type and rating
g)	Solenoid valve coil	8 no's of each type and rating
h)	HEA spark gap	8 no's
i)	HEA Transformer	8 no's
j)	HEA rectifier	8 no's
k)	HEA inductor	8 no's
l)	Resistor	8 no's of each type and rating
m)	Capacitor	-do-
	* One set means one complete replacement of one HEA Ignitor	
15	**Soot Blowers**	
a)	Complete assembly of water wall deslagger	5 no's
b)	Complete valve assembly for water wall deslagger	2 no's
c)	Complete valve assembly for long retractable soot blower	2 no's
d)	Reduction gear box & motor for air preheater soot blower oscillation	2 nos. of each type (If separate type & rating of SB are envisaged for primary & secondary APH, then 2 Nos. of each type.)
e)	Complete valve assembly for air preheater soot blower	2 no. of each type (If separate type & rating of SB are envisaged for primary & secondary APH, then 2 Nos. of each type.)
f)	Bearings & oil seals for	
g)	Long retractable soot blower	2 sets*
h)	Water wall deslagger	3 sets*
i)	Complete steam safety valve assembly	2 no's
j)	Steam control valve assembly	2 no's
k)	Stem & disc. Assembly for above	2 sets*
l)	Gaskets	6 sets*
m)	Gland packings	4 sets*
n)	Seat rings	2 sets*

o)	Long retractable soot blower assemblies complete	2 nos. of each type
p)	Limit switches	2 nos. of each type & ratings.
q)	Complete power pack assembly for Long Retractable soot blower	(One no. for rotary + One no. for transverse)
r)	Spare set of rotary & transverse chain for long retractable soot blowers	2 no's of each type & size
s)	Spares for rack gear assembly	
t)	Set of Gears & shaft (Spur & worm)	2 set
u)	Rack & pinion	2 set
v)	Thermocouples for temp probes	Two no's of each type & size
w)	LRSB lance tube (SS)	10 no's
	* One set means one complete replacement of one valve/Equipment.	
16	**Valves**	
i	**Spares for Steam Separator Safety valves**	
a)	Complete separator safety valve assembly	2 no. of each type
b)	Upper adjusting ring	2 no. of each type
c)	Lower adjusting ring	2 no. of each type
d)	Locking pin set	2 no. of each type
e)	Safety valve disc	2 no. of each type
f)	Safety valve stem	2 no. of each type
g)	Valve spindle	2 no. of each type
h)	Guide	2 no. of each type
i)	Washers	2 no. of each type
j)	Gaskets	2 no. of each type
k)	Gland packing set	2 no. of each type
17	**Spares for SH Safety Valves**	
a)	b) Complete SH safety valve assembly	c) 2 no. of each type
d)	e) Disc	f) 2 no. of each type
g)	h) Valve spindle	i) 2 no. of each type
j)	k) Set of washers	l) 2 no. of each type
m)	n) Guide	o) 2 no. of each type
a)	Set of locking pins	2 no. of each type
b)	Upper adjusting ring	2 no. of each type
c)	Lower adjusting ring	2 no. of each type
d)	Gaskets	2 no. of each type
e)	Gland packing set	2 no. of each type
18	**Spares for Hot RH & Cold RH safety Valves**	
p)	Complete safety valve assembly	2 no. of each type
q)	Disc	2 no. of each type
r)	Valve spindle	2 no. of each type
s)	Set of washers	2 no. of each type
t)	Guide	2 no. of each type
u)	Set of locking pins	2 no. of each type
v)	Upper adjusting ring	2 no. of each type
w)	Lower adjusting ring	2 no. of each type
x)	Gaskets	2 no. of each type

y)	Gland packing set	2 no. of each type
19	**Super heater Spray Block Valve Spares**	
a)	Gland packing set	5 sets of each type*
b)	Pressure seal gasket	5 sets of each type
c)	Stem	2 sets of each type
d)	Valve plug	2 sets of each type
	Note: 1 set means complete replacement for one valve	
20	**Reheater Spray Block Valve Spares**	
a)	Gland packing set	5 sets of each type*
b)	Pressure seal gasket	5 sets of each type
c)	Stem	2 sets of each type
d)	Valve plug	2 sets of each type
	Note: 1 set means complete replacement for one valve	
21	**Spares for boiler main steam stop valve**	
a)	Boiler main stop valve assy excluding Valve body	1 no.
b)	Set of gland packings	5 sets*
c)	Pressure seal gaskets	5 no's
d)	Stem	2 nos. of each type (1 no. for main valve & 1 no. for integral bypass)
e)	Disc	3 no's
f)	Seat rings	3 no's
g)	Fasteners	2 sets
h)	Actuators	2 nos. of each type (1 no. for main valve and 1 no. for integral bypass valve)
i)	Packing & Gaskets	1 set
	Note: 1 set means complete replacement for one valve	
22	**Boiler Feed Check Valve**	
a)	Body seat rings	1 no.
b)	Flap	1 no.
c)	Pressure seal ring	2 no's
d)	Gland packings	5 sets*
e)	Fasteners	4 sets
	Note: 1 set means complete replacement for one valve	
23	**Start up vent valve**	
a)	Stem	4 no's
b)	Disc	4 no's
c)	Body seat rings	5 sets*
d)	Gland packings	5 sets*
e)	Pressure seal rings	3 no's
f)	Fasteners	5 sets*
	Note: 1 set means complete replacement for one valve	
24	**Spares for Superheater spray control valve**	
a)	Complete superheater spray control valve	3 nos. of each size & type

b)	Gland packings set	2 sets *
c)	Pressure seal gasket	3 sets *
d)	Stem	1 no.
e)	Plug valve	2 nos.
25	**Spares for Reheater spray control valve**	
a)	Complete reheater spray control valve	3 nos. of each size & type
b)	Gland packings set	2 sets *
c)	Pressure seal gasket	3 sets *
d)	Stem	1 no.
e)	Plug valve	2 nos.
24	**Auxiliary Steam Pressure Reducing &Desuperheating System**	
i	**High Capacity PRDS System (MS)**	
a)	Desuperheater liners	1 set*
b)	Steam pressure reducing cum desuperheating valves	1 no.
c)	Stem	1 no.
d)	Disc	1 no.
e)	Body seat rings	2 nos. for each type, size and rating of valves
f)	Gland packings	2 nos. for each type, size and rating of valves
g)	Pressure seal ring	2 no's
h)	Gasket	2 no's
ii	**Spray water line control valves**	
i)	Valve trim including cage, plug, stem, seat rings, guide bushings, stem packing	1 no. for each size, type & rating of valves
iii	**Low Capacity PRDS System (CRH)**	
a)	Steam pressure reducing valve	1 no.
b)	Stem	1 no.
c)	Disc	1 no.
d)	Body seat rings	2 nos. for each type/size
e)	Gland packings	2 nos. for each size, type & rating of valves
f)	Pressure seal ring	3 no's
g)	Gaskets	2 no's
h)	Spray water line control valves	
i)	Valve trim including cage, plug, stem, seat rings, guide bushings, stem packing	1 no. for each size, type & rating of valves
j)	Strainer, Traps & Filters	
k)	Basket/Element	1 set (for each type & size)

l)	O-rings/Gaskets	2 sets (for each type & size)
25	**Low Pressure Piping**	
m)	Valves	**5% of the total population** of each type, size and class OR minimum 2 nos. of each type, size and class whichever is more.
	Note: Complete valve along with Actuators (pneumatic / hydraulic) and all other accessories which are the part of original supply shall be supplied	
26	**Electrostatic Precipitator (ESP)**	
a)	Support insulator	15 no's
b)	Shaft insulator	15 no's
c)	Emitting electrodes	1% of the installed quantity in ESP
d)	Helical wire type	5% of the installed quantity in ESP
e)	Wire pipe in rigid frame	10% of the installed quantity in ESP
f)	Mast type	2% of the installed quantity in ESP
g)	Collecting electrode	2% of the installed quantity in ESP
h)	Inner arm assembly	30 no's each for collecting & emitting system
i)	Outer arm assembly	20 no's each for collecting & emitting system
j)	Plain bearing	25 no's of each type and size
k)	Shock bar/anvil	60 no's of each type and size
l)	**Rappers**	
i.	**For electric rappers**	
a)	Assembled rapper/drop rods	30 no's of each size and type
b)	Coil assembly along with sleeve	6 no's
c)	Casing	6 no's
d)	Gaskets & packing	12 no's of each size and type
ii.	**For tumbling rappers**	
a)	Hammers	30 no's of each size and type
b)	Bearing components	6 no's
c)	Shafts	6 no's
d)	Gear motors	2 no's
e)	Gaskets	1 set (One set means one complete replacement for all the TR sets of one ESP Pass)
m)	Transformer Rectifier Set	2 sets
a)	High voltage insulator	4 nos
b)	Switched and gasket	1 set (One set means one complete replacement of all the TR sets for ESP)
c)	Transformer-rectifier set intermitter range controller complete	4 nos.
d)	Rapper controller complete	1 no.
e)	Electronic Cards	
f)	For Rapper Controller & ESP Management System	1 set
g)	For Transformer Rectifier Controller	2 set
h)	Display unit	1 no. of each type
i)	Key board	1 no. of each type

j)	Push Buttons for	
k)	TR Set controller	2
l)	Others	1 set
m)	Indicator Lamps	1 set
n)	Control Fuse	1 set
o)	Power Fuse	1 set
p)	Thyristor Fuse	1 set
q)	Thyristor of Transformer Rectifier Controller	2 sets
r)	MCC of TR Controller	
•	Power Contacts	2 sets
•	Auxiliary Relay	2 sets
•	Over Load Relay	2 sets
n)	Rapping motors	5 nos. of each type
o)	ESP controllers	2 nos.

27	**MILL REJECT HANDLING SYSTEM**	
A	**Pneumatic Conveying System**	
a)	Conveying System Spares	
b)	Pneumatic main valves	4 sets of each type
c)	Pneumatic/Solenoid Two/ Three position control valve	4 sets of each type
d)	Plate valve(including seals) with Actuators (pneumatic/hydraulic)	6 no's
e)	Plate valve seals	6 sets

Electromatic relief valve

i) Complete electromatic relief valve - 1 no. of each type
ii) Spares for above :
- a) Disc for main valve - 2 nos. of each type
- b) Spring for main valve - 2 nos. of each type
- c) Seal rings for main valve - 2 nos. of each type
- d) Seal bushing for main valve - 2 nos. of each type
- e) Disc and steam assembly for pilot valve - 2 nos. of each type
- f) Bushing for pilot valve - 2 nos. of each type
- g) Spring for pilot valve - 2 nos. of each type
- h) Seal ring - 2 nos. of each type

Air & Gas Duct Dampers (for each type & size)

a) Complete dampers along with drives - 1 no.
b) Gasket - 1 set
c) Nut & bolts - 1 set

Thermal Insulation - 5 % of quantity used

Refractories - 5 % of quantity used

STEAM TURBINE GENERATOR & AUXILIARIES

S. No.	Description	Qty
2.1	**STEAM TURBINE**	
A	**High Pressure Turbine**	
I.	MS pipe/casing U-seal ring as per Drawing	3 sets

S. No.	Description	Qty
II.	MS pipe /casing U-seal ring-Unmachined	2 sets
III.	Inner/Outer casing U-seal ring as per Drawing	1 set
IV.	Inner-Outer casing U-seal ring -Unmachined	1 set
V.	Inner/Outer I-seal ring-Unmachined	1 set
VI.	HPT exhaust Pipe/Casing U-seal ring Unmachined	1 set
VII.	HPT exhaust Pipe/Casing U-seal ring as per Drawing	1 set
VIII.	CRH NRV flap, hinge pin assembly	1 set
IX.	Breach Nut	1 set
X.	Rotating Blades	1 set
XI.	Stationery Blades	1 set
XII.	Fasteners of HP turbine and its piping	1 set
XIII.	Gland Seal Segments	1 no.
XIV.	Evacuation Valve stem, disc and seal (if applicable)	1 set
XV.	HP outer & inner casing fasteners & fixing materials & size	1 set
XVI.	HP inlet & HP exhaust assembly (U-sealing, lock washers, connecting nuts/ cap nuts between pipe & casing)	1 set
XVII.	HP shaft coupling bolts, nuts, lock washers, pins, screws, coupling guards	1 set
XVIII.	HP shaft gland seals (Complete set for replacement of front & rear with fixing material)	1 set
XIX.	Front pedestal oil guard ring (Complete set of oil guard assembly for front & rear with fixing material)	1 set
XX.	Combined thrust and journal bearing (Complete with torous, intermediate pieces sole/base plate and matching seats & all other fixing/assembly materials required to complete thrust & journal bearings assembly except housing)	1 set
XXI.	Seal rings of HP turbine casing with piping, extraction seal rings & labyrinth seals of fixed and rotating blades of HP turbine	1 set
B	**Intermediate Pressure Turbine**	
a.	Inlet pipe angle ring-Unmachined	1 set
b.	Extraction Pipe Angle ring unmachined	1 set
c.	Rotating Blades	1 set
d.	Stationery Blades	1 set
e.	Fasteners of IP turbine and its piping	1 set
f.	Gland Seal Segments	1 set
g.	IP outer & inner casing fasteners & fixing materials & size	1 set
h.	IP inlet & IP exhaust assembly (U-sealing, lock washers, connecting nuts/ cap nuts between pipe & casing)	1 set
i.	IP shaft coupling bolts, nuts, lock washers, pins, screws, coupling guards	1 set
j.	IP shaft gland seals (Complete set for replacement of front & rear with fixing material)	1 set
k.	Front pedestal oil guard ring (Complete set of oil guard assembly for front & rear with fixing material)	1 set

S. No.	Description	Qty
l.	Seal rings of IP turbine casing with piping, extraction seal rings & labyrinth seals of fixed and rotating blades of IP turbine	1 set
C.	**LP Turbine**	
a.	Expansion – 1 Bellows	1 set
b.	Expansion – 2 Bellows	1 set
c.	Expansion – 3 Bellows	1 set
d.	Expansion bellows installed in LPT turbine, piping and extraction lines	1 set
e.	LPT inlet pipe bellows	1 set
f.	LPT casing to gland bellows	1 set
g.	Clamping Pieces and locking plates for free standing blades	1 set
h.	Free standing rotating blades	1 set
i.	Stationery Blades	1 set
j.	LP outer & inner casing fasteners & fixing materials & size	1 set
k.	LP inlet & HP exhaust assembly (U-sealing, lock washers, connecting nuts/ cap nuts between pipe & casing)	1 set
l.	LP shaft coupling bolts, nuts, lock washers, pins, screws, coupling guards	1 set
m.	LP shaft gland seals (Complete set for replacement of front & rear with fixing material)	1 set
n.	Front pedestal oil guard ring (Complete set of oil guard assembly for front & rear with fixing material)	1 set
o.	LP turbine atmospheric diaphragm (Complete set for replacement of one diaphragm assembly)	1 set
p.	LP Turbine rear bearing (Complete set of bearing assembly including torous, intermediate pieces and matching seats, sole/ base plate and all other fixing/ assembly materials required to complete one bearing assembly without housing)	1 set
q.	Seal rings, labyrinth seal rings, gland seals installed in LP turbine	1 set
r.	All type of fasteners of LP turbine and its piping	1 set
D.	**Bearing**	
a.	HP, IP, LP turbine bearings complete with torous, intermediate pieces and all other fixing/assembly material required to complete one TG unit with housing and thrust bearing pads	1 set.
E.	**Jacking Oil System**	
a.	Jacking oil flexible hoses for each bearing	1 set
b.	Jacking oil pump assembly	1 no.
c.	Jacking oil to each bearing NRV	1 set
d.	Jacking oil header pressure regulating valve assembly	1 set
F	**Control Oil System and Governing Rack**	
e.	Hydraulic Governor Bellows	g. 1 set
h.	Main Trip Valve Assembly	j. 1 set
k.	All kind of "O "rings	m. 1 set
n.	Filter Elements	p. 1 set

S. No.	Description	Qty
G	**Lubricating Oil System**	
a.	Main Oil pump assembly complete with Bearings	1 no.
b.	HPT/ MOP gear coupling	1 no.
c.	MOP suction Oil Injector assembly	1 set
d.	Oil strainer/filter	1 set
e.	AOP assembly	1 set
f.	MOP assembly	1 set
H	**Coupling Bolts**	
a.	Coupling nuts and bolts of MOP, HP, IP, LP, generator and exciter	1 set
I	**Turning Gear**	
a	Stationery Blades/Nozzle	1 set
b	Rotating Blades	1 set
c	Gear internal with shafts, bearing, bushes, lock washers, oil seals, 'O' rings.	1 set
d	25% nozzle segments & moving blades and complete set of sealing strips with caulking material (If hydraulically operated).	1 set
J	**HPSV/CV**	
a.	All type of internals like stem, disc, seal, bushings, pilot valves, seat of HP valves, safety valves and control valves with one set of fasteners, one set of actuator cylinder, spring set, pins, couplings and its fasteners	1 set
K	**IPSV/CV**	
a.	All type of internals like stem, disc, seal, bushings, pilot valves, seat of IP valves, safety valves and control valves with one set of fasteners, one set of actuator cylinder, spring set, pins, couplings and its fasteners	1 set
L	**LPBP/CV**	
a.	All type of internals like stem, disc, seal, bushings, pilot valves, seat of LP valves, safety valves and control valves with one set of fasteners, one set of actuator cylinder, spring set, pins, couplings and its fasteners	1 set
M	**HPBP**	
a	All type of internals like stem, disc, seal, bushings, pilot valves, seat of HP & LP bypass valves and its spray valves with one set of fasteners, one set of actuator cylinder, spring set, pins, couplings and its fasteners	1 set
N	**MS Strainer**	
a	Element along banking device gasket, sealing ring, protection ring (metallic ring)	1 set
O	**HRH Strainer**	
a	Element along banking device gasket, sealing ring, protection ring (metallic ring)	1 set
P	**Condenser**	
a	CW Pipe to condenser flexible joint assembly	2 no.
Q	**Evacuation System**	
a	Manhole Gaskets	1 set

S. No.	Description	Qty
b	Vacuum pump assembly	1 set
c	Cooler element	1 set
R	**Heaters**	
a	All HP & LP heaters safety valves (water box & shell side)	1 set
S	**Feed Water System**	
a.	BFP Assembly	1 set
b.	Bearings	1 set
c.	Discharge Valve stem and disc	1 set
d.	Hydraulic coupling assembly	1 set
T	**Condensate system**	
a.	CEP assembly	1 set
b.	CEP suction strainer	1 set
c.	CEP Discharge Valve stem and disc	1 set
d.	Condensate line NRV before Deaerator assembly	1 set
U	**Turbine gland seal steam system**	
a	Gland system condenser assembly	1 set
b	Gland steam control valves actuator	1 set
V	**TDBFP Turbine**	
a	Rotating and stationary blades along with labyrinth seals, gland seals, fasteners, coupling along with nuts and bolts	1 set
W	**Generator Seal Rings**	
a	Turbine & Generator seal rings	1 set
X	Turbine & Generator shaft journal bearings (Complete set of bearing assembly including torous, intermediate pieces sole/base plate and all other fixing/assembly materials required	1 set
Y	Turbine HP piping valves	10% of total population of each type, size and class or minimum of 2 nos. of each type, size and class which ever is more
Z	Turbine LP piping valves	10% of total population of each type, size and class or minimum of 2 nos. of each type, size and class which ever is more
AA	Each type of pump like turbine governing (EH) oil pump, HP/LP bypass oil unit pumps	1 set
BB	Bladders, filters, seal/O rings	1 set

COAL HANDLING PLANT

S. No.	Description	Quantity
A	**Idlers**	
i.	35^0 troughing idlers complete with base frame and mounted brackets, etc.	10% of population
ii.	Rolls for i above	10% of population
iii.	Troughing idlers complete with base frame and mounting brackets, etc. (for belt feeders)	20% of population
iv.	Rolls for iii above	20% of population
v.	35^0 impact idlers complete with mounting brackets and base frame etc.	20% of population
vi.	Rolls for v above	20% of population
vii.	35^0 troughing training idlers complete with base frame and brackets, etc. (if used)	20% of population
viii.	Transition idler complete	20% of population
ix.	Flat return idlers complete with mounting brackets, etc.	10% of population
x.	Flat Return Idlers complete with mounting brackets, etc. (for belt feeders)	30% of population
xi.	Flat return trainer complete with mounting brackets, etc.	10% of population
xii.	Belt cleaning spiral rubber disc return idler complete with mounting brackets, etc.	20% of population
xiii.	Two roll with 10otroughing return idler assy.	10% of population
xiv.	Rolls for xiii above	10% of population
xv.	SS Idlers	10% of population
B	**Conveyor Gear Boxes**	
i.	Gear Boxes	1 Set of each type and rating (for population upto 10 Nos.)
		2 Sets of each type and rating (for population more than 10 Nos.)
ii.	Complete gear box assembly with hold back device	1 Set of each type and rating (for population upto 10 Nos.)
		2 Sets of each type and rating (for population more than 10 Nos.)
iii.	Complete Set of internal including oil seal, bearing, each type	1 Set of each type and rating (for population upto 10 Nos.)

		2 Sets of each type and rating (for population more than 10 Nos.)
C	**Conveyor drive and conveyor belt**	
i.	Gear Coupling complete	10% of each type
ii.	Coupling bolt set	10 Sets of each type and rating
iii.	Fluid coupling complete	1 Set of each type and rating (for population upto 10 Nos.)
		2 Sets of each type and rating (for population more than 10 Nos.)
iv.	Runner & impeller assembly of fluid coupling	1 set of each type& rating
v.	Fusible plug	25 nos. each type
vi.	Complete Scoop control assembly	1 set of each type& rating
vii.	Mechanical face seal	2 Set of each type and rating
viii.	Resilliance disc assembly(if applicable)	1 set of each type& rating
ix.	Multi Disc Coupling/ Rubber Inserts etc	1 set of each type& rating
x.	Hydraulic oil cooler	1 set of each type& rating
xi.	Conveyor Belt	2 drums length of 250M of each type, size and rating
xii.	Boom conveyor, belt feeder, intermediate conveyor	Two Complete lengths of each type plus 20% of population
D	**Pulleys**	
i.	Pulleys complete with shaft excluding bearing & plummer blocks (complete with lagging)	1 No. of each type & size in pulley drum & shaft Ø (for population upto 10 Nos.)
		2 Nos. of each type and size in pulley drum & shaft Ø (for population more than 10 Nos.)
ii.	Plummer Block	2 No. of each type & size (for population upto 10 Nos.)
		4 No. of each type & size (for population more than 10 Nos.)
iii.	Bearing of all type	4 nos. of each type
iv.	Bearing adopter, lock washer, lock nut	4 nos. of each type

v.	Life line shaft with plummer block & bearings assembly	2 nos. of each type
E	**Coal Crusher**	
i.	Plummer Block assembly complete including bearing, lock nut, lock washer etc.(DE+NDE)	2 sets of each type
ii.	Hammer sets	8 sets of each type
iii.	Rotor assembly complete consisting of rotor shaft & keys, End discs, Centre discs, distance rings, suspension bars, disc clamping nuts and shaft extension, bearings etc. but without hammers, and pillow blocks as applicable	1 set of each type and size
iv.	Crusher Shaft with key & Lock nut	2 nos. of each type
v.	Suspension bar with lock nut	4 sets of each type and size
vi.	End discs, Centre discs, distance rings of crusher	2 sets of each type and size
vii.	Disc locking device of crusher	1 set of each type and size
viii.	Cage bars, if applicable	2 sets of each type and size
ix.	Breaker Plate	2 sets of each type and size
x.	Liners	2 sets of each type and size
xi.	Screen plate upper & lower	2 sets of each type and size
xii.	Crusher Fluid coupling complete assembly	1 No of each type
xiii.	Runner & impeller assembly of fluid coupling	1 No of each type
xiv.	Fusible plug	10 nos. of each type
xv.	Scoop control assembly with motor	1 No of each type
xvi.	Mechanical face seal	2 No of each type
xvii.	Resilliance disc assembly(if applicable)	1 No of each type
xviii.	Multi Disc Coupling/ Rubber Inserts etc	1 Set of each type and rating
xix.	Oil & water Pump with motor	1 No of each type
xx.	Hydraulic Oil Cooler	1 No of each type
F	**Vibrating Grizzly Feeder**	
I.	Screen Plates	4 sets of each type & size
II.	Drive & driven unbalanced shafts	2 sets of each type &

		rating
III.	Bearings	2 sets of each type & size & rating
IV.	Vibrating blocks	1 set of each type & rating
V.	Main shaft (with universal coupling)	2 sets of each type & rating
VI.	Unbalanced weights	1 set of each type & rating
VII.	Vibrating gear box	2 sets of each type & rating
VIII.	Vibrating assembly consisting of all rotating parts including drive & driven unbalanced shafts including bearings, casing, spring, vibrating blocks, main shaft, sheave & unbalanced weights as applicable.	1 set of each type
IX.	Drive unit assembly (including electric motor, hydraulic pump, hydraulic motor, flexible shaft, gear box, as applicable)	1 set of each type
X.	Spring set	2 set of each type
XI.	Hydraulic pump with motor	1 set of each type
XII.	Hydraulic motor	1 set of each type
XIII.	Gear box	2 set of each type
XIV.	Internal gear set of gear boxes	2 set of each type
XV.	V Belt	2 set of each type
XVI.	Drive & driven pulley of v belt drive	1 set of each type
G	**Stacker Reclaimer (including boom)**	
I.	Fluid Coupling complete assembly	1 No. of each type
II.	Runner & impeller assembly of fluid coupling	1 No. of each type
III.	Fusible plug	10 No. of each type
IV.	Mechanical face seal	1 No. of each type
V.	Resillance disc assembly	1 No. of each type
VI.	Multi disc coupling/ rubber inserts etc	1 No. of each type
VII.	Hydraulic pump for luffing, slewing, bucket wheel drive with electric motors, coupling, valves and servo motor, EP control, bearings	1 No. of each type
VIII.	Solenoid valves, pressure regulating valves & hydraulic circuit valves of all type	2 set of each type

IX.	Hydraulic cylinder including luffing cylinder	1 No. of each type
X.	Repair kit for hydraulic cylinder including oil seals etc.	1 No. of each type
XI.	Slew gearbox with shaft and pinion	1 No. of each type
XII.	Slew bearing (for machines older than 20 years)	1 set of each type
XIII.	Coupling for gear boxes	1 set of each type
XIV.	Gearbox of bucket wheel	1 No. of each type
XV.	Internal gear set of all gear boxes	1 set of each type
XVI.	Traverse drive assembly consisting of reducer, couplings, brake assy. etc.	1 No. of each type
XVII.	Complete carriage wheel assembly)	1 No. of each type
VIII.	Brake assembly with hydraulic & electric drive	1 set of each type
XIX.	Brake shoe	2 sets of each type
XX.	Plumber block & bearings of all wheel	2 sets of each type
XXI.	Bearing adopter, lock washer, lock nut	2 sets of each type
XXII.	Hydraulic oil cooler	1 set of each type
XIII.	Hydraulic hoses of all type	2 sets of each type
XIV.	Rail Clamp Assembly	1 set of each type
XXV.	Chain Assy with sprocket (for Scrapper type reclaimer	1 set of each type & rating
XVI.	Scrapper blades of Scrapper type reclaimer)	10 No. of each type
VII.	Hoisting gear box (for Scrapper type reclaimer)	1 set of each type & rating
XVIII.	Vibrating Grizzly Feeder of Stacker Reclaimer	
	a. Gearbox of vibrating grizzly feeder	1 no
	b. Vibrating Springs	1 set
	c. Oil Seals and Bearings	1 set
G	**Tripper**	
I.	Drive gear box	1 No. of each type
II.	Internal gear set of all gear boxes	1 set of each type
III.	Actuator for flap gate	1 set of each type
IV.	Drive shaft and wheel assly.	1 set of each type
V.	Plumber block & bearings of all wheel	2 set of each type

VI.	Bearing adopter, lock washer, lock nut	2 set of each type
VII.	Brake assembly with hydraulic & electric drive	1 set of each type
VIII.	Rail Clamp Assembly	1 set of each type
IX.	Couplings	1 set of each type
X.	Festooning Cable of Tripper	1 complete Length
H	**Wagon Tippler and accessories**	
I.	Gear Box	1 set of each type
II.	Internal gear set of all gear boxes	1 set of each type
III.	Couplings	2 sets of each type
IV.	Hydraulic Pump	1 No. of each type
V.	Hydraulic Motor	2 sets of each type
VI.	Open segment gear and pinion	1 set of each type
VII.	Flap Gate Actuators with motor, gear box etc	2 sets of each type
VIII.	RPG Actuators with motor, gear box etc	1 set of each type
IX.	Hydraulic hoses of all type	2 sets of each type
X.	Hydraulic oil cooler	1 set of each type
XI.	Spur Gear Set	2 set of each type
XII.	Plumber block & bearings/ Bush of all Drive shaft	2 set of each type
I	**FLAP GATES (INCLUDING THAT OF TRIPPERS)**	
I.	Limit switch	8 nos. of each type & rating
II.	Actuator (complete with motor, gear box,limit switches etc.)	1 nos. of each type & rating
III.	Oil seals of Actuator	2 nos. of each type & rating
IV.	Flap gate shaft	1 nos. of each type & rating
V.	Pressure nut	12 nos. of each type & size
J	**RACK & PINION GATE**	
I.	Limit switch	2 no. of each type & size
II.	Rollers with bearings	2 no. of each size
III.	Motor gear box assembly	1 set of each type
IV.	Actuator (complete with motor, gear box, limit switches etc.)	1 nos of each type & rating

K	**SUMP PUMP**	
I.	Complete pump assembly with pump, motor, coupling base etc	1 Set
II.	Impeller with key & nut	2set of each size & type
III.	Oil seal	2 nos. of each size
IV.	Coupling bolt with bushes	2 set of each type
V.	Pump shaft	2 no. of each size
VI.	Shaft sleeve	2 sets of each size
VII.	Bearing bush	2 sets of each size
VIII.	Set of bearings	2 Sets
L	**DUST SUPRESSION, SERVICE WATER, POTABLE WATER, COOLING WATER (for hydraulic coupling or any other purpose), Dust Extraction System**	
a.	Pump impeller with key & nut	1 set of each type & size
b.	Pump Shaft	1 no of each type & size
c.	Bearings	1 sets each type & size
d.	Wearing rings	2 sets of each type & size
e.	Shaft sleeve	2 sets of each type & size
f.	Bushings	2 sets of each type & size
g.	Coupling bolts & nuts (with bushes) 2 sets	1 sets each type & size
h.	Spray nozzles	50 nos.of each type & size
i.	Spray nozzles (for plain water dust suppression)	25 nos.of each type & size
j.	Solenoid valves	5 % of each type and size
k.	Globe valve / plug valves	10 % of each type and size
l.	Gate valve	2 nos. of each size
m.	Strainers	1 no. of each type
n.	**Compressor**	
i.	Air filter element	8 Nos.
ii.	Oil filter	6 Nos.
iii.	Discharge Check Valve	3 Nos.
iv.	Oil Pump Parts (including distance ring, eccentric rings, Pump element, Pin, Key O, Ring) as applicable	2Sets

v.	Inlet Valve Assembly	2 Nos.
vi.	Electronic regulator	3 Nos.
M	**DUST EXTRACTION SYSTEM**	
1.	Fan Motor	1 nos. of each type & rating
2.	Plummer Blocks	2 sets of each type
3.	Bearing of fans & motor	1 set of each type
4.	Pulley	2 nos of each type
5.	Belts	2 sets of each size
6.	Impeller and shaft of coal slury disposal pump	1 set of each type
7.	Bearing of pumps	1 set of each type
8.	Pump Motor	1 nos of each type
9.	Motor terminal blocks with studs for all motors	1 set of each rating and type of motor
10.	Spray nozzle	10 nos of each type
11.	Solenoid valve with coil	2 nos of each type
N	**SIDE ARM CHARGER**	
1.	Carriage Wheels	
a)	Bearings	1set of each size and type
b)	Oil Seals	2set of each size and type
c)	Plummer Block	1 set of each type and size
d)	Carriage wheel fitted with shaft (without Plummer Block)	1 Set
2.	Coupling	1 set each type
3.	Travel Wheel Assembly	1 No
4.	Bearing	1 no. of each type
5.	**Speed Reduers**	
a)	Internals complete including input and output shafts and gears etc.	1 set of each type and Rating.
b)	Oil seals	4 sets of each type and rating
c)	Bearings	2 sets of each type and rating
6.	Motor	
a)	b) Motor including slip ring motor	1 set of each type and size

c)	d) Bearings	1 set of each type and size
e)	f) Oil Seal	1 set of each type and size
7.	Brakes	
a)	Complete assembly	1
b)	Linings & springs	1
8.	Couplings	
	Complete assembly	1 no. of each type and size
O	**APRON FEEDERS**	
1.	Head Pulley complete with shaft	1 no.
2.	Tail pulley complete with shaft	1 no.
3.	Drive Motor	1 no. of each type and size
4.	Gear Box	1 no. of each type and size & direction.
5.	Complete internals of gear box including input and output shafts	1 set of each type & size
6.	Fluid coupling, flexible coupling etc.	1 No. of each type and size
7.	Traction rollers	20 %of population
8.	Carrying idlers	20 %of population
9.	Return Rollers	20 %of population
10.	Sprocket segments	2 sets of each type and size
11.	Link Chain	50 % of each type and size
12.	Pans (flights)	1 Set for one full Apron Feeder
13.	Hydraulic Cylinder	1 sets of each type and size
14.	Seal kit of hydraulic cylinders	2 sets.
15.	Plummer Blocks	1 no. of each type and size
16.	Bearings	1 set of each type and size
P	**Dribble Conveyor**	
	a. Pulleys	1 of each type
	b. Carrying Roller & Return Roller	30% of total installed capacity
	c. Conveyor Belt	Equivalent to length of 1 complete belt
	d. Bearings	1 of each type

Q	**Marshalling Yard**	
	a. CRC Slippers	10% of total installed capacity of each type
	b. Quarter Pins of Points	20% of total installed capacity of each type
	c. Clips of CRC Slippers	20% of total installed capacity of each type
	d. Complete Point Set	4 nos
	e. Tongue Rail (Left & Right)	2 of each type
	f. Rail Line Length	6 standard length of installed weight and specifications
	g. Blocks of rail line	8 nos of each type
	h. Rubber Pads (between rail line and slipper)	10% of total installed capacity of each type
R	**Metal Detectors**	
	a. Electronic cards of Metal Detector	1set
S	**Suspended Magnet**	
	a. Rectifier controller card	1 complete set
	b. Insulating Oil	Equivalent to replacement of 1 Suspended Magnet
D	**ILMS**	
	a. Cleated Belt of ILMS	4 nos
	b. Pillow Block and bearings of ILMS	3 sets of each type
	c. Pulleys of ILMS	1 of each type
	d. Gearbox of ILMS	1 of each type
E	**Coal Sampler**	
	a. Bearings of Coal Sampler	1 set of each type
	b. Coupling of Coal Sampler Cutter	2 sets
F	**In motion Weigh Bridges**	
	a. Rail Mounted Load Cells	1 complete set
	b. Cards of In-motion weigh bridge	1 set
	c. Set of Track Switches	1 set
G	**Bull Dozers**	
	a. Element Assembly	3 no

	b. Set of O-rings	2 sets of each type
	c. Hose Pipes	2 of each type and size
	d. Engine Maintenance Kit	2 set
	e. Gasket Set	2 set
	f. V Belts	1 of each type
	g. Coolant	10 Ltrs
	h. Air Filter Assembly	Complete set of each type for replacement till 4 services
	i. Oil Filter	Complete set for each type for replacement till 4 services
H	**Wheel Loaders**	
	a. Air Filter Assembly	Complete set for each type for replacement till 4 services
	b. Oil Filter	Complete set for each type for replacement till 4 services
	c. Hose Pipes	2 of each type and size
	d. O-rings	2 sets of each type
	e. Coolant	10 Ltrs
	f. V Belts	1 of each type
I	**Dumpers**	
	a. Air Filter Assembly	Complete set for each type for replacement till 4 services
	b. Oil Filter	Complete set for each type for replacement till 4 services
	c. Hose Pipes	2 of each type and size
	d. V Belts	1 of each type and size
	e. O-rings	2 sets of each type
	f. Coolant	10 Ltrs
J	**Diesel Locomotives**	
	a. Air Filter Assembly	Complete set for each type for replacement till 4 services
	b. Oil Filter	Complete set for each type

		for replacement till 4 services
	c. Hose Pipes	2 of each type and size
	d. V-Belts	1 of each type and size
	e. O-RINGS	2 sets of each type
	f. Solenoid Valves	2 sets of each type
	g. Coolant	10 Ltrs
I	**Electrical**	
1)	**Conveyors**	
a.	Belt sway switches	5 % of each type
b.	Pull cord switches	10 % of each type
c.	Zero speed switches	10 % of each type
d.	Chute block switches	10 % of each type
e.	Position switches for trippers	5 % of each type
f.	thruster brake assembly with drum	1 set of each type
g.	Drive assembly of cable reeling system	1 set of each type
2)	**Crushing Equipment**	
a.	VGF/VSF Drive Motor	1 no. of each type
3)	**Stacker Reclaimer**	
a.	Drive assembly of cable reeling system	1 set of each type
b.	Electric cards, modules	1 no, of each type
3)	**Wagon Tippler & Accessories**	
a.	Tripper Flexible cable	1 length of each type
b.	Tripper Drive assembly of cable reeling system	1 set of each type

CW & ACW SYSTEM

S. No.	Description	Quantity (each type of pump)
A)	**Mechanical Items**	
1.	**Spares for CW& ACW pump**	
	Shaft sleeves	2 sets
	Bearing of pump (all bearings including thrust bearing of applicable)	1 set
	Bearing of motor (all bearings including thrust bearing of applicable)	1 set

S. No.	Description	Quantity (each type of pump)
	Wearing rings or equivalent for impeller (if applicable)	1 set
	Wearing rings or equivalent for Casing/ Bowl (if applicable)	1 set
	Complete Line shaft Coupling	1 set
	Coupling between line shaft & head shaft	1 set
	Bushes for the Coupling	1 set
	Mechanical seal or gland packing as applicable for the pumps	1 set
	Pads of thrust bearing of each type	2 sets each.
	Gaskets	1 set
	Shafts	1 set
	Impeller	1 set
	Nuts & bolts	1 set
2.	**Spares for Discharge Butterfly valves**	
	Valve discs .	1 set of each type/size.
	Gland packing	1 set
	Shaft	1 no.
	Bearing	1 set
	Seals, O-rings & Gaskets	1 set
	Gear box units for valve (if applicable)	1 set
	Gear box internals with shaft (if applicable)	1 set
	Bearing & 'O' rings for gear box unit (if applicable)	1 set
	Nuts & bolts	1 set
3.	**Spares for Electric actuators of Discharge Butterfly valves**	
a)	Complete actuating assembly	1 set
4.	Complete assembly of rubber expansion joints (including bolts & nuts)	1 set
5.	**RE Joint**	
a	Complete RE Joint	1 set
b	Nuts & bolts, locking rods	1 set
c	Gasket	1 set
One set means complete requirement of one pump set		

PUMPS & PLATE TYPE HEAT EXCHANGERS FOR DMCW SYSTEM

S. No.	Description		Quantity
A) Auxiliary Cooling Water Pumps, DMCW Pumps (as the case may be)			
i)	Impeller	:	1 No of each type & size.
ii)	Shafts	:	1 No of each type & size.
iii)	Shaft Sleeve	:	1 Set of each type & size.
iv)	Casing and impeller Wearing rings	:	2 Sets of each type & size.
v)	Bearings for Pumps	:	2 Sets of each type & size.
vi)	Motor Bearings	:	1 Set of each type & size.
vii)	Thrust Bearings	:	2 Sets of each type & size.
viii)	Sleeve nuts & Bearings	:	1 Set of each type & size.
ix)	Gland Packing	:	2 Sets of each type & size.
ix)	Fastners	:	1 Set of each type & size.

xi)	Complete Coupling (Pump & Motors)	:	1 Sets of each type & size.
xii)	Mechanical Seal	:	1 Set of each type & size.
B) Plate Type Heat Exchangers			
i)	Gaskets	:	30% of total requirement of each type & size.
ii)	Fasteners	:	10% of each type & size
iii)	Plates	:	10% of each type & size

CONDENSATE POLISHING UNIT

S. No.	Description	Quantity
i)	Service and regeneration vessels (for each type and size)	
	Diffusers, distributors and nozzles	10%
	Perforated laterals and under drain collectors	10%
	Gaskets etc.	2 sets
	Nuts and bolts etc.	1 set
ii)	Resin traps	1 No of each type & size.
iii)	Valves	20% of each type and size
iv)	Storage, preparation and metering tanks etc	
	Tank stirrers (as applicable)	1 set
	Dissolving baskets (as applicable)	1 set
	Heating element (as applicable)	1 set
	Gaskets etc.	2 sets
	Nuts and bolts etc.	2 sets

FIRE DETECTION AND PROTECTION SYSTEM

S. No.	ITEM DESCRIPTION		QUANTITY	
1.0	**PUMP**		**Hydrant/SPRAY**	**BOOSTER/ Jockey**
	1.	Impeller	1 set	1 set
	2.	Pump bearing(Incl. thrust brg, journal brg., line shaft brg.)	1 set	1 set
	3.	Pump shaft	1 set	1 set
	4.	Wearing rings	2 sets	2 set
	5.	Shaft Sleeve	2 sets	2 sets
	6.	Bushings	2 sets	2 set
	7.	Bearing housing (if provided)	1 set	1 set

S. No.	ITEM DESCRIPTION		QUANTITY	
	8.	Coupling bolts & nuts(with bushes)	2 sets	1 set
	Above quantity/items are required for each type and rating of pumps being supplied under the contract			
2.0	**DIESEL ENGINE** (1 set means item required for 1 diesel engine)			
	1.	Sprayers/Injector	1 set	1 set
	2.	Pistons	1 set	1 set
	3.	Piston rings & sealing rings	2 sets	2 sets
	4.	Inlet valve assembly	1 set	1 set
	5.	Exhaust valve assembly	1 set	1 set
	6.	Springs	2 sets	2 sets
	7.	Packings and gaskets	2 sets	2 sets
	8.	Fuel oil filter elements with seals	8 sets	4 sets
	9.	Fuel oil filter assy	1 set	1 set
	10.	Lub. oil filter elements with seals	8 sets	4 sets
	11.	Scrapper rings	2 sets	2 sets
	12.	Solenoid coil for fuel valve	2 nos.	2 nos.
	13.	Corrosion inhibitor(if provided)	1 sets	1 set
	14.	Main bearing	1 set	1 set
	15.	Big end & small end bearing of connecting rod	1 set	1 set
	16.	Speedometer	1 no.	1 no.
	17.	Speedometer wire	1 no.	1 no.
	18.	Rubber hoses of water line with mounting clamps	2 sets	2 sets
	19.	Cranking starter assembly complete	1 set	1 set
	20.	Lub. oil and fuel oil hoses with end connectors	2 sets	2 sets
	21.	Water pump belts	2 sets	2 sets
	Above quantity/items are required for each type and rating of diesel engine being supplied under the contract			
3.0	**MOTORS**			
	Bearings		2 sets	
4.0		**GEAR BOX (DIESEL ENGINE)**		
	1.	Bearings	1 set	
	2.	Gears	1 set	
		(drive & driven)		
	3.	Lub. oil heat exchanger	1 set	

S. No.	ITEM DESCRIPTION		QUANTITY
5.0		**FIRE HOSES WITH COUPLINGS**	
	1.	7.5m long fire hoses with end connectors	10% of population
	2.	15m long fire hoses with end connectors	10% of population
6.0		**BRANCH PIPES WITH NOZZLES**	
	1.	Nozzles with branch pipes quick coupling ends	10% of population
	2.	Nozzles of water monitors	10% of population
7.0		**DELUGE VALVE ASSEMBLIES**	
	1.	Complete deluge valve assembly alongwith internals	10% of population each type
	2.	Clapper assembly complete(consisting of clapper seat rubber, screws, etc.)	10% of population
	3.	Solenoid coils	10% of population each type
8.0		**Y-TYPE STRAINERS**	
	1.	Strainers elements with 0-rings and stiffners.	20% -do-
9.0		**MVW SPRAY SYSTEM**	
	1.	Spray Nozzles	10% of population
10.0		**HVW SPRAY SYSTEM**	
	1.	Spray nozzles	10% -do-
	2.	QB Detectors	20% -do-
	3.	Spot /Heat detectors(for boiler burner front area and Battery room)	20% -do-
11.0		**HYDRANT VALVE**	
	1.	Hydrant valve complete (internal) single headed with instantaneous female coupling	20% of population
	2.	Hydrant valve complete (external) single headed with instantaneous female coupling	20% -do
	3.	Hydrant valve complete(double headed) with instantaneous female coupling	10% -do-
	4.	Water monitor sets with nozzle branch pipe etc.	10% -do-
	5.	Spindle with nuts of Hydrant valve	10% -do-
	6.	Bonnet, gland nut, rubber assembly of hydrant valve	10% -do-
	7.	Seat, check nut, washer assembly of hydrant valve	10% -do-

S. No.		ITEM DESCRIPTION	QUANTITY
	8.	Rubber washer for female coupling	20% -do-
	9.	Instnataneous female coupling assembly complete for hydrant valve	20% -do-
	10.	Lock pin assy for hydrant valve	20% -do-
12.0		**SMOKE / HEAT DETECTORS**	
	1.	Photo-electric type detector(Addressable)	10% of population
	2.	Ionisation type detectors(Addressable)	10% -do-
	3.	Indicators assembly for smoke detectors provided in false ceiling	5% -do-
	4.	Duct Mounted Detectors	10% -do-
	5.	LHS cable	10% -do-
	6.	Sopt type heat detectors	10% -do-
		Manual pull stations	20 Nos. of each type
13.0		**INFRA RED DETECTORS**	
	1.	IRD unit with local control unit, purging unit, other accessories (for complete replacement)	20% of population
14.0		**PORTABLE EXTINGUISHERS**	
	1.	Portable extinguishers	10% of each type & size
		a) Water Type	
		b) Foam Type	
		c) CO_2 Type	
		d) Dry Chemical Type	
15.0		**MOBILE EXTINGUISHERS**	10% of each type & size
		a) Foam type	
		b) Dry Chemical Type	
		c) CO_2 Type	
16.00		**FIRE ALARM CONTROL/ANNUNCIATION PANELS (Addressable)**	
	1.	Fuses	100% of population
	2.	Indicating lamps	100 % -do-
	3.	Lamp holders	10 % -do-
	4.	Push Buttons	10 % -do-
	5.	Selector Control Switches	10 % -do-
	6.	Auxiliary relays/Contractors	10 % -do-
	7.	Annunciation window lamps	10 % -do-

S. No.		ITEM DESCRIPTION	QUANTITY
	8.	Control cards for annunciation facia, fire detection system, gas extinguishing etc of each type	10 % -do-
	9	All PCB assmebly cards, loop cards in cluding mother boards etc	10 % -do
	10	LCD display units of panels	10 % -do
	11	Interface units/ modules for noon-addressable devices, output relay modules, supervisory control modules etc	10 % -do
	12	LED's if applicable	100% of population
	13	Power supply modules	10 %
17.0		**FIELD DEVICES**	
	1.	Pressure gauges	5 nos.
	2.	Temprature gauges	2 Nos.
	3.	Level Indicator	2 Nos.
	4.	Pressure Switches	5 Nos.
	5.	Flow Switches	2 Nos.
	6.	Limit Switches for isolation valves.	20 Nos.
18.0		**INERT GAS EXTINGUISHING SYSTEM**	
	1.	Nozzles	2 Nos of each size/type
	2.	Automatic & Manual release system	1 No of each size/type
	3.	Cylinder valve with safety pressure relief device	1 No of each size/type
	4.	Gas cylinder	5 Nos. of each size/type
	5.	Flexible hoses(if applicable)	2 Nos of each size/type
	6.	Solenoid coils	2 Nos.of each size/type

NOTE:

1. Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2. Any fraction of a item shall mean the next higher integer.

AIR CONDITIONING SYSTEM

S.No.	Description	Quantity
1.	**Reciprocating Chilling Machine**	
a	Compressors with motors	1 No.
b	Piston	1Set.
c	Valve Plate, spring plate, seating washer	4 Nos.
d	Suction and discharge valve required for compressors	1 Set.
e	Piston ring/Guide ring	6 Sets

S.No.	Description	Quantity
f	V-belts for compressor	4 Sets
g	Oil pressure failure safety switch	2 Nos.
h	Crank-case heater	2 Nos.
i	Gaskets	2 Sets
j	Set of 'O' rings and oil seals each type	2 Sets
k	Suction filter elements	4 Sets
l	Bearings	2 Sets
m	Complete set of suction Valves	2 Sets
n	Complete set of Discharge Valves	2 Sets
2.	**Screw Compressor Chilling Machine**	
a	Oil filter	1 set
b	Oil filter O ring	1 set
c	Refrigerant filter	1 set
d	Ref filter O ring	1 set
e	EXV valve	1 set
f	Differential pressure switch	1 no.
g	Solenoid valve 2 way	1 no.
h	Solenoid valve coil	1 set
i	Solenoid valve O- ring	1 set
j	Solenoid valve gasket	1 set
k	Master solenoid valve	1 no.
l	Master solenoid valve coil	1 set.
m	Master solenoid gasket	1 set
3.	**Air handling unit (for each model)**	
A	Impeller / Blower with Motor	1 No
B	V-belts for AHU Blower	4 Sets
C	AHU Blower bearing	2 Sets
D	Blower motor bearing	2 Sets
E	Filters at suction and discharge of AHU	50% of installed population
4.	**Controls (for each model)**	
a)	HP/LP cut out	1 No.
b)	Anti-freeze thermostat	2 Nos.
5.	**Cooling Tower** (for each model)	
a)	Nozzles for cooling towers	20 Nos
b)	Float valve assembly	1 No
c)	Fan Bearings	1 Set
d)	Motor bearings	1 Set
e)	V-belt for C.T. fan (if applicable)	1 Set
6	**Valves (For each type & size) for A/C system**	
a.	One (1) No. where total quantity of a particular type & size of valve is less than or equal to 10 (ten)	

S.No.	Description	Quantity
b	Two (2) Nos. where total quantity of a particular type and size of valve is less than 40 but more than 10.	
c	10% of the total quantity (to nearest whole no. of a particular type & size where the total quantity of a particular type & size of valve is more than 40.	
7	Humidity sensors	one (1) no.
8	Geyserstat	Two (2) nos.
9	Antifreeze thermostat	one (1) no.
10	Local Humidity Indicator	Two (02) no.

VENTILATION SYSTEM

S No.	Description	Quantity
1.00.00	Air Washer Units	
1.01.00	Supply Air Fans	
1.01.01	V-belts for Supply air fans	4 Sets
1.01.02	Supply air fan bearings	2 Set
1.02.00	Air Washer pump	
1.02.01	Pump Impeller	1No.
1.02.03	Pump Bearing	2 Set
1.02.04	Shaft Sleeves	4 Nos.
1.02.05	Gland packings for pumps	4 Nos.
1.03.00	Metallic or Fabric (as applicble) Panel filters	1 Set (Quantity of suit one no. of air washer)
1.04.00	Spray nozzles	5% of total population or 100 numbers whichever is higher.
1.05.00	Flooding nozzles if applicable	5 % of total population or 2 numbers whichever is higher.
1.06.00	Air Washer Pump inlet water strainer	1 No.
1.07.00	Brass suction/screen strainer for air water tank	1 Set
2.00.00	**Unitary air filtration unit (For Each Model and Capacity)**	
2.01.00	Supply air fans	
2.01.01	V-belts for supply of fans	2 Sets
2.01.02	Supply of air fan bearings	1 Set
2.02.00	UAF Pump	
2.02.01	Pump Impeller	1 No.
2.02.02	Pump bearings	1 Set
2.02.03	Shaft sleeves	2 Nos.
2.02.04	Gland packings for pumps	2 Sets
2.02.05	Pump Shaft	1 no.
2.03.00	**Nylon Filter**	1 Set
2.04.00	Spray nozzles	5% of total population or 5 numbers whichever is higher.
2.05.00	Water strainer	2 No.
2.06.00	Brass suction screen/strainer for unitary air filteration unit tank	2 Set
2.07.00	Motor for Centrifugal fan for UAF	1 No.

WATER SYSTEM

S. No.	Description	Quantity
1.0	**Vertical Pumps**	
	Impeller	One No each for each type of pump
	Shaft (line shaft & vertical shaft)	One set for each type of pump
	Shaft Sleeves	One No each for each type of pump
	Impeller wearing rings	One No each for each type of pump
	Pump & Motor Bearings	One No each for each type of pump
	Shaft coupling	One set for each type of pump
	Gaskets	One set for each type of pump
	Bushes	One set for each type of pump
	Nuts and bolts	One set for each type of pump
2.0	**Horizontal Pumps**	
	Impeller	One no. each for each type of pump
	Shaft	One no. each for each type of pump
	Shaft Sleeves	One no. each for each type of pump
	Pump & Motor bearing	One no. each for each type of pump
	Packing rings	One no. each for each type of pump
	Oil Seals – one set (two nos.)	One no. each for each type of pump
	Mechanical seal	One no. each for each type of pump
3.0	**Metering Pumps / Dosing pumps**	
	Complete pump-motor set	One no. each for each type of Metering Pump
	Connecting Rod	One no. each for each type of Metering Pump
	Worm and worm wheel	One no. each for each type of Metering Pump
	Pump & Motor bearings	One no. each for each type of Metering Pump
4.0	**Agitator**	
	Agitator assembly with motor and gear box	One no. each for each type of Agitator
5.0	**Clariflocculator Bridge Mechanism**	
	For Flocculator Paddle Drive	
	Oil Seal (1 Set = 2 Nos.)	One set each for each type
	Bearings for gear box unit	One no. each for each type
	Bearings for Motor	One no. each for each type
	For End Carriage Drive	One no. each for each type
	Oil Seal (1 Set = 2 Nos.)	One set each for each type
	Bearings for gear box unit	One no. each for each type
	Bearings for Motor	One no. each for each type
	Chain & Socket for End carriage drive	One no. each for each type
	Bevel gear & Pinion set for flocculator drive	One no. each for each type
	Rubber squeeze for scraper blades	One no. each for each type
	Carbon brush for current collector assembly	One no. each for each type
	Central Bearing Assembly	One no. each for each type
	Telescopic Bleed Arrangement	One no. each for each type
	Gearbox for Flocculator Paddle Drive	1 set

S. No.	Description	Quantity
	Gearbox for End Carriage Drive	1 set
6.0	**Blowers**	
	V Belt	One no. each for each type of blower
	Oil seal	One no. each for each type of blower
	Filter	One no. each for each type of blower
	Bearings (Blower & Motor)	One set each for each type of blower
	Impeller with Shaft & gear unit	One set each for each type of blower
7.0	**Ion exchange resins & Activated Carbon/vessels**	10% of Resin / Activated Carbon supplied
	Strainers	20 Nos of each type
	Resin trap	One no of each type
	Ejector	One No. of each type
	Rasching ring	10% of rasching ring supplied
8.0	**Zero Discharge ETP**	
	RO & UF membrane	10% of total quantity installed (minimum two number)
	Pressure tubes	10% of total quantity installed (minimum two number)
	Assembly & connection components including nuts & bolts	4 sets of that requited for One pressure tube
	RO Cleaning system, cleaning hose with end coupling	1 no.
	RO Cleaning system, complete micron cartridge filter assembly, with filters	1 no.
	Cartridge filters elements for RO	50% of total quantity installed

Chlorine Di-Oxide system.

Blowers		
1.	Impeller with lock nuts and washers	1 set
2.	Air Filters	2 no
3.	Bearings for drive & driven	1 set
4.	Oil Seals	1 set
5.	Gears	1 set
6.	V-belts	1 Set for each drive
Pumps: Unloading/Transfer/N-pit		
1.	Impeller for each type	1 set
2.	Wearing rings – Impeller for each type (if applicable)	1 set
3.	Wearing rings – Casing for each type (if applicable)	1 set
4.	Shaft for each type	1 set
5.	Shaft Sleeves for each type	1 set
6.	Stuffing box for each type	1 set
7.	Coupling between Pump & motor, bushes, pins with all fasteners & coupling Guards	1 set
8.	Pump bearings for each type	1 set
9.	Gland , Packing & Gland Assembly/Mechanical seal assy. for each type	1 set
10.	Diaphragm Pump for acid/alkali injection & dosing	1 complete pump set
11.	Diaphragms for acid/alkali injection & dosing	2 no.

12.	Y Strainers	1no. Minimum of each type
13.	Relief Valves in Air Blowers unit	1no. Minimum of each type
14.	Fume Absorber	1no. Minimum of each type
Valves		
1.	Diaphragm Valves of All types	1 no of each type, size & rating for total population < 10 nos 2 nos of each type, size & rating for total population ≥ 10 nos
2.	Diaphragms	One fourth quantity of total population
3.	NRV (Flap type and Dual Plate Type)	Minimum 1 no. each type, size & rating
4.	Ball Valves of all types	Minimum 2 no. each type, size & rating
5.	Butterfly Valves of all types	Minimum 1 no. each type, size & rating
6.	Any other type valve	Minimum 1 no. each type, size & rating
Agitators		
1.	Agitator assy of each type	1 complete set

ELEVATORS

S.No		**Description**		**Quantity**
(A)		**Goods Elevator**		
1.		Friction block	:	2 nos.
2.		Guide roller of each type	:	20% of total population or 3 nos.of type whichever is higher
3.		Contactors of each type	:	2 nos.
4.		Control transformer	:	1 no. of each type
5.		Time device	:	2 nos. of each type
6.		Rectifiers	:	2 nos. of each type
7.		Overcurrent relay	:	2 nos. of each type
8.		Auxiliary relay	:	3 nos. of each type
9.		Resistor	:	3 nos. of each type
10.		Fuses of each rating	:	20% of the total population
11.		Limit switches of each type	:	3 nos.
12.		Push button	:	3 nos. of each type
13.		Contact device (if applicable)	:	3 nos. of each type
14.		Brake motor	:	2 nos. of each type
15.		Transmitters	:	2 nos. of each type
16.		Switches of each type	:	3 nos.
17.		Receiver	:	2 nos. of each type
18.		Bearings of each type & size	:	2 nos.
19.		Roller of each type	:	3 nos.
20.		Worm gear spares		
	(a)	'O' rings	:	3 sets *
	(b)	Sealing ring of each type	:	3 sets *
21.	Spares for brake			:
	(a)	Fan	:	2 nos. of each type
	(b)	Magnetic coil	:	3 nos. of each type

S.No		Description		Quantity
	(c)	Brake disc	:	2 sets*
	(d)	Brake pad	:	2 sets*
22.		Bushing (for door front)	:	2 sets *
23.		Pinion	:	2 nos. of each type
(B)		**Passenger Elevator**		
1.		Friction block	:	4 nos. of each type
2.		Guide roller of each type of type	:	20% of total poulation or 3 nos whichever is higher
3.		Contactors of each type	:	4 nos.
4.		Control transformer	:	3 nos. of each type
5.		Time device	:	4 nos. of each type
6.		Rectifiers	:	4 nos. of each type
7.		Overcurrent relay	:	4 nos. of each type
8.		Auxiliary relay	:	6 nos. of each type
9.		Resistor (if applicable)	:	6 nos. of each type
10.		Fuses of each rating	:	20% of the total population
11.		Limit switches of each type	:	6 nos.
12.		Push button	:	6 nos. of each type
13.		Contact device (if applicable)	:	6 nos. of each type
14.		Brake motor	:	3 nos. of each type
15.		Transmitters	:	3 nos. of each type
16.		Switches of each type	:	6 nos.
17.		Receiver	:	3 nos. of each type
18.		Bearings of each type & size	:	4 nos.
19.		Roller of each type	:	6 nos.
20.		Worm gear spares of each type		
	(a)	'O' rings	:	4 sets *
	(b)	Sealing ring of each type	:	4 sets *
21.		Spares for brake for each type		
	(a)	Fan	:	3 nos.
	(b)	Magnetic coil	:	6 nos.
	(c)	Brake disc	:	3 sets *
	(d)	Brake pad	:	3 sets *
22.		Bushing (for door front)	:	4 sets of each type*
23.		Pinion	:	4 nos. of each type *
(C)		**Chimney Elevator**		
1.		**BRAKE ASSEMBLY**		
	(a)	Brake Assembly complete		01 nos
2.		**GEAR ASSEMBLY**		
	(a)	Gear Assembly complete		01 nos
3		**DOOR FRONT**		
	(a)	Bearing 3 Nos.		03 nos
	(b)	Roller		03 nos
	(c)	Bushing (if applicable)		02 nos
4.		**LIMIT CAMS**		
	(a)	Sensor		03 nos
	(b)	Switch arm		03 nos
5.		**CAB**		
	(a)	Guide roller		100% of the total ones installed each type or min. 1no. whichever is higher
	(b)	Switch		03
	(c)	SLIDING DOOR		
	(d)	Rollers (if applicable)		4 Nos. each type

S.No		Description		Quantity
	(e)	MACHINERY		
	(f)	Guide roller		02 nos
	(g)	Pinion		02 nos
	(h)	Rubber inserts (if applicable)		12 nos
	(i)	Groove ring (if applicable)		06 nos
	(j)	Brake motor		01 nos
	**	**One set means one complete replacement for a unit**		
	*	**One set means one complete replacement for an equipment**		

FUEL OIL HANDLING SYSTEM

	ITEM	QUANTITY
1.1	Strainer elements	
	a. Drain Pumps	1 no.
	b. LDO unloading pumps	1 no.
1.2	Relief valve complete assembly	
	a. LDO unloading pumps	1 no.
1.3	Bearings of	
	a. LDO unloading pumps	1 set
	b. Drain Pumps	1 set
1.4	Rotor Assembly (Complete cartridge assembly)	
	a. LDO unloading pumps	1 no.
	c. Drain Pumps	1 no.
1.5	Coupling Bolts with nuts, washer and bushed for LDO unloading pumps	1 set for each size of coupling
1.6	Wearing Rings	1 set for each type of pump
1.7	Gland Packing (if applicable)	1 set for each type of pump
1.8	Mechanical seal Assembly (if applicable)	2 sets each for LDO
1.9	Shaft Sleeve	1 set for each type of pump
1.10	Neoprene rubber unloading hoses with end connections (complete hose)	Ten (10) Nos.
1.11	Valves (Each type and size)	a) 1 number, where the total quantity of a particular type and size of valve is less than or equal to 10.
		b) 2 numbers, where the total quantity of a particular type and size of valve is less than 40 but more than 10.
		c) 10% of total quantity (to nearest whole number) of a particular type and size of valve, where the total quantity of a particular type and size of valveis more than 40
1.12	Dirty Oil Pump complete assembly with motor	01 set
	Note : One (1) set means total numbers as required for one complete replacement for one equipment.	

ASH HANDLING SYSTEM

1.	**Bottom Ash Hopper**:			
	a)	Inspection window assembly	:	3 Nos.
	b)	Flushing header nozzles	:	10 nos
	c)	Gaskets for hydraulic operating cylinder	:	4 sets
2.	**Clinker Grinder**			
	a)	Rolls with shaft (drive/driven)	:	3 sets
	b)	Lantern rings for clinker grinder	:	16 Nos.
	c)	Bearing for grinder motor clinker grinder gear box and clinker grinder	:	2 Nos. each type
	d)	Fluid coupling assembly	:	2 Nos.
	e)	Chain (complete length for clinker grinder	:	4 Nos.
	f)	Sprocket (Drive/Driven) each set consist of 1 No. drive and 1 No. driven	:	4 sets
	g)	Gear box for grinder drive	:	2 Nos.
	h)	Shaft Sleeves	:	16 nos.
3.	**Jet Pumps (for each size and type)**:			
	a)	Complete assembly	:	3 Nos.
	b)	Nozzle tips with ceramic liners	:	9 Nos.
	c)	Tail piece	:	3 Nos.
	d)	Gaskets/0-seals(one set consist of all sizes): used in jet pump		6 sets
4.	**Alloy CI fittings** (i.e. pipe bends, elbows, laterals): for bottom ash system			5 of each size & type
	Sleeve couplings (complete set) for BA system		:	20 Nos.
	Gaskets for sleeve couplings for BA system		:	30 Nos.
5.	a)	Pipe line fittings (90 degree bends, 45 degree, 22.5 degree bends/laterals elbows as applicable) for fly ash system	:	5% per size but not less than 5 per size and type
	b)	Plain end pipes for fly ash system	:	10% of each size
	c)	Sleeve couplings of assorted	:	20 Nos. of each size

		size and type for fly ash system		
	d)	Coupling gaskets of assorted size and type for replacement for FA system	:	20 sets of each size
6.	**Ash Extraction Valves**:			
	a)	Complete assembly with solenoids etc	:	15 Nos.
	b)	Valve flaps/slides	:	15 Nos.
7.	**Branch Air Intake Valves**:			
	a)	Complete assembly	:	4 Nos.
	b)	Spring for air intake valve	:	8 Nos.
	c)	Seat & disc	:	4 Nos. each
8.	**Branch Isolating Valves**:			
	a)	Complete assembly	:	8 Nos.
	b)	Disc and Seat	:	20 Nos. each
9.	Vacuum breakers (complete set)		:	3 Nos.
10.	**Mechanical Exhauster**			
	a)	Mechanical Exhauster (excluding motor, pulleys & belts)	:	2 Nos.
	b)	Pulleys & belts (as required)	:	3 sets each (each consists of all sizes of pulleys and belts)
11.	**Fluidizing System**			
	Air slides for silos		:	40 Nos.
	Fluidizing Pads for ESP hoppers		:	40 Nos.
12.	**Knife gate valves**			
	a.	Slide plate	:	5 No. per size
	b.	Body	:	3 No. per size
	c.	Complete Assembly	:	2 nos. per size
13.	**Ash inlet valves**			
	a.	Cone/Dome/ Flap/Disc	:	4 Nos.
	b.	Gasket	:	12 Nos.
	c.	Body	:	2 Nos.
	d.	Cylinder	:	4 Nos.

	e.	Assembly	:	4 Nos.
14.	**Air Drying Plant**			
	a.	Pre Filter Element	:	2 Sets
	b.	After Filer Element	:	2 Sets
	c.	Solenoid valve	:	2 Nos.
	d.	Heating Element	:	3 Sets
	e.	Thermostat	:	2 Nos.
15.	**Air Blowers** (for each type)			
	a.	Lobes with shaft	:	1 Set
	b.	Body	:	1 No.
	c.	Filter	:	2 Sets
	d.	Gears	:	2 Sets
	e.	Set of V Belts	:	2 Sets
16.	**Rotary Feeders**			
	a.	Body	:	2 Nos.
	b.	Rotor	:	2 Nos.
	c.	Shaft	:	2 Nos.
17.	**Dust Conditioners**			
	a.	Nozzle	:	2 Sets
	b.	Blades	:	2 Sets
	c.	Blade liner	:	2 Sets
	d.	Shaft	:	2 Sets
	e.	Plume block	:	2 Sets
	f.	Flexible coupling	:	2 Sets
	g.	Gear box	:	1 No.
18.	**Bag/Vent Filters** (for each size and type)			
	a.	Bags	:	20 of total population.
	b.	Cages	:	20 of total population
	c.	Ventilator	:	1 Set
	d.	Timer Card	:	1 No.
	e.	Solenoid Valves	:	4 Nos.
	f.	Venturi	:	10 of total population
19.	**Bearings**			
	a.	Conveying air compressor	:	3 Sets.
	b.	Conveying air compressor motor	:	3 Sets.
	c.	Fluidizing blower	:	1 Set of each type
	d.	Fluidizing air blower motor	:	1 Set of each type
	e.	Water pumps	:	1 Set of each type
	f.	Water pump motors	:	1 Set of each type
	g.	Instrument air compressor	:	2 sets
	h.	Instrument air compressor motor	:	2 sets

	e.	Mechanical Exhauster	:	2 Nos.
	f.	Mechanical Exhauster Motor	:	2 Nos.
20.	**Water Pumps** (for each type of pump)			
	a.	Impeller along with wearing rings	:	1 set
	b.	Shaft	:	1 Set
	c.	Shaft sleeves	:	2 Sets
	d	Gland along with packing	:	2 Sets
	e.	Flexible coupling bushings and lock nuts	:	2 Sets
21.	**Wetting Head**			
	a.	Complete assembly	:	1 No.
	b.	Nozzles	:	1 Set (required for one Wetting Head)
22.	**Air washer**			
	a.	Fog Jet Nozzle Assembly	:	1 Set (required for one Air washer)
	b.	Nozzles	:	1 Set (required for one Air washer)
23.	**Collector tank**			
	a.	Tail Pipe	:	6 Nos
	b.	Wear Plates	:	1 Set (required for one collector tank)
23.	**Ash Disposal Pumps**			
	a.	Impeller		4 Nos.
	b.	Wear liners (each set of one suction and one discharge liner)	:	8 Sets
	c.	Casing (inner & outer)	:	4 Nos.
		Pump bearings	:	4 Sets (each set consist of all bearings)
		Motor bearings	:	4 Sets (each set consist of all bearings)
		Shaft sleeves	:	4 Sets
		Water seal rings	:	4 Sets
		Suction sleeves	:	4 Sets
		'V' belts	:	8 Sets
24.	Telescopic chute			
	Motor		:	1 no.
25.	Bearings of each type and size for following motors and pumps			
	➢	Vacuum pumps		8 sets
	➢	Vacuum pump Motor		4 sets
	➢	Ash disposal pump		3 sets
	➢	Ash disposal pump motor		3 sets
	➢	Coarse Ash pump		2 sets
	➢	Coarse Ash pump motor		2 sets

EOT CRANES & HOISTS (FOR EACH TYPE & CAPACITY)

S No.	Description	Quantity
	EOT Crane	
1.	Carbon brushes for each Motor	3 Sets
2.	Brush holders for each Motor	1 Set
3.	Bearing for Each Motor	1 Set
4.	One set of bearings for each reduction gear unit	1 Set
5.	Bearings each for across travel & long travel wheels	1 Set
6.	Linings for each of the brake shoes complete with rivets	2 Sets
7.	Contactors of each type & rating	2 Nos . each
8.	Timers of each type	2 Nos. each
9.	Limit switches & switches of each type	1 Set each
10.	Sockets of each type	1 Set each
11.	Double roller collectors	3 Sets
12.	Porcelain insulators of each type	2 Sets each
13.	Contacts for Master Controllers	2 Sets
14.	Brake springs for main &auxillary hoist brakes	3 Sets
15.	Coils for all Contactors	1 Set each
16	**Hoists**	
a	All Bearings	1 set of each type / rating
b	Brake assembly and its liners	1 set of each type / rating
c	Wire rope	1 complete length
d	Limit switch	2 nos of each type & rating

FLUE GAS DESULPHURIZATION SYSYTEM

S. No	Description	Unit	Quantity	Remarks
1.	Flue Gas System			
A.	Dampers & Gates			
a)	Seals	Set	1 set of each type.	Set means that required of single damper of each type.
b)	Actuators	Set	1 set of each type.	Set means that required of single damper of each type.
C.	Flue Gas Duct Liner			
a)	Raw gas Duct liner	%	10 % of total population	% of that required for one unit.
b)	Clean Gas duct liner	%	10 % of total population	
2.	Lime Stone grinding & slurry preparation system			
A.	Lime stone Silos			
a)	Poking hole assembly	Set.	1	Set means that

S. No	Description	Unit	Quantity	Remarks
b)	Mechanical rapper assembly	set	1	required for one limestone silo.
c)	Silos lining	Set	1	
B.	Feeders			
i)	Belt	Set	1	Set means that required for one limestone Feeder.
ii)	Belt drive reducer	Set	1	
iii)	Speed Reducer Assembly	Set	1	
iv)	Weighing Instruments	Set	1	
v)	Feeder weighing roll	Set	1	
vi)	Gravimetric feeder gate actuator assembly	Set	1	
vii)	Counter assembly of feeder complete	Set	1	
viii)	Feeder head pulley assembly	Set	1	
ix)	Inlet Span Roller assembly	No.	2	
C.	Lime stone Mills			
i)	Mill Wear Parts(Liners) & Grinding element	set	1	Set means that required for single mill
ii)	Auxiliary Motor (if applicable)	Set	1	Set means that required for single mill
iii)	Gear box internals (including Bearings and Seals	Set	2	Set means that required for single mill
iv)	Complete Gear Box	Set	1	Set means that required for single mill
v)	Mill motor Bearings	Set	1	
d)	Lube Oil system			
i)	Pressure regulator	set	1	Set means that required for single mill
ii)	Filters	set	2	
iii)	Pump & Motor coupling	set	2	
D.	Mill Recycle Pumps			
i)	Complete Impeller Assembly	Set	2	Set means that required for single pump
ii)	Casing Liners	Set	2	
iii)	Bearing	Set	2	
iv)	Pump suction & discharge valve assembly	Set	2	
v)	Seals	Set	2	
vi)	Coupling	Set	2	
E.	Mill Hydro cyclone			
i)	Hydro-cyclone Isolation	set	1 set of each	Set means that

S. No	Description	Unit	Quantity	Remarks
	Valve		type	required for single hydro cyclone.
ii)	Hydro-Cyclone	set.	1	
iii)	Hydro-Cyclone (rubber/polyurethane)lining	Set	1	
F.	Agitators for Mill recycle tank & Lime stone slurry tanks			
i)	Impeller Assembly	set	1 set of each type	Set means that required for single agitator of each type
ii)	Bearing Assembly	set	2 set of each type	
iii)	Gear Box Assembly (If Applicable)	set	1 set of each type	
G.	Lime stone slurry Pumps			
i)	Complete Impeller Assembly	Set	2	Set means that required for single pump
ii)	Casing Liners	Set	2	
iii)	Bearing	Set	2	
iv)	Pump suction & discharge valve assembly	Set	2	
v)	Seals	Set	2	
vi)	Coupling	Set	2	
H.	Limestone Slurry bends	Set	2	Set means that required for complete one set bends of one unit.
3.	Absorber System			
A.	Absorber			
i)	Liner material	%	15% of total population of each material and thickens of each Absorber	% means total requirement of three units.
ii)	Absorber spray/ Oxidation nozzle	%	30 % of each type	
iii)	Absorber mist eliminator washing nozzle	%	30% of each type	
iv)	Absorber Mist Eliminator	%	15 % of each type	
B.	Absorber Recirculation Pumps			

S. No	Description	Unit	Quantity	Remarks
i)	Complete Impeller Assembly	Set	1 set of each type	Set means that required for one pump
ii)	Casing Liners	Set	3 set of each type	Set means that required for one pump
iii)	Bearing	Set	3 set of each type	
iv)	Motor	Set	1 set of each type	Set means that required for one pump
v)	Pump suction & discharge valve assembly	set	1 set of each type	Set means that required for one pump of each type. Refer(i) above
vi)	Coupling	Set	1 set of each type	Set means that required for one pump
vii)	Seals	Set	1 set of each type	
C.	Oxidation Air Compressor/Blowers			
i)	Impeller assembly	set	2	Set means that required for one blower /compressor.
ii)	Bearings	Set	2	
D.	Mist Eliminator wash pumps			
i)	Complete Pump Assembly	set	1	Set means that required for one pump
ii)	Complete Impeller Assembly	Set	1	
iii)	Casing Liners	Set	1	
iv)	Bearing	Set	1	
v)	Pump suction & discharge valve assembly	Set	1	
vi)	Seals	Set	1	
vii)	Couplings	Set	1	
E.	Reclaim Water Pumps			
i)	Complete Pump Assembly	Set	1	Set means that required for one pump
ii)	Complete Impeller Assembly	No.	1	
iii)	Casing Liners	Set	1	
iv)	Bearing	Set	1	
v)	Pump suction & discharge valve assembly	Set	1	
vi)	Coupling	Set	1	
vii)	Seals	Set	1	

S. No	Description	Unit	Quantity	Remarks
F.	Emergency Absorbent pumps			
i)	Complete Impeller Assembly	Set.	1	Set means that required for one pump
ii)	Casing Liners	Set	1	
iii)	Bearing	Set	1	
iv)	Pump suction & discharge valve assembly	Set	1	
v)	Coupling	Set	1	
vi)	Seals	Set	1	
G.	Agitators for absorber retention tank, reclaim water tank, emergency absorbent tank, absorber sump			
i)	Impeller Assembly	Set	1 set of each type	Set means that required for one agitator of each type.
ii)	Bearing Assembly	Set	1 set of each type	
iii)	Gear Box Assembly (IfApplicable)	Set	1 set of each type	
H	Slurry Piping	%	5	% of that required for single unit.
4.	Gypsum Dewatering System			
A.	Gypsum Bleed Pumps			
i)	Complete Pump Assembly	Set	2	Set means that required for one pump
ii)	Complete Impeller Assembly	Set	2	
iii)	Casing Liners	Set	2	
iv)	Bearing	Set	2	
v)	Pump suction & discharge valve assembly	set	2	
vi)	Coupling	set	2	
vii)	Seals	set	2	
B.	Gypsum Primary & secondary waste water hydro cyclone			
i)	Hydro-cyclone Isolation Valve	Set	One set of each type	Set means that required for single hydro cyclone of each type.
ii)	Hydro-Cyclone	Set	1	
iii)	Hydro-Cyclone rubber lining	Set	1	
C.	Gypsum Cake wash water Pumps			
i)	Complete Impeller Assembly	Set	1	Set means that required for one pump
ii)	Casing Liners	Set	1	
iii)	Bearing	Set	1	
viii)	Pump suction & discharge valve assembly	Set	1 set of each type	
ix)	Coupling	Set	1	
x)	Seals	Set	1	
D.	Gypsum secondary hydro cyclone feed Pumps			
i)	Complete Impeller Assembly	Set	1	Set means that required for one
ii)		Set	1	

S. No	Description	Unit	Quantity	Remarks
	Casing Liners			pump
iii)	Bearing	Set	1	
iv)	Pump suction & discharge valve assembly	Set	1 set of each type	
v)	Coupling	Set	1	
vi)	Seals	Set	1	
E.	Vacuum Belt Filter			
i)	Filter Cloth	Set	2	Set means that required for one filter.
ii)	Belt (ifapplicable)	Set	1	
iii)	Vacuum Box Seals	Set	2	
F.	Vacuum Pumps			
i)	Pump Impeller Assembly	Set	1	Set means that required for one pump.
ii)	Pump Bearing	Set	1	
iii)	Seals	Set	1	
G.	Vacuum Breaker Valves			
i)	Valve Assembly	Set	1	Set means that required for one valve
ii)	Actuator	Set	1	
H.	Waste water Pumps			
i)	Complete Impeller Assembly	set	1	Set means that required for one pump.
ii)	Casing Liners	set	1	
iii)	Bearing	set	1	
iv)	Suction & Discharge valve	set	1	
	Coupling	Set	1	
v)	Seals	Set	1	
5.	Process water system			
A.	Process water Pumps			
i)	Complete Pump Assembly	Set.	1	All these spares shall be supplied separately for each type of pump listed in Volume III, Chapter 12. Set means that required for one pump.
ii)	Complete Impeller Assembly	Set	1	
iii)	Casing Liners	Set	1	
iv)	Bearing	Set	1	
v)	Pump discharge valve assembly	set	1	
vi)	Coupling	Set	1	
vii)	Seals	Set	1	
6	Sump pumps			
i)	Complete Impeller Assembly	set	1 set of each type	Set means that required for one pump of each type.
ii)	Casing Liners	set	One set for each type	
iii)	Bearing	Set	One set for each type	
iv)	Pump suction & discharge valve assembly	set	One set for each type	

S. No.	Description	QTY	Unit
I	**LIMESTONE & GYPSUM HANDLING SYSTEM**		
			Drawing/ Catalog
a)	**Surface Feeder/ Box Feeder/ Truck Unloading System**		required for
			identifying parts
	i) Head shaft	one	no
	ii) Tail shaft	one	no
	iii) Chain	one length	no
	Iv) Flight Bars	one	Set
	v) Keeper Plates	one	Set
	vi Side Liners	one	set
	vii Gearbox	one	No each type
	viii Coupling	one	No each type
	viii Bearings	one	No each type
	ix Oil seals	one	No each type
b)	**IDLERS**		
1	i) 35° Troughing idlers complete with base frame and mounting brackets etc.	2.5%	of population of each type
	ii) Rolls for (i) above	1%	of population of each type
2	i) Troughing idlers complete with base frame & mounting brackets Etc.(for belt feeder).	30%	of population of each type
	ii) Rolls for (i) above	30%	of population of each type
3	i) 35^0 impact idlers complete with mounting brackets and base frame etc.	25%	of population of each type
	ii) Rolls for (i) above	25 %	of population of each type
4	35^0 troughing training idler complete with base frame and brackets etc. (if used)	10%	of population of each type
5	Transition idler complete as in (1) above	10 %	of population of each type
6	Flat return idlers complete with mounting brackets etc.	2%	of population ofeach type
7	Flat return idlers complete with mounting brackets etc.(for belt feeders)	30 %	of population of each type
8	Flat return trainer complete with mounting brackets etc.	10 %	of population of each type

9		Belt cleaning spiral rubber discreturn idler complete with mounting brackets etc.	20 %	of population ofeach type
10	i)	Two roll 10° troughing return idler assy	2%	of population of each type
	ii)	Rolls for (I) above	2%	of population of each type
11		SS idlers	25 %	of population ofeach type
12		Any other type of idlers	10 %	of population of each type
13		Guide Rollers for bucket elevator	30 %	of population of each type
c)		**CONVEYOR GEAR BOXES**		
	i)	Input shafts with pinion	1	set of each type and rating
	ii)	Oil seals	1	sets of each type and rating
	iii)	Bearings	1	set of each type andrating
	iv)	Hold back device	1	nos. of each type and rating
	v)	Cooling fan with cover	2	nos.of each type and rating
	vi)	Complete gear box assy with hold back device	1	set of each type and rating for population upto 10 nos.
			2	set of each type and rating for population more than 10 nos.
d)		**CONVEYOR DRIVE AND CONVEYOR BELT**		
1		**Gear Coupling**		
	i)	All type of drive couplings including gear Coupling	1	nos. of each type
	ii)	Bolts for gear coupling	1	sets of each size
	iii)	Seal kit for gear coupling (o-ring)	1	sets of each type
2		**Fluid Coupling**		
	i)	Fluid Coupling complete	1	no. of each type andsize
	ii)	Multi Disc assembly (for fluidcoupling)	2	nos each type andsize
	iii)	Resilient Drive plate assy.	1	no. of each type andsize
	iv)	Bearings	1	no. of each type

	v) Seal kit for fluid coupling	1 sets of each size sets of each size	andsize
	vi) Fusible plug	5	nos. of each size
	vii) Complete actuator and engaging assembly (including motor, gear box etc.) viii) Oil Cooler assembly (if applicable)	1 1	set of each type set of each type
	ix) Oil pump-motor set (if applicable)	1	set of each type
	x) Oil filters	3	sets of each type
	xi) Oil/Cooler valves (if applicable)	1	nos. of each type
3	**Belting**		
	Conveyor Belt		
4	i) Main Conveyors ii) Belt feeder iii) Bucket elevator **Brakes**	1 1 on e on e	drum length of 250 m of each type, sizeand rating if total population of particular type, size and rating of conveyor is equal toor more than 2500 m drum length of 250 m of each type, sizeand rating if total population of particular type, size and rating of conveyor is less than 2500 m complete length of each type complete length of each type
	i) Brakes	1	no of each size & type
	ii) Brake shoes	1	sets of each size
e)	**PULLEYS**		
	i) Pulleys complete with shaft excluding bearing & plummer blocks (complete with lagging)	1	no. of each type and size in pulley drum and shaft dia.(for population upto 10 Nos)
		2	no. of each type and size in pulley drum and shaft dia.(for population

				more than 10 Nos)
	ii)	Plummer Block complete with	1	no. each type and
		bearings & sleeves		size
	iii)	SS Pulleys complete with shaft	1	no. of each type and
		excluding bearing & plummer		size in pulley drum
		blocks (complete with lagging)		and shaft dia.
f)	**BELT CLEANERS AND SKIRT BOARD**			
	i)	Modular segments for belt cleaner	5	%of total population of each type & size
	ii)	Modular segments skirt rubber for skirt board	5	%of total population of each type & size
	iiI)	Skirt Rubber	5	%of total population of each type & size
	iv)	Complete belt cleaner (internal / external)	2	%of total population of each type & size
g)	**IN-LINE MAGNETIC SEPARATORS**			
	i)	Cleated conveyor belt	1	set
	ii)	Motor, gear box drive assy. complete	1	set
	iii)	Pulleys with plummer block & bearings	1	set of each size & type
	iv)	Sheaves	1	no. of each size & type
	v)	V-belts	1	no. of each size & type
h)	**LIME SAMPLER**			
	i.	Plummer block	1	no. of each type and size
	ii.	Hammers	1	set of each type and size
	iii.	Liner plate	1	set
	iv.	Cutter lip	1	no.
	v.	Cutter seal	1	no.
	vi)	V-belts (for crusher)	1	sets
	vii)	Hammer pins	1	sets of each typeand size
	viii)	Pulley	1	no. of each type andsize
	ix)	Conveyor belt	1.2	times length of eachtype and rating
	x)	Gear box assembly for conveyor and	1	no. of each type rating
	xi)	Gear box drive assy, for primary type andand secondary samplers	1	set of each rating
	xii)	Hydraulic pump with motor and	1	set of each

		typecoupling		
	xiii)	Hydraulic motor	1	set of each type
	xiv)	Hydraulic cylinder	1	set of each type
	xv)	Cylinder sealing kit	1	set of each type
	xvi)	Set of hoses	1	set of each type
	xvii)	Coupling with grid for primary setssampler	1	
	xviii)	Screw conveyor gear box	1	setassembly
i)		**LIME CRUSHER (If applicable)**		
	i)	Plummer Block assembly nut, lock washer etc.(DE+NDE)	1	Setcomplete inclu
	ii)	Shaft seal	1	sets
	iii)	Hammer sets sets(consisting of hammer arm, hammer head, bush for arm etc)	2	
	iv)	Rotor assembly complete End discs, Centre discs, distance rings, suspension bars, disc clamping nuts and shaft extensionetc. but without hammers, bearings and pillow blocks	1	setconsisting of rc
	v)	Cage bars/Perforated screen setsplates as applicable	1	
	vi)	Breaker plate	1	sets
	vii)	Liners	1	sets
	viii)	Suspension bars	1	set
	ix)	Kick-off plate	1	set
	x)	Screen plate upper & lower	1	no. each

	xi)	Tramp iron pick up plate	1	no. each
	xii)	Fluid coupling		
	xiii)	Fluid coupling complete	1	set
	xiv)	Bearings	1	sets
	xv)	Seal kit	1	sets
	xvi)	Fusible plugs	2	nos.
	xvii)	Oil pump motor set	1	set of each type
	xviii)	Oil filter	2	sets
	xix)	Complete actuator and engaging (including motor, gear box etc.)	1	setassembly
	xx)	Cooler assembly	1	no.
	xxi)	Oil / Water valves	1	nos. of each type
	xxii)	Gear Coupling/ other flexible crusher drive along with bolts and sealing kit, asapplicable	1	setscoupling of
	xxiii)	Multi Disc assembly (for fluid coupling)	1	sets. of each typ and rating
	xxiv)	Resilient Drive plate assy	1	sets. of each typ and rating
j)		**VIBRATING FEEDER AND VIBRATING SCREEN FEEDER**		MS to be provided for VF and VSF seperately
	i)	Bearings	1	no. of each type size
	ii)	Seals	1	no. of each size
	iii)	Liners	1	sets.
	iv)	Screen plates	5	sets
	v)	Complete vibrating assembly andconsisting of all rotating parts direction including drive & driven unbalanced shafts including bearings,casing,spring,vibrating blocks,main shaft,sheave & unbalanced weights as applicable	1	set of each type rating and
	vi)	Hoses (if applicable)	1	set
	vii)	Drive unit assembly (including hydraulic pump, hydraulic motor, , flexible shaft,gear box, as applicable)	1	setelectric motor
	viii)	Base springs, rubber pads &	1	sets. of each typ size
	ix)	V belts	2	sets. of each typ &size

AIR COMPRESSORS

a)	**Oil free Screw Air Compressor**	
(i)	Complete HP Stage with HP element.	1 No.
(ii)	Complete LP stage with LP element	1 No.
(iii)	Motor Bearings	2 Sets
(iv)	LP stage Pinion	1 No.
(v)	HP stage Pinion	1 No.
(vi)	Air Oil Filter Kit	4 Nos.
(vii)	After cooler Safety Valve (if applicable)	1 No.
(viii)	Inter Cooler Safety Valve (if applicable)	1 No.
(ix)	Oil Pump kit	2 Nos.
(x)	After cooler drain valve kit (if applicable)	1 No.
(xi)	Inter cooler drain valve kit (if applicable)	1 No.
(xii)	Air receiver drain/moisture trap	1 No.
(xiii)	'O' Rings for oil cooler	8 Nos.
(xiv)	Moisture separators for Aftercooler (if applicable)	2 Nos.
(xv)	Moisture separators for Intercooler (if applicable)	2 Nos.

ELECTRICAL PACKAGES

GENERATOR & AUXILIARIES

S. No.	Description	Quantity
1.01.00	**Generator & Auxiliaries**	
1.01.01	Gaskets of all type (one set should include all types and sizes of gaskets for one generator, hydrogen seals for TG and EE hydrogen coolers)	1 set
1.01.02	(a) Insulating packer below slot wedges	50% of slot nos.
	(b) Ripple springs	50%
	(c) Insulating material below the retaining rings	
	(i) Liners	1 set
	(ii) civil spacers	1 set
1.01.03	Generator bearings for TE and EE (complete with torous, intermediate pieces and all other fixing/assembly material required to complete one TG unit except housing)	1set
1.01.04	Oil guard rings spare for TE and EE bearings	1 set
1.01.05	Brush holder of each type (one set should include all types and sizes of brush holder for one generator excitor) (details of quantity) (for static excitation only)	1 set
1.01.06	Carbon brush (details of quantity) (for static excitation only)	2 set
1.01.07	Slip ring with brush	1 no.
1.01.08	Stator winding bars and connections (one set comprising of two bars of each variant)	1set
1.01.09	Slot wedges	100% for one unit
1.01.10	Hydrogen seals rings TE, EE	2 sets each for phase and neutral side
1.01.11	Set of Teflon Hoses with connectors (for stator water cooling system)	Half (1/2) the no. of slots of one generator
1.01.12	One pair of retaining rings (unmachined)	1 pair set
1.01.13	Static Excitation system (if applicable)	
	a) Static rectifier element with heat sink and fuse assembly system requirement	100% of complete one unit.
	b) Relays	1 no. each type
	c) Electronic control card	1 no. of each type
	d) Excitation Transformer	1 no.
	e) Shunt trip and closing coil for field circuit breaker	Two sets
	f) Initial excitation diode	Two Sets
	g) Cooling Fan	one Set

S. No.	Description	Quantity
	h) Thyristor assembly with semiconductor fuses	100% for one channel.
	i) DC field breaker	1 no.
	j) Field flashing breaker	.1 no
	k) Rotating Diode assembly with heat sinks, RC network and Fuses	25% of Unit.
	l) Over voltage suppressor (Thyristor based)	1 set
	h) Control transformer of each type/rating	1set
1.01.14	Brushless Excitation system (if applicable)	
	a) Relays	1 no. each type
	b) Electronic control card	1 no. of each type
	c) Control transformer of each type/rating	1set
	d) Diode with fuses	25% of one unit
	e) Thyristor assembly with semiconductor fuses	100% for one channel.
	f) DC field breaker	1 no.
	g) Field flashing breaker	.1 no
	h) Rotating Diode assembly with heat sinks, RC network and Fuses	25% of Unit.
	i) Over voltage suppressor (Thyristor based)	1 set
1.01.15	Complete HMI for DVR	01 no.
1.01.16	Software & Programmes / programmed EPROMs with necessary hardware/software keys for multiple use.	
1.02.00	**Gas System**	
	a) Diaphragm valve	1 no. of each type.
	b) Gas valves of all type & sizes (other than item no. C)	1 no. of each type & size
	c) Valves for H_2& CO_2 manifolds	2 nos.
	d) Safety valve	2 nos.
	e) H_2 gas regulator from cylinder to manifold	3 nos.
	f) CO_2 gas regulator from cylinder to manifold	1 nos.
	g) Temperature, Pressure and temperature pressure switch	1 no. of each type

S. No.	Description	Quantity
	h) Bearings & seals for fan and gas drier	1 set
	i) Thermostat for gas drier	1 no.
	j) Dessicant for gas drier	1 complete fill
	k) Thermometers	1 no. of each type and range
	l) Filter for gas analyser	2 set
1.03.00	**Seal Oil System**	
	a) Complete motor and Pump assembly for AC seal oil pump	1 no. of each type
	b) Motor pump set for DC seal oil pump	1 set
	c) Pump and motor bearings	1 set
	d) Screw pump (bearings rotating elements)	1 set
	e) Vacuum pump spares (1 set bearing rotor with shaft, gas ballets valve gaskets. 'O' rings, felt filters, other filter elements)	1 set (if applicable)
	f) Differential pressure regulator	1 no.
	g) Non-return shut off valves	1 no. of each type
	h) Float valve	1 no. of each type
	i) Non-return valve	1 no. of each type
	j) Filter elements	2 nos.
	k) Vacuum pressure gauge	2 nos.
	l) Differential pressure	1 no.
	m) Bellow for differential pressure regulator	2 set
	n) Vacuum valves of all sizes and types	1 no. each
1.04.00	**Seal Oil Pressure Measuring Equipment**	
	a) Amplifier circuit board	1 no.
	b) Calibration circuit board	1 no.
	c) Sensor module	1 no.
	d) 'O' rings	1 no.
	e) Isolating cocks of different type (Details to be given)	1 set
	f) Pressure transmitter	1 no.
	g) Limit valve monitor	1 no.
1.05.00	**Stator Water Cooling System**	
	a) Pump	1no.
	b) Motor	1 no.
	c) Float for level regulator	1 nos.
	d) Filter elements	2 sets
	e) S.S. 3 way cock	1 no.
	f) All type of valves in stator water cooling system(details to be given)	1 set/ 1 no. of each size & type
	g) Ferro-dynamic indicator	1 set
	h) Level signaling device	1 set
	i) Specific resistance measuring	1 set
	j) Insulators for stator water header	1 set

S. No.	Description	Quantity
	k) Pressure gauge (details to be given)	1 set /1 no. of each type and size
1.06.00	**Local panels for T.G**	
	a) Indicating instruments type	1 no. each size
	b) Pressure and temperature switches	20% of the total population or minimum 2 nos.
	c) Indicating lamps	100% of the population

GENERATOR TRANSFORMER

MANDATORY SPARES FOR EACH TYPE & RATING OF TRANSFORMERS

S. NO.	ITEM	QUANTITY
1.	HV Bushing with metal parts and gaskets	3
2.	LV bushing with metal parts and gaskets	3
3.	HV Neutral bushing with metal parts and gaskets	3
4.	WTI with contacts	1
5.	OTI with contacts	1
6.	Pressure relief device	1
7.	MOG	1
8.	Buchholz relay complete	1
9.	Set of gaskets	1 set
10.	Set of valves	1 set
11.	Cooler fan with motor	2
12.	Oil pump with motor	2
13.	Air cell for conservator	1
14.	Set of Tap changer contacts	1 set
15.	Sudden Pressure relay	1
16.	Set of Tap changer contacts	1 set
17.	Oil pump with motor	1 set
18.	Oil flow indicator	1 set
19.	Oil surge relay	1 set
20.	Breather with silica gel	1 set
21	RTD for WTI and OTI	1 no. each

Note : 1 set consists of quantities required for 1 complete transformer

MANDATORY MAINTENANCE AND TESTING EQUIPMENT

1.	High vacuum type oil purifying equipment of 6000 litres/hr. capacity	1 No.
	a) Type	Weather proof mobile and outdoor type high vacuum oil filtration plant.
	b) Capacity	6000 litres/hr.
	c)Processing temperature (direct heating of oil prohibited)	60^{o}C (max.)
	d)Capability of plant on a single pass basis	
	i) Removal of moisture	From 100 ppm to 3 ppm

	ii) Removal of dissolved gas content	From 10% by vol. to 0.1% by Vol.
	iii) Improvement of dielectric strength	From 20 kV to 70 kV
	e) Filtration pore diameter	0.5 microns or less
	f) Vacuum pumping system	Two independent vacuum pumping combination, one for degassing chamber and other for transformer oil evacuation and creating high vacuum in tank. The blank off vacuum of each pumping system shall be 10^{-3}torr or less.
	g) Operating voltage	440/400 Volt, 50 Hz, 3 phase, 4 wire supply.

GENERATOR BUS DUCT AND NEUTRAL GROUNDING EQUIPMENT

Generator bus duct

1. BUS SUPPORT INSULATOR		**5 % OF TOTAL POPULATION.**
2. Flexible equipment terminal Connector complete with Hardware for		
i)	Generator	3 set * (Single Phase)
ii)	Generator Transformer	3 set * (Single Phase)
iii)	Generator bushing	1 set
iv)	Generator capacitor	1 no
v)	Unit Transformer	3 set * (Single Phase)
vi)	PT & SP Cubicle Tap off	3 set * (Single Phase)
3.	Seal off bushings suitable for	
i)	Main run	1 no.
ii)	Tap off run	1 no.
iii)	Individual Tap off run	1 No.
* Set means complete requirement for one (1) phase		
4. Current Transformer, VT & SP Cubicle, Expansion Bellow		
A.	Current transformer	
	Main Run CT's	
i)	Overall differential	3 nos.
ii)	Generator Relaying	3 nos.
iii)	Generator metering and EHG	3 nos.
iv)	AVR System	3 nos.
v)	EHG System	3 nos.
vi)	Tap Off CT's	
vii)	Overall Differential	3 nos.
viii)	UT Differential	3 nos.
ix)	UT overcurrent	3 nos.
B.	Voltage Transformer and SP Cubicle	
	VT for metering, relaying and EHG	3 nos.
	VT for performance test and EHG	3 nos.
	VT for EHG and AVR system	3 nos.
	VT primary fuse	3 nos.

	VT secondary Fuse	10 nos.
	Lighting arrester	1 no.
C.	Expansion Bellow	
	Main Run	1 set
	Tap off	1 set

Neutral grounding equipment

Flexible connectors	1 set
Neutral grounding transformer	1 no.
Neutral Grounding Resistor (NGR)	1 Set

STATION TRANSFORMER

S NO.	ITEM	QUANTITY
a)	set of gaskets	One (1)
b)	Bushing of each type	One (1)
c)	CT of each type	One (1)
d)	Cooler fan	One (1)
e)	oil pump	One (1)
f)	Pressure relief device/valve	One (1)
g)	Oil flow indicator	One (1)
h)	set Buchholz relay	One (1)
i)	WTI	One (1)
j)	OTI	One (1)
k)	set of valves of each type	One (1)
l)	Remote tap position indicator]	One (1)
m)	RTD with RWTI	One(1)
n)	Fan with Starter	One(1)
o)	Thermometer	One(1)
p)	Breather	One(1)
q)	Prismatic oil gauge with LOLA	One(1)
r)	Gas collecting Device	One(1)
s)	Air cell(oil preservation equipment)	One(1)
t)	Flat / Ring / Box spanner set	One(1)
u)	Set of Tap changer contacts	1 set
v)	Oil pump with motor	1 set.
w)	Oil flow indicator.	1 set
x)	Oil surge relay.	1 set
y)	Breather with silica gel	1 set
z)	RTD for WTI and OTI	1 no. each

UNIT TRANSFORMERS

S. NO.	ITEM	QUANTITY
1.	HV Bushing with metal parts and gaskets	3
2.	LV bushing with metal parts and gaskets	3
3.	WTI with contacts	1
4.	OTI with contacts	1
5.	Pressure relief device	1
6.	MOG	1
7.	Buchholz relay complete	1
8.	Set of gaskets	1 set
9.	Set of valves	1 set
10.	Cooler fan with motor	3
11.	Air cell for conservator	1
12.	Set of Tap changer contacts	1 set
13.	Sudden Pressure relay	1
14.	Set of Tap changer contacts	1 set
15.	Oil pump with motor	1 set.
16.	Oil flow indicator.	1 set
17.	Oil surge relay.	1 set
18.	RTD for WTI and OTI	1 no. each

PROTECTION SYSTEM FOR GENERATOR, GT, UT, ST and SYNCHRONISING SCHEME

S. No.	DESCRIPTION	QUANTITY
1.	Generator Integrated Protection relay (G1)	1
2.	**Generator 100% stator earth fault relay (64G)**	1
3.	Generator out of step protection relay (78 G)	1
4.	Generator back up Impedance relay (If not covered in Generator Integrated protection relay (21G)	1
5.	Generator rotor earth fault relay (64 F)	1
6.	Overall differential relay (87 GT)	1
7.	Generator voltage balance protection relay (P.T. fuse failure relay) (60 G)	1
8.	Generator Transformer V/H protection relay (61 G)	1
9.	Synchronising check relay (25)	1
10.	Generator transformer differential relay (87 T)	1

11.	Generator transformer H.V. side restricted e/f relay (64 GT)	1
12.	Generator transformer H.V. side back up IDMT relay (51 NGT)	1
13.	Generator transformer H.V. side back up over current relay (51 GT)	1
14.	Unit transformer differential relay (87 UT)	1
15.	Unit transformer H.V. side over current relay with high set unit.	1
16.	Local breaker back up protection relay For Generator transformer breaker	1
17.	Under voltage relays to be used in loss of excitation scheme (27 G) (If not provided in Generator integrated protection relay G1)	1
18.	Pole discrepancy relay	1
19.	Master trip relay (86 G) of each type	2
20.	Auxiliary relays used in the scheme each type	2 nos. of each type and rating.
21.	Timer used in the scheme each type	1 no. of each type and rating
22.	Aux. CTs/ VTs used in the scheme each type	1 no. of each type and rating
23.	Switches used in the scheme each type	1 no. of each type and rating
24.	Indicating lamps	5 No.
25.	Any other protection relay which are not indicated above but used in the scheme.	1 No. each
Note:- All protection relays supplied as mandatory spares should be of same make and model as installed ones		

HV BUS DUCTS

1	Bus insulators	3 Nos
2	Set of seal-off bushings	3 Sets
3	Set of 3 phase, Aluminium flexibles	3 Sets
4	Set of three phase, Copper flexible	2 Sets

5	Drain plug with cap	6 Nos
6	Silica Gel Breathers	3 Nos
7	Gaskets of each type (20 mtrs. Set)	4 Sets
8	Belleville washers	50 Nos
9	Rubber bellows	4 Sets
10	Densal or equivalent compound	1 Kg
11	Space heaters complete set	2 Sets

HV SWITCHGEAR (11 KV & 6.6 KV)

S. NO.	ITEM	QUANTITY
1)	Spring charging motor complete	4 nos of each type
2)	Shunt trip coil	25 nos of each type
3)	Closing Coil	25 nos of each type
4)	Current transformer of each type & ratio	3 nos of each type
5)	Potential transformer of each type & ratio	1 no of each type
6)	Relays	
	a)each type & rating (anti-pumping relay also included)	1 no of each type
	b)Aux. relays / Lock out relays/ TIMERS	2 nos of each type
7)	Moving contact assembly of each installed rating	4 sets
8)	Stationary (fixed) contact	4 sets
9)	Bus seal-off bushings	2 nos of each type
10)	Busbar support insulators	5 % of total population
11)	Limit switches of each type	6 nos.
12)	Closing spring	3 nos of each type.
13)	Tripping spring	3 nos of each type.
14)	Control switches	3 nos of each type.
15)	Selector switches	3 nos of each type.
16)	Isolation switch for the control supply	3 nos of each type.
17)	Operating mechanism rod for each rating	3 nos
18)	Set of gaskets of each rating	4 sets
19)	Ammeter of each type & range	1 no of each type & range
20)	Voltmeter of each type & range	1 no of each type & range
21)	Circuit breaker aux. contact assembly	6 nos of each type & rating
22)	a) Indicating lamps	60 nos.
	b) Indicating lamp covers of all colours, lamp resistors & holders	10 % of installed quantity.
23)	a)Fuse base and holder of each type & rating	6 nos. of each type.
	b)Fuse of each rating	12 nos. of each type.
24)	Maintenance tools and accessories for maintenance (bidder to list)	3 sets.
25)	Carbon brushes for spring charging motor (if applicable)	20 sets
26)	Isolating contact(Fixed and moving)	1 set of each rating

27)	Terminal blocks	12 nos.
28)	Arc chute (if applicable for each rating)	3 nos.
29)	SF6 cylinders with SF6 gas filled alongwith nozzle for filling the gas if applicable	3 nos.
30)	Bearings for spring charging motor	6 sets
31)	Multiple pin plug contact assy. With cables (male & female)	6 nos.
32)	Guide for moving contact set	6 sets (complete)
33)	Interphase barrier	3 nos. for each type
34)	Pressure gauge (for SF6 breaker)	2 nos.
35)	Contactors with HRC fuses	10 % of each type and rating
36)	Aux. contactors	10 % of each type and rating
37)	Control supply transformers (If applicable)	1 no of each type.
38)	Breaker Trolley	1 no. with each panel
39)	Breaker	One (1) no. of each type & rating.
40)	Transducers	5 no. of each type
41)	PT	3 nos. of each type and ratio.

LV SWITCHGEAR

S.NO.	ITEM.	QUANTITY
1)	Complete pole of breaker	1 no of each type and rating
2)	Spring charging motors	6 nos.
3)	Aux. contact set of each type and rating	6 set.
4)	Limit switches	6 nos.
5)	Arc chutes	4 nos.
6)	Fixed contact set of each type and rating	3 sets
7)	Moving contact set of each type and rating	3 sets
8)	Arcing contact	6 sets
9)	Charging spring	3 nos.
10)	Current transformer (metering)	3 nos.
11)	Current transformer (protection)	3 nos.
12)	Closing coil of each type and rating	10nos.
13)	Trip coil of each type and rating	10 nos.
14)	CT for Bimetal O/L relays	1 no of each type and rating.
15)	Voltage Transformers of each type and ratio	3 nos.
16)	Control supply transformer	1 no each rating.
17)	Ammeter	1 no of each rating and size.
18)	Voltmeter	1 no of each rating and size.
19)	Relays	1 no of each type and rating

20)	Power contactor	5 nos of each rating.
21)	Coil of above contactor	10 nos.
22)	Air break switches	10 % of each rating.
23)	DP air break switches (DC)	2 nos. each
24)	Control & selector switches	5 % of each type and size.
25)	Control fuses & neutral links	30 % 0f population for fuses, 10 % 0f population for link.
26)	Indicating lamps	20 % of installed quantity.
27)	Bus bar support insulators(each type)	5 % of installed quantity.
28)	Bus duct flexible connectors	1 no of each type.
29)	Primary disconnect in MCC (Male/ female contact)	1 set of each rating.
30)	Push buttons	10 % of each type.
31)	Power fuses	50 % of each type.
32)	Thermal bimetal relays	6 nos. of each rating and size.
33)	Indication Lamp Holders complete	20 % of installed quantity.
34)	Maintenance tools and accessories for Maintenance (bidder to list)	2 nos.
35)	Terminal blocks	10 % of installed quantity.
36)	Busbar aluminium flat pieces	12 meters of each size.
37)	Bus bar angles/formed pieces for breaker	1 no.
38)	Complete ACB	1 no. each type and rating
39)	Transducers	5 nos. of each type and rating

NOTE:

a. Quantity mentioned in percentage (%) is the % of total installed.
b. If percentage comes as fraction next higher integer should be considered for the purpose of quantity required.

AUXILIARY TRANSFORMERS

S. No.	Components	Qty
1.	Each rating of HV, LV and Neutral bushing	1 set of each type of bushing
2.	Winding temperature indicator for each rating of transformer.	1 No.
3.	Tap changer contacts for each rating of transformer.	1 Set
4.	Magnetic oil gauge / oil level indicator with contacts	1 No.

	as applicable for each rating of transformer.	
5.	Oil temperature indicator with contacts for each rating of transformer	1 No.
6.	Buchholz Relay for each rating of transformer.	1 No.
7.	Float with contact for Buchholz Relay for each rating of transformer	1 No.
8.	Set of gaskets (other than that with bushing) for each rating of transformer	1 No.
9.	Set of valves for each rating of transformer	1 Set
10.	Pressure relief device for each rating of transformer(as applicable).	1 No.
11.	NGR	1 No.
12.	RTD for WTI and OTI	1 no. each

LV TRANSFORMERS

S. No.	Components	Qty.
i)	Limb of complete LT and HT of temperature sensing devices	1 Set.
ii)	Bushing (if provided as a separate item on transformers offered) HV, LV and LV Neutral.	3 Nos.
iii)	Tap changer Contacts	1 set.
iv)	Thermister /RTD with associated leads complete for one transformer.	1 set
v)	Terminal box insulator for LV and HV side	1 set of each type

MOTORS (HT/LT/DC)

a.	**11 KV & 6.6 KV Motor**	
1.	Termination kits (if elastimold type)	2 Nos. of each type
2.	Termination kits (end connection)	20 Nos.
3.	Temp. indicators	10 Nos.
4.	Vibration indicators	10 Nos.
5.	Terminal box Teflon glands	20 Nos.
6.	Phase segregated terminal boxes	2 Nos.
7.	Heaters	4 sets
8.	Couplings	2 Nos. each
9.	Bearings (DE and NDE) for each type and rating of motors	4 sets
10.	Terminal box insulator for HV side	1 set of each type
b.	**415 V Motors**	
1.	**Terminal plates**	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW
2.	Heaters	2 sets
3.	Greasing arrangements	4 sets each type of motor
4.	Bearings (DE and NDE) for each type and rating of motor	4 sets
c.	**D C Motors**	
1.	Carbon brushes	10 sets each type
2.	Brush assemblies	2 sets each type
3.	Terminal blocks	2 sets each type
4.	Heaters	2 sets each type
5.	Pulleys	2 sets each type

6.	Bearings (DE and NDE) for each type and rating of motor	4 sets
d.	**Motors (HT/LT/DC)**	10% of each type and rating or 1 no. whichever is higher.

BATTERY

S NO.	ITEM DESCRIPTION	QUANTITY
1	Battery cell against battery bank installed at various locations	10 nos.
2	MT cell container of each type	10 nos.
3	Level indicator	6 nos.
4	Vent plugs	12 nos.
5	Inter-cell connector with hardware	5% or 5 Nos. whichever is more for each set of battery bank.
6	Nuts, bolts and washer	12 sets

BATTERY CHARGERS

The list of mandatory spare parts for the battery charger covered under this package are as follows:

1. **For float cum boost charger'**

Sr. No.	Item Description	Quantity
a)	Electronic Cards (with all components mounted)	1 set of each type and rating.
b)	Fuse Links and Glass Fuses	3 nos. of each type and rating
c)	SCR assembly	3 sets of each type and rating
d)	Blocking Diode	6 sets of each type and rating
e)	Potentiometer	3 sets of each type and rating.
f)	Rectifier Transformer	1 No. of each type & rating
g)	Control Transformers	1 No. of each type & rating

ELCTRICAL ACTUATORS WITH INTEGRAL STARTERS

10% or 1 no. of each type, class, size and model whichever is more.

EARTHING SYSTEM

GI Flats – 10% of each size & type

ILLUMINATION SYSTEM

1.0	**Illumination System including Aviation Lighting**		
i)	LED Light Fixtures	No.	10% of each Type & Rating
ii)	Control gear box complete	Set	5

	• Aviation Lamps for Chimney and Cooling Tower	No.	6
	• Power supply card for Aviation warning lights for Chimney and Cooling Tower	No.	6
	• Electronic flasher card for Aviation warning lights for Chimney and Cooling Tower	No.	3
iii)	Timer/photo cell (wherever applicable)	No.	2

VFD SYSTEM

1.0	**VFD System**		
	(For the following items each type & rating to be repeated)		
i)	Control Card	No.	2
ii)	IGBT cards	No.	1
iii)	PCB	No.	2

ROOF TOP SOLAR SYSTEM

1.0	**Roof Top Solar System**		
i)	Solar PV Modules	%	1% of total population
ii)	Inverter of string of highest size of supplied capacity	No.	1
iii)	Flexible solar DC Cable of supplied rating	M	500
iv)	DC side surge arrestor (if applicable)	No.	1

DIESEL GENERATORS

Alternator

1)	sets of carbon brushes for Generator, and self-starter motor	Six (6)
2)	set of current transformers of rating	One (1)
3)	set of instruments of each range	One (1)
4)	set of relays of each type	One (1)
5)	set of timers	One (1)
6)	sets of indicating light	One (1)
7)	sets of fuses of each rating	Two (2)
8)	set of space heaters with thermostat & isolating switch	One (1)
9)	set of cubicle illuminating lights	One (1)
10)	set of terminal blocks	One (1)

Diesel Engine

1)	Sets of fuel injection nozzles	Two (2)
2)	Crank shaft with standard size journals	One (1)
3)	Set main bearings	One (1)

4)	Set big-end bearings	One (1)
5)	Diesel filter packs	Twenty four (24)
6)	Mobile oil filter packs	Twenty four (24)
7)	V-belt for radiator fan	Six (6)
8)	Fuel injector	Two (2)
9)	Set of fuel injection piping	One (1)
10)	Ring gear for fly wheel	One (1)
11)	Starter (Spare).	One (1)
12)	Bidder shall furnish suitable nozzle tester, barring bar, slings, eyebolts and other special equipment necessary for servicing the engine.	
13)	Gaskets & packing	1 set
14)	Valve springs	1 set
15)	Fuel pump complete	1 set
16)	Battery charging rectifier diodes	4 Nos.
17)	Solenoid coil for each solenoid operated valve or relay used	2 each
18)	Diodes forward for alternator	3 No.
19)	Diodes reverse for alternator	3 No.
20)	Lube oil pump assembly/rotating assembly/impeller/shaft	1 set
21)	Voltage transformers	1 No. of each type

AMF Panel

1	Protective relay of each type	1 No.
2	Auxiliary relay of each type	1 No.
3	Timer of each type	1No.

COMMUNICATION SYSTEM

Spares of different types and ratings of equipment, accessories used including 1 set of electronic cards.

POWER AND CONTROL CABLES

i)	11 KV Grade power cables for each type and size.	10% of installed quantity
ii)	6.6 KV Grade power cables for each type and size.	10% of installed quantity
iii)	1.1 KV Grade power cables for each type and size	10% of installed quantity
iv)	1.1 KV Grade control cables for each type and size	10% of installed quantity

TRANSFORMER OIL 5% of Total Quantity of all types & grades

400 KV GAS INSULATED SWITCHYARD

	(For the following items each type & rating to be repeated)		
1.1	400 KV GIS		
i)	Trip coils for circuit breaker	No.	4
ii)	Closing coils for circuit breaker	No.	4
iii)	Gaskets	Set	6

iv)	Motor for circuit breaker operating mechanism (If applicable)	No	2
v)	Valve block with drive cylinder for circuit breakers	Set	2
vi)	Motor for earthing switch	No.	1
vii)	Motor for disconnectors	No.	1
viii)	Operating mechanism for disconnectors	Set	1
ix)	Operating mechanism for earthing switch	Set	1
x)	SF6 gas cylinder with 40 kgs of SF6 gas	No	3
xi)	Control switch and auxiliary relay	No	4
xii)	MCB (as applicable)	No	4
xiii)	Current Transformers	Set	1
xiv)	400 KV SF6 Air Bushing	No	3
1.2	400 KV Capacitive Voltage Transformers		
	(For the following items each type & rating to be repeated)		
i)	400 kV CVT	No.	3
ii)	Oil Seals	Set	1
iii)	Insulators	No.	1
iv)	Gaskets (all sizes used)	Set	1
v)	Oil filling, draining and sampling plugs	Set	1
vi)	Oil level gauge	No	2
1.3	400 KV WAVE TRAP		
	(For the following items each type & rating to be repeated)		
i)	400 KV Wave Trap complete with all accessories	Set	1
1.4	SWITCHYARD EQUIPMENT ACCESSORIES		
	(For the following items each type & rating to be repeated)		
i)	400 KV Glazed Brown Insulator	Set	2
ii)	SF6 gas pressure Relief Devices, 3 No. of each type		2 set
iii)	SF6 Pressure gauge with coupling device cum switch or density monitors and pressure gauge, as applicable (1 no. of each type)		1 Set
iv)	Molecular filter for SF6 gas with filter bags (1set - 20% total quantity of absorber bags used in GIS)		1 Set
v)	Covers with all accessories necessary to close a compartment in case of dismantling of any part of the Enclosure to ensure the sealing of the compartment for 1 phase enclosure (3 Nos. of each type)		1 Set
vi)	Locking device to keep the Dis-connectors and Earthing switches in close or open position in case of removal of		3 No.

	the driving mechanism (If applicable)		
vii)	Bus support insulator of each type for single phase enclosure (6 Nos. of each type)		1 Set
viii)	SF6 to air bushing for 1 phase enclosure		2 Nos
ix)	Relay of each type & rating		1 Nos.
X	All types of Corona shield (3 Nos. of each type)		1 Set
Xi	Window scope/ Observing window, 3 Nos. of each type (if applicable)		1 Set
1.5 (i)	**Circuit Breaker:-** Complete Circuit Breaker 1 phase pole of each type & rating complete with interrupter, main circuit and enclosure with operating mechanism		1 Sets
(ii)	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating (If applicable)		One (1) Set
(iii)	Closing assembly/ valve, 3 nos. of each type (If applicable)		(2) Sets
(iv)	Trip assembly/ valve, 3 nos. of each type (If applicable)		2 Sets
(v)	Rupture disc, 3 Nos. of each type (If applicable)		1 Set
1.6 (i)	**Disconnector:-** Complete set of 3 nos. of single phase disconnector including main circuit, enclosure and driving mechanism		1 Set
(ii)	High speed/ fast acting fault making grounding switch, 3 nos. of single phase of each rating, including main circuit, enclosure and driving mechanism		1 Set
(iii)	Limit switches and Aux. switches for complete 3-phase equipment i. For Disconnector - 3 Sets ii. For earth switch - 1 Set iii. For High speed earth switch - 1 Set		
1.7	**Potential/Voltage Transformer**		
(i)	Gas Insulated complete VT with enclosure.		1 No
(ii)	SF6 Gas Insulated Surge Arrestor with enclosure		1 no. of each type
(iii)	SURGE ARRESTER complete in all respects with surge counter, etc		1 No. of each type
(iv)	Clamps and connectors (Minimum 3 Nos. of each type)		3 nos. of each type
(v)	Spacers (Minimum 3 nos. of each type) -		3 nos. of

			each Type
1.8	LA 400 kV side		3 no.
1.9	EMVT 400 KV side		1 no.

AIS (220kV)		Additional requirement:- a. Complete set of 1 no. of single phase disconnector including main circuit, enclosure and driving mechanism - One (1) Set. b. Complete Circuit Breaker 1 phase pole of each type & rating complete with interrupter, main circuit and enclosure with operating mechanism - One (1) Set.
SAS Including GRPs		Additional requirement:- a. Bay Control unit (complete with all components) - two (2) Nos. b. Numerical Relays comprising various bay protection units, Bus Bar and Islanding Scheme - One (1) No. of each type. c. Numerical Relays comprising GRP - One (1) No. of each type d. Switchgear control unit - two (2) no of each. e. Merging unit – two (2) no of each type. f. Cards/modules of Generator Disturbance Recorder, Line DR (if stand-alone) - One (1) No. of each type. g. Energy Meter (ABT meter) class: 0.2s - One (1) no. of each type. h. Terminal Blocks 5 nos. of each type, make, model and rating. i. MCBs 1no of each type, make and model used in the system. j. Relays other than Numerical Relays – One (1) no of each type of total population (min One (1) no.). k. Transducers One (1) no. of each type. l. Auxiliary CT/PT One (1) no. of each type.
	Additional requirement: ICT	**Spares for 400 / 220 kV ICT:-** Following spares may be added:- a. Set of gaskets One (1) b. Bushing of each type One (1) c. CT of each type One (1) d. Cooler fan One (1) e. Oil pump One (1) f. Pressure relief device / valve One (1) g. Oil flow indicator One (1)

		h. Set Buchholz relay One (1). i. WTI One (1) j. OTI One (1) k. Set of valves of each type One (1) l. Remote tap position indicator One (1) m. RTD with RWTI One (1) n. Fan with Starter One (1) o. Thermometer One (1) p. Breather One (1) q. Prismatic oil gauge with LOLA One (1) r. Gas collecting Device One (1) s. Air cell (oil preservation equipment) One (1) t. Flat / Ring / Box spanner set One (1) u. Set of Tap changer contacts - One (1) set v. Oil pump with motor - One (1) set. w. Oil flow indicator. x. Oil surge relay

AIS (220KV)

220 kV side CT		1 no.
Disc insulator string 400 kV side		10%
Disc insulator string 220 kV side		10%
Clamp And connectors		5% of each type
Isolator arm for 220 KV and 400 KV		1 set of each type
Post Insulator for 400 kV and 220 kV		1 set each type

CHIMNEY LIGHTING

Power supply cards	6 Nos.
Electronic Flash Cards	3 nos.
Photo cell control Unit	3 sets
LEDs	4 nos.

COOLING TOWER LIGHTING

Power supply cards	6 Nos.
Electronic Flash Cards	3 nos.
Photo cell control Unit	3 sets
LEDs	4 nos.

CONTROL & INSTRUMENTATION

III. CONTROL & INSTRUMENTATION (MANDATORY SPARES)

1.00.00	**Description**		
1.00.01	**Measuring & Field Instruments**		
1.00.01.01	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**		
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
(ii)	For skid mounted instruments	Nos.	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more
(iii)	Panel and Wall mounted Indicators	Nos.	10% of total number of instruments or a minimum of one number for each type, model, range etc. whichever is more
1.00.01.02	Temperature Elements and Thermowells		
(i)	Thermocouple/RTD elements	Nos.	100% of flue gas temp, coal air mixture temp, boiler/TG metal temp thermocouples and 5% for other applications of total duplex thermocouple element assemblies and duplex RTD assemblies (with head assembly, terminal block and nipple) of each type and length whichever is more. The element assembly shall be suitable for direct replacement in the corresponding thermowell.
(ii)	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each type & size, whichever is more

1.00.01.03	Temperature Transmitters and Electronic Transmitters of all type, range and model no. (For Pressure, DP, Temp, Flow, Level), Process Transmitters, Radar type level transmitter, 3D type level Transmitter with local display, Magnetic/Electromagnetic flow meter with local display, mass flow meter with local display., Process meters, Junction Box, Position Transmitter, Transducer or any other instrument etc.	Nos.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
1.00.01.04	Process actuated switch Devices- As applicable for each package as per following: 1. Temperature Switches 2. Differential pressure Switches 3. Pressure switches 4. Flow switches 5. Level Switches 6. Safety Protection Switches	Nos.	10% of total nos. or 1 no. of each make, model, range and type whichever is more
1.00.01.05	Local Gauges like temperature gauges, pressure gauges, differential Pressure gauges, flow gauges, flow meters with local display etc.	Nos.	10% of total number of instruments/transducers offered for each model and type, rating or a minimum of one number for each model, rating and type , whichever is more.
1.00.01.06	All type of Rota meters & Sight Flow Indicator.	Nos.	1 no. of each range and type
1.00.01.07	PD type flow transmitters with local display.	Nos.	1 no. of each type and model
1.00.01.08	Guided wave RADAR for Hot well application	Nos.	1 no.
1.00.01.09	Guided wave RADAR for LP heaters	Nos.	1 no. for each of the LP heaters
1.00.01.10	Impact head type flow element	Nos.	20% or 2 nos. of each make and type, whichever is more
1.00.01.11	Ultrasonic type flow measurement	Nos.	20% or 2 nos. of each make and type, whichever is more
1.00.01.12	Ultrasonic type level transmitter	Nos.	50% of each type and length, including sensors
1.00.01.13	Any other instruments not indicated in the tender P&ID but required for control, monitoring and operation of the equipment/plant/systems	Nos.	10% or 2 nos. of each type whichever is more

1.00.01.14	Level Gauges	Nos.	a) 10% or 2 nos. whichever is more of each type of illuminators with holder and reflector. b) 20% or 5 nos. whichever is more of each type of bulb. c) 10% or 2 nos. whichever is more of each type of bi-color rollers. d) 10% or 2 nos. whichever is more of each type of glass along with pair of gaskets (cushion & wet gaskets). e) 10% or 2 nos. whichever is more of each type of gaskets for gauge cocks/valve bonnet/ packing. f) 10% or 2 nos. whichever is more of each type scale.
1.00.01.15	Complete Electronic cards, PCB assembly and Power supply card assembly.	Nos.	10% of Electronic card/PCB assembly for each type, model & rating or a minimum of one number for each model, rating and type , whichever is more for each type of Transmitter, switch & Flow Meters.
1.00.02	DDCMIS, DCS,PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, MIS, LAN, Simulator, WAN, Plant Intruder system, CCTV, Video Conferencing System Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.		
	DDCMIS and PLC		
1.00.02.01	I/O cards		
a.	Analog Input module	Nos.	20% of qty Installed of each category/type/model or at least 2 No. of each type/model (Whichever is more)
b.	Analog output module	Nos.	20% of qty Installed of each category/type/model or at least 2 No. of each type/model (Whichever is more)

c.	RTD/TC cards/modules	Nos.	20% of qty Installed of each category/type/model or at least 2 No. of each type/model (Whichever is more)
d	Digital input module	Nos.	20% of qty Installed of each category/type/model or at least 2 No. of each type/model (Whichever is more)
e.	Digital output module	Nos.	20% of qty Installed of each category/type/model or at least 2 No. of each type/model (Whichever is more)
1.00.02.02	All types of electronic modules, controllers, function modules, communication/Interface cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub-systems and any other type of PCB not covered above.	Nos.	20% of qty Installed of each category/model/type or at least 2 No. of each type/model (Whichever is more)
1.00.02.03	MCB, MCCB, of each current rating required for the project.	Nos.	20% spare for each type/Model
1.00.02.04	Electronic/Power supply/ Processor cards of each type used for each type of Servers supplied with any control system	Nos.	Twenty (20) percent or 2 no. (Whichever is more)
1.00.02.05	Plug-in type keyboard & Mouse	Nos.	Ten (10) percent or 10 nos. of each type/model (Whichever is more).
1.00.02.06	OWS with licensed software loaded along with monitor & LVS work station	Nos.	Ten (10) percent or Two numbers (Whichever is more) of each type/model with complete accessories & monitors.
1.00.02.07	Utility/Engineering OWS with licensed software loaded along with monitor	Nos.	Ten (10) percent or Two No. (Whichever is more) of each type/model with complete accessories & monitors.
1.00.02.08	Intelligent UPS for workstation, server, LVS WS	Nos.	1 no. of each type and rating.
1.00.02.09	Bulk storage drive unit	Nos.	Twenty (20) percent or Two nos. (Whichever is more) of each type/model.
1.00.02.10	HDD/DVD	Nos.	10 NOS. of each type & rating.
1.00.02.11	Data highway cable with adequate connectors of each type	set.	200 mts. Each set
1.00.02.12	Cables and Connectors		
1.00.02.12.1	Prefab interconnecting cables with connectors	Nos.	2 nos. of each type and length
1.00.02.12.2	System bus cable with connectors	Nos.	2 nos. of each type and length

1.00.02.12.3	I/O bus cable with connectors for remote I/O units	Nos.	2 nos. of each type and length
1.00.02.13	Hard disc drive unit	Nos.	Five nos of each type
1.00.02.14	Batteries used for battery backup of RAMs (if applicable)	Nos.	10% of each type and model or minimum 2 nos. whichever is more.
1.00.02.15	Cooling fans for Power supply and cabinets	Nos.	10% of each type and model or minimum 1 no. whichever is more.
1.00.02.16	Prefab interface cable with connectors of each type and model of peripherals and I/O hardware.	Nos.	25 % or 5 nos (whichever is more) of each type of Installed
1.00.02.17	Cubicle power supply packs and power supply modules	Nos.	Twenty (20) percent or 5 nos (whichever is more) of Installed of each type and rating
1.00.02.18	Interposing/coupling relays & relay Board.	Nos.	Twenty (20) percent Installed of each type and rating
1.00.02.19	Ethernet Switches, Routers, modems, Firewalls & other network hardware etc.	Nos.	10% of qty Installed of each type/model or a minimum of 2 numbers from each type/model, whichever is more.
1.00.02.20	GIU	Nos.	Ten (10) percent of qty installed or 2 no. of each type (whichever is more).
1.00.02.21	**Printers and their parts**		
1.00.02.21.1	Printer toners for all printers	Nos.	Ten (10) percent of qty installed or 3 no. of each type printer toners (whichever is more) of each type.
1.00.02.21.2	Line impact heavy duty DMP printer head of the total quantity	Nos.	2 nos. of 132 colums of each type
1.00.02.21.3	Color laser printer (A4)	No.	2 nos. of each type
1.00.02.21.4	Drum for A3 sized scanner cum copies, printer	Nos.	2 nos. of each type
1.00.02.22	55" LED monitors.	Nos.	2 nos
1.00.02.23	29" LED monitors.	Nos.	5 nos
1.00.02.24	RJ 45 connector with box of each type	Nos.	Twenty (20) percent or 2 no. (Whichever is more) of each type.
1.00.02.25	Hooters, Buzzers, Cooling fans of each type.	Nos.	Ten (10) percent or 2 no. (Whichever is more) of each type.
1.00.02.26	Interface cables	Set	Ten (10) percent or 2 sets (Whichever is more) of each type/model.
1.00.02.27	Power supply modules (AC to DC convertors)	Nos.	10% or Five no. (Whichever is more) of each type/model
1.00.02.28	DVD drive unit of each type	Nos.	10 nos.

1.00.02.29	Power supply cords/cables & VGA Cables - for work stations, Servers, Laptops, printers etc.		10% or Ten no. (Whichever is more) of each type/model
1.00.02.30	Control, logic, power supply fuses.	Nos.	200 % of Installed of each type.
1.00.02.31	**Simulator**		
1.00.02.31.1	Electronic/Power supply/ Processor cards of each type used for each type of Servers.	Nos.	Twenty (20) percent or 2 no. (Whichever is more).
1.00.02.31.2	Plug-in type keyboard & Mouse	Nos.	Ten (10) percent or 2 nos. of each type/model (Whichever is more).
1.00.02.31.3	OWS & EWS with licensed software loaded along with monitors.	Nos.	One No. of each type/model with complete accessories & monitor.
1.00.02.31.4	Intelligent UPS for workstation/server/LVS WS	Nos.	1 no. of each type and rating.
1.00.02.31.5	Ethernet Switches, Routers, modems, Firewalls & other network hardware etc.	Nos.	10% of qty Installed of each type/model or a minimum of 1 numbers from each type/model, whichever is more.
1.00.02.31.6	Cables and Connectors	Nos.	2 nos. of each type and length
1.00.02.31.7	Prefab interconnecting cables with connectors	Nos.	2 nos. of each type and length
1.00.02.31.8	System bus cable with connectors	Nos.	2 nos. of each type and length
1.00.02.31.9	Printer toners for all type of printers	Nos.	Ten (10) percent of qty installed or 3 no. of each type printer toners (whichever is more) of each type.
1.00.02.31.10	MCB, MCCB, of each current rating required for the project.	Nos.	20% spare for each type/Model
1.00.02.31.11	Interface cables	Set	Ten (10) percent or 1 sets (Whichever is more) of each type/model.
1.00.02.31.12	Power supply cords/cables & VGA Cables - for work stations, Servers, Laptops, printers etc.	Nos.	10% or Two no. (Whichever is more) of each type/model
1.00.02.31.13	All types of electronic modules, controllers, Communication/Interface cards, terminal boards, relay boards, power supply cards etc for projector.	Nos.	10% of qty Installed of each category/model/type or at least 1 No. of each type/model (Whichever is more)
1.00.02.31.14	LVS		
1.00.02.31.14.01	LED Kits.	Nos.	100% (Installed) spares of each type & size.

1.00.02.31.14.02	LVS Filters	Nos.	20% spare or min 2 nos.
1.00.02.31.14.03	Electronic cards of each type for LVS	Nos.	1 nos. or 10% whichever is more
1.00.02.31.14.04	Interfacing cables	Set	100% of each type & size.
1.00.02.31.14.05	Power supply modules of each type for LVS	Nos.	1 nos. or 10% whichever is more
1.00.02.31.14.06	Cooling modules of each type for LVS	Nos.	1 nos. or 10% whichever is more
1.00.02.31.14.07	Projection Engine	Nos.	1 no. of each type.
1.00.02.31.14.08	LVS Controller of each type for LVS	Nos.	1 no.
1.00.02.32	Conference hall mic.	Nos.	5 no. of each type
1.00.02.33	Conference hall speakers.	Nos.	5 no. of each type
1.00.03	**Steam and Water Analysis System (SWAS) and water Chemistry Analysers used in Plant water system.**		
1.00.03.01	Pressure reducing elements for sample flow.	Nos.	10% spare of qty installed or 3 nos. (Whichever is more).
1.00.03.02	Ion exchange columns with resin as utilized with cation conductivity analysers	Nos.	Four Nos. and 12 sets or No. of sets required for complete one year operation, whichever is more of replacement cartridge for ion exchange column.
1.00.03.03	Conductivity cells as utilized with conductivity monitors	Nos.	Four nos of each type
1.00.03.04	pH flow-through type cells used with pH monitors	Nos.	Four nos. of each type
1.00.03.05	Chemical reagents for all type of analysers	Set	12 months continuous operation of all analysers from date of taking over.
1.00.03.06	Chemical reagents for colorimetric silica analyzers	Set	12 months continuous operation of all analysers from date of taking over.
1.00.03.07	Electronic Modules	Nos.	Two (2) no. for each type of Analyser.
1.00.03.08	Power supply sub-assemblies		10 % or two no. (Whichever is more) for each type of Analyser.
1.00.03.09	Pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware's, valves in SWAS & water Chemistry analyser for plant water system.	Nos.	Two (2) no. of each type

1.00.03.10	panel mounted type sample pressure gauges, sample temp gauges and sample flow indicators	Nos.	2 nos. of each type.
1.00.03.11	Temp. switch/flow switch/temp. controller/temp.gauge/pressure gauge each for the chilled water system.	Nos.	1 no. each type.
1.00.03.12	Flow assembly and measuring chamber for each of the following analysers a. Dissolved Oxygen b. Sodium c. Silica d. Hydrazine f. Chloride g. Turbidity h. pH i. Conductivity.	Nos.	One no. for each analyser of each type.
1.00.03.13	Complete Primary coolers and secondary coolers with assembly.	Nos.	Two (2) No of each type & rating.
1.00.03.14	Filters	Nos.	Two nos. of filters along with forty nos. of filter elements.
1.00.03.15	Sample probes	Nos.	Ten nos. or minimum 1 no. of each type whichever is more
1.00.03.16	Sample shut-off valves	Nos.	2 nos. of each type.
1.00.03.17	Sample blow down valves	Nos.	4 nos. of each type.
1.00.03.18	Solenoid valves	Nos.	2 nos. of each type.
1.00.03.19	Safety relief valves	Nos.	2 nos. of each type.
1.00.03.20	isolation valves used for pressure indicator and flow indicator isolation	Nos.	6 nos. of each type.
1.00.03.21	Back pressure valves.	Nos.	2 nos. of each type.
1.00.03.22	Grab sample valves.	Nos.	2 nos. of each type.
1.00.03.23	Quick disconnection type valves.	Nos.	4 nos. of each type.
1.00.03.24	Sample temp. control valves (3 way type) and Thermal shut off valve.	Nos.	4 nos. of each type.
1.00.03.25	valves	Nos.	2 nos. of each type.
1.00.03.26	Rubber tubes & capillary tubes of all types & sizes	lot	100%
1.00.03.27	Lamps of all types, size & rating	lot	100%
1.00.03.28	Flexible Tygon tubing for grab sampling	set	1set
1.00.04	**Analysers for DM & PT Plant**		
1.00.04.01	**pH /Conductivity/turbidity Analyzer**		

	a. Flow Through type cell and electrode	Nos.	1 no. of each type
	b. Electronic Transmitter unit without sensor	Nos.	1 no. of each type
	c. Pre-fabricated cable with connector	set	1 set
1.00.04.02	**Residual Chlorine Analyzer**		
	a. sensor	Nos.	1 no. of each type
	b. Transmitter	Nos.	1 no. of each type
	c. Pre-fabricated cable with connector	Set	1 set
	All chemical Reagents for 12 month operation (Supply to be staggered as per the shelf life)	set	1 set
1.00.04.03	**Silica Analyser**		
	Main PCB Assembly	Nos.	1 no. of each type
	Power supply cards (if applicable)	Nos.	1 no. of each type
	Rubber Tubes and capillary Tubes	set	1 set
	Pre-fabricated cable with connector	set	1 set
	Solenoid valves	set	1 set
	All chemical Reagents for 12 month operation (Supply to be staggered as per the shelf life)	set	1 set
1.00.04.04	**Sodium Analzer**		
	Main PCB Assembly	Nos.	1 no. of each type
	Power supply cards (if applicable)	Nos.	1 no. of each type
	Rubber Tubes and capillary Tubes	set	1 set
	Pre-fabricated cable with connector	set	1 set
	Solenoid valves	set	1 set
	All chemical Reagents for 12 month operation (Supply to be staggered as per the shelf life)	set	1 set
1.00.05	**Microprocessor based control system**		
1.00.05.01	**Complete set including integral microprocessor based control system along with system & application software and special cables.**	Nos.	10% or 1 set of each type/model whichever is more
1.00.06	**Relay based Control Panels**		
1.00.06.01	LEDs for indicating lights	Nos.	100% of qty installed.
1.00.6.02	Control circuit fuses Semiconductor Fuses	Nos.	300% of installed of each type, current rating.
1.00.06.03	MCB/MCCB		Ten percent spare replacement of each current rating required shall be furnished
1.00.06.04	Cooling Fans of each type, model and rating.		20% or 2 nos. of each type and rating, (whichever is more).

1.00.06.05	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.
1.00.06.06	Push buttons, ILPBs of each type.(complete with contact elements)		Ten (10) percent or 2 nos (whichever is more) of each type and color
1.00.06.07	Electric meter like Ammeters, Voltmeters etc.		Ten (10) percent or 2 nos (whichever is more) of each type
1.00.06.08	Control switches		5 nos. of each type and rating
1.00.06.09	Selector switches		1 no. of each type and rating
1.00.06.10	Any special meter		1 no. of each type and rating
1.00.06.11	Power supply modules.		Ten (10) percent or 2 nos (whichever is more) of each type
1.00.06.12	Control supply transformers		1 no. of each type and rating
1.00.07	**Alarm Annunciation System**		
1.00.07.01	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed
1.00.07.02	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed
1.00.07.03	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	Nos.	20% of qty installed
1.00.07.04	Annunciator hooter	Nos.	One (1) No. of each type
1.00.08	**Un-interrupted Power Supply System and DC Control Power Supply System**		
1.00.08.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)		
1.00.08.02	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board
1.00.08.03	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Nos.	Minimum of 15% or atleast four (whichever is more) of each type model and rating of SCR and power diodes, power transistors shall be included
1.00.08.04	Electronic cards for Battery health Monitoring System for UPS and DC control power supply system separately. .	Nos.	10% or at least two nos. (whichever is more) of each type

1.00.08.05	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating
1.00.08.06	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.
1.00.08.07	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)
1.00.08.08	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)
1.00.08.09	Cooling Fans in UPS & 24 V DC charger panels	Nos.	20% or 2 nos. of each type and rating, (whichever is more)
1.00.08.10	following accessory equipment for the battery shall be furnished : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer e) Supply of corrosion-preventive grease.	Set	Two sets of each type.
1.00.08.11	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	10% or One set (whichever is more) of each type, model & rating with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.
1.00.08.12	MCCB for UPS & 24 V DC charger panels and ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)
1.00.08.13	Battery cells complete with contactor, cover plates etc.		Ten (10) percent of each type & Size installed
1.00.08.14	Rectifier & controller modules for 24 V DC charger system		Ten (10) percent of each type & Size installed
1.00.08.15	Intelligent UPS for workstation/server/LVS WS	Nos.	1 no. of each type and rating.
1.00.08.16	Battery health Monitoring system– Electronic Cards and Interface cards.		20 % of installed or 5 Nos of each type (whichever is more)
1.00.09	**Erection hardware mounted in field, LIE & LIR**		
1.00.09.01	Instrument valves, manifold, fittings, impulse pipe, impulse tubes, drains pipes etc.	Nos.	Ten (10) percent of each type, rating, model number and size of devices.

1.00.09.02	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher .
1.00.09.03	Manifold 2 way, 3 way, 5 way valve manifolds	Nos.	Ten (10) percent of each type & Size installed
1.00.09.04	Fittings	Nos.	Twenty (20) percent of each type & Size installed
1.00.09.05	Purge meters		Ten (10) percent of each type & Size installed
1.00.09.06	Air Filter cum Regulator		Ten (10) percent of each type, make and model installed
1.00.09.07	MCB, and Power sockets used in LIE/LIR.		Ten (10) percent of each type
1.00.09.08	Fuses used in LIE/LIR.		Fifty (50) percent of each type of
1.00.10	**LVS**		
1.00.10.01	LED Kits.	Nos.	200% (Installed) spares of each type & size.
1.00.10.02	LVS Filters	Nos.	50% spare or min 8 nos.
1.00.10.03	Electronic cards of each type for LVS	Nos.	2 nos. or 20% whichever is more
1.00.10.04	Interfacing cables	Set	100% of each type & size.
1.00.10.05	Power supply modules of each type for LVS	Nos.	3 nos. or 20% whichever is more
1.00.10.06	Cooling modules of each type for LVS	Nos.	3 nos. or 20% whichever is more
1.00.10.07	Projection Engine		1 no. of each type.
1.00.10.08	LVS Controller of each type for LVS	Nos.	2 nos.
1.00.11	**Master Slave Clock system**		
(i)	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set	
(ii)	Electronic cards	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating
(iii)	Signal Conditioner cards	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating
(iv)	Slave clocks of each type used for Master slave clock system	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating
(v)	Cubicle power supply modules	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating

1.00.12	**Plant Security and surveillance system**		
1.00.12.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)		
1.00.12.02	Electronic cards	Nos.	One No. of each type
1.00.12.03	PTZ controller	Nos.	One No. of each type
1.00.12.04	Electronic modules used for server system	Nos.	10% or Two No. of each type (whichever is more)
1.00.12.05	Special cables & connector	Set	(5 sets) of each type
1.00.12.06	Cartridges for air filter	Nos.	Two No. of each type
1.00.12.07	Relay	Nos.	5 nos. or 10% (whichever is more) of each type
1.00.12.08	Power supply modules of each type	Nos.	5 nos. of each type
1.00.12.09	Camera of each type used for Plant Security and surveillance system.	Nos.	Two no. of each type
1.00.12.10	Network switches, media convertor, interface card and any other communication Hardware.	Nos.	10% or Two No. of each type (whichever is more)
1.00.12.11	Camera & Data base server.	Nos.	1 no. of each type
1.00.12.12	Work station with monitor with compete accessories.	Nos.	1 no. of each type
1.00.13	**HMS**		
1.00.13.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set	
1.00.13.02	Electronic cards	Nos.	Two no. of each type
1.00.14	**Vibration Monitoring System and TSS for TG & TD-BFP**		
1.00.14.01	Sensors of all types, make etc. for with special cables, Power supply modules, Relay, Driver/Interface Module, and electronic modules used for vibration monitoring system.		20% or two no. (Whichever is more) of each type
1.00.14.02	Pre-fab sensor cable and connectors of all types, makes, range		20% of total quantity installed
1.00.15	**Control desk and Control Panels:-**		
1.00.15.01	Devices mounted on Control desk		Ten (10) percent or 2 nos (whichever is more) of each type
1.00.15.02	LEDs for indicating lights shall be furnished.		100.00%
1.00.15.03	control circuit fuses		One hundred percent spare replacement of each current rating required

1.00.15.04	MCB/MCCB		Ten percent spare replacement of each current rating required
1.00.15.05	Blank Mosaic Grid Tiles.		Ten (10) percent or 20 nos (whichever is more)
1.00.15.06	Push buttons, ILPBs.(complete with contact elements)		Ten (10) percent or 2 nos (whichever is more) of each type and color.
1.00.15.07	Cooling Fans		20% or 2 nos. (whichever is more) of each type, model and rating.
1.00.15.08	Electric meter.		Ten (10) percent or 2 nos (whichever is more) of each type
1.00.15.09	Power supply modules.		Ten (10) percent or 2 nos (whichever is more) of each type

1.00.16 **Mandatory Spares for Solenoid Valves, Control valves, Power Cylinder, Control Dampers, Actuators, Flow Elements and Accessories**

(A) Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.

a) One set of spare control valve stem packing for each control valve.
b) Two molded rubber diaphragms for each control valve.
c) 100% of Diaphragms, O-rings and rubber gaskets, seals for each type, make etc. of control valve.
d) 100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.
e) 2 sets of limit switches and 1 set of valve positioner for each control valve.
f) 20 percent of position transmitter (4-20mA) and its accessories for total qty. of control valve.
g) One (1) set of valve trims (such as plug, stem, seat ring / cage, guide bushing, stem lock pin, packing retaining ring, etc) for each type of control valve.
h) One complete Pneumatic and electro-hydraulic actuator assembly of each type or min 10% for each type, model, rating and size whichever is more.
i) 20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.
j) 20% of I to P converters, Pressure regulators.
k) 10% or 2 nos. of each type whichever is more Air Filter Regulator and air lock relays

(B) Mandatory spares for each type of critical applications special control valves.

a)	Soft Goods Kit Valve	1 Set
b)	Metal seat	1Set
c)	Seat Ring	1Set
d)	Spindle	1Set
e)	Actuator Soft Goods kit	1 Set
f)	Feed back transmitter unit	2 NOS.
g)	Electronic Position Transmitter	2 NOS.

h)	Solenoid valves	2 NOS.
i)	Air Filter Regulators	2 NOS.
j)	Air Lock Relay	2 NOS.
k)	Complete actuator for each type and model	1 Set

C) Following spares shall be supplied for each of the HP/LP By Pass & Spray control valves

a.	Stem	1 NO.
b.	Jet Cage	1 NO.
c.	Nozzle Body	1 NO.
d.	Seat	1 NO.
e.	Guide bushing	1 NO
f.	Valve Packing	1 Set
g.	Valve Gaskets	1Set
h.	Actuator seal set	1 Set

D) Common spares for HP By Pass & Spray control valves system and LP By Pass & Spray control valves system separately:

i)	Feedback transmitter	2 NOS.
ii)	Electronic positioner	2 NOS.
iii)	Proportional Valve	2 NOS.
iv)	Quick opening device	2 NOS.
v)	Seal sets	4 Sets
vi)	Solenoid Valves	2 NOS.
vii)	Filters for Oil Units	1 set
viii)	Supply manifold for oil units	1 No
ix)	Hose for each service	1 each
x)	Seal set for oil unit	1 Set
xi)	Complete actuator for each type and model	1 set

E) 1 No of Nozzle for each PRDS De Super heater & Spray water desuperheater and orifice plate for CEP flow.

F) Solenoid Valves — 20 percent or min 10 no. of each type & model qty. for total (whichever is more)

1.00.17 **Mandatory Spares for Acoustic Steam leak Detection System**

1) Processor and interface module- 10% or 1 no. of each type and model, whichever is more.
2) sensor and Transceivers- 10% or 1 no. of each type and model, whichever is more.
3) Consumables like batteries, fuses etc. for two years operation of Acoustic Steam leak detection system.

1.00.18 **Mandatory spares not covered above**

Bidder to supply 10% or 1 no. (whichever is more) of each type of sensors, instruments, analysers, special instruments, Electronic cards , instrumentation fittings , mechanical fittings etc. for any other electronic system, feeder control cabinets, hydra-step (EWLI), Separator level control

system, Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, Solid flow meter, 3 D Acoustic type level transmitters, Station LAN, MIS, Viscosity Meter, Hydrogen Instruments etc.

i. OTHER RELATED CONTROL AND INSTRUMENTATION SYSTEMS/EQUIPMENTS

1. Other SG related sub-systems

Sl. No.	ITEM		QUANTITY
1	**Flame Monitoring System**		
	(i)	Complete Flame Scanner Assembly including scanner head assembly, scanner housing, and fibre optic cables.	20% or 4 nos. whichever is more.
	(ii)	Flame Scanner Lens.	100%
	(iii)	Electronic cards for scanners	10% or 2 nos. of each type whichever is more.
	(iv)	Power Supply Modules	10% or 2 nos. of each type whichever is more.
2	**Coal Feeders**		
	(i)	Calibration Motor	10% or 2 nos. whichever is more.
	(ii)	Correction Motor	10% or 2 nos. whichever is more.
	(iii)	Motion monitor	10% or 2 nos. whichever is more.
	(iv)	Speed pick-up	10% or 2 nos. whichever is more.
	(v)	Torque switch	10% or 2 nos. whichever is more.
	(vi)	Load Cell	10% or 2 nos. whichever is more.
	(vii)	Electronic cards & Power Supply cards	10% or 2 nos. whichever is more.
	(viii)	Clutch (if applicable)	10% or 2 nos. whichever is more.
	(ix)	Local indication lamps	200% .
	(x)	Panel meters	10% or 2 nos. whichever is more.
	(xi)	Limit switch assembly for coal-on-belt, no coal flow, shear pin failure, etc.	10% or 2 nos. whichever is more.
	(xii)	Coupling (eddy current type etc., if applicable)	10% or 2 nos. whichever is more.
3	**Electromatic Safety Valves**		
	(a)	Pressure switches, local PB stations and solenoid Valves.	10% or 2 nos. of each type whichever is more.
4	**Furnace Temperature Probes**		
	(a)	Thermocouple	2 Nos. of each type
5	**Acoustic Pyrometers**		
	(a)	Signal Processor and interface	10% or 2 nos. of each type and

		modules	model whichever is more
	(b)	Sensors and Transceivers	20% or 2 nos. of each type and model which is more.
	(c)	All electronic cards including power packs	10% or 2 nos. of each type and model whichever is more
	(d)	Seal kit for Sound Generator	10% or 2 nos. of each type and model whichever is more
6	**Furnace and Flame Viewing System**		
	(a)	Flame Cameras	10% or 2 nos. of each type whichever is more.
	(b)	Electronic Modules	10% or 2 nos. of each type whichever is more.
7	**Coal Bunker Level Indicating System**		
	(i)	Sensors of each type	20% or 2 nos. of each type whichever is more.
	(ii)	Electronic Cards of each types, model	10% or 2 nos. of each type and model whichever is more.
	(iii)	Power supply module	10% or 2 nos. of each type and model whichever is more.
	(iv)	Panel indicators/displays for Bunker Level	20% or 2 nos. of each type whichever is more.
8	(i)	Solenoids for SG pneumatic drives/valves.	20% or 2 nos. of each type whichever is more.
	(ii)	Solenoid valves.	20% or 2 nos. of each type whichever is more.
	(iii)	Diaphragms	20% or 2 nos. of each type whichever is more.
9	**Conductivity type level monitoring system**		
	(i)	Electrodes	50% of population of each type and model.
	(ii)	Electronic Cards	20% or 2 nos. of each type and model whichever is more.
	(iii)	Lamps/LEDs of display units	100%
10		**Mill and Air heater Fire detection system.**	
	(a)	Thermocouple	10% or 2 nos. whichever is more
	(b)	Process actuated switches	10% or 1 no. whichever is more
	(c)	Electronic cards	20% or 2 nos. whichever is more
11		Any other instruments (if applicable)	10% or 1 no. whichever is more
12		Any other control system (if applicable)	10% or 1 no. whichever is more

2. Other TG Related Sub-Systems

Turbine Supervisory System/EHTC/TSC/ATT/ATRS/GSPC/TDBFP etc.		
Sl. No.	**ITEMS**	**QUANTITY**
(i)	Power Supply assemblies of all types	10% or 2 nos. of each type whichever is more
(ii)	Temperature Sensing elements	10% or 2 nos. of each type whichever is more
(iii)	CJC assemblies of all types	10% or 2 nos. of each type whichever is more
(iv)	Local gauges/transmitters of all types, range, model no. etc. for Temperature, pressure, DP, differential expansion, axial shift etc.	10% or 1 no. of each type whichever is more
(v)	Process Actuated Switch Devices of all types, range, model no. etc. for pressure, DP, temperature, flow, level, proximity/speed etc.	10% or 1 no. of each type, whichever is more
(vi)	Electronic Cards/PCB's/interface units/special cables etc. of each type of measurement used in TSI.	10% or 2 nos. of each type whichever is more.
(vii)	Instrument valves of all types like isolating, 2/3/5 way valve manifolds, hi pressure reducing, safety relief, each type of solenoid valves etc.	10% or 2 nos. of each type, model etc.; whichever is more.
(viii)	Sensors of all types, range, model etc. for vibration, eccentricity, proximity, differential expansion, axial shift , EHC position, Stop/Control valve position and any other measurements etc.	10% or 2 nos. of each type whichever is more.
(ix)	Electro-hydraulic converter/Servo unit and position feedback transmitter for main turbine	1 set
(x)	Electro-hydraulic converter/Servo unit and position feedback transmitter for LPBP and HPBP	1 set each
(xi)	Electro-hydraulic converter/Servo unit and position feedback transmitter for TDBFP	1 set
(xii)	Any other instruments (if applicable)	10% or 1 no. whichever is more
	Any other control system (if applicable)	10% or 1 no. whichever is more

1.00.20 COMMUNICATION SYSTEM

1.00.20.01 EPABX & TELEPHONE SYSTEM

S. No.	**Item**		**Qty.**
i.	Electronic card & power supply card of each type & model for PC/OWS.	Nos.	1 set or 10% whichever is more.
ii.	UPS & charger		
a.	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)		
b.	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each

			panel /board
c.	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Nos.	Minimum of 15% or at least four (whichever is more) of each type model and rating of SCR and power diodes, power transistors shall be included
d.	Electronic cards for Battery health Monitoring System for UPS and DC control power supply system separately. .	Nos.	10% or at least two nos. (whichever is more) of each type
e.	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating
f.	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.
g.	Digital/Analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)
h.	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)
i.	Cooling Fans in UPS & 24 V DC charger panels	Nos.	20% or 2 nos. of each type and rating, (whichever is more)
j.	Following accessory equipment for the battery shall be furnished : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer e) Supply of corrosion-preventive grease.	Set	Two sets of each type.
k.	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	10% or One set (whichever is more) of each type, model & rating with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.
l.	MCCB for UPS & 24 V DC charger panels and ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)
m.	Battery cells complete with contactor, cover plates etc.	Nos.	Ten (10) percent of each type & Size installed
n.	Rectifier & controller modules for 24 V DC charger system	Nos.	Ten (10) percent of each type & Size installed
iii.	Interfacing cables & Power cords	**Set**	**Ten (10) percent or 1 sets (Whichever is more) of each type/model.**

iv.	Different types and ratings of equipment, accessories used including electronic cards & Power supply card.	**Nos.**	**1 set or 10% (whichever is more), of each type & model.**

1.00.20.02 PUBLIC ADDRESS SYSTEM

a. Handsets

Sr. no.	**item**	**quantity**
i	Handset with cord for outdoor station	10 nos. Of each type.
ii	Handset with cord for indoor station (desk for mounted)	2 nos. Of each type.
iii	Handset with cord indoor flush mounted	1 no. Of each type.
iv	Portable handset	1 no. Of each type.

1.00.20.02.02 **Loudspeakers**

Sr. no.	**item**	**quantity**
(i)	Outdoor horn type loudspeaker	10 nos. Of each type.
(ii)	Indoor cone type loudspeaker	2 nos. Of each type.
(iii)	Cradle switch	2 nos. of each type
(iv)	Push button of all types and models	2 nos. of each type
(v)	Amplifier PCB with all components mounted for wall mounted Handset station	10% of each type
(vi)	Extension Amplifier PCB with all components mounted for all wall mounted handset station (in case different from (v) above)	2 nos. of each type
(vii)	JB's of Handset	2 nos. Of each type.
(viii)	JB's of Loudspeaker	2 nos. Of each type.
(ix)	Electronic modules of all types	10 % of each type

Interfacing cables & Power cords - Ten (10) percent or 2 sets (Whichever is more) of each type/model.

1.00.20.03 WIRELESS SYSTEM (WALKY TALKIE SYSTEM)

a. Five (5) Nos. hand held two way transmitter receiver sets.
b. Battery charger for hand-set batteries – Five (5) Nos.
c. 1 set Electronic card & power supply card of each type & model for Base Stations.

1.00.21 **Mandatory Spares for Station LAN & MIS.**

i. Ten (10) percent or 2 nos (whichever is more) for Electronic modules, routers, bridges, modems, Fire wall, Ethernet switches, Power supply modules, Connectors, media convertor, patch cord, and communication Hardware etc of each type, rating, size, model used for communication network.
ii. 1 no. of each type MIS/LAN Data base server.
iii. 1 no. of each type Work station with monitor and Laptop with compete accessories.

1.00.22	**Flue Gas Analyzers & CEMS**	
1.00.22.01	Flue gas analyser instruments for SO_2, NOx, CO_2, CO analyser and Flue Gas Flow Transmitter	
	Analyser instrument (SO2, NOx, CO2 and CO)	1 no. of each type
	Flow Transmitter	1 no. of each Type.
	Electronic Module	10% of each type
	gaskets/O-rings	2 nos. of each type
	Diaphragms	2 nos. of each type
	Filter and light sources	2 nos. of each type
	Heater/cooler assemblies	2 nos. of each type
	Solenoid assembly	1 no. of each type
	Temp. Sensor and heater assembly	20%
	Complete Probe with shield assembly	1 no. of each type
	Manifold	1 no. of each type and size
	Cooling fans	1 no. of each type, size and rating
	Air flow meter	1no
	Calibration gases of all types and ranges. For hot- extractive/Dilution extractive/In-situ (cross-duct) type analysers	One year supply
	Heavy duty Blower Assembly	1 no. of each type, size and rating
	Calibration Cells	1 no. of each type
1.00.22.02 Opacity analyser		
	Stack Opacity Monitors/ESP/SPM/RPM	1 nos. complete instrument of each make and type
	Electronic Card Assemblies of each type	10%
	Light source bulb	100%
	Air blower and filter unit	10%
1.00.22.03	Tribo electric analyser	
	ESP Dust emission monitor instrument	1 no. complete instrument
	Sensor Assembly	10%
	Electronic card assembly of each type	10%
	Probe extension –Enclosure cover	2 nos.
1.00.22.04	Oxygen Analyser (LT O2 and HT O2)	
	Flue gas analyser instruments for O2 analyser	2 nos. complete Instrument of each Type
	Electronic Card Ass. of each type	10%
	Set of gaskets/O-rings	2 set
	Temp. Sensor and heater assembly	20%
	Air flow meter	1 no
	Consumables like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
1.00.22.05	Mercury Analyser	
	Flue gas analyser instruments for Mercury analyser	1 no complete Instrument

	Electronic Card Ass. of each type	10%
	Set of gaskets/O-rings	2 set
	Consumables like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
1.00.23	**AAQMS**	
(i)	SO2 analyser	
	SO2 analyser instrument	1 no complete Instrument.
	Electronic Card Assemblies of each type	10%
	Sets of Gaskets/"O" rings	2 sets
	Heater Assembly / Thermister	20%
	Air flow meter	1 no
	Consumables like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(ii)	NO-NO2-NOx analyser	
	NO-NO2-NOx analyser instrument	1 no complete Instrument of each Type.
	Electronic Card Assemblies of each type	10%
	Sets of Gaskets/"O" rings	2 sets
	Heater Assembly / Thermister	20%
	Air flow meter	1 no
	Consumables like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(iii)	CO analyser	
	Co analyser instrument	1 no. complete Instrument.
	Electronic card Assemblies of each type	10%
	Sets of Gaskets /"O" rings	2 sets
	Heater assembly/thermister	20%
	Consumable like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(iv)	Dust monitor/Analyser	
	Dust monitor analyser instrument	1 no. complete Instrument.
	Electronic Card Assemblies of each type	10%
	Sets of Gaskets /"O" rings	2 sets
	Air flow meter	1 no.
	Consumable like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(v)	Mercury Analyser	
	Mercury analyser instrument	1 no. complete Instrument.
	Electronic Card Assemblies of each type	10%
	Sets of Gaskets /"O" rings	2 sets
	Air flow meter	1 no.
	Consumable like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(vi)	Ozone Analyser	
	Ozone analyser instrument	1 no. complete Instrument.

	Electronic Card Assemblies of each type	10%
	Sets of Gaskets /"O" rings	2 sets
	Consumable like filter elements light sources etc.	100%
	Calibration gases of all types and ranges	One year supply
(vii)	Wireless equipment	
	Electronic modules including power supply unit	10% of each type
	Modem	1 no. of each type
	Connectors/Patch Cord	2 nos. of each type and length
1.00.24	**IDENTIFICATION**	
	Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.	
1.00.25	**CONTRACT-QUANTITIES**	
	The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.	
1.00.26	**DOCUMENTATION**	
	Bidder shall furnish detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval to enable owner procurement of these spare parts directly from the respective manufacturer.	

1.00.27 Notes:

1. Wherever quantity has been specified percentage (%) the quantity of mandatory spares to be provided by the bidder shall be distributed into various ranges/size/rating/type (as the case may be) in the same proportion of the main population. In case the quantity so calculated happens to be fraction, the same should be rounded off to next higher whole number.
2. Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all items supplied and installed and the breakup for these shall be furnished in the bid.

3. Incase spares indicated in the list are not applicable to the particular design offer by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed in the above list.

4. Interchangeability and Packing:

   All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares shall include all mounted accessories like components, boards, add or items, fittings, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require additional item. All electronic modules should be preset and/or preprogrammed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/ROM listing etc should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/ re programming before putting them in to service. The spare shall be treated and properly packed for long term storage.

5. Identification:

   Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

CHAPTER – 10

STORAGE OF EQUIPMENT/GOODS AT SITE

1.0 SCOPE

1.1 This chapter details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the BIDDER until the same are erected and handed over to the OWNER.

1.2 The equipment covered under this specification shall be stored in the type of storage as recommended by the MANUFACTURER/OWNER/CONSULTANT.

2.0 CONSTRUCTION OF STORES

2.1 Land for labour colony, laydown area for storage of equipment, fabrication yard or any other construction related activities is not available within the plant boundary. Bidder has to make his own arrangement to have these facilities outside plant boundary.

Disposal and cleaning of all construction debris inside the plant boundary and facilities of bidder outside plant boundary are included in bidder's scope.

2.2 To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise wasteful handling during retrieval of items required for erection.

2.3 The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The BIDDER shall check the satisfactoriness of these facilities prior to monsoon.

2.4 The stores sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.

2.5 In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the BIDDER to provide adequate heating / air conditioning facilities on round the clock basis. The BIDDER shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air-conditioners/space heaters inoperative, the BIDDER shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.

2.6 Adequate lighting facility shall be provided by the BIDDER in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the OWNER. The BIDDER shall carry out regular inventory of materials

received, issued and erected and notify the OWNER of any loss when noticed.

2.7 The BIDDER shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.

2.8 Where necessary, the BIDDER shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

3.0 **MAINTENANCE DURING STORAGE**

3.1 The BIDDER shall pack the equipment after inspection and store the same in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks.

3.2 The BIDDER shall carry out frequent inspection of materials stored and also extend necessary facilities to the OWNER / CONSULTANT to carry out such inspection, when considered necessary. The BIDDER shall implement the suggestions of the OWNER/CONSULTANT in this connection.

3.3 At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground by providing good wooden sleepers.

3.4 Welded and cast units shall be stored in such manner that there is no danger of distortion.

3.5 All special measures to prevent corrosion shall be taken by the BIDDER.

3.6.1 Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The BIDDER shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.

3.7 While handling the equipment, no dragging on the ground is permitted. The BIDDER shall submit his scheme for handling major pieces of equipment for approval by the OWNER / CONSULTANT prior to actual handling of the same. In cases where a scheme is recommended by the OWNER / MANUFACTURER, it shall be strictly adhered to.

3.8 The BIDDER shall periodically inspect materials with specific reference to

3.8.1 Ingress of moisture and corrosion damages.

3.8.2 Damage to protective coating.

3.8.3 Open ends in pipes, vessels and equipment. In case any open ends are noticed, the BIDDER shall get them capped.

3.8.4 Insulation of electrical equipment. Regular insulation checks are essential and these values shall be properly logged.

3.8.5 Any damages to equipment / materials.

a) In case of any damages, these shall be promptly notified to the OWNER. In all cases, the repairs / rectification shall be carried out strictly as directed by the OWNER / CONSULTANT.

b) If such repairs / rectification is necessitated due to causes attributable to the BIDDER, such repairs / rectification shall be carried out at no extra cost to the OWNER. In other cases, compensation for such repair / rectification works will be as mutually agreed to.

c) In case such damages are attributable to the BIDDER and if, in the opinion of the OWNER/ CONSULTANT, the BIDDER is not competent to carry out necessary repairs / rectification, the OWNER shall get this done by any other agency and recover the expenditure incurred by him from the BIDDER.

4.0 MODES OF STORAGE

Given below are the general guidelines for storage of various equipments under the broad storage classifications. Wherever the specific recommendations of the MANUFACTURER/OWNER/CONSULTANT are at variance with what is indicated below, the former shall prevail.

4.1 Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

4.1.1 Welding Electrodes

These deteriorate under adverse conditions of storage and are preferably stored in air conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens.

It is essential to regularly inspect the conditions of electrodes and ensure that temperature is maintained within specified range at all times.

4.1.2 **Ball, needle and roller bearings:** These shall be stored in their original packing.

4.1.3 **Photographic materials and films**: These shall be stored in their original moisture vapor proof packages.

4.1.4 **Rubber Goods**: These shall be protected against sunlight and artificial light as well as high humidity conditions.

4.1.5 **Hydraulic / Electronic equipment / instruments and components** - These shall be stored in sealed packages.

4.2 **Closed storage**

The following materials are normally stored in closed storage.

4.2.1 **Cement bags.**

4.2.2 All small parts / components liable to be misplaced / lost. These shall include the following:

a) Small structural cleats, bolts, nuts, washers, etc. High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items

b) Pipe hangers, spring hangers, etc. The identification numbers on spring hangers shall be carefully preserved during storage

c) Stainless steel and copper tubes, pipe fittings, etc.

d) Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.

e) Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes

f) Turbine governing system components

4.2.3 All loose turbo generator parts, turbine sole plates and packing plates, bolts and studs.

4.2.4 Generator and turbine rotors, stators, bearings, liners, control gears, etc.

4.2.5 Boiler fine fittings, soot blowers, mill and fan bearings, hangers and couplings.

4.2.6 Electrostatic precipitator electrodes, connecting links, etc.

4.2.7 Drive units of regenerative air heaters, fans, mills, etc., motors, pumps, blowers, ejectors and compressors, including those supplied disassembled.

4.2.8 Oil and hydrogen coolers.

4.2.9 Seal oil and gas control system equipment.

4.2.10 All indoor switch gear equipment.

4.2.11 Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.

4.2.12 All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.

4.2.13 Thermal and insulation materials. Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.

4.2.14 DM plant chemicals and resins.

4.2.15 Synthetic paints. Normally in separate stores.

4.3 Semi-Closed Storage

The following materials are normally stored in semi-closed storage.

4.3.1 Condenser tubes stored in boxes.

4.3.2 Dust collector elements in boxes.

4.3.3 Coal mill liners, shell, coal feeders and gates, separator assembly.

4.3.4 Boiler dampers, manhole doors, mountings, casing frames, buck stays, Air pre-heater frames tubes, baskets. Burner panels and burners, Electrostatic precipitator shell, discharge and collecting plates.

4.3.5 Fan impellers, large assembled pumps, compressors, crushers, pulleys and idlers, wagon tippler drive assemblies and bearings, outdoor motors, etc..

4.3.6 Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.

4.3.7 Outdoor switch gears and panels, small transformers, cable tray parts, etc.

4.3.8 Crane rope drums, hoists, trolleys. Wire ropes in drums covered with tarpaulin.

4.3.9 Bearing stands

4.3.10 Conveyor belts

4.4 **Open Storage**

The following materials are normally stored in open storage.

4.4.1 Fabricated and un-fabricated structural steel members, Chimney steel, stairways and hand rails. Gallery steel Crane bridges and steel members, Reinforcement steel.

4.4.2 Coarse aggregates and sand.

4.4.3 Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes, Ash disposal pipes.

4.4.4 Boiler, drum, tubes, tube panels and headers.

4.4.5 Mill drums, bunker plates, etc.

4.4.6 Condenser shell parts, water boxes, etc.

4.4.7 Air pre-heater tube plates.

4.4.8 De-aerators, feed water heaters, etc.

4.4.9 Conveyor steel, and wagon tippler parts except drive units

4.4.10 Pressure vessels, reaction towers and columns, Fabricated vessels and tanks shall have their openings firmly blanked.

4.4.11 Flocculator Bridge, D.M. plant filters, vessels, etc.

4.4.12 Cable drums

4.4.13 Power transformers

5.0 SPECIFIC GUIDELINES FOR STORAGE

Given below are the guidelines for certain other major equipment / materials. These are broad guidelines only and storage shall be strictly as directed by the Manufacturer / OWNER / CONSULTANT.

5.1 Condenser

Condenser shells shall be stored on sleepers in open storage. The materials shall be kept resting in such a manner that there is no distortion to the assemblies. The bracings provided at the factory shall not be disturbed. Handling shall be strictly as per the recommendations of the Manufacturer. The tube sheets shall be protected against corrosion and tube holes against scratches. The condenser tubes shall be inspected on receipt and stored in boxes in which they are reviewed.

5.2 Deaerator

The deaerator shall be drained of water and stored dry. The nozzles shall be sealed / capped. If trays are delivered separately, these shall be stored on racks in closed storage.

5.3 Feed Water Heaters, Heat Exchangers, Vessels and Bearings

5.3.1 These equipment shall be drained of water and stored dry, with openings and flanges sealed / capped.

5.3.2 The hooks, eye bolts, etc., provided shall be used for handling these equipment.

5.3.3 All machined surfaces shall be coated with approved protective coating at regular intervals.

5.3.4 Heat exchangers shall be stored in horizontal position.

5.4 Rotating Equipment such as Pumps and Compressors

5.4.1 These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.

5.4.2 The BIDDER is responsible for proper lubrication of these equipment as directed.

5.4.3 The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.

5.4.4 Pumps, if delivered in dis-assembled condition, shall be stored with the parts properly greased and wrapped in paraffin paper. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed; in the cases of equipment such as boiler feed pump.

5.4.5 The shafts of rotating equipment shall be turned by 90° every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.

5.4.6 The BIDDER shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.

5.5 **Piping and Valves**

5.5.1 All pipes shall be stored on sleeper beds with open ends securely capped. The beveled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.

5.5.2 Pipes shall be neatly arranged and stacked for easy identification and retrieval.

5.5.3 Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.

5.5.4 Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service.

5.6 **Switch gear & Control Panels**

5.6.1 Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.

5.6.2 The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.

5.6.3 Insulation resistance shall be measured at regular intervals and megger values properly logged.

5.7 **Transformers**

5.7.1 It is advisable to assemble and set the transformer filled with oil in its permanent location soon after receipt even if it is not likely to be put in service for a while. In case of gas filled transformers, a positive pressure should be maintained during storage as recommended by the Manufacturer. If transformer is to be stored partially or fully dis-assembled, it shall be protected against moisture ingress / absorption by keeping them immersed

in transformer oil or as recommended by the MANUFACTURE / OWNER / CONSULTANT.

5.7.2 Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

5.8 **Cells, Accumulators, Batteries**

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

5.9 **Cables**

Cable drums if stored indoors shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

5.10 **Motors**

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

5.11 **Instruments**

5.11.1 These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.

5.11.2 Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.

5.11.3 In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

5.12 **STEEL**

5.12.1 **Reinforcement steel:**

Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.12.2 **Structural steel:**

Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 200 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid

water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

5.13 **Cement**

5.13.1 Cement shall be stored in bags in a separate shed away from where mechanical and electrical equipment are stored to minimise the possibility of cement dust settling on the equipment.

5.13.2 The storage shed where cement is stored shall be absolutely water tight. The flooring shall be a 150 mm thick concrete slab laid on a dry course soling or as recommended. The ground shall be drained away from the shed to prevent accumulation of water in its vicinity.

5.13.3 The bags shall be neatly stacked with adequate passage in between for easy retrieval. The cement shall be issued on 'First-In-First-Out' basis.

5.13.4 In case different grades of cement are stored in the same shed, each grade shall be stacked separately to avoid mix up and clear indication boards shall be provided to identify different grades.

5.14 **Paints**

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

5.15 **Slings & Wire Ropes**

All slings and wire ropes shall be coated with approved grease and hung from racks in rolled condition.

6.0 **DOCUMENTATION**

The BIDDER'S store-keeping function will include maintaining various records as required by the OWNER / CONSULTANT. These records shall include but not be limited to:

6.1 Supplier wise record of equipment / material received stored and issued for erection as well as stock position.

6.2 Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the OWNER.

CHAPTER – 11

QUALITY ASSURANCE REQUIREMENTS

1.0 INTRODUCTION

1.1 The minimum Quality Assurance/Quality Control (QA/QC) requirements and the services the Contractor is expected to provide to assure "Quality Assurance" are described in this chapter. "Quality Assurance' is defined as the entire program adopted by the Contractor during engineering, procurement and construction to assure conformity with the contract specifications. Quality Assurance/Quality Control procedures proposed by the Contractor should address the QA/QC requirements under the following phases of the project:

(a) Engineering
(b) Procurement
(c) Construction including commissioning and testing

1.2 Contractor shall submit documents to demonstrate that the Contractor and his sub-vendors possess, QA/QC programs meeting the requirements set forth in this chapter. Contractor shall prepare the quality assurance plans for all the offered equipment to cover the overall quality assurance requirements. Contractor shall submit a quality assurance plan along with the bid as per the format enclosed for all applicable equipment & systems.

1.3 The Contractor must submit an organization chart defining the permanent positions responsible for QA/QC accompanied by a brief description of each position's function and responsibility. A second organization chart along with a descriptive write up should also be provided outlining the proposed QA/QC program for this particular project. This chart and write up should identify the personnel responsible for the Engineering Quality Assurance Plan for the completion duration of the project.

2.0 ENGINEERING

2.1 Prior to finalization of contract

Prior to finalization of the Contract, the Contractor shall prepare and submit a project Quality Assurance Plan that covers the engineering phase of the Works. The plan shall be designed for this project and shall address the specifics of how the Contractor will control, monitor and verify the requirements contained in this chapter. The Contractor shall utilize all of his QA/QC resources, manuals and procedures when preparing the plan. Owner shall review the plan prior to utilization and upon issue the plan shall become the basis by which Owner will evaluate the Contractor's engineering QA/QC activities as they relate to this project.

2.2 Owner's Participation

The Owner reserves the right to audit and verify procedures set forth in the Engineering Quality Assurance Plan. This audit right in no way relieves the Contractor from performing the control verification procedures outlined in the plan.

2.3 Engineering Quality Assurance and Quality Control Requirements

Following are the minimum Quality Assurance and Quality Control requirements for the project. The Contractor's Engineering Quality Assurance Plan shall set forth in detail the procedures to satisfy these QA/QC requirements.

2.3.1 Design Control

The Contractor shall define, document and advise the appropriate handling of the following design controls:

(a) Establish internal as well as external discipline relationships.

(b) Qualifications of personnel assigned for each task.

(c) Establish audit procedures to ensure that the design conforms to the requirements.

(d) Define and outline the number of multi-discipline design reviews.

(e) Establish procedures for handling design changes.

(f) Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-contractors.

2.3.2 Document Control

The Contractor must include in its QA/QC Plan the document control procedures defining:

(a) Authorized use of documents

(b) Receipt, logging and distribution of documents

(c) Procedure for updating and implementation of additions and revisions.

(d) Procedure for document transmittal to Owner. Some of the requirements for document transmittal may be covered in other parts of this specification.

2.3.3 Audits

All documents shall be audited by the Contractor for conformance with the QA/QC procedures.

The Owner reserves the right to review design details, either directly or through their Consultants. The Owner may audit detailed design related design, structural/foundation designs / piping design and other areas.

2.3.4 Engineering Sub-Contractor

The subcontracting of detailed engineering to third parties does not relieve the Contractor the responsibility for Engineering Quality Assurance.

2.4 Procurement

2.4.1 Source Quality Control

It is the Owner's intent that the Contractor deal only with Sub-Contractors and Manufacturers (Vendors) who have established and demonstrated effective quality assurance and quality control programs. Owner does require, however, that the Contractor perform such normal inspection of Sub-contractors'/Vendors' work as is necessary to obtain equipment and materials conforming to the project specifications and their supporting documents (applicable codes and industry consensus standards) and good engineering, fabrication practices as described herein. Source Quality Control is also a valuable input for confirmation of delivery performance.

Minimum inspection requirements in respect of electrical and instrumentation / control equipment and civil works are covered in their respective specifications. Prior to finalization of the contract, the Contractor shall prepare and submit a Project Quality Assurance Plan that covers Procurement and a requirement for procured items for the complete Works.

2.4.2 After Award of Subcontract

Once Sub-contractors and manufacturers are established, Owner and the Contractor shall review item-by-item all major engineered equipment and systems and any special fabrication/fitting to reach an agreement on the need for prefabrication/pre-inspection meetings.

2.4.3 Owner's Participation

2.4.3.1 The Owner reserves the right to audit the performance of the Sub-contractors/manufacturers and the Contractors inspection effort. This is normally accomplished by visiting the Sub-contractors/Manufacturers with the Contractors' Inspector at pre-selected points during manufacture. Contractor shall identify notification points so that the Owner can be present at particularly important stages of fabrication should the Owner wish to attend. The notification points are not hold points unless specifically identified as such. Should Owner select not to or fail to attend, the Work shall proceed without interruption. The Owner reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-Contractor and/or the Contractor's inspection effort. Owner may wish to hold technical meeting with the machinery Sub-Contractor during the design and fabrication of the machinery. Should Owner desire to hold technical meetings, the Contractor will be advised at a reasonable notice.

2.4.3.2 During audit visits to fabricator shops, Owner may select to spot-check base materials and welds to verify proper metallurgy using whatever methods Owner may wish to utilize, but only in the presence of Contractor's Inspector unless otherwise agreed. Some of these requirements have been identified in the minimum inspection requirements listed in this chapter.

2.4.4 Communication

2.4.4.1 Direct, timely communication between the Contractor's Inspectors and Owner's auditing Inspectors is mandatory, especially in notification points and in the event of problems, Owner shall be advised in a timely manner of all situations where changes or compromises in specifications are considered

or where non-conformances are being encountered. Suggested format for inspection request is enclosed with this chapter. The Contractor shall give advance notice of thirty (30) days for all overseas travel and fifteen (15) days for travel inside India.

2.4.4.2 Rejection reports shall be e mailed by the Contractor's Inspector from works directly to Owner's Representative at the same time as e mailed to the Contractor's home office. Reports shall be e mailed to Contractor's home office for typing, editing and transmitting to Owner.

2.5 QA/QC Requirements

2.5.1 Inspection Plan

Inspection plans with detailed instructions for the Inspector's guidance shall be provided for each item. The Contractor shall develop the QA plans for all other equipment/systems on a similar basis as indicated in the Tables above. The Contractor's procurement Inspection function shall begin with the award of the purchase order and concludes when the Inspector (including inspection by client's inspector wherever applicable) has duly released the equipment in the Sub-contractor's shop.

2.5.2 Inspection Office

2.5.2.1 The Contractor shall identify the key inspection office located at its engineering and construction office. All inspection assignments, inspection instructions, after placement of the purchase order shall be covered from this designated office.

2.5.2.2 One individual in the Contractor's key inspection office shall be designated to fill the function outlined in 2.5.3 and must report to the Contractor's Manager of inspection. Additional staff may be added as necessary, provided they are under the supervision of the individual designated. This individual will hereafter be referred to as the "Quality Control Project Inspector (QCPI)".

2.5.2.3 For technical problems arising during manufacturing, after purchase orders are placed, the QCPI is responsible for clearing such technical problems with Engineering and/or Owner. All purchase orders shall have a clause requiring the Sub-Contractor to submit all questions of a technical nature concurrently to the QCPI and requisitioning Owner in writing through fax or letter for resolution. The QCPI shall be responsible for obtaining replies from engineering, documenting the response to the Sub-Contractor and making distribution. The assigned QCPI shall be on distribution for all other correspondence. When technical requests arise from rejection made by the Contractor's source Inspector, the source Inspector's rejection report must be attached to the Sub-Contractor's request for engineering evaluation.

2.5.3 Inspection Co-ordination and Responsibility

The QCPI shall have the overall coordination responsibility for inspection activities. The QCPI's responsibilities shall include, but not be limited to the following:

(a) Issue assignments for source inspection.

(b) Issue specific inspection instructions when required to the assigned source inspector.

(c) Indicate the required type of report forms.

(d) Coordinate and respond to questions of a technical nature.

(e) Monitor inspection reports to determine if inspections are being performed as per written instructions.

(f) Forward all related order correspondence to the assigned source Inspector.

(g) Receive inspection reports from the source Inspector and make distribution as required.

(h) Ensure that comprehensive files are maintained for each job.

2.5.4 **Inspector's Qualifications**

The Contractor shall submit with their QA/QC Manual resumes of contractor's inspectors detailing their experience, education and qualifications for Owners review/approval. The Inspectors shall have sufficient prior experience and qualifications for the equipment assigned.

2.5.5 **Inspectors responsibilities**

After receiving the assignment from the QCPI, the source Inspector shall review the order, conduct a pre-inspection meeting (when instructed), perform the inspections outlined, maintain field file in an organized manner and report the results to the key office and Owner. The following is a more detailed, but not inclusive, list of what Owner typically expects from the Contractor's source QCPI:

(a) Pre-fabrication meeting – the Contractor's Inspector shall conduct a pre-fabrication meeting with the Sub-contractor prior to start of fabrication. The discussion shall include, but not be limited to a review of the following items:

(i) Purchase order requirements with emphasis on any special requirements (technical and quality).

(ii) Code Requirements.

(iii) Sub-contractors Quality Control Programs.

(iv) Fabrication Schedule.

(v) Major Sub-contractors.

(vi) Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Welder Performance Records (WPR).

(vii) Non-Destructive Examination Requirements.

(viii) Testing – Hydrostatic and Pneumatic.

(ix) Manufacturer's Data Reports.

(x) Preservation, Packing and Shipping.

(xi) Extent of Owner / Contractor Inspection.

(xii) Witness Points and Hold Points and Notice requirements.

(b) Initial inspection visit: The Inspector shall perform as a minimum, the following inspection activities prior to start of fabrication.

(i) Review fabrication schedule to ensure required Quality Control examinations and other intermediate tests have been included.

(ii) Establish approval of major Sub-contractors.

(iii) Verify that Welding Procedures and Procedure Qualifications have been approved.

(iv) Verify that all welders assigned to job are qualified.

(v) Review Mill Test Reports to verify materials meet specifications.

(vi) Review Sub-contractor's Examination and Inspection Plan.

(vii) Review Sub-contractor's procedure for identifying and transferring material markings.

(viii) Make a visual examination of major materials, verify Sub-contractor's examination of all materials, and verify proper storage facilities (environment and security).

(c) Progressive inspection visits: The following minimum activities, where applicable, shall be executed and reported upon by the Inspector:

(i) Monitor on a random basis the transfer of material marking throughout the fabrication.

(ii) Initial and random inspection of edge preparation, root gap and fit up for all vessel and fabricated machinery components.

(iii) Initial and random witnessing of production welding to verify approved procedures, qualified welders and proper techniques are being used.

(iv) Ensure that welding materials are being properly controlled.

(v) Inspect major weld seams, nozzle and attachment welds, overlay welding and any weld repairs.

(vi) Perform random check of back gouging of pressure retaining welds.

(vii) Inspect critical/major materials from sub-Sub-contractors.

(viii) Check nozzles / man ways for size, rating and extension.

(ix) Check dimensions and workmanship of components.

(x) Examine gaskets and bolting against specifications.

(xi) Check location and attachment welds for support clips, lugs, brackets and saddles.

(xii) Make final visual inspection for quality of work and for damage.

(xiii) Make complete dimensional inspection.

(xiv) Witness all hydrostatic and pneumatic testing.

(xv) Witness routine and special testing as may be outlined in project specifications or data sheets for Electrical and Instrumentation chapters.

(xvi) Assure electrical and instrument function and operational checks have been performed as per project specifications.

(d) Non-destructive Examination (NDE) – The Inspector shall perform as a minimum, the following NDE activities during progressive inspections:-

(i) **Radiographic examination (RE)**

- Review Sub-contractor's radiography procedures for approval.
- Review all radiographs progressively through out fabrication.
- Evaluate for acceptable film quality and weld quality.

(ii) **Ultrasonic examination (UE)**

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness at least 25% Ultrasonic examinations
- Review certified results

(iii) **Magnetic particle examination (MPE)**

- Review Sub-contractor's procedures and Inspector qualifications.
- Witness the initial MPE examinations and 10% minimum of all MPE examinations, as well as all examinations after repair.

(iv) **Liquid penetrant examination (LPE)**

- Same as for MPE

(v) **Hardness testing – production welds**

- Review procedure and witness initial tests
- Verify 10% of hardness values during progressive inspections.
- Review all hardness readings for acceptance per specifications and require certified results.

(e) **Shipping**

(i) Verify that all shipping requirements related to cleaning, dry out, surface preparation.

(ii) Verify that pressure equipment is appropriately code stamped and all "Manufacturer's Certified Data Reports" are complete and properly signed.

(iii) Verify required documentation for acceptance and record is complete.

2.5.6 **Inspection Reports**

2.5.6.1 Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found /corrected at that time. Final checklists should indicate all items inspected during interim inspections.

2.5.6.2 Inspection rejection reports shall be by telefax to the key office and Owner when the Sub-Contractor's proposed resolution deviates from order specifications, or would require repairing.

2.5.6.3 Final inspection reports shall be by check off for all major equipment and bulk piping components. The check off indicates the inspections were performed and would be covered on an interim inspection report.

2.5.6.4 Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order have been met. The Sub-contractor shall be given the inspection release certificate as authorization to present final billing to the Contractor and a copy of same shall be attached to the packing list to serve as notification to the job site of inspection approval.

2.6 **Construction**

2.6.1 **Owner's Participation**

Owner will have a Quality Assurance/Quality Control organization to audit the Contractor's QC effort. The assigned Owner's personnel will provide assurance to Owner's management that the Work meets specifications, however, the basic inspection and quality control responsibility is vested with Contractor.

Owner's auditing may include spot checks of materials including their testing in the field to ensure that inadvertent substitutions have not been made in the fabrication shops or mixing point or in field ordered materials. Owner's auditing shall also include testing of concrete, cement mortar, etc.

2.6.2 **Communication**

2.6.2.1 Direct, informal communication between the Contractor's field Inspectors and Owner's auditing Inspectors is mandatory. Further Owner shall be advised when major problems related to design or fabrication is uncovered.

2.6.2.2 Contractor's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Owner's auditing Inspectors during the course of the Works.

2.6.2.3 At the end of the Work, Contractor's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be turned over to Owner in an organized, agreed upon format. Contractor shall verify that all of the required documentation of the equipment has been received and placed in the equipment files. The Contractor is responsible for obtaining any outstanding documentation from the suppliers.

2.6.3 **Construction QA/QC requirements**

2.6.3.1 It is the Owner's intent that the Contractor (and any Sub-contractors employed) provides sufficient qualified Inspectors to assure that facilities are installed in accordance with the plans and Owner's specifications and intents and that the level of quality called for therein is obtained. Prior to finalization of Contract award, the Contractor shall submit a detailed Field Quality Assurance Program for Owner's review. The program must be tailored to show compatibility with engineering design, compliance with applicable codes, specifications, standards, drawings, support documents, governmental regulations and this document.

2.6.3.2 For the construction period, the Contractor shall provide a full time, dedicated Quality Assurance Organization. As a minimum the Contractor's Construction Quality Assurance Program shall include the following: -

(a) **Quality Control Program**

Details of the program to be implemented, its use, control and identification of hold and inspection points shall be submitted to Owner for approval.

(b) **Organization, Authority and Responsibility**

Delineate the Contractor's Quality Control organization, responsibility and authority for performance of QC functions by discipline.

(c) **Inspector Qualifications**

The Contractor's Construction Assurance organization shall consist of people with qualifications similar to the requirements outlined in clause 2.5.5. The field QA organization will be a full time organization, with no other construction-related duties. As with engineering and procurement, Owner will review Construction QA staffing plans/

(d) **Document Control**

This system shall ensure that the latest issues of drawings, specifications, standards, and supporting documents shall be used for fabrication and installation and that field changes are incorporated into final "As Built" drawings.

(e) **Receiving Control**

Procedure for receipt of purchased items delivered at the job site initial identification, qualification and review of supporting documents shall be described. In addition, the procedure shall ensure that spare parts supplied by Contractor are properly labeled by the Sub-Contractor with description and purchase order number.

(f) **Receiving inspection**

This shall establish the method of notification and inspection to be performed on received items to verify the condition and conformance to the appropriate acceptance standards reference or contained in the purchased documents.

(g) **Sub-contractor Non-conformance**

This shall provide for documentation and disposition of non-conformances resulting from Sub-contractor errors and shipping damage to material, fabrications and equipment received at the job site. It also provides for interface with the design engineer when the non-conformance does not comply with the engineering design.

(h) **Storage and Maintenance of Materials and Equipment**

This system shall describe the controls and inspection performed to show that the handling, storage and preservation of materials and equipment are performed to prevent damage or harmful deterioration to the materials and equipment received at the job site.

2.6.5 **Inspection, examination and testing of on-site fabrication and installation**

2.6.5.1 This chapter shall establish the responsibility for performance and recording of examinations, tests and inspections as required by the engineering design.

2.6.5.2 Inspection of work in progress to determine conformance with drawings, specifications, any field definition agreed to shall be included. Some of the inspections are listed below:

a. Soil testing

b. Pile driving record data (if applicable)

c. Structural concrete

d. Performing random dimensional check and visual material verification of field fabricated pressure equipment and of any piping, vessel, electrical and instrumentation installation.

e. Internal checking of all vessels for:

   i. Cleanliness

   ii. Proper internals. This involves opening the vessel manways and removal of internals.

f. Witness testing and installation of items such as:

   i. Welder testing and qualifications and maintenance of records thereof.

   ii. Weld examination and maintenance of records thereof in accordance with applicable codes and specifications.

   iii. Hydro tests, hydro-pneumatic tests, pneumatic tests, lead and service tests.

   iv. Electrical inspection and testing which includes witnessing of Hipot testing, megger testing, AC power factor testing etc.

   v. Instrument model/name plate data verification

   vi. Instrument installation checkout

   vii. Instrument loop checks

   viii. Mechanical and electrical equipment bearing flushing and filling.

   ix. Mechanical equipment cold alignment checks and rotation verification.

   x. Witness verification that piping loads on machinery equipment meet specifications.

   xi. Pump installation check out

   xii. Coating and lining tests

   xiii. Surface preparation, paint application and thickness verification.

g. Final checking of installed facilities, completing check out forms, and signing on behalf of the Contractor documents attesting completion of the work, as called for in the Contractor documents.

h. Monitoring or inspecting the work of Sub-contractors - This requires pre-award and pre-field start meetings for major subcontracts with Contractor's / Sub-Contractor / Owner participation to establish quality (QA/QC) requirements and how they will be met. Typical areas/disciplines may include, but not be limited to the following:

i. Foundations
ii. Field fabricated vessel
iii. Tanks
iv. Piping
v. Electrical
vi. Instrumentation
vii. Insulation
viii. Painting
ix. Buildings

i. Execute Contractor's standard quality tracking program.

j. Perform final check of installed facilities with Owner's representatives to verify completeness and accuracy in accordance with P and ID's / Engineering Flow Diagrams and other scope documents as may be required.

k. "Source" inspect/monitor any field award shop fabrication orders as specified.

l. See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

2.6.6 **Non-conformances of on-site Fabrication and Installation**

This chapter shall control on-site fabrication and installation items, which do not conform to the engineering design or for which the engineering design is incorrect.

2.6.7 **Calibration of test equipment**

Calibration of tools, gauges, instruments and other measuring and testing devices shall be included.

2.6.8 **QA personnel qualification and certification**

The qualification required of QA/QC personnel shall be outlined.

2.6.9 **Quality assurance/Quality Control Records**

The system, which shall ensure that all quality assurance records are maintained for ready reference and shall also provide for the accumulation, evaluation, retention and distribution of QA/QC records.

2.6.10 **Interface with Statutory Authorities**

Participation of statutory authorities, which require testing, witnessing and inspection, shall be provided.

2.6.11 **Audits**

Requirements for audits to verify implementation of the QA/QC program on a regular basis shall be included.

2.6.12 **Mechanical Completion Acceptance**

Contractor shall perform final inspection of the Work in accordance with the Contract documents.

2.6.13 Periodic reporting of QA/QC activities (once a month or earlier) as required shall be submitted.

2.7 **Inspection at Works**

Owner shall witness all the tests including performance tests of all the items like fans, pumps and all other equipment in contractor's/sub-contractor's works before dispatch.

INSPECTION REQUEST FORM

From :

To :

Attention:

Dear Sirs,

Items detailed below are ready for inspection. Please arrange inspection and confirm the date of inspection.

1.	Owner	:
2.	Project	:
3.	Owner's order reference	:
4.	Consultant's reference	:
5.	Sub-order reference	:
6.	Sub-contractor's name and full address	:
7.	Place of Inspection (full address)	:
8.	Contact person, telephone no. and fax no.	:
9.	Description of item and quantity	:
10.	Nature of inspection required	:
11.	Proposed date(s)	:
12.	Weekly holiday	:

We confirm that the items have been fully inspected/tested by us at all stages, of inspection as per quality plan, and all material test certificates, QC records, test Reports, calibration records of measuring/testing instruments with tractability to national level are available with us.

Thanking you and awaiting your confirmation.

Yours sincerely,

cc: Sub-contractor

QUALITY ASSURANCE PLAN FOR MECHANICAL

I N D E X

SECTION - M1

STEAM GENERATOR & AUXILIRIES

1.0. SHOP TESTS FOR STEAM GENERATOR

2.0. Pressure parts

The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.

All Plates above 40mm & all bar stock / forgings above 40mm diameter shall be ultrasonically tested. For pressure parts, plates of thickness equal to or above 25 mm shall be ultrasonically tested.

I. Separator

(a) Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160 1999 / equivalent ASTM standards. Elevated temperature tensile tests shall also be carried out on plate material for each heat.

(b) After cutting to size and removal of cut outs, the plates shall be subjected to magnetic particle test along the edges of the plate and on areas adjacent to the cutouts.

(c) All forged connections shall be examined by 100% UT before machining.

(d) Fully machined connecting pieces of internal diameter 100mm and above, shall be subjected to magnetic particle examination.

(e) Mechanical tests shall be carried out on specimens prepared from the production control test plates of the longitudinal welds.

(f) Mechanical tests shall be conducted on the specimens from manhole cutouts of dished ends.

(g) All butt welds shall be subjected to 100% radiographic examination before stress relief.

(h) On completion of welding, the entire Separator shall be subjected to stress relieving in the furnace.

(i) All butt welds shall be subjected to 100% ultrasonic and magnetic particle examination after stress relief.

(j) All full penetration welds shall be subjected to ultrasonic examination after stress relief.

(k) After stress relieving (SR) all welds, internal and external shall be examined by MPI methods depending on size and accessibility and all butt welds shall be subjected to 100% radiography.

(l) All connecting tubes & pipes shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.)

(m) **Hydraulic Test and Pneumatic Test :**

Complete Separator shall be subjected to hydraulic pressure test and all compensating pads to be pneumatically tested.

II. Headers

(a) Raw material for headers shall be subjected to UT prior to fabrication as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

(b) All butt welds shall be subjected to RT examination. Also MPI after SR.

(c) All full penetration nozzle and attachment welds shall be subjected to UT prior to stress relieving.

(d) All nozzles, branches, stubs and load bearing attachment shall be examined by MPI techniques after the toes of the weld have been ground smooth and stress relieved.

(e) Non-load bearing welds shall be examined by MPI techniques after the toes of the welds have been ground smooth and stress relieved.

(f) Completed closed end headers shall be subjected to hydraulic pressure tests and all compensating pads to be pneumatically tested.

(g) All weld joints in alloy steel headers of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. 3% hardness check shall be carried out on welds of other alloy steel Headers.

III. Tubes & Tube Elements

a) Raw material pipes/ tubes for water wall, superheater, reheater, Economiser, riser, supply and connecting tubes including nozzle/stubs, connections, headers Pipe work etc. shall be subjected to 100% UT prior to fabrication as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.

b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces.

c) All tubes/stubs/panels/coils shall be checked for clearance by steel ball test and for cleanliness by sponge passage.

d) Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%.

e) Minimum 10 % of the fillet joints shall be subjected to MPI/LPI. However Fillet welds of material grades P 5B and above or any other equivalent new material grade subject to the acceptance by Client/ Consultant shall be subjected to 100% MPI/ LPI.

f) Tubes and fabricated panels/coils shall be subjected to hydraulic pressure test excluding loose tubes but including burner panels, reheaters, superheaters & economizers.

g) 10% hardness survey on butt welds of P5B material group and above.

h) In case of RT of tube welds with DWDI (elliptical view) number of exposure shall be as per relevant code/ plant standard and will not be less than two exposures for each weld.

IV. Boiler Piping

a) All raw materials used shall have co-related mill test certificate meeting material specification.

b) All pipe lengths shall be subjected to 100 % ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

c) All bent pipes shall be checked for ovality and thinning by UT on first off lot & on random samples for subsequent pieces. Outer surface of bends shall be subjected to MPI/LPI.

d) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrant check. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

e) All butt welds in alloy steel piping of P91, X20 and X 22 shall be checked for RT/ UT and MPI after SR. UT shall be of Digital Recordable Type.

f) All weld joints in alloy steel piping of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. For PWHT Induction Heating shall be deployed. However PWHT can be done in furnace also. 3% hardness check shall be carried out on welds of other alloy steel piping.

g) All load bearing attachment welds shall be subjected to MPI after SR.

h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with.

1. Temperature > 400 Deg, C and/or pressure exceeding 71 bar.

   i. 100% RT/UT on butt welds and full penetration branch welds.
   ii. 100% MPI.

2. Temperature > 175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.

   i. 100% RT/UT on butt welds and full penetration branch welds for pipe diameter more than 100 NB.
   ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.
   iii. 100% MPE.

3. For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

   i. Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

V. Fittings

1. Raw material of all forged fitting shall be ultrasonically tested. All mother pipes used for formed fitting shall be ultrasonically tested as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.

2. Fittings shall be subjected to suitable NDT as per applicable standards. However following minimum. NDE requirement shall also be applicable / met.

   i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
      - For use above 71 bar design condition.
      - For use above 400°C design condition.
   ii. For fittings X20, P-91 and material group 5B & above
      - 100% MPI &
      - 10% hardness check &
      - For fittings of 200 NB & above 100% UT/RT
   iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.
   iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

VI. VALVES

a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table A.

b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI

16.34/ IBR.

e) Air seat leak test shall be carried out as per applicable Standards/Codes.

f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet.

1. Smooth operation
2. Valve travel, closing and opening time.
3. Current drawn by actuators.
4. Springs for safety valves shall be tested with suitable NDT and for spring rate.
5. Safety and safety relief valves shall be tested for performance.
6. All forgings rounds above diameter 40 mm shall be ultrasonically tested.

Table - A
NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above but below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on changes of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT (on 100% area)

Note:
- For body and bonnet forgings UT with MPI may be adopted in place of RT.
- For austenitic steel MPI may be replaced by LPI.

I. Non Pressure Bearing Attachments

Load bearing welds shall be subjected to examination by ultrasonic testing (UT) and magnetic particle inspection (MPI) techniques after stress relief (SR). No load bearing welds shall be subjected to MPI after stress relief. The toes of the welds adjoining the /separator shall be ground smooth prior to stress relieving before carrying out this examination.

II. Fuel oil heater

Hydraulic pressure test shall be carried out on the heating coils. All pipes, valves steam traps and mountings shall be subjected to hydraulic test as called for under IBR, BS or other approved codes.

III. Soot Blowers

a) Butt weld between nozzle and lance tube shall be subjected to 100 % radiography tests.

b) Hydraulic test on valve body

c) Soot blower shall be subjected to operational checks as below:
   1. Smooth operation
   2. Long Tube travel, closing and opening time.
   3. Current drawn.

IV. Steam Generator Boiler Start up Drain Re-circulation Pump

a. Raw material for casing, shaft and impeller shall be tested for high temperature physical properties, apart from mandatory & supplementary check of material specification.

b. All forging and castings shall be subjected to 100% UT/RT and MPI/DP check.

c. Static and dynamic balancing of the rotary parts shall be carried out.

d. Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.

e. Interchangeability shall be maintained and checked.

f. Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.

g. Following test shall be carried out on assembled units : -

Type Test:

i. NPSH test
ii. Temperature rise test.
iii. Under voltage test.
iv. Quality assurance proof test.
v. Tests to establish unit functioning of pump at temp and pressure.
vi. Hot standstill and start up tests.

Routine Test:

i. Hydrostatic test of complete unit.

ii. Overspeed test.

iii. Tests to determine unit characteristics

iv. Pump performance.

v. Unit run at rated voltage

vi. Starting current at rated voltage.

vii. Cold start up test.

viii. Endurance test of motor windings, joints and terminal seals

ix. Noise level.

x. Inspection of dismantled unit.

xi. High voltage test.

xii. For heat exchanger for these pumps, butt welds on pressure parts shall be tested with RT/UT and all other welds shall be tested with MPI/LPI. Hydraulic test shall be carried out both on tube side as well as shell side at min. 1.5 times the design pressure.

V. Hydraulic Test

a) All components which are to be subjected to fluid pressure shall be tested to minimum of 150% of the design pressure. In determining the value of the maximum attainable pressure for any component the contractor shall take in to account all relevant factors (e.g. safety valve blow off pressure, fluid surges, etc.) which may cause an elevation in the pressure. The contractor shall furnish details of the basis of the calculation of maximum attainable pressure tests. The duration of the pressure tests shall be sufficient, as approved by the Engineer, to show any leakage paths and to permit a through examination of the component whilst under pressure.

b) The temperature of the fluid used for the pressure test shall be such as to avoid any possibility of brittle fracture at a low temperature and the same to be modified and submitted to the Engineer for approval, before commencing the test.

c) The fluid used shall be of a sufficient purity and where relevant, inhibits to avoid excessive corrosion and /or damage to temporary parts either during the test or prior to drying and cleaning.

VI. Pneumatic Test of Compensating Pads:

All compensating pads shall be provided with two-threaded weep holes to test welds at 0.5Kg/sq.cm (g) with soap solution and "no leakage" shall be ensured.

2.0. ROTATING AND OTHER EQUIPMENTS/ITEMS FOR STEAM GENERATOR

2.1.

a) The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.

b) For sleeve bearing, UT shall be carried out on the babbitting of bearing. Dye penetrant check shall be done on edges.

c) Blue matching is to be performed between components.

2.2. **Air Preheater**

(a) Forged shafts coming under air preheater like stub shaft, main rotor forging, housing hub shall be subjected to 100% UT at mill and magnetic particle inspection after machining.

(b) For non-modular design trial assembly is to be carried out at shop prior to despatch to site.

(c) Critical welds of rotor post shall be subjected to radiographic examination.

(d) Trial run of Air preheater Rotor drive assembly (Gear Box + pinion + Electric motor + air motor) needs to be carried out at shop.

2.3. **Fans: Induced Draft, Forced Draft and Primary Air fans and GR fans**

(a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.

(b) Butt welds in rotor components shall be 100% RT and all welds shall be magnetic particle tested after stress relieving.

(c) All rotating components and assemblies of fan shall be balanced dynamically to quality grade 2.5 of ISO 1940.

(d) Test for natural frequency of all fan components, including fan blades shall be carried out for ID, FD, GR & PA Fans.

(e) ID Fan Hydraulic Coupling shall be checked for String Test i.e. Operational check of one fan assembly using Hydraulic coupling to include tests Temperature rise check, smooth operation, Vibration & Noise level. Dry run test shall be carried out during string test.

(f) Performance Test shall be carried out for each ID/FD/PA/GR Fan instead of one (1) for each type and size.

2.4 **Fans: Seal air Fan, Scanner air fans**

a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.

b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI / DPT after stress relieving.

c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO 1940.

d) Full range performance test shall be carried out as per BS 848, Part-1.

2.5 Coal Mills, PF Piping and Burners

i. Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.

ii. Wear-resistant parts shall be UT/ RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out. For ceramic materials check for various properties including hardness, density, wear rate and composition shall be carried out.

iii. Butt welds in the tube/ separator /body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.

iv. All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.

v. Fabricated pipe welds should be examined by MPI.

vi. Ceramic/basalt lined piping/bends shall be checked for proper layout.

vii. Weldments on burner components shall be checked with suitable NDT. The burner assembles shall be tested for operation at shop.

viii. Trial assembly (stacking) of atleast two Mill complete with all major components needs to be carried out at shop.

2.6 Coal Feeders

a) Any welds in the casing/ pulley fabrication shall be checked with MPI.

b) Type tests including degree of protection and routine tests shall be done as per relevant Indian Standards or equivalent International Standards.

c) All major items like plates for casings, head pulley, tail pulley, Pulley shaft and major castings shall be procured with respective material test certificates.

d) Explosion proof test at 50 psi as per NFPA code shall be done as type test. Leak tightness test shall be done on individual feeder casing. Endurance test for load cell shall be carried out.

e) Test for weighing accuracy, calibration and repeatability shall be carried out at various speeds by a coal flow on two feeders.

f) Calibration check shall be carried out on all feeder cabinet/assemblies prior to dispatch.

2.7 Fuel Oil Pumps

(a) Bar stock/forging above 40 mm diameter shall be subjected to UT. Impeller and rotor shall dynamically balanced.

(b) Pump assemblies shall be subjected to hydraulic test.

(c) All pumps including spare cartridges shall be subjected to performance test at the manufacture's works under as near site conditions as possible and strip down examination after the test.

2.8 EOT CRANES

1.0 Hooks

1.01 All Tests including Proof Load Test as per relevant IS shall be carried out.

1.02 MPI/DPT shall be carried out after proof load test.

2.0 Steel Casting

2.01 DPT on machined surface shall be carried out.

3.0 Griders, End Carriage, Crab, Gear Box, and Rope

3.01 The plates of thickness 25mm and above shall be ultrasonically tested.

3.02 NDT requirements on weldments shall be as follows:

a)	Butt Welds in Tension	100% RT and 100% DPT
b)	Butt Welds in Compression	10% RT and 100% DPT
c)	Butt Welds in Rope	100% RT and 100% DPT
d)	Fillet Welds	Random 10% DPT

4.0 FORGINGS (wheel, gears, pinions, axle, hooks & hook trunion).

4.01 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to **Ultrasonic test**.

4.02 PT/MPI shall be done after hardfacing and machining.

5.0 Wire rope shall be tested as per IS: 3938.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per IS-3177 shall be carried out at shop.

All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

2.9 Lube Oil systems/ Hydraulic Power Pack

Lube Oil system/ hydraulic power packs shall be tested for performance.

Fans & pumps which are not mentioned in other clauses above shall be dynamically balanced and functionally tested at Manufacturer's works. Complete performance tests shall be carried out on first pump/fan of each type and capacity to verify its output against total head, power input, efficiency, vibration and noise level. Head/volume, efficiency and power input curves corrected for site conditions shall be furnished.

2.10 **Dampers**

a) All the dampers shall be subjected to operational test/checks.

b) Leak tightness of test of Dampers / Gates.

c) All dampers shall be checked for sealing dimensions to establish guaranteed tightness.

2.11 **Boiler Structure, Ducts, Hoppers etc.**

Steel Structure of Boiler, Mill Bunker building including Coal bunkers, Coal transfer points. Coal conveyor galleries and supporting trestles, Ducts, Hoppers, etc

a) Only material which has been identified against mill sheet or test certificates shall be used for construction. Structural steel and built up plate girders for main boiler shall be fully killed fine grained and normalised. All plates of tension and compression flanges and connection material and plates above 40mm thickness shall be 100% ultrasonically tested..

b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.

c) NDT requirements of structural steel welds (other than Coal Bunkers) shall be as under:

   i. 100% RT/UT on butt-welds of plate thickness > 32 mm.
   ii. For plates of thickness > 25mm & < 32mm - 10% RT and 100% MPI
   iii. For plates of thickness < 25mm - 10% MPI/LPI.
   iv. All fillet welds of built up plate girders shall be inspected 100% by MPI.

d) (Edge for field weld shall be examined by MPI for plate thickness > 32mm. Edge for field weld for ceiling girders shall be examined by UT for 100mm from the edge).

e) Ceiling girders/columns, ducts hoppers & tunnels shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive girders along with cross member shall be assembled at a time.

f) Production test coupons for Butt and fillet welds of Main columns, ceiling grinders shall be carried out.

g) Coal Bunkers / Bins

   i. 10% DPT after back gouging.

ii. 5 % spot radiography test on butt welds. Where access not available, UT shall be carried with prior approval of Client/Consultant.

iii. Full penetration welds (other than butt welds) shall be subjected to 10% Ultrasonic testing.

2.12. **Hangers & Supports:**

a) All major raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test and shall meet the requirements of specification.

2.13. **Metallic Expansion Joint (if applicable)**

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by Client/Consultant on a prototype expansion bellow, as defined in Sec.D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

2.14 **Thermal Insulation, Lagging & Cladding:**

a) Lightly resin bonded mineral wool:

LRB mattresses/sections of Rockwool/ Glasswool shall confirm to & tested as per relevant clauses of Indian Standards. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal

Conductivity Type Test shall be carried out minimum once in six months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification.

b) Castable Refractory:

Fire Bricks / Castable Refractory confirming to & tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Castable Refractory shall have proper identification, supplier name, customer name, Batch No., Date, material name & Net weight in Kgs. with proper instructions for handling.

c) Lagging &Cladding:

All insulation shall be protected by means of an outer covering of Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of specification.

3.0. FIELD /ERECTION CHECKS FOR STEAM GENERATOR & AUX.

Raw Material, In process and Non Destructive Testing indicated during manufacture shall be applicable for site fabrication/erection of the respective item.

a) All rotary equipments shall be checked for its direction of rotation and free movement after placing it on the foundation.

b) All Valves shall be checked for its direction of flow.

c) Insulation shall be carried out only after satisfactory inspection of leak test.

d) Erection checks, tolerance limits and Quantum of NDE are indicated in respective Drawing, Field Quality plan and Field Welding Schedule.

3.1. Hydraulic Tests of Pressure Parts

On completion of erection of Steam Generator, Piping and Auxiliaries, the unit with its fittings and mountings in position shall be subjected to hydraulic pressure test in accordance with requirements of Indian Boiler Regulations.
Water used for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator shall be drained and suitably preserved.

4.0 Electrostatic Precipitators (ESP)

Discharge and collecting electrodes

1) Work tests for discharge electrodes shall include the following (for the wire type electrodes):

   a) Chemical and tensile tests.

   b) Metallographic examination-longitudinal and transverse (250X)

   c) Surface finish and surface purity from chloride ions.

d) Spring back and surface finish after coiling (applicable to helical discharge electrodes

2) Work tests for collecting electrodes and rigid discharges electrode shall include the following:

a) Chemical and mechanical properties.

b) Check for profile and straightness.

c) Check for surface finish and dimensional accuracy.

d) Cupping test for deep drawn sheets.

ESP structure

a) Visual inspection of all welds shall be performed in accordance with AWS D1.1.

b) Also the butt and fillet welds for built up plates and columns shall be inspected by 100% MPI.

c) Radiographic examination shall be performed on butt welds as per AWS D1.1. 100% radiography on tension flange (bottom flange) welds and spot radiography on all joints in compression flange (top flange) of all beams and columns shall be carried out. The minimum length of welds for spot radiography and acceptance criterion shall be as per AWS D 1.1.

d) Edge preparation for field welding shall be examined by MPI.

e) Thermal insulation shall be subjected to all tests as per IS: 8183

5.0 POWER CYCLE PIPING

5.1 H.P.PIPING FOR STEAM GENERATOR AND AUX.

I. Piping:

a) All raw materials used shall have co-related mill test certificate meeting material specification. All test, as given in respective material code (other than supplementary requirements), shall be carried out as minimum. This includes the tests wherein it is specified in the ASTM code that the tests is to be carried out when specified by the purchaser or any such indication, in the code.

b) All pipe lengths shall be 100 % ultrasonic tested. However for critical piping applications (Main Steam, CRH, HRH, Feed water, spray to superheater and Reheater, HP/LP Bypass, Upstream of Aux PRDS and any other system in which alloy steel is used) shall be subjected to 100% ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to.

c) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrate check.

d) Pipe bend shall be checked for ovality and thinning by ultrasonic or other acceptable methods on first off lot & on random samples for subsequent pieces for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination/LPI.

e) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

f) All butt welds in alloy steel piping of P-91, X -20 , X-22 & material P-5B group & above shall be checked for RT/ UT & MPI after SR.

g) For welds in P91, X20 & X22 and material P5B group & above Materials requiring heat treatment, induction type of heating shall be deployed for post weld heat treatment, or heat treatment can be carried out in furnace.

h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with

1. Temperature > 400 Deg, C and/Or pressure exceeding 71 bar.

   i. 100% RT/UT on butt welds and full penetration branch welds.
   ii. 100% MPE.

2. Temperature > 175 Deg, C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.

   i. 100% RT/UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.
   ii. 10% RT/UT on butt welds and full penetration branch for pipe dia upto 100NB.
   iii. 100% MPE.

3. 100% UT & 100% MPI on all butt welds of P 91 and X22 UT shall be carried out by digital recorded type. Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.

4. For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of under ground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

5 Hardness survey of welds shall be carried out on alloy steel/stainless steel piping (100% Hardness survey of welds on P91, X20 & X22 material grade piping) and 3% hardness survey on welds of other alloy steel).

II. Fittings:

a) Raw material of all forged/formed fitting shall be ultrasonically tested. All mother pipes used for fitting shall be ultrasonically tested or

hydraulic tested. Forged fitting shall be ultrasonically tested and formed fittings shall be MPI tested.

b) Fittings shall be subjected to suitable NDT as per applicable standards. However, following minimum NDE requirements shall be applicable / met.

i. 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
- for use above 71 bar design condition.
- for use above 400°C design condition.

ii. For fittings X20, P-91 and material group 5B & above
- 100% MPI &
- 10% hardness check.
- Also 100% UT/RT, For fittings of 200 NB & above

iii. 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.

iv. 100% UT/RT for fittings of all other piping of size OD 508mm & above.

III. Hangers & Supports:

a) All raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.

b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.

c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.

d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test.

IV. Thermal Insulation & Lagging, Cladding:

a) Insulation:

Insulation shall confirm to and tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification. Insulation shall conform to IS: 8183.

b) Lagging &Cladding:

Aluminium sheeting confirming to ASTM B-203-1060 temper H14 from reputed manufacturer meeting the requirements of specification.

V. Valves:

a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table 1.

b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

c) Color matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/IBR.

e) Air seat leak test shall be carried out as per applicable Standards/Codes.

f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet
   i. Smooth operation
   ii. Valve travel, closing and opening time.
   iii. (Current drawn by actuators.

g) Springs for safety valves shall be tested with suitable NDT and for spring rate.

h) Safety and safety relief valves shall be tested for performance.

   i. All forgings rounds above diameter 40 mm shall be ultrasonically tested.

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above But below100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT on100% area)

NOTE: For body and bonnet forgings UT with MPI may be adopted in place of RT for austenitic steel MPI may be replaced by LPI.

VI. Metallic expansion Joint (if applicable)

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec.D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Employer.

VII. CHEMICAL DOSING SYSTEM

a) Pumps of chemical dosing system shall be performance tested as per relevant international codes.

b) Dosing skid shall be subjected to leakage test and functional test.

c) Oxygen cylinders shall be as per relevant standard meeting statutory requirements.

VIII. Low Pressure Piping

	Tests/Check Items / Components	**Material test**	**DPT/MPI**	**Ultrasonic Test**	**WPS / WQS / PQR**	**Balancing**	**Hydraulic / Water Fill Test**	**Pneumatic Test**	**Assembly Fit up**	**Dimensions**	**Functional / Operational Test**	**Performance test**	**Other tests**	**All tests as per relevant Std**	**Adhesion / Spark Tests**	**Remarks**
1.	Pipes & Fittings and Metered Bends	Ya	Yb		Y		Y			Y			Y15			
2.	Diaphragm Valves	Ya					Y5			Y				Y6		
3.	Butterfly Valves(Low Pressure)															
a)	Casted Butterfly Valves						Y		Y	Y	Y		Y7			
i.	Body (Cast)	Ya	Yb													
ii.	Disc (Cast)	Ya	Yb													

	Tests/Check Items / Components	Material test	DPT/MPI	Ultrasonic Test	WPS / WQS / PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional / Operational Test	Performance test	Other tests	All tests as per relevant Std	Adhesion / Spark Tests	Remarks
iii.	Shaft	Ya	Y	YC												
b)	Fabricated Butterfly Valves															Refer note 14
4.	Gate/ Globe/Swing Check Valves	Ya	Yb	YC			Y5	Y	Y	Y	Y		Y8			
5.	Dual Plate Check Valves	Ya	Yb	YC			Y	Y	Y	Y	Y		Y4			
6.	Rolled & Welded Pipes	Ya	Y3		Y		Y1			Y			Y^{15}			
7.	Coating & Wrapping of Pipes	Y2											Y2			
8.	Tanks & Vessels	Ya	Yb		Y		Y			Y			Y^{16}			
9.	Strainers	Ya	Yb				Y						Y^{11}			
10	Rubber Expansion Joints	Ya					Y^{12}		Y				Y^{13}			
11	Rubber Lining of Pipes	Ya	Y		Y		Y^{12}		Y	Y				Y^{9}	Y	
12	Hangers & Supports	Ya								Y						
13	Fasteners	Ya		Y				Y								
14	Site Welding		Y^{10}		Y		Y									

Notes:

Y-Applicable

The S.nos. indicated below shall be subscript of Y as indicated in table above.

1. 100% hydraulic test to be carried out. Weld Joints not subjected to hydraulic test shall be subjected to 100% RT.

2. Spark Test, Adhesion Test and Material Test for primer and enamelled & Coal Tar Tapes as per AWWA-C-203-91

3. DPT on route run and after back gouging and on finish welds.

4. Dry Cycle Test (Dual Plate Check valve) for one lakh Cycles shall be carried out as a type test.

5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.

6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.

7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Employer's representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes. Fire safe test for ball valve shall be done wherever specified. In case of already carried out, the test report shall be submitted for review and acceptance by owner / owner's representatives. Valves shall be offered for hydro test in unpainted condition**.**

9.
   i. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material
   ii. Dry film thickness check, humidity check, pipe temperature check, adhesion check and Holiday Detection test shall be done.

10. 10% of welds shall be subjected to DPT (100% DPT for compressed air line and boiler & deaerator fill line.)

11. Pressure drop across the strainer for each type and size as a special test shall be carried out. In case of already carried out, the test report shall be submitted for review and acceptance by Client/Consultant.

12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.

13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.

14. In addition of all tests as indicated for Cast Butter Fly valve being applicable for fabricated butterfly valves, following test shall be done for fabricated butter fly valve:

- UT as per ASTM A-435 on plate material for body and disc shall be carried out for plate thickness 20mm and above.
- 100% RT and DPT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc. 10% DPT on other welds shall be done.
- Post weld heat treatment as per ASME, Section-VIII, Division-I on butt joints of body and disc if thickness is more than 30mm.
- Welders and WPS shall be qualified as per ASME- section IX.

(a) One per heat/heat treatment batch/lot.
(b) On machined surfaces only for castings and on finished butt welds.
(c) For shaft/spindles > or = 50 mm

15. **If applicable:** Segmented flange exceeding 30 mm thickness shall be stress relieved and not more than 4 segments is allowed. For stainless segmented flanges and stainless steel fabricated fitting, 100% radiography of all weld seams including mother pipe weld seam shall be employed.

    Segmental flanges exceeding 37.5 mm thickness shall be stress relieved as per norms of ASME Section VIII after welding.

16. **If applicable:** For pressure vessel welds RT shall be done as per design code requirements.

SECTION M2

STEAM TURBINE GENERATOR

1.0. GENERAL REQUIREMENTS

a) Shop Tests

Shop tests shall include all tests to be carried out at Contractor's works, at works of his sub-contractor and at works where raw material supplied from manufacture of equipment is manufactured. Testing requirement of major equipment over and above the respective code / standard requirements are given for ST & Aux. including Condenser, HP Bypass System & Vibration Isolating System.

b) Site Tests

The Contractor shall prepare and submit detailed field quality plans by setting out the quality practice and procedures to be adopted by him for assuring quality for each equipment of material at this specification from the receipt of material at site, during storage erection, pre commissioning to final commissioning of the plant. These procedures shall necessarily include all checks/tests conducted at site for preservation, assembly, alignment, positioning of the equipment, foundation preparation, welding/bolting heat treatment, non-destructive examination, hydraulic test, running test, performance test etc. The Contractor shall also furnish detailed quality procedure proposed by him for storage, preservation, painting, acid cleaning, alkali boil out, steam blowing, hydraulic test air/gas tightness test etc. to the Owner. The same shall be discussed and finalized with the Owner and six numbers of such finalized copies shall be submitted.

2.0. STEAM TURBINE AND ASSOCIATED EQUIPMENT

2.1. High Pressure & Intermediate Enclosure

High pressure Cast Steel Enclosures (for example High pressure and Intermediate Pressure Inner and Outer Cylinders, Steam Chests and liner, Steam Inlet Pipes, nozzle boxes).

1) Test pieces fully representative of the material and condition of the casting shall be provided to enable the properties of material to be determined. Casting suppliers should have established practices to ensure requirements of creep and rupture, in order to establish the adequacy of material to meet the duty requirements of long exposure to high temperatures and pressures. This data will be furnished for Employer's approval.

Creep requirements:

a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate

stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

d) Unspecified alloying elements shall be controlled as per the applicable standard.

2) Each casting shall be subjected to magnetic particle examination on the entire inner and outer surfaces after heat treatment.

3) Each casting shall be subjected to a 100% examination for internal flaws by ultrasonic/ radiographic method after heat treatment and suitable preparation.

4) Cast enclosure shall be subjected to a hydraulic pressure test based on established practice of manufacturer. Bidder to furnish their practice in this regard for Owner approval.

5) Excavated area of all the defects shall be subjected to MPI to ensure excavation up to sound area. All the areas repaired/upgraded by welding shall be examined by UT, RT (to confirm findings of UT wherever required) and MPI. Sketches/reports of location of repair and reports of NDT carried out on repaired areas shall be submitted along with certificates. Hardness survey shall be carried out on the repaired area.

6) Where stub pipes and transition pieces are welded to the main body of an enclosure the following shall be carried out:

i. Radiographic examination and Magnetic particle or dye penetrant examination of weld preparation.

ii. Magnetic particle examination of finished welds after stress relief.

iii. Radiographic or ultrasonic examination of finished welds.

iv. Before dispatch to site, the site weld preparations on the stub pipes and transition pieces shall be subjected to 100% RT/UT and magnetic particle examination.

v. Hardness survey on the weld joint, HAZ and parent material.

7) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting shall be carried out.

8) Colour matching of castings by putting two halves together and feeler gauge tightness check from both sides, i.e. inside and outside to ensure required contact area and joint tightness shall be carried out.

2.2. **Low Pressure Enclosure (Fabricated)**

a) Where welds are made by chipping and grinding back to the first side weld before completing the weld from second side, a magnetic particle or dye penetrant examination of the chipped area shall be carried out.

b) Bidder to furnish their practice regarding stress relieving of the fabricated enclosures for Owner approval.

c) Bidder to furnish their standard practice regarding NDT on welds for Owner approval, however following are minimum NDT requirements:

Butt welds	10% RT or UT and 10% MPE/DP test
Fillet welds	10% MPE/DPT
Nozzle welds	10% MPE/DPT
Lifting lug & other load bearing fillet welds	100% MPE/DPT
Site weld edge preparations	10% MPE/DPT

d) Bidder to furnish his proven practice for hydraulic pressure tests. If it is not their practice, the justification for not carrying out hydraulic test shall be furnished for Owner approval.

e) Feeler gauge tightness check from inside and outside to ensure required joint tightness shall be carried out.

2.3. **Rotors**

a) Forgings

Rotor forgings (mono block and/or discs), Impulse Wheel & Nozzle Box and coupling forgings:

1) Fully representative tangential, radial and axial test pieces shall be provided at each end of the body, at each shaft end and from the trepanned core (when a core is trepanned) to determine mechanical properties including impact, brinell hardness etc. and tests for notch toughness i.e. FATT / NDTT (both transition temperature and room temperature impact values).
2) Forging suppliers should have established practices to ensure requirements of creep and rupture in order to establish the adequacy of material to meet the duty requirements of long exposure to high temperatures and pressures. This data will be furnished for Employer's approval

3) **Creep requirements:**

a) Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

b) Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

c) Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience or adequate stress rupture data, in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

d) Unspecified alloying elements shall be controlled as per the applicable standard.

4) Heat treatment should be carried out in such a way so as to ensure minimum residual stress in the rotor. Residual stress measurement will be carried out.

5) Each forging shall be subjected to a 100% ultrasonic examination. Normal probes and angular probes with different probe angles shall be used for thorough examination to

ensure complete soundness of the forging. Supplier should furnish the proposal, along with scanning plan and probe angles to be used, for Owner approval.

6) Each rotor shall be subjected to a 100% magnetic particle examination after final machining on journal areas and before gashing on other areas.

7) When a rotor forging is bored, a visual and magnetic particle examination of the bore shall be carried out.

8) Thermal stability tests shall be carried out on HP and IP rotor forgings to ensure the thermal stability of the rotors in service and at over speed.

9) Following tests shall be carried out on the rotor welds:

   i. Ultrasonic examination with normal and angular probes of the weld to ensure complete coverage and freedom from harmful defects.

   ii. Run out of rotor before and after welding

   iii. MPE on finish welds.

   iv. Hardness survey on the welds

   v. Stress relieve annealing.

   vi. Test reports of filler material used.

   vii. Dimensional record of weld preparation.

10) Dimensional Examination of the rotor blade grooves and other important dimensions to be carried out to ensure the conformance to drawing dimensions, Log sheets/records shall be prepared for all important dimensions.

b) **Complete Rotors**

1) Axial & radial run-outs and surface finish checks shall be carried out before and after blading and after over speed tests. Run out examination will be carried out at blade shrouds also.

2) Check for clearance between rotor groove and blade at the root in line with manufacturer's standard and proven practice being followed.

3) Rotors shall be dynamically balanced at rated speed.

4) An over speed test shall be carried out during which the rotor shall withstand an over speed of 120% for five continuous minutes. If bidder's practice is different from as stated above, then same shall be furnished to Owner approval. During this test vibration measurement and analysis shall be carried out.

5) After blading and again after over speed testing, rotor stages with blades over 225 mm of active length are to be given standing vibration tests to determine natural frequencies in various vibration modes to ensure that the ranges are outside operating frequencies. The modes to be tested are: Bucket group tangential, wheel axial and group axial.

6) In case, impulse stage and or blade discs are fitted on the rotor, fit up between such disc and rotor to be checked up before and after over speed.

7) Lock blade lift after the over speed shall be checked and record for same shall be maintained.

2.4. Stator & Rotor Blades and Shroud Bands

a) Fully representative test pieces shall be provided to enable mechanical properties of the material to be determined. In case of blades machined from bar stock, mechanical tests shall be carried out on the hardest and softest specimens of each heat treatment batch. Hardness test will be carried out on 100% basis.

b) Each bar stock for machining blades and forging shall be subjected to 100% ultrasonic examination.

c) When erosion shielded, the erosion shield and blade joint shall be radiographed. In case of flame and laser hardening MPI shall be done.

d) Dye penetrant checks shall be made on the erosion shield and blade joint in manufacture prior to fitting to the wheel and after over speed tests.

e) Magnetic particle inspection or dye-penetrant examination (when MPI is not applicable) shall be carried out on finish machined blade profile, roots and shrouds.

f) All moving blades of over 225 mm active length are to be moment weighed and assembled on shaft in a prescribed sequence to ensure optimum balancing of rotor.

g) Natural frequencies of the L.P. Turbine blades shall be determined before mounting on rotors to ensure that the same are outside operating frequency range.

h) Shroud bands after punching and after rivet-ting shall be subjected to 100% DPT to ensure freedom from harmful surface defects.

i) Creep requirements shall be similar as applicable for high pressure cast steel enclosures.

j) In case of cast blades, following testing shall be done:-

1. Chemical analysis/Mechanical testing per heat/heat treatment batch.
2. Rough machined and finish machined blade shall be subjected to MPI.
3. RT/UT on blades as per supplier standard practice.
4. Before starting mass productions, following technological tests shall be carried out on the first lot of 10 to 15 blades :-

   i. 100% radiography and 100% MPI on blades

   ii. 100% hardness testing.

   iii. Mechanical testing and metallurgical testing.

   iv. Weld repair shall not be permitted unless prior approval of Owner is obtained.

In case of repair is allowed, manufacturer shall submit WPS/PQR and defectogram for Owner approval before welding. After weld repair, RT shall be carried out on repaired area.

2.5. **Diaphragms**

a) **Welded and fabricated Diaphragms**

1) Concentricity checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades.

2) 10% Ultrasonic examination and 100% magnetic particle examination shall be carried out on finished, stress relieved and machined welds.

b) **Cast/Forged/Machined Diaphragms**

1) Details of the results of the tests conducted to determine mechanical properties together with chemical analysis, metallographic/ metallurgical examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.

2) Concentricity, flatness, blade drop and area checks shall be carried out on finally machined diaphragms to ensure that there are no negative overlaps between guide and moving blades and port wall. Finish shall be to Owner approval.

3) A 100% ultrasonic examination shall be carried out on diaphragm materials. Blade junction areas with the side walls shall be checked by magnetic particle or dye penetrant testing.

c) Colour matching of all the diaphragms by putting two halves together, and feeler gauge tightness check shall be carried out.

2.6. **Stop, Control and bypass valves, actuators/servo-motors and steam strainers**

a) Test pieces shall be provided to enable the mechanical properties of valve bodies, bonnets, valve disc and seat, and valve spindle material to be determined. Casting suppliers should have established practices to ensure requirements of creep and rupture, in order to establish the adequacy of material to meet the duty requirements of long exposure to high temperatures and pressures.

Test Creep requirements:

i. Steels chosen for design metal temperatures less than 400°C are exempt from creep /stress rupture testing.

ii. Steels chosen for design metal temperatures between 400°C to 540°C and having less than 3% chromium, shall require 5 years performance feedback experience in the absence of which, creep rupture test will be required to be carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

iii. Steels chosen for design metal temperatures above 540°C and/or having more than 3% chromium, shall require 10 years performance feedback experience OR adequate stress rupture data, in the absence of which, creep rupture test will be required to be

carried out for maximum test duration of 1000 hrs/mutually agreed parameters for Owner approval.

iv. Unspecified alloying elements shall be controlled as per the applicable standard.

b) Dye penetrant checks shall be carried out on stellited / nitride areas of components and stellite components in the finish ground or honed condition. Hardness check shall be carried out to ensure required hardness.

c) Valve body and bonnet castings/forgings shall be subjected to 100% radiography or 100% ultrasonic examination. Body and bonnet shall also be subjected to 100% magnetic particle examination on entire surface. All pressure containing welds in body and bonnet shall be subjected to 100% RT/UT and MPI examination.

d) Wall thickness of the body and bonnet after finish machining shall be measured by ultrasonic method and valve seat bore shall be checked for size and concentricity.

e) Bar stock for valve stem shall be subjected to ultrasonic examination and finish machined stem shall be subjected to magnetic particle/Dye penetrant examination.

f) Each valve body and bonnet shall be hydraulically tested at minimum 1.5 times the maximum working pressure after applying temperature corrections.

g) All the actuating cylinders/servomotors shall be performance tested.

h) Performance testing shall be carried out on valve operators/ actuators to check functional requirements like trip closing and opening time, valve lift and hysteresis.

i) Colour matching of the valve disc and seat to ensure the required contact area is to be carried out.

2.7. Cast and Forged Steel Components such as LP casing, in case of cast design, inlet & extraction / exhaust connections, shaft seal covers and rings, governor shaft, breach nut, threaded ring, angle ring, U-ring, servomotor parts such as body, piston, cover, yokes; turning gear casing and other items which are not specifically covered elsewhere

a) Results of tests conducted to determine mechanical properties, chemical analysis, metallurgical/ metallographic examination, and heat treatment procedures recommended and actually followed shall be recorded on certificates.

b) Each pressure containing enclosure shall be subjected to a hydraulic pressure test at 1.5 times the design pressure.

c) Each casting/forging shall be subjected to suitable non-destructive examination by Radiographic or ultrasonic and magnetic particle or dye penetrant examination methods to ensure freedom from harmful defects.

2.8. **Bolts and nuts for pressure Retaining enclosures and Rotor Couplings**

a) Bar stock for bolts shall be subjected to ultra- sonic examination.

b) Finish machined bolts shall be subjected to magnetic particle examination for surface defect examination.

c) Coupling bolts and nuts shall be suitably identified after weight control checks.

2.9. **Governing and Protection System Equipment such as Electro-hydraulic Controller, Hydraulic Amplifier, Hydraulic Controller, Electro hydraulic Convertors, Hydraulic Convertors, Hydraulic Speed Governor, Trip Devices etc.**

a) All pressure retaining parts shall be subjected to hydraulic testing.

b) All the major castings/forgings shall be subjected to suitable NDT methods depending upon their application and criticality to ensure the freedom from harmful defects.

c) All the main assemblies and sub-assemblies shall be subjected to functional test.

d) All butt welds shall be subjected to minimum 10% RT/UT and all fillet and corner welds shall be subjected to MPI/DPT.

e) All control equipment shall be subjected to rig testing, if it is not possible to test it on the steam turbine light run. The purpose of rig testing shall be as far as practical to prove that the functioning of the control equipment is in accordance with the approved design.

f) Nitrided and stellited components will be subjected to DPT and hardness check.

2.10. **Inspection of Completed Turbine**

The steam turbine shall be assembled in the manufacturer's works to such an extent that a thorough inspection can be carried out. The purpose of this inspection will be to ensure that the fit between mating components is correct and that all clearances are in accordance with the design requirement. Contractor will prepare the checklist in this regard and submit the same for Owner approval. However, minimum clearances which are required to be checked and records to be maintained during assembly of Inner Casing - Rotor, Inner Casing - Outer Casing, Rotor - Outer Casing, Gland Steam Housing - Shaft - Casing etc. are shroud diameters, axial distances for shroud bands for casings, clearance between shaft seal casings and shaft seal rings, radial and axial blade clearance in blading section, axial and radial alignment of rotor in respect of shaft seals, alignment of over speed governor etc. This is indicative check only. However, the details shall be finalized during QP finalization stage.

These check lists shall be designed so that a comparison can be made between the design clearances, the clearances measured during works assembly, and those measured during the site turbine build. The vendor shall state, in his proposal, whether or not it is his practice to carry out no load works running tests on the steam turbine. (To this end the vendor shall give details of their normal works practice. In order to prove the compliance with design of the steam turbine control and emergency control equipment, functional tests shall be carried out in the manufacturer's works).
These tests shall be:

a) Part of a no-load run under steam and / or
b) By approved rig tests.

3.0. **AUXILIARIES OF STEAM TURBINE**

3.1. **Bearing Pedestals and Bearings**

a) Cast Pedestals & Housing

Leakage tests shall be conducted on pedestals.

b) Fabricated Pedestals & Housing

1) Leakage test shall be conducted on pedestals.

2) 10% weld shall be checked after stress relieving by magnetic particle test and minimum 10% of the butt welds will be checked by RT or UT.

c) Bearings shell

1) The shell and castings\forgings shall be subjected to suitable non destructive examination like RT\UT & MPI as applicable.

2) Colour matching of the shells by putting two halves together and feeler gauge tightness checks from inside and outside to ensure required contact area and joint tightness shall be carried out.

3) The shell shall be subjected to hydraulic pressure test.

4) Chemical analysis of white metal shall be carried out. The effectiveness of the white metal adhesion shall be checked by ultrasonic or other approved method and the exposed edges of the white metal shall be subjected to a dye penetrant examination.

3.2. **Cross around pipes**

a) Weld edge preparation of shop and site welds shall be checked by magnetic particle examination

b) All butt welds shall be subjected to 100% Radiographic examination/ ultrasonic examination depending on thickness.

c) Magnetic particle examination shall be carried out on un-machined welds. In case welded area is machined then DPT shall be carried out.

3.3. **LUBRICATING OIL, JACKING OIL AND CONTROL OIL SYSTEMS**

a) Pumps

1) Main oil pump shaft shall be subjected to ultrasonic examination. Butt welds shall be subjected to RT/UT.

2) Pump impeller shall be subjected to suitable NDT method like MPI/DPT for surface defect examination. Impeller of main oil pumps shall also be subjected to an over speed test at 120% of rated speed for 5 minutes.

3) Pump casing shall be subjected to hydraulic pressure test at 2 times the working pressure or 1.5 times the pump shut off head whichever is higher. Rotor assemblies shall be dynamically balanced.

4) All pumps shall be performance tested at the manufacturer's works. Test shall include check for vibration and noise levels also. Procedure for performance testing shall be submitted to Owner for approval.

b) Oil purifiers.

1) All pressure parts will be subjected to hydraulic pressure test.

2) Components/parts of the equipment shall be subjected to suitable NDT depending upon the criticality of the application to ensure freedom from surface and sub surface defects.

3) All rotating parts like bowl assembly etc, shall be subjected to static and dynamic balancing test.

4) The complete purifier shall be tested at manufacturer's works for capacity, mechanical running sequential operation and interlocks, moisture content, vapour tightness, vibration, noise level, quality improvements etc. Sample shall be drawn from inlet and outlet of purifier after works test and shall be tested for moisture content, chemical tests and particle size of impurities.

c) Refer relevant clauses of the specification for other items such as piping, heat exchangers, valves, filters, blowers / exhausters etc in this system.

4.0. STEAM SURFACE CONDENSERS

4.1. Shell, Hotwell, Water Boxes, Doors and Tube sheets.

a) All welds shall be visually examined. Radiographic examination of 10% of butt welds shall be carried out. However, for vacuum containing welds, R.T on at least 10% of each butt weld shall be carried out. Surface defect examination by magnetic particle inspection or equivalent test method shall be carried out for minimum 10% weldments. This shall apply to site welds also.

b) All edge preparations shall be examined for surface defects. Edge preparation for welds to be carried out at site shall be checked by magnetic particle inspection method before dispatch.

c) In case of fabricated flanges, welds shall be checked by 100% radiographic / ultrasonic and 100% magnetic particle inspection methods to ensure freedom from internal and surface defects.

d) To ensure dimensional control of condenser, parts\sub-assemblies shall be trial assembled at shop. BIDDER shall furnish his proposal in this regard, which will be subject to Owner approval. Trial insertion of a few tubes through main tube plates and support plates shall be carried out to ensure alignment of tube plates and proper fitting and matching of parts\sub-assemblies.

e) Bidder to furnish his practice regarding stress relieving of the water boxes and water chambers.

4.2. Condenser Tubes shall be tested as per the requirements of relevant codes and standards.

4.3. Steam Throw Off Device

a) Edge preparations shall be examined for surface defects by MPI/DPT. 10% radiographic or ultrasonic examination shall be carried out for all weldments.

b) Welds shall be subjected to surface defect examination by 10% magnetic particle\dye penetrant examination.

4.4. **Spring Assembly**

a) Static load testing of the springs shall be carried out and spring characteristics shall be drawn and verified.

b) Surface defect test shall be carried out on all the springs after coiling and heat treatment.

c) Surface cleaning shall be checked prior to painting and check for thickness of painting shall be carried out.

5.0. **CONDENSER AIR EVACUATION SYSTEM**

5.1. **Pumps**

a) Vacuum pump shafts shall be subjected to ultrasonic test. After finish machining, shaft shall be subjected to magnetic particle examination/dye penetration test.

b) Pump casings and impellers shall be subjected to magnetic particle/dye penetration test. Finished pump rotor shall be subjected to dynamic balancing.

c) Pump casings shall be subjected to hydraulic test at 1.5 times the shut off pressure or twice the maximum operating pressure, whichever is higher.

d) Each pump shall be tested at supplier's works at full speed and load conditions to demonstrate successful operation and performance in accordance with the design requirements.

e) Supplier shall demonstrate by carrying out visual cavitations test that pump will be operating under all operating condition including blank off condition without cavitations. Then records of same to be furnished for Employer's approval.

f) Refer relevant clauses of the specification for other items such as heat exchangers, filters, piping, valves, etc. in this system.

5.2. The complete package shall be subjected to hydraulic pressure and leakage test and shop tested to check interlocks and functional requirements. The one complete unit shall also be subjected to demonstrate successful operation and performance testing, with saturated air conditions at condenser design vacuum point as well as vacuum pump design point with total minimum three points The test should be conducted with the respective motors to be supplied. The test shall include check for vibration and noise level.

6.0. **FEED WATER HEATER, DRAIN COOLERS, GLAND STEAM CONDNSER, HEAT EXCHANGERS & PRESSURE VESSELS / STORAGE TANKS**

6.1. All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

6.2. Material for Tube plates shall be ultrasonically tested. Finished plates shall be subjected to suitable NDT. For cladded plates, bonding shall be checked by UT. Vendor shall furnish their practice regarding manufacturing & NDT for supply of cladded plates for Owner

review. Drilled Tube plates shall be checked for ovality of holes, ligaments, surface finish etc.

6.3. Dished ends shall be subjected to 100% MPI and RT/UT on welded joints. Knuckle portion shall be checked by MPI for surface defects and thinning shall be checked by UT.

6.4. Butt Welded / Full penetration joints shall be checked by suitable RT / UT. Fillet welds shall be checked by MPI / DPT.

6.5. Tubes shall be tested as per the relevant codes / specification / standards.

6.6. Before tubes expansion in the tube sheets, the mockup test for expansions shall be carried out, in case not done earlier. Torque setting of expander shall be based on mock up tests. Joints shall be checked for tube thinning.

6.7. Completed assemblies shall be pressure tested with working-fluid/ hydraulically/ pneumatically. The heat exchangers shall be tested on both tube side and shell side. After hydro test, the heat exchangers shall be suitably dried and nitrogen capped. Atmospheric tanks shall be tested for leakage by water fill test for at least 12 hrs.

7.0. PIPING, BELLOWS AND THERMAL INSULATION FOR TURBINE & AUX SYSTEMS

7.1. Piping and Fittings

a) All raw materials used shall have co-related mill test certificate meeting mandatory and supplementary checks of material specification.

b) All pipe lengths shall be subjected to 100% ultrasonic examination or hydraulic tests and UT/RT on longitudinal welds at the tube mill.

c) All mother pipes used for fittings shall be subjected to a hydraulic test or an ultrasonic test at the tube mill. Raw material of all forged fittings shall be ultrasonically tested. Forged fittings shall be ultrasonically tested.

d) Welded and cast fittings, if any, shall be subjected to suitable NDT as per applicable standards. However, as a minimum 100% RT shall be carried out on all alloy steel fittings and on carbon steel fittings for use above 71 bar design conditions.

e) The edge preparation for shop and site welds shall be checked by MPI/LPI however edge preparation in stainless steel alloy/ steel shall be subjected to a Dye penetrant check.

f) Thickness of pipe bends shall be checked by ultrasonic or other acceptable methods on sample basis for high pressure applications. Outer surface of bends shall be subjected to magnetic particle examination / LPI.

g) Non-destructive examination of welds shall be carried out after post weld heat treatment, if any.

h) Non-Destructive Examination of welds shall be carried out in accordance with the relevant design/manufacturing codes. However, as a minimum, the following requirements shall be met (except for oil piping). Further statutory requirement, wherever applicable shall also be complied with

1) Temperature > 400°C and / or pressure exceeding 71 bar.

i. 100% RT/UT on butt welds and full penetration branch welds.
ii. 100% MPE.

2) Temperature > 175°C up to 400°C and / or pressure exceeding 17 bar and up to 71 bar.

i. 100% RT / UT on butt welds and full penetration branch welds for pipe dia more than 100 NB.

ii. 10% RT / UT on butt welds and full penetration branch welds for pipe dia up to 100 NB.

iii. 100% MPE.

3) Wherever SR/PWHT is envisaged, above NDTs shall be after SR/PWHT.

4) For all other pipes not covered above (except oil piping), shall be subjected 100% MPE / DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.

5) Hardness survey of welds shall be carried out on alloy steel/stainless steel piping. (100% Hardness survey of welds on P91, X20 & X22 material grade pipings).

6) For welds in P91, X20 & X22 materials, only induction type of heating shall be deployed for heat treatment.

i) Oil piping shall be subjected to following NDT.

1) Butt welds of Oil piping shall be subjected to 10% RT and 10% DP Test. For Jacking oil lines 100% RT & 100% DPT shall be carried out on butt welds.

2) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

j) Rubber lined pipes shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

1) Adhesion test

2) Check for resistance to bleeding

3) Measurement of thickness

4) Shore hardness test

5) Visual examination and spark test at 5 kv/mm of thickness.

7.2. **Metallic Expansion Bellows**

a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.

b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.

c) All welds shall be subjected to 100% magnetic particle/dye pentrant check and butt welds shall be subjected to 100% radiographic testing.

d) All the bellows subjected to vacuum service shall be subjected to vacuum test.

e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.

f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec. D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). Test reports may be furnished by manufacturer for consideration and approval of Employer.

7.3. **Rubber Expansion Joints**

a) Rubber compound test slab after valcanising shall be tested for tensile strength, elongation and shore hardness. Tests on rubber compound shall also include hydrostability test as per ASTM D-3137 and ozone resistance test as per ASTM D- 380.

b) Fabric strength of synthetic fiber for reinforcement shall be checked, and test for rubber to fabric adhesion as per IS: 3400/ASTM D- 413, rubber to metal adhesion as per IS 3100/ASTM D-429 shall be carried out.

c) All expansion joints in assembled condition shall be subjected to vacuum test at 730 mm Hg under conditions to ensure its suitability to withstand deflection in each axial transverse and longitudinal direction. Duration of test shall be of minimum 10 minutes.

d) All bare bellows shall be subjected to hydraulic pressure test in normal condition at twice the design pressure for a duration of 30 minutes.

e) Additionally, all bare bellows shall be subjected to deflection tests under pressure, pressure being raised from zero to the design value in regular steps and deflection measured at each step.

f) All expansion joints in assembled condition along with control rod assembly shall be subjected to deflection test under design pressure. The details of test procedure shall be subjected to approval by Owner.

g) Either during the hydraulic test or during the vacuum test, change in circumference at the top position of the arch shall not exceed 1.5% of measured circumference at normal position.

h) Twenty Four (24) hours after the above tests, the permanent set (variation in dimensions with respect to its original dimension) shall be measured and recorded. The permanent set shall not be more than 0.5%.

i) Life cycle test and burst test shall be carried out on bellows of each type, design and size. Test certificate for the same may be furnished for approval of Employer.

7.4. **Thermal Insulation**

a) For mineral wool insulation, testing shall be carried out as per IS:3144.
b) For sprayed mineral wool, testing shall be carried out as per IS:9724.
c) Thermal conductivity (k value) shall generally be measured in line with IS:3346.

7.5. **Hangers and Supports**

a) Forged components such as clevis, turnbuckle, eye- bolts, coupling etc. will be subjected to material testing, hardness, MPE, proof load test etc.

b) Dampers with viscous fluids will be checked for viscosity of liquid used, damping resistance of the damper, stiffness of the damper etc.

c) Springs used for variable constant load and spring hangers shall be checked for chemical, mechanical and spring rate tests.

d) Complete variable and constant load spring cage will be subjected to performance test and load/deflection test.

e) Complete hanger will be subjected to performance test and load test.

8.0. **VALVES**

8.1. Inspection and testing requirements for valves other than extraction line valves and butterfly valves shall be as follows:-

a) Pressure retaining parts of valves shall be subjected to NDT as per Table 1.

b) Bar stock/forging above 40mm diameter for valve trim shall be subjected to UT

c) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.

d) Colour matching of valve disc/plug and seat shall be carried out to ensure contact.

e) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34.

f) Air seat leak test shall be carried out as per applicable Standards/Codes.

g) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet:

1) Smooth operation

2) Valve travel, closing and opening time.

3) Current drawn by actuators..

h) Springs for safety valves shall be tested with suitable NDT and for spring rate.

i) Safety and safety relief valves shall be tested for performance.

TABLE-1

NDT REQUIREMENTS FOR PRESSURE RETAINING COMPONENTS OF VALVES

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600 below 900	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI

50 & above but below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on change of section & weld ends)	MPI & RT on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT (on 100% area)

Note:

i. For body and bonnet forgings UT with MPI may be adopted in place of RT. For austenitic steel MPI may be replaced by LPI.

ii. Weld Edge Preparation shall be subjected to MPI/LPI

8.2. **Extraction Line Valves**

a) Surface crack examination and hardness check shall be carried out on all hard faced/stellieted surfaces, if any.

b) As a minimum requirement of castings for all valves on cold reheat and extraction lines shall be subjected to 100% MPI on all areas and RT on Butt Weld ends and change of Section. For forgings minimum requirement shall be 100% UT and 100% MPI.

c) Bar stock for valves stem shall be subjected to UT. Finish machined valve stem shall be subjected to magnetic particle examination/dye penetration test.

d) Wall thickness measurement by ultrasonic for critical and highly stressed zones of the casting/forging shall be carried out.

e) Colour matching of the valve disc and seat to ensure required contact area shall be carried out.

f) Hydraulic pressure tests shall be carried out on each valve to check body and bonnet strength. Seat leakage and back seat leakage test (wherever applicable) shall be carried out. Air seat leakage test shall also be carried out. Minimum test requirements of pressure shall be as per ANSI B 16.34.

g) Functional testing shall be carried out on each valve to check for freedom of movement, adherence to clearance, opening/ closing etc. Type tests for discharge co-efficient and pressure drop co-efficient, shall be carried out. In case the type tests have been carried out in the past and documents generated, the same shall be furnished to the Owner for approval.

8.3. **Butterfly valves**

a) Valve disc shall be checked for surface and sub-surface defects by magnetic particle examination.

b) Stubs and driving shafts shall be tested for internal defects by ultrasonic method.

c) Dye penetration test shall be carried out on shafts, seat rings etc.

d) Test samples for rubber seal shall be subjected to tensile and hardness test for vulcanizing and after ageing. Hydraulic stability test and ozone crack resistance tests also be carried out.

e) Valve shall be subjected to hydraulic pressure test for body and air seat leakage tests as per AWWA-C504

f) Proof of design tests for valves and actuator shall be carried out as per AWWA-C504. In case the test has already been carried out on previous supplies, the contractor may submit the test certification of same for approval of Owner.

g) After complete assembly each valve with actuator will be subjected to performance test by opening and closing the valve from fully closed to fully open position and the reverse, under no flow for at least 25 cycles to check.

1) Smooth uninterrupted movement of valve.
2) Closing and opening time.
3) Current drawn by actuator.
4) Operation of tripping switch and position indicator.

h) After assembly, one valve of each size with respective actuator shall be shop operated over the full range of movement in both the directions, with the body subjected to the full hydrostatic pressure conditions, to demonstrate that the unit is in working order without any leakage through the joints and torque switches/clutches, limit switches are operating satisfactorily. During the test, hand wheel operation, opening/closing time and current drawn shall also be checked. The test shall be conducted for three consecutive cycles with valve shaft both in vertical and horizontal planes.

9.0. MISC. ITEMS / EQUIPMENTS

9.1. Filters / Strainers

a) Filters / strainers shall be tested as per the requirements of relevant codes / standards.

b) Filters / strainer shall be performance tested for pressure drop, flow, particle size. If performance test is earlier established, then records shall be reviewed.

9.2. BLOWERS/ EXHAUSTERS

a) Rotors shall be dynamically balanced. Leakage tests (if applicable) shall be carried out.

b) Performance tests including noise and vibration tests shall be carried out as per relevant standards / codes.

10.0. Electrical and Control & Instrumentation:

Refer Electrical and Control & Instrumentation Sections of QAP C & I specification.

11.0. SITE TEST:

Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

11.1. **Hydraulic Test of Pressure Parts :**

On completion of erection of pressure parts of each steam turbine generator, the unit with its fittings and mountings in position shall be subjected to hydraulic test pressure in accordance with requirement of Indian Boiler Regulations. Water used for hydraulic test shall be made alkaline by addition of suitable chemical. After the test, all parts shall be drained and suitably preserved.

11.2. **Condenser Assembly :**

a) If the condenser sections calls for site assembly, care shall be taken in assembly of sections and correctness of alignment and fit up shall be checked. Site welding shall be carried out as per the procedure approved by the Owner.

b) All weld seams shall be subjected to magnetic particle examination. At least 10% of butt welds shall be subjected to radiographic examination.

c) All welds between condenser neck and LP turbine shall be subjected to 100% radiographic and magnetic particle examination.

d) Condenser tubes shall be visually examined for dents, mechanical damages or any other defects prior to insertion. Both tube ends shall be thoroughly cleaned to a length of 100mm to remove oil, grease etc. and shall be checked for freedom from burrs prior to insertion.

e) Tube expansion shall be carried out by electronic automatic torque control expanding unit, which shall be calibrated before use. Tube wall thinning and length of expansion shall be controlled and recorded.

f) Hydrostatic testing of condenser steam space shall be carried out after connecting all the pipes with the condenser along with condenser vacuum systems by filling the steam space with water up to the tip of the last stages of blades of LP cylinder.

g) Condenser water boxes shall be tested hydraulically at a minimum test pressure of 1.5 times the design pressure.

11.3. **TURBINE ASSEMBLY**

Bidder shall clearly indicate the extent of assembly to be carried out at site. Accordingly, bidder shall submit elaborate erection and assembly inspection program of turbine for Owner approval.

12.0. **CONDENSATE EXTRACTION PUMPS**

INPROCESS TEST												**FINAL TESTS**					
TEST / **ITEM DESCRIPTION**	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	Hyd. Test	Inclusion Rating	Pressure Drop Test	Performance test	NPSH Test	Vibration	Noise	Strip Down Test
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Pump Casing	Y	Y1	-	-	-	-	Y	-	-	Y	-						
Suction Bell	Y	Y^1	-	-	-	-	Y	-	-		-						
Shaft	Y	Y^1	Y	Y	Y	-	Y	Y	-		Y						
Impeller	Y	Y^1	Y	-	-	-	Y	-	Y		-						
Rotor	-	-	-	Y	-	-	-	-	Y		-						
Fabricated Items	Y	Y^1	-	-	-	Y^2	Y	-	-	Y^2							
CEP													Y^4	Y^5	Y^6	Y^7	Y^7
Strainer																	
a) Body	Y	Y	-	-	-	-	Y*	-	-	Y	-						
b) Assembly												Y**					

Y- Applicable

Y^1 - Chemical/ Mechanical shall be one per heat/HT batch.

Y^2 -10% Random on Butt Welds.

Y^3 -Pressure Containing Parts.

Y^4 -Performance Test on each Condensate Extraction Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design requirements specified in the specification. Measurements shall be carried out at 0%,25%, 50%,65%, 80%, 100% and 125% of design flow with cold water.

Y^5 -NPSH (R) test shall be carried out on one Condensate Extraction Pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure **/ varying suction pressure**.

Y^6 -Vibration on all Condensate Extraction Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.

Y^7 -Noise Level on each Condensate Extraction pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition. One Condensate Extraction Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

Note:

1) Quantum of In-Process Checks/ Tests is 100% until & unless specified otherwise.
2) Shop tests shall be conducted with soften Quality Water.
3) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.
4) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard.
5) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	+ 5% of design head (Under 152.4 meter)

	+3 % of design head (for 152.4 meter and above)

* In case of fabricated construction
** One per type and size.
Results must show no minus tolerance with regard to flow and head.
No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed

13.0. **POWER CYCLE HEATERS AND DEAERATOR**

13.1. **Deaerator**

Sl. No.	**TESTS /CHECKS /COMPONENTS /ACTIVITY**	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQR/App Performance test	Mock up Test
1.	Shell & Dished End	Y	Y	Y				Y(a)		Y(g)				Y(a)				Y(e)		
2.	Fabrication/ Welding													Y				Y		
a)	Edge Preparation/ Fillet Weld									Y(b)	Y(b)									
b)	Butt Joints/ Branch Welding							Y(c)	Y(c)	Y	Y			Y				Y(d)	Y	
3.	Complete Deaerator															Y		Y		
4.	Safety & Safety Relief Valve & other valves	Y	Y					Y(f)	Y(f)	Y(f)	Y(f)					Y		Y(h)		

13.2. **Heaters**

Sl. No.	TESTS/ CHECKS COMPONENTS/ ACTIVITY	Chemical Analysis	Mech. Properties	Impact	Hardness	Flattening	Flaring	UT	RT	MPI	DPT	Eddy Current	Helium Leak Test	SR	HT	Hydraulic	Pneumatic	Dimensions	WPS/PQR/WQR/App.	Mock up Test
1.	**Tube Sheet**																			Y
a)	Forging	Y	Y					Y		Y					Y			Y[l]		
b)	Plates	Y	Y	Y				Y			Y							Y[i]		
c)	Cladding							Y			Y			Y		Y		Y		
2.	Shell Plates	Y	Y	Y				Y												
3.	Feed Nozzle Manhole forging	Y	Y			Y[k]		Y[l]				Y[k]		Y[i]				Y		
4.	**Welding /Fabrication**																			
a)	Weld Edge Preparation									Y[b]	Y[b]									
b)	Back Chipping									Y[b]	Y[b]									
c)	Weld Joints																			
i.	Butt							Y[c]	Y[c]	Y	Y				Y		Y	Y		
ii.	Fillet									Y	Y				Y		Y	Y		
iii.	Nozzle / Branch							Y[c]	Y(c)	Y	Y				Y		Y	Y		
iv.	Tube to tube sheet										Y		Y			Y				
5.	Dished End & Hemi Head	Y	Y	Y				Y[a]		Y[b]	Y[b]			Y			Y[e]			
6.	Tubes	Y	Y			Y[q]	Y[q]					Y			Y[n]	Y		Y		
7.	Tube expansion in tube sheet																	Y[o]		
8.	Complete Heater															Y[p]	Y			

13.3. REMARKS FOR DEAERATORS AND HEATERS

a) After forming of plates. For dished end and Hemi head.

b) DPT may be used as an alternate to MPI.

c) UT/RT to be decided according to configuration/accessibility.

d) (i) For plates

(ii) For welding
(iii) For wall thickness

e) Including wall thickness

f) (i) 100% RT/UT shall be carried out on bodies, bonnets, nozzle and stem of valves of HP heater.

(ii) 100% DPT/MPI on machined surfaces of valve body, bonnet, stem, disc & springs.

g) Outer surface (Dished end Knuckle Portion)

h) Including - Seat leakage
- Relieving
Capacity-popping test at set and blow down pressure

i) Include ovality of holes, surface finish and size of holes.

j) For cladding bond and cladding thickness during bond check and after drilling

k) For feed nozzle (pipes)

l) For forgings

m) After bending also

n) Dimension to include wall thinning

o) Both tube and shell side. After Hydro test drying and nitrogen filling to be done.

p) As per the code.

q) For HP Heater & Gland steam coolers the statutory requirements as per IBR to be ensured and to be certification original to be furnished as per IBR statutory requirements.

Note:

1) Quantum of Checks shall be 100% unless otherwise specified.

2) Chem./Mech. shall be One/ per heat or HT batch.

14.0. **BOILER FEED PUMPS & DRIVE TURBINE**

BFP + BOOSTER PUMP + TURBINE																
INPROCESS TESTS																
S No.	**TESTS** **ITEM/ DESCRIPTION**	Chemical Analysis	Mechanical Prop.	Heat Treatment	Run out	U.T.	R.T	D.P.T.	M.P.I.	Balancing	F.A.T.T.	Hyd. Test	Inclusion Rating	Pr. Drop	Dimensions	Remark
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A.	**BFP+BOOSTER PUMP**															1 - Chemical/Mechanical Shall be one per heat / HT batch. # On BFP Impeller as per ASTME 446 level 2 *** In case of Fabricated Construction. [2] - One per type and size. + Type of NDE & quantum of check shall
i.	Barrel Casing	Y	Y1	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
ii.	Discharge Branch	Y	Y1	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iii.	Casing Cover	Y	Y1	Y	-	Y	-	-	Y	-	-	Y	-	-	-	
iv.	Suction Branch	Y	Y1	Y	-	-	-	Y	-	-	-	Y	-	-	-	
v.	Diffuser	Y	Y1	Y	-	-	-	Y	-	-	-	-	-	-	-	
vi.	Ring Section	Y	Y1	Y	-	Y	-	Y	-	-	-	-	-	-	-	
vii.	Impeller	Y	Y1	Y	-	-	Y#	Y	-	Y	-	-	-	-	-	
viii.	Shaft	Y	Y1	Y	-	Y	-	Y	Y	-	-	-	Y	-	Y	
ix.	Rotor	-	-	-	Y	-	-	-	-	Y	-	-	-	-	-	
B.	**STRAINER**															
i.	Body	Y	Y	-	-	-	-	Y***	-	-	-	Y	-	-	-	
ii.	Assembly	-	-	-	-	-	-	-	-	-	-	-	-	Y2	-	

C.	**GEAR BOX AND HYDRAULIC COUPLING**														be as per relevant code & pressure class. ++ Include body & seat leakage test and functional test **Note:** Quantum of Checks/ Tests is 100% until & unless specified otherwise.
i.	Gear	Y	Y 1	Y	-	Y	-	Y	Y	-	-	-	-	-	-
ii.	Pinions	Y	Y 1	Y	-	Y	-	Y	Y	-	-	-	-	-	-
iii.	Shaft	Y	Y 1	Y	-	Y	-	Y	Y	-	-	-	-	-	-
iv.	Casing	Y	Y 1	-	-		-	-	-	-	-	Y	-	-	-
v.	Wheels	Y	Y 1	Y	-	Y	-	Y	Y	-	-	-	-	-	-
vi.	Assembled Rotating Component	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y
D.	**RECIRCULATION VALVE**	Y	Y 1	Y	-	Y +	-	Y +	Y +	-	-	Y ++	-	-	Y
E.	**DRIVE TURBINE**	Tests as per relevant portion of specification													

Final Test													
TESTS **ITEM/ DESCRIPTION**	Performance Test	NPSH Test	Vibration	Noise	Pressure Pulsation	Axial thrust	Dry Running	Thermal Shock	Visual Cavitation	Strip Down Test	Mech. Run test	Other Tests	Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	
BFP	Y1	Y^2	$Y^{3\,(a)}$	$Y^{3\,(b)}$	$Y^{3\,(c)}$	$Y^{3\,(c)}$	Y^4	$Y^{3\,(d)}$	Y^5	Y^7	Y	Y^6	
Booster Pump	Y^1	Y^2	$Y^{3\,(a)}$	$Y^{3\,(b)}$	-	-	Y^4	-	-	Y^7	-	Y^6	
Gear Box	Y^8	-			-	-	-	-	-	-	Y^8	-	
HYD Coupling	-	-	-	-	-	-	-	-	-	-	Y^8	Y^6	
Drive Turbine	Tests as per relevant portion of specification												
Elect Items	Tests as per relevant portion of specification												

1(a) Performance Tests on each Boiler Feed Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure compliance with design requirements specified in the specification. Measurement shall be carried out at 10%, 25%, 50%, 65%, 80%, 100% & 125% of Design Flow with loop water at design temperature. Performance Test at other specified Conditions shall be carried out on all Boiler Feed Pumps at their respective Speeds at design temperature.

1(b) Performance Test on each Booster Pump to determine the characteristic curve (Head, Capacity, Efficiency & Power) at Design Speed and to ensure Compliance with design

requirements specified in the specification. Measurements shall be carried out at 0%, 25%, 50%, 65%, 80%, 100% and 125% of design flow with cold water.

2 NPSH (R) test shall be carried out on one Boiler Feed Pump and one booster pump using cold water at pump flows of 25%, 50%, 80%, 100% and 125% of Design Flow at Design Speed. This shall be preferably done at 1 % and 3% head break by Suction Throttling Procedure.

3(a) Vibration on all Boiler Feed Pumps and Booster Pumps shall be measured in transverse, Horizontal and Vertical Direction at all measuring points.

(b) Noise Level on each Boiler Feed Pump and Booster Pump shall be measured at a distance of 1.5 meter above floor level in elevation and 1 mtr horizontally from the nearest surface of the equipment as per HIS. The measurement shall be taken at six points around the equipment for each flow condition.

(c) Pressure Pulsation and Axial Thrust Measurement shall be carried out on one Boiler Feed Pump at all measuring points. Pressure Pulsation shall be measured at suction as well as at discharge in the operating range.

4. Dry running withstand capability shall be demonstrated and established on one Boiler Feed Pump and its corresponding booster pump. Feed pump shall be capable of accepting complete loss of water and must be capable of being shut down in a controlled manner and brought down to rest after being tripped from design condition with simultaneous closure of suction valve. To demonstrate the capability during shop testing, suction valve actuation should be fast in order to ensure operation during vapour phase. Pump shall then be restarted and bring it back to design condition.

5 Visual Cavitation Test on one first stage production impeller of Boiler Feed Pump shall be carried out to demonstrate absence of Cavitation at test speed in Cold Water. The test will establish the cavitation characteristic of one production first stage impeller to confirm that the cavity length under dynamically scaled site conditions corresponding to test point will not exceed an agreed size. This test shall be carried out at 25%, 50%,65%,80%,100% and 125% of Design Flow

6 String Test:- Operational Test of One Motor Driven Boiler Feed Pump assembly using contract Booster Pump, Drive Motor, Hydraulic Coupling and Main Boiler Feed Pump to include test as specified at 1 & 3 (a) & (b). Dry Run Test shall preferably be carried out during String Test.

7 Complete Strip Down of Boiler Feed Pump which under goes Performance Test, NPSH Test, Dry Run Test, etc. shall be done in order to check problems like Internal Rubbing Damage, Excessive Wear etc. One Booster Pump shall be dismantled for visual inspection after completion of performance test and NPSH Test. For other Pumps strip down test shall be conducted only in case abnormal performance such as Excessive Vibration, High noise, high bearing temperature etc. is observed during performance test.

8 Full load full speed/back to back locked rotor torque test for one gearbox.

9 Smooth operation, vibration, noise and temperature rise check on all equipment.

Note:

1) Shop tests shall be conducted with soften Quality Water.

2) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

3) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard, USA.

4) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	5% of design head (Under 152.4 meter) + 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.
No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

5) It is preferred to carry out performance, NPSH(R) & Dry Running tests of the boiler feed pump at design speed. However, in case of any constraint of manufacturer to carry out the above tests at design speed, the testing of pump at reduced speed as per HIS guidelines may be proposed to Owner for review and approval.

15.0. **LOW PRESSURE PIPING**

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y[a]	Y[b]		Y		Y									
2)	Diaphragm Valves	Y[a]					Y[5]			Y				Y[6]		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
(i)	Body (Cast)	Y[a]	Y[b]				Y		Y	Y	Y		Y[7]			
(ii)	Disc (Cast)	Y[a]	Y[b]													
(iii)	Shaft	Y[a]	Y	Y[c]												
b)	Fabricated Butterfly Valves															Ref. Note 14
4)	Gate / Globe / Swing Check Valves	Y[a]	Y[b]	Y[c]			Y[5]	Y	Y				Y[8]			

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
5)	Dual Plate Check Valves	Y^a	Y^b	Y^c			Y	Y	Y				Y^4			
6)	Rolled & Welded Pipes	Y^a	Y^3		Y		Y^1			Y						
7)	Coating & Wrapping of Pipes	Y^2											Y^2			
8)	Tanks & Vessels	Y^a	Y^b		Y		Y									
9)	Strainers	Y^a	Y^b				Y						Y^{11}			
10)	Rubber Expansion Joints	Y^a					Y^{12}		Y				Y^{13}			
11)	Rubber Lining of Pipes	Y^a	Y^b		Y		Y			Y				Y^9	Y	
12)	Hangers & Supports	Y^a						Y								
13)	Fastners	Y^a		Y^b				Y								
14)	Site Welding		Y^1		Y		Y									

Notes:
Y-Applicable

The S.nos. indicated below shall be subscript of Y as indicated in table above.

1. Weld Joints not subjected to hydralic test shall be subjected to 100% RT.

2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91

3. DPT on route run and after back gouging and on finish welds.

4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test.

5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.

6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.

7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Owner representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes 9.

9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material

10. 2% of welds shall be subjected to DPT.

11. Pressure drop across the strainer for each type and size as a special test shall be carried out

12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.

13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.

14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.

    a) One per heat/heat treatment batch/lot.

    b) On machined surfaces only for castings and on finished butt welds.
    For shaft/spindles > or = 50

16.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

16.1 General Requirements

Refer QA & I portion of General Technical conditions of technical specification.

16.1.1 Ball Recirculation Pump

(a) All rotating parts shall be dynamically balanced.
(b) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.
(c) Complete pump assembly shall be subjected to shop performance test at supplier's works.

16.1.2 Ball Sorter / Fabricated Body (housing)

(a) In the case of fabricated design, all butt welds shall be subjected to 10% radiographic/ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and sub-surface defects.

(b) Body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
(c) Performance test shall be carried out on ball sorter assembly.

16.1.3 Strainer

(a) Strainer mesh shall be checked for chemical composition and mesh size.
(b) Strainer body shall be subjected to hydraulic pressure test at 1.5 times the design pressure.
(c) Strainer assembly shall be checked for its function.

16.1.4 The complete system and the individual equipment shall be subjected to performance testing at Site to demonstrate successful operation and performance to meet the design conditions. The tests shall also include hydraulic test, function test, check for interlocks and sequential operation. Site test shall also include test to establish pressure drop across the strainer section, proper functioning of DELTA-P system.

16.1.5 Piping and Fittings

Piping and fabricated fittings shall be subjected to following NDT.

(a) Butt welds of piping shall be subjected to 10% RT and 10% DP Test. Butt welds of Segmental flanges shall be checked by 100% RT and DPT.
(b) Fillet welds with load transfer shall be subjected to 100% MPE/DPT and fillet welds without load transfer shall be subjected to 10% MPE/DPT.

Wrought/ forged fittings shall be tested as per relevant code/ specification/ standard.

16.1.6 Coating / lining

16.1.7 Coating shall be checked for DFT and adhesion. Further, Contractor shall furnish his practice for testing of coating to ensure the uniformity and freedom from pinholes.

16.1.8 Rubber lined items shall be hydraulically tested before rubber lining. All rubber lining is to be subjected to following tests as per IS-4682 part-I or acceptable equivalent:

(a) Adhesion test
(b) Check for resistance to bleeding
(c) Measurement of thickness
(d) Shore hardness test
(e) Visual examination and spark test at 5 kv/mm of thickness.

16.1.9 VALVES
Conventional gate/ globe/ check/ ball valves shall be tested as per relevant standard.

16.2 ELECTRICAL AND CONTROL & INSTRUMENTATION: Refer Electrical and Control & Instrumentation Sections of QA&I specification.

SITE TEST: Quality requirements for site activities shall be as a minimum, those specified for corresponding shop activities.

17.0 LP Chemical Dosing System

a) Pumps of chemical dosing system shall be performance tested as per relevant international codes.

b) In case of diaphragm type of pumps, the life cycle test shall be done on pumps. If this test is already conducted for same model in earlier projects, then TC's for same shall be reviewed.

c) Dosing skid shall be subjected to leakge test and functional test.

SECTION - M3

T.G. HALL EOT CRANES, OTHER CRANES AND HOISTS

1.0 **HOOKS**

1.1 All tests including proof load test as per relevant IS/BS/DIN shall be carried out.

1.2 MPI/DPT shall be carried out after proof load test.

2.0 **STEEL CASTING**

2.1 DPT on machined surface shall be carried out

3.0 **GIRDERS, END CARRIAGE, CRAB, GEAR BOX AND ROPE DRUM**

3.1 Theplates of thickness25mm and above shall be Ultrasonically Tested.

3.2 NDT requirements on weldments shall be as follows:

a) BUTT WELDS IN TENSION - 100% RT AND 100% DPT
b) BUTT WELDS IN COMPRESSION - 10% RT AND 100% DPT
c) BUTT WELDS IN ROPE DRUM - 100% RT AND 100% DPT
d) FILLET WELDS - RANDOM 10% DPT

4.0 **FORGING (WHEEL, GEARS, PINIONS, AXLE, HOOKS & HOOK TRUNION)**

4.01 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing.

4.02 DPT/MPI shall be done after hard facing and machining.

5.0 **WIRE ROPE**

Wire ropes shall be tested as per IS: 3938.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no-load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. all tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per is-3177 shall be carried out at shop.

8.0 All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

9.0 Lifting Beam: Lifting beams shall be subjected to suitable test during manufacturing.

9.1 NDT requirements on weldments shall be as follows:-

i. butt welds in tension:- 100% RT and 100% DPT
ii. butt welds in compression:- 10% RT and 100% DPT
iii. fillet welds:- Random 10% DPT

9.2 All forgings greater than or equal to 50 mm diameter or thickness shall be subject to ultrasonic testing.

9.3 DPT/MPI shall be done after machining.

9.4 Lifting Beam will be subjected to overload testing at @1.25 X SWL of Lifting Beam at manufacturer works.

Section M4

EQUIPMENT COOLING WATER SYSTEM

	TEST / CHECKS ITEM / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit Up	Visual & Dimensional Check	UT	RT	Hydraulic / Water Fill	Balancing	Type Test	Performance Test	Other Test
A	**PLATE TYPE HEAT EXCHANGER**		Y	Y[3]	Y	Y			Y				
A.1	Heat Transfer Plates	Y[1]		Y[2]		Y	Y[5a]						Y[7]
A.2	Gaskets	Y				Y							
A.3	Cover Plates (Front & Rear)	Y[1]				Y	Y[5a]						
A.4	Tie Rods	Y[1]		Y[4]			Y[5b]						
B	**HORIZONTAL / VERTICAL CENTRIFUGAL PUMPS**				Y	Y						Y[10]	
B.1	Casing	Y[1]		Y[4]		Y			Y[8]				
B.2	Impeller	Y[1]		Y[4]		Y				Y[9]			
B.3	Shaft	Y[1]		Y[4]		Y	Y[5b]			Y[9]			
B.4	Fabricated Components	Y[1]	Y	Y[3]	Y	Y	Y[5a]	Y[6]	Y[8]				

Notes:	
Y	Applicable
Y[1]	One per heat / HT batch
Y[2]	DP Test shall be conducted for 10% of the lot of HT plates. However, in case of any defect, entire lot shall be tested and only defect free plates shall be accepted
Y[3]	100% DP Test shall be conducted on butt welds and 10% DPT on fillet weld after final run
Y[4]	100% DPT shall be carried out on machined surfaces
Y[5a]	UT shall be done on plates with thickness 25 mm or above
Y[5b]	UT shall be done on shaft / tie rod with diameter 50 mm or above
Y[6]	RT shall be conducted on butt joints having plate thickness above 10 mm. Quantum of RT shall be based on pressure rating
Y[7]	Each Plate after pressing shall be subject to either of the following tests, as per Manufacturer Practice a) Light Box Test b) Vacuum Test c) Air Chamber Test

Y^8	All pressure retaining parts shall be hydrostatically tested at 200% of pump rated head or 150% of shut – off head, whichever is higher, for at least 30 minutes. No leakage is allowed
Y^9	Static and Dynamic Balancing shall be carried out on complete rotor assembly
Y^{10}	All pumps shall be tested at rated speed, for head, flow capacity, efficiency and power consumption for the entire operating range i.e. from shut off head to maximum flow. A minimum of 7 readings shall be taken to plot the curve, with one reading at design flow. Testing standard shall be HIS (Hydraulic Institute Standard) of USA. Performance test shall be carried out with contract motor, wherever Liquidated Damages are to be ascertained based on performance test at shop
Y^{11}	For Piping & Valves, refer LP Piping System

Section - M5

CW SYSTEM

TESTS/CHECK ITEMS / COMPONENTS		Material Test	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/ operational st	Performance Test	Other Test	All Test as per relevant Std/ Approved Data Sheets	Remarks
A.	**CW PUMPS, CENTRIFUGAL PUMPS, SUMP PUMPS, SUBMERSIBLE PUMPS, DRAINAGE PUMPS**								Y[1]	Y		Y[2]			
1	Shaft	Y[a]	Y[b]	Y[c]		Y				Y					
2	Impeller	Y[a]	Y[b]		Y[3]	Y									
3	Suction Bell/Bowl Castings/ Inserts	Y[a]	Y[b]				Y			Y			Y6		
4	Discharge Head / Column Pipes / Distance /Piece/Base Plate	Y[a]	Y[b]		Y[4]		Y		Y						
5	Companion Flanges	Y[a]	Y[b]		Y[5]				Y						
5	Thrust Bearing (Tilting Pad type)	Y[a]	Y	Y					Y	Y				Y	
B.	**BUTTERFY VALVES**						Y[7]		Y	Y	Y		Y8	**Y**	
1	Body & Disc	Y[a]	Y[b]										Y9		
2	Shaft	Y[a]	Y[b]	Y[c]											
3	EH Actuators	Y[a]	Y				Y	Y	Y		Y				
C.	**RE JOINTS**	Y[a]					Y[10]		Y	Y			Y[14]	Y[14]	
D.	**STOP LOG GATES**	Y[a]	Y[b]						Y	Y			Y[12]		
E.	**PIPES**	Y[a]	REFER NOTE 16												
F.	**CRANES & HOISTS**	REFER SEPARATE TABLE FOR QA CHECKS ON EOT CRANES AND HOISTS													

G.	**VENTILATION FANS**									Y		Y		Y	
1)	Hub/Blades/Casing /Impeller	Y	Y			Y									
2)	Shaft	Y[a]	Y	Y[c]											
3)	Pre/Fine Filters												Y[14]		
H.	**GATE, GLOBE, CHECK, VALVES, PIPINGS & SPECIALITIES**	Y[a]	Y[b]	Y[c]			Y[15]		Y	Y	Y	Y	Y[15]	Y	

Notes:	
Y	Applicable
Y[1]	One per Heat/ Heat Treatment Batch/ Lot.
Y[2]	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components.
Y[3]	For Shaft diameter 40 mm and for plate thickness 40 mm (in case of EOT crane components)
Y[4]	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
Y[5]	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics
Y[6]	In case of CW pump impellers, Radiographic Examination shall be conducted as per ASTM E186/446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
Y[7]	Spot Radiography for Butt weld of Fabricated Components for thickness below 37.5 mm shall be carried out. If thickness is 37.5 mm, 100% RT shall be carried out. (RT may be replaced by Ultrasonic Test due to constraint if any.) Stress relieving shall be carried out as per norms of ASME Section VIII.
Y[8]	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any). Maximum number of segments shall be 4 only.
Y[9]	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
Y[10]	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
Y[11]	For Proof of Design Test refer respective chapters of engineering portion in the technical specification.
Y[12]	For Butterfly Valves of Fabricated construction (Sizes 600mm and above), butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Components shall undergo stress relieving.
Y[13]	During Hydraulic & Vacuum test at 25mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.
Y[14]	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D- 471, Ozone Resistance test as per ASTM D-1149, Aging test, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.
Y[15]	Smooth operation and Leakage test shall be carried out at site.

Y[16]	Followings are the testing requirements for fabrication of pipes at site	
	Tests	**Quantum of Check**
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% for pipes up to 1200 mm diameter
	DPT after back gauging	100% for pipes above 1200 mm diameter
	Rt	5%
	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working pressure whichever is higher
Y[17]	Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out	
Y	a. All pipes and fittings shall be tested as per applicable code. b. All strainers shall be subjected to Hydraulic pressure test for leakage and Pressure drop v/s Flow for each type and size. c. All valves shall be hydraulically tested for body, seat and back- seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. d. Valves shall be offered for hydro test in unpainted condition e. Functional checks of the valves for smooth opening and closing shall also be done. f. Anti-corrosive protection shall be tested as per applicable code.	

SECTION - M6

AIR CONDITIONING & VENTILATION SYSTEM

1.0 CHILLING UNIT

1.1 REFRIGERANT COMPRESSOR (SCREW/SCROLL)

1.1.1 Hydraulic/Pneumatic test of castings for cylinder block / crank case / casings etc. shall be carried out. No leakage shall be permitted

1.1.2 DPT on connecting rod, piston, crankshaft, screw, Impeller with shaft, Vanes, crank case/cylinder/casing after machining shall be carried out.

1.1.3 All rotating parts of screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3.

1.1.4 Leak tightness & vacuum check for chilling units / compressors in assembled condition shall be carried out. No leakage shall be permitted.

1.1.5 Performance test of assembled compressor & Chiller Assembly shall be done to check for following :

a) Capacity test for oil pump for reciprocating compressor

b) No load air run (free run) test of all types of compressors / chilling units to check FAD (Free air delivery), Noise, and Vibration & Temp. rise of bearing & body.

c) Pump up & leak back rate for reciprocating compressor.

d) Functional run test for Chiller assembly and Capacity control (for part load performance) check shall be carried out

1.2 CONDENSER & EVAPORATOR

1.2.1 DPT shall be carried out on finish welds.

1.2.2 10% RT of butt weld joints on shell shall be carried out.

1.2.3 Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.

1.2.4 Mock-up test for tube to tube sheet expansion shall be carried out. In case such a test is already conducted for similar tube/tube sheet thickness and materials, record for the same shall be furnished for review.

1.2.5 Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. No leakage shall be permitted.

2.0 AIR HANDLING UNIT

2.1 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

2.2 UT of fan shafts (dia greater than or equal to 50mm) shall be carried out.

2.3 DPT of fan shafts after machining shall be carried out.

2.4 DPT of welding on shaft (in case of fabricated shaft) shall be carried out.

2.5 Rotating Components of fan shall be statically and dynamically balanced to ISO 1940 Gr. 6.3

2.6 One fan of each type and size shall be performance tested as per AMCA / BIS for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise and Vibration.

2.7 One per type of assembled AHU (AHU casing & fan assembly) shall be subject to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.

2.8 All cooling coil shall be pneumatically tested and no leakage shall be permitted.

3.0 CENTRIFUGAL PUMP

3.1 UT on pump shaft (dia. greater than or equal to 50mm), MPI/DPT on pump shaft and impeller after machining shall be carried out.

3.2 All rotating components of the pumps shall be statically and dynamically balanced to ISO-1940 Gr. 6.3

3.3 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head Characteristics Curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.

3.4 Standard Running Test

a) All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance shall be as per approved datasheet & HIS standard only

b) Noise and vibration shall be measured at shop for reference purpose only.

c) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.

d) NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

4.0 FANS

4.1 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

4.2 DPT of fan shafts shall be carried out after machining.

4.3 UT of fan shafts (dia greater than or equal to 50mm) shall be carried out.

4.4 Rotating components of all fans shall be statically and dynamically balanced to ISO-1940 Gr. 6.3

4.5 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.

4.6 One fan of each type and size will be performance tested as per corresponding IS code for Airflow, Static Pressure, Total Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

5.0 LOW PRESSURE AIR DISTRIBUTION SYSTEM

5.1 Functional test for fire damper along with solenoid shall be done.

5.2 Prototype tests for fire resistance rating as per UL-555 of each type and size of damper shall be carried out. In case prototype tests have already been done, the contractor shall submit the test report for verification and approval.

5.3 SITE TEST:-After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.

6.0 INSULATION

6.1 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.

6.2 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density, outer diameter and thickness of material as applicable as per IS:3346 or equivalent standard.

7.0 COOLING TOWER

7.1 UT of fan shaft and drive shaft (dia greater than or equal to 50mm) shall be carried out.

7.2 DPT of fan hub and shafts shall be carried out after machining.

7.3 Colors of fills shall be as per approved data sheet.

7.4 Fan assembly shall be statically balanced.

7.5 Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. Cooling Towers being supplied in knocked-down condition, these tests shall be done at site.

8.0 AIR FILTERS

Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.

9.0 PIPES & FITTINGS

9.1 Dye penetration test of welds of pipes / fittings (including welds of rolled and welded pipes, if any) shall be carried out.

9.2 All pipes and fittings shall be tested as per applicable codes/standards at manufacturer's works. Piping shall be tested at site hydraulically/pneumatically as per application requirement.

10.0 VALVES & SPECIALTIES

10.1 Visual and dimensional check of valves as per relevant code / approved drawing.

10.2 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

10.3 Refrigerant line valves shall be pneumatically tested for body and seat leakage test.

10.4 All valves shall be offered for hydro test and pneumatic test in unpainted condition.

10.5 Functional check of the valves for smooth opening and closing shall be done.

10.6 Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.

10.7 One valve of each type, size and rating for 3-way mixing valve shall be subjected to cycle test for 500 cycles.

11.0 PACKAGED AIR CONDITIONERS (PAC)/ SPLIT/CASSETTE AC

11.1 For PAC Units, Split/Cassette Air conditioner up to 10 TR capacity will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate. However for these units capacity assessment shall be done at site as per approved procedures.

11.2 For Air Cooled PAC of Capacity more than 10TR, One Unit (Both indoors and out door interconnected) of each type and rating shall be subjected to production routine test inclusive of Performance Test as per IS: 8148 at prevalent ambient condition.

12.0 Air Washer and Unitary Air Filter (UAF)

12.1 Hydraulic test of pressure parts at 1.5 times the design.

12.2 Pressure and water fill test of tanks shall be carried out.

12.3 Random 10% DPT shall be carried out on weld joints

12.4 Trial assembly of Air washer/UAF for one of each size shall be done in shop.

SECTION - M7

COMPRESSED AIR SYSTEM

1.1 AIR COMPRESSORS:

a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure prior to painting and lining, if applicable. The test pressure will be maintained for 30 minutes.
b) All other parts including inter-connecting pipings shall be hydraulically tested wherever possible, as per relevant codes.
c) Ultrasonic testing shall be carried out on all forgings and shafts (if dia.>= 50mm) viz. Crank shaft, connecting rod, piston rod, etc. MPI/DP test will be done on machined areas of the above components.
d) Pistons shall be subjected to DP testing.
e) During assembly all clearances and alignments shall also be checked and recorded.
f) Rotor shall be statically and dynamically balanced.

1.1.1 PERFORMANCE TEST (SHOP TEST) :

a) Performance test on the compressors shall be carried out in accordance with ISO: 1217/eq. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valves.
b) Power consumption at motor input terminal at rated capacity as well as at fully unloaded condition of the compressor shall be measured.
c) Vibration and noise level measurement will be done during shop performance test.
d) Test shall be carried out on all compressors with contract drive motor where power consumption for compressors has been indicated as a guaranteed parameter
e) Clearance on Type test requirements from Employer's Engg. Shall be reviewed prior to final clearance.

1.2 INTAKE AIR FILTER & SILENCER

a) Test for Capacity, Pressure drop and Efficiency shall be done as per manufacturer's standard.

1.3 AIR RECEIVER, HEAT EXCHANGERS, MOISTURE SEPERATORS, AIR DRYING PLANT

a) Each finished vessel shall be hydraulically tested to 150% of the design pressure for duration of 30 minutes.
b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below:
   (i) 100 % DPT on root run of butt welds.
   (ii) 100% DPT on all finished butt welds and fillet welds
   (iii) 10% RT on butt welds which shall include all T-joints.
c) Tube-to-Tube sheet joint of the heat exchangers shall be subject to Mock-up test as per the relevant standards.
d) Reactivation blowers shall be tested for FAD, temp. rise, noise & vibration. Rotating parts shall be dynamically balanced.

e) Completely assembled ADP shall be pneumatically tested at design pressure for a duration of 5 minutes. Functional and sequential operation testing of the completely assembled ADP shall be demonstrated at shop. Other accessories shall be tested as per relevant code and sections. Dew point measurement shall be done

1.4 E.O.T. CRANE :

a) Chain pulley Blocks shall be tested as per IS: 3832.
b) Following NDT requirements shall be met :
   i. 100% RT of Butt welds in tension and 10% RT of butt welds in compression.
   ii. DP at random on all weldments.
   Deflection, load, overload & travel check on HOT crane assembly shall be carried out as per IS: 3177.

1.5 PIPINGS, VALVES, BLOWERS, TANKS & VESSELS, FITTINGS AND OTHER SPECIALITIES

Refer relevant clauses as indicated in Technical specification.

All forgings, dia 50 mm shall be Ultrasonic Tested irrespective of the type, size & rating of the valve.

SECTION – M8

MILL REJECT SYSTEM

1.0 PNEUMATIC CONVEYING SYSTEM

1.1 PIPING, VALVES, STRAINERS AND FITTINGS

a) All pipes and fittings shall be tested as per applicable code.

b) All valves shall be hydraulically tested for body, seat and back seat (if applicable) as per relevant Standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. Valves shall be offered in unpainted condition only.

c) Functional checks of the valves for smooth opening and closing shall also be done.

d) Strainer body shall be hydraulically tested. One of each type and size of Strainer shall be tested for Pressure drop v/s flow rate, if not tested earlier.

1.2 PRESSURE AND STORAGE VESSELS:

(a) Atmospheric Tank

i) All weld joints shall be DP tested and complete tanks shall be water fill tested.
ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to all tests (Hydro, NDT and Vacuum) according to design code as applicable.

(b) Pressure Vessel

(1) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below:

i) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds.
ii) 10% DPT on all finished butt welds
iii) 10% RT (covering all 'T'/cross joints) of butt welds

(2) Butt Welds of dished ends shall be stress relieved and subjected to 100% RT.

(3) Each finished vessels shall be hydraulically tested to 150% of the design pressure for duration of 30 minutes.

1.3 CONVEYING AIR COMPRESSOR

In addition to Hydraulic tests of pressure parts, performance test of the compressor shall be done for FAD, pressure, power consumption, as per relevant code. Noise and vibration shall also be measure.

1.4 BAG FILTERS

1.4.1 Leakage test shall be carried out for casing and other pressure parts

1.4.2 Pulsing and sequential test on bag filter cages shall be done.

1.5 MONO RAIL HOIST/CHAIN PULLEY BLOCKS

1.5.1 Chain pulley blocks shall be tested as per IS:3832

1.5.2 UT & MPI/DPT shall be done on gear blank, pinion shaft, axles.

1.5.3 Proof Load Test on hooks shall be carried out followed by DPT.

1.5.4 100% Radiography on weld joints under tension and 25% radiography on compression butt joints followed by 100% DPT shall be done for rope drum, girder, end carriage etc.

1.5.5 Complete hoists shall be tested for load and overload test as per IS:3177

1.6 VENTILATION SYSTEM

1.6.1 Shop Run Test for all Centrifugal Fans to check noise, temp. rise & vibration

1.6.2 Performance test on one fan of each type for capacity, pressure, efficiency and power consumption.

SECTION – M9

FUEL OIL HANDLING SYSTEM

1.1 TANKS AND VESSELS

1. Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, forgings etc)

2. Only Qualified welders as per approved WPS and PQR shall be deployed for fabrication of tanks.

3. Dimensional checks, during in-process and final inspection, shall be carried out for alignments, circularity, verticality, orientation of connections, slope of bottom plate etc.

4. NDT on weld joints shall be done as per relevant / applicable standard. However, minimum requirement of NDT, as given below, shall be complied:

   a. 100% DPT on root run (butt welds / back-gouged welds).

   b. 100% DPT on all finished welds.

   c. RT on butt welded seams (which shall cover all 'T' / Cross joints) as per design code / Standard.

5. All tanks shall be subjected to hydraulic test. Other tests, (as per relevant design standard), given below shall be applicable:

   a. Vacuum test for bottom plate seam testing and annular plate.

   b. Air/vacuum test for roof testing.

1.2 FUEL OIL PUMPS/DRAIN OIL PUMPS/WATER PUMPS

1. Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, forgings etc)

2. All forged/rolled bars (for pump rotors/screws) shall be subjected to Ultrasonic Test (for diameter>= 50mm) at proof machine condition and DPT/MPI after finish machining.

3. Rotating parts i.e. Screws/Rotors, Impellers shall be statically and dynamically balanced as per requirements of code ISO: 1940 Gr. 6.3 or better.

4. The machined surfaces of castings shall be subjected to DP Test.

5. Pump casing shall be hydraulically tested at a pressure 150% of specified shut off head or 2 times working pressure (whichever is higher) for leak tightness.

6. All pumps shall be performance tested as per relevant / applicable code.

1.3 PIPING, VALVES, STRAINERS AND FITTINGS

1. Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, forgings, castings etc)

2. All pipes and fittings shall be tested as per applicable code. Welds of Steam Pipe joints shall be 10% radio graphed and 100% DP tested.

3. Following are the testing requirements for fabrication of pipes at site

TESTS	QUANTUM OF CHECKS
WPS, PQR, Welder Qualification Test	100%
DPT on root run	100% for pipes up to 1200 mm dia
DPT after back gauging	100% for pipes above 1200 mm dia
RT	5%
DPT on finished butt weld joints	10%
Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working-pressure whichever is higher
100% RT of that field butt weld joint shall be carried out which could not be covered in hydraulic test	

4. All valves shall be hydraulically tested for body, seat and back seat (as applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

5. Valves shall be offered in unpainted condition.

6. Functional checks of the valves for smooth operation, valve travel, opening and closing time shall be checked. Current drawn by actuators shall also be checked.

7. Fire safe test for ball/Plug valves shall also be done as per applicable codes/standard.

8. All fabricated strainers shall be subjected to Welding Checks & NDT checks as per design standard requirements. Strainer body shall be hydraulically tested and Pressure drop v/s flow rate test shall be done for Strainers. Weld joints are to be DP tested.

1.4 MONORAIL HOISTS

1. Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, pipes, tubes, forgings, castings etc)

2. Plates of thickness 25 mm shall be subjected to Ultrasonic Test.

3. For fabricated items, only qualified welders shall be deployed as per approved and qualified procedure.

4. NDT requirements on weldments shall be as follows:

   i. Butt weld joints in Tension – 100% RT, 100% DPT

ii. Butt Weld Joint in Compression – 10% RT, 100% DPT
iii. Butt Weld Joint in Rope Drum – 100% RT, 100% DPT
iv. Fillet Weld – 10% DPT.

5. UT shall be carried out on forgings of diameter 50mm in proof machined condition.

6. Chain pulley block shall be tested as per IS: 3832

7. Deflection, load, overload and travel check as per IS: 3177 shall be done on assembled HOT.

1.5 FLEX HOSES

Tests such as Adhesion, Property before and after aging, swelling, tensile, elongation at break for rubber and vacuum test, pressure test, burst/proof pressure test, dimension of finished hose shall be carried out as per relevant standard.

Section - M10

Cathodic Protection

Attributes /Characteristics **Items, Components, Sub-System Assembly**	Make, type, model, rating & TC	Visual Check	Electrical Properties	Mechanical Properties	Chemical Properties	Dimension and Finish	Functional &Operational Feature	Painting as per tech specs.	All Routine and Acceptance test s as per relevant standards/tech Specs
TR unit	Y	Y	Y			Y	Y	Y	Y
Silicon Chromium Anode	Y	Y		Y	Y	Y		Y	
Junction Box	Y	Y	Y			Y		Y	Y
Permanent Reference Cell(Cu-CuSO4)	Y	Y				Y			
Scarificial Magnesium Anode	Y	Y		Y	Y	Y		Y	Y
Zinc Anode	Y	Y		Y	Y	Y		Y	Y
MMO Anode	Y	Y	Y	Y	Y	Y	Y	Y	Y
Surge Diverter	Y	Y	Y		Y	Y			Y
ER Probe and Reader	Y	Y				Y			Y
Polarisation Cell	Y	Y	Y		Y	Y			Y
Cables	Y	Y	Y	Y		Y			Y
Test Station	Y	Y						Y	Y

Notes:	
1.	This is an indicative list of tests/checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant and supporting documents
2.	Make of all Bought Out Items will be subject to NTPC approval

SECTION – 11

COAL HANDLING PLANT

1.0 Brakes and Clamps

1.1 Final testing of brakes shall include load, HV/IR & heat run tests.

2.0 Monorails and Hoists

2.1 All electric hoist shall be tested as per IS 3938 and chain pulley block shall be tested as per IS 3832.

3.0 Hoppers & Liners

3.1 Rack & Pinion Gates/Flap Gates/Rod Gates

a) MPI/DP test shall be conducted on rack and pinion / rod / weld joint

b) Functional checks on the gates shall be carried out along with respective actuator, if applicable.

4.0 Belt Conveyor System

The details of the checks to be carried out in the various equipment are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with the Owner.

4.1 Idlers

a) Check for run out and free movement shall be carried out on idlers. Run out shall be restricted as per IS: 8598

b) Test for dust proofness, water proofness and dynamic friction factor of the Idlers shall be conducted at shop. The detailed procedures for the same shall be submitted for review and approval.

4.2 Belting

a) Rubber cover of finished belt shall be checked for tensile strength and elongation at break before and after ageing. Rubber cover shall also be checked for abrasion, tear strength and hardness.

b) For finished belts, checks for elongation at 10% nominal tensile strength, tensile and elongation at break in longitudinal (warp) direction and tensile in transverse (weft) direction shall be carried out.

c) Adhesion test between ply to ply and cover to ply shall be carried out.

d) Trough ability test and Test for fire resistance shall be carried out.

e) Test for procedure qualification for belt vulcanizing joint (at site) shall be done. Procedure for belt vulcanizing joint shall be discussed and finalized during FQP finalization.

f) There will be a limitation on the no. of repairs allowed on the belts. Following will be the acceptance norm for the cover repairs.

i) The maximum size of a repair shall be limited to a size equivalent to one fifth the belt width. No single dimension shall exceed one fifth (1/5) of belt width.

ii) Small local repair by dough filling of size 25mm x 25mm to a limited extent shall not be counted of repairs. However, in case of cluster of repairs, same shall be counted as a patch repair.

iii) The maximum number of patch repair shall not exceed 5 per 100 mts. However, the total number of patch and dough filling repairs shall not exceed 10 per 100 meters.

g) In addition to above, Steel Cord belt shall also be tested for following:

i. Cord dia and breaking strength
ii. Finished belt shall be tested for cord pull-out strength before and after aeging, peeling resistance.
iii. Dynamic cord pull out test
iv. Cord dia, pitch and number of cords

h) In no case shall the cover thickness or the width of belt be less than that given in specification.

i) For testing purpose, belt sample shall be taken from anywhere of the belt roll length offered

4.3 Belt Vulcanizing Machine

a) Check for tensile strength shall be carried out on a sample vulcanized belt joint for each type of belt in shop. However if such test has been done earlier, the report for same shall be submitted for verification.

b) Complete assembly shall be tested at shop for temp. and pressure developed

4.4 Pulleys

a) In addition to chemical, mechanical, hardness, microstructure as per applicable material specification, pulleys shaft forgings shall be subjected to ultrasonic testing.

b) 100% MPI/DPT on all welds shall be conducted and 10% RT/UT on butt welds shall be conducted.

b) Static balancing of pulleys shall be carried out after rubber lagging.

c) Checks on rubber lagging to include abrasion loss, shore hardness test, peel-off strength test and physical properties. Peel-off strength shall be 10 Kg/Cm, Abrasion loss shall be less than 250 cubic mm when tested as per DIN 53516.

4.5 Pull Chord & Belt Sway Switches

a) Acceptance tests

i) Over all dimension and functional test
ii) HV & IR test
iii) Degree of protection test report.

4.6 Zero Speed Switch, Under Belt Switch and Chute Blockage Switch

a) Acceptance test

i) Burn in test at 50 degree C for 48 hours shall be done for electronic switches.
ii) Over all dimension and functional test shall be carried out.
iii) HV & IR
iv) Degree of protection test

5.0 Drive Equipments

5.1 **Gear Boxes:**

a) In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.

b) MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard facing shall be checked to ensure freedom from defects.

c) Gear reducer shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.

5.2 Flexible Coupling

a) Ultrasonic testing shall be conducted on forgings for gear sleeve and gear hub, if gear coupling is provided.

b) MPI shall be carried out after machining to ensure freedom from cracks.

5.3 Fluid Coupling

a) Dynamic balancing shall be carried out for the rotating parts.

b) Check for leak tightness of the coupling shall be carried out.

c) Functional test on fusible plug for each type of coupling shall be conducted at shop.

d) All couplings to be run tested at shop on no load.

e) Check for temperature rise, torque-speed, and torque-slip characteristics and over speed test shall be included during performance test of one coupling of each type preferably at full load.

6.0 BELT SCALES

The details of the checks to be carried out in the various equipments are to be submitted by the Contractor for Employer's approval. However, some indicative checks are given below which should necessarily form a part of the quality assurance plan to be agreed with the Employer.

6.1 Mounting arrangement/Overall dimensional check shall be carried out on the Belt Scales.

6.2 Belt scale shall be calibrated with test weight/test chain in static at works and with test weight for dynamic condition at site.

6.3 All electronic modules shall be subjected to burn in test at 50 Degree C for 48 hours.

6.4 General check for load cell shall be carried out.

6.5 Test report for degree of protection on enclosure shall be furnished.

6.6 Accuracy/performance check shall be demonstrated at site.

7.0 **Dust Control & Miscellaneous Systems (Dust Suppression & Dry Fog Dust Suppression System)**

The details of the checks to be carried out on the various equipments are to be submitted by the Contractor for Owners approval. However some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with by the Owner.

7.1 **Pumps**

a) All materials should be of tested quality and test certificates to be provided.

b) DPT of machined shaft and impeller shall be done.

c) Shaft forgings to be also subjected to ultrasonic testing.

d) Impellers to be dynamically balanced to ISO 1940 Gr.6.3

e) All pressure parts shall be hydraulically tested at 150% of the shut- off head or 200% of rated head, whichever is higher for 30 minutes. No leakage is allowed.

f) All pumps to be performance tested as per Hydraulic Institute Standard/Indian Standard. Performance test to include check for noise, vibration level and temperature rise.

7.2 Valves & Specialities

a) Valves and Specialities shall be tested as per relevant standards / codes.
b) Seat Leakage and hydraulic test to be carried out as per relevant standards /codes.

7.3 Pipes and Fittings

Pipes and fittings shall be tested as per relevant standards / codes.

7.4 Air Compressor

a) All pressure parts shall be hydraulically tested at not less than 150% of design pressure for duration of 30 minutes prior to painting.

b) All other parts including inter-connecting piping shall be hydraulically tested wherever possible, as per relevant codes.
c)
d) Ultrasonic testing shall be carried out on all forgings and rotor for dia 50mm and above. MPI/DPT shall be done on machined area of the components.
e) During assembly all clearances and alignments shall also be checked and recorded
f) Rotor shall be statically and dynamically balanced
g) Performance Test (Shop Test)

i. Performance test on the compressor shall be carried out in accordance with ISO: 1217/Eq. The test shall also include demonstration of loading and unloading mechanism (Capacity control) and operation of safety valve.

ii. Vibration and Noise level measurement shall be done during shop performance test.

7.5 Air Receiver

a) Each finished vessel shall be hydraulically tested at 150% of the design pressure for duration of 30 minutes
b) NDT on weld joints shall be as per respective code requirements or the minimum as specified below:

i. 100% DPT on root run of butt welds
ii. 100% DPT on all finished butt welds and fillet welds
iii. 10% RT on butt welds which shall include all T-Joints

8.0 Dust Extraction, Ventilation Systems

8.1 Fan

a) All materials should be of tested quality and test certificates should be provided.
b) Dynamic balancing of the fan impellers to be carried out.
c) Shop run test shall be conducted on all centrifugal fans including check for noise and vibration level.
d) Performance test shall be conducted on one fan of each type at shop for capacity, pressure, efficiency and power consumption.

8.2 Valves and Specialities

Refer 7.2 above

8.3 Pipes and Fittings

Refer 7.3 above

8.4 Package Air-Conditioner

For Air Cooled PAC Units, Split/Cassette Air conditioner up to 10 TR capacity will be accepted on the basis of Manufacturer Standard Guarantee and Warrantee certificate. However for these units capacity assessment shall be done at site as per approved procedures. For Air Cooled PAC of Capacity more than 10TR, One Unit (Both indoor and outdoor interconnected) of each type and rating shall be subjected to production routine test inclusive of Performance Test as per IS: 8148 at prevalent ambient condition.

9.0 VIBRATING GRIZZLY FEEDERS AND VIBRATING FEEDERS

a) Shaft forgings to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification

b) Following minimum NDT requirements to be ensured for welds:

i. Butt welds - 10% UT/RT and 100% MPI/DPT.
ii. Fillet Welds - 10% MPI/DPT.

c) Shop trial run test shall be conducted to checks for speed (RPM), amplitude (stroke), temperature rise and noise level.

10.0 CRUSHERS (RING GRANULATORS)

The details of the checks to be carried out for various components are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the Quality Assurance Plan to be agreed with the Owner.

a) All plates equal to or above 25mm thickness shall be ultrasonically tested.

b) Shaft forgings and suspension bars to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. As per applicable material specification.

c) Following minimum NDT requirements to be ensured for welds:

i. Butt welds - 10% UT/RT and 100% MPI/DPT.
ii. Fillet Welds - 10% MPI/DPT.

d) Crusher rotor to be dynamically balanced. Procedure to be submitted for approval.

e) No-load trial run test to be carried out at shop to check for speed (RPM), temperature rise, noise level and vibration.

11.0 TRAVELLING TRIPPERS & BUNKER SEALING ARRANGEMENT

Mobile Trippers

a) Shaft and wheel forgings – Ultrasonic test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification shall be conducted.

b) Following minimum NDT requirements to be ensured for welds:

i. Butt welds - 10% UT/RT and 100% MPI/DPT.

ii. Fillet Welds - 10% MPI/DPT.

c) Shop trial run test shall be carried out and shall include check for noise level and vibration.

13.0 **In-Line Magnetic Separators**

i. Overall Dimensional, Visual check alongwith control panel
ii. HV & IR
iii. Operation, temperature rise, lifting capacity, force index and gauss strength.

14.0 **Metal Detectors**

i. Functional test including sensitivity, Burn in test, operation of liquid spray marker, detection of smallest piece of different materials as specified.
ii. Test report for Degree of protection test to be furnished.

15.0 Coal Sampling Units

a) Free carriage and cutter movement, speed of cutter and dust door closing and sealing shall be tested for samplers.
b) "No load test" shall be carried out for crushers.

16.0 Elevators

The details of the checks to be carried out in the various equipment are to be submitted by the contractor for owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the quality assurance plan to be agreed with the owner.

16.1 All forgings shall be subjected to ultrasonic test to ensure free from internal defects in addition to check for chemical and mechanical properties.
16.2 10% of the welds selected at random shall be subject to DP test.
16.3 All forged components shall be subjected to DPI/MPI after machining.
16.4 Gear Reducer shall be checked for gear ratio, backlash, and contact pattern. No load shop trial run shall be conducted on gear boxes to check for oil leakage, temperature rise, noise and vibration.
16. 5 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.
16.6 All components prior to assembly shall be checked for dimensions.
16.7 Function test of Elevator assembly shall be carried out.
16.8 All electrical equipments shall be of proven quality.
16.9 Galvanized components/parts shall be checked for weight of Zn coating, thickness of coating, uniformity of coating and adhesion test and visual examination as per IS 2633 and IS 2629.

16.10 Reduction gears shall be checked for reduction ratio and backlash. Run outs of wheel shafts and work shafts, tooth contact and running test should also be carried out.

16.11 Breaking load test shall be carried out along with all other tests as per relevant standard for steel wire rope.

16.12 Buffer springs shall be subjected to load test as per relevant specifications. Material certificates for springs shall also be furnished.

16.13. All components prior to assembly shall be checked for dimensions.

16.14 All rotating components shall be shop tested for dynamic balancing.

16.15 Car sling and car body in assembled condition shall be checked for position of all major components i.e. car sling, inside depth, width, height, positions of push box, indicator box lights, fans etc.

16.16 Vibration level shall be determined on work geared machine.

16.17 Mechanical balance test and determination of vibration level on lift and accessories shall be carried out. Vibration level shall be measured at site also.

16.18 Pressurization Unit: In case the lift is provided with 'Pressurised Unit' the fan shall be dynamically balanced and complete unit shall be performance tested.

16.19 For electrical & instrumentation etc. refer Electrical and C&I tables.

17.0 Reversible Stacker Cum Reclaimer

17.1 All plates equal to or above 25mm thickness shall be ultrasonically tested.

17.2 Forgings/Castings for Shaft, Gears/Pinion, Axles, Rail Wheels, Bucket Hub/Teeth/Blade etc., shall be subject to ultrasonic testing in addition to check for chemical, mechanical, hardness and micro-structure as per applicable material specification

17.3 MPI/DPT shall be carried out on forgings/casting after machining/hard-facing if applicable.

17.4 Following minimum NDT requirements shall be followed for welds:

i. Butt Welds in Tension - 100% UT/RT and 100% MPI/DPT.
ii. Butt Welds in Compression - 10% UT/RT and 10% MPI/DPT.
iii. Fillet Welds - 10% MPI/DPT.

17.5 Trial assembly of Stacker/Reclaimer, Sub-assemblies shall be carried out at shop.

Manufacturer shall furnish detail procedure for various sub assemblies such as wheel bogies, base frame, slew deck, bucket wheel, boom, bucket wheel with shaft and sample bucket etc. for Owner approval.

18.0 WAGON TIPPLER ALONGWITH SIDE ARM CHARGER

18.1 All plates equal to or above 25 mm thickness shall be ultrasonically tested.

18.2 Casting and forgings/bars (Shafts, Racks, Pinion wheels, Arm etc.) shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.

18.3 Machined and hard faced surface of casting/forging shall be subjected to DPT/MPI.

18.4 Following minimum NDT requirements shall be followed for welds:

i. Butt Welds in Tension - 100% UT/RT and 100% MPI/DPT.
ii. Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.

iii. Fillet Welds - 10% MPI/DPT.

18.5 Trial assembly of various sub-assemblies of Wagon Tippler alongwith Side Arm Charger shall be carried out in shop. Manufacturer shall furnish detail procedure for the same for Owner approval.

19.0 APRON FEEDER

a) All plates equal to or above 25 mm thickness shall be ultrasonically tested.
b) Castings and forgings, forged/rolled bar/section shall be subjected to ultrasonically test in addition to check for chemical, mechanical, hardness, microstructure etc. as per applicable material specification.
c) Machined and hard faced surface of casting/forging and other hardened, stellited parts shall be subjected to DPT/MPI in addition to check for case depth, hardness as applicable for chain/sprocket/gear reducer/rollers/wheel/pan etc.
d) Suitable check for life time sealing of rollers for protection from dust and water shall be done
e) Following minimum NDT requirements shall be followed for welds:
   i. Butt Welds in Tension- 100% UT/RT and 100% MPI/DPT.
   ii. Butt Welds in Compression- 10% UT/RT and 10% MPI/DPT.
   iii. Fillet Welds - 10% MPI/DPT.
f) For other items like drive system, motor, pulley, belt relevant portion of specification shall be applicable
g) No load trial run test shall be carried out at shop on completely assembled apron feeder to check for trouble free operation, temperature rise, Noise & vibration.

Section - M12

FIRE DETECTION & PROTECTION SYSTEM

1.0 **HYDRANT SYSTEM:** Shop Tests

1.1 Hydrant Valve:

a) All valves shall be hydro tested for body and seat.

b) Capacity test / flow test shall be done as per relevant standard.

1.2 Water Monitor, Hoses, Branch Pipes, Couplings and Nozzles

a) All tests including hydraulic test shall be done as per relevant Indian /International standard.

1.3 For Pumps, Diesel Engine, Gear-Box refer the requirements indicated separately.

2.0 HIGH / MEDIUM VELOCITY WATER SPRAYS SYSTEM: Shop Tests

2.1 For Pipes, Fittings, Valves and specialties, requirements are indicated separately.

2.2 Deluge Valve and Spray Nozzles

a) All valves shall be hydro tested for body and seat.

b) Performance test / functional test of 'Deluge Valve' and 'Spray Nozzles' shall be carried out.

2.3 Detectors

All 'Detectors' shall be tested as per relevant Indian / International Standards. Detectors shall also meet the requirements of UL / FM / LPC etc.

3.0 **INERT GAS EXTINGUISHING SYSTEM**: Shop Tests

3.1 a) Complete system selection / Major components shall be approved by TAC / UL / FM / LPC etc.

b) Storage Cylinders / Containers with all accessories, all piping, valves, fittings and nozzles shall be subjected to all tests as per the design code to which they are supplied and shall also meet the requirements of TAC / UL / LPC / FM / NFPA etc.

c) Storage Containers shall also meet the statutory requirements of approval / acceptance by CCE.

d) Test for fill density, weight, leakage etc. shall be done for charged cylinders / containers.

4.0 **VERTICAL / HORIZONTAL CENTRIFUGAL PUMP**: Shop Tests

a) UT on Pump Shaft (>= 50mm dia) and MPI / DPT on Pump Shaft and Impeller shall be carried out.

c) All rotating components of the pumps shall be statically and dynamically balanced as per ISO: 1940 Gr. 6.3 or better.

d) Tests shall be carried out on the materials of the pumps to establish their properties, and chemical compositions

e) 100% DPT or MPE shall be carried out for the rotor and machined surfaces of casing and impellers.

f) Hydraulic test shall be conducted on pump casing with water at 1.5 times the shut off pressure or twice the head pressure whichever is higher for a minimum duration of 30 minutes.

g) Performance test and Standard Running test:

(i) All the pumps shall be tested in the manufacturer's works for capacity, efficiency, head and brake horse power. Pump shall be given running test over the entire operating range covering the shut off head to the maximum flow. The duration of test shall be minimum one hour. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pump shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and / or as per applicable Indian Standard or equivalent. Tolerance on parameters shall be as per HIS.

(ii) The test shall be conducted at the rated speed preferably with the type tested contract drive motor being furnished . However, in case of any limitation , test bed motor duly calibrated can also be used.

(iii) Noise and Vibration shall be measured.

(iv) Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level / vibration are observed during the shop test.

5.0 **COMPRESSION IGNITION DIESEL ENGINE**

7.3 Shop Tests:

a) All pressure parts shall be subjected to Hydraulic pressure tests at 1.5 times the design pressure.

b) All Diesel engine shall be performance tested as per relevant IS / equivalent code.

c) All gear boxes shall be tested at No-load for back lash, gear ratio, noise vibration and temp. rise.

7.4 Performance Test:

a) Performance test of diesel engine shall be carried out as per BS-5514/ IS or equivalent international code to determine the rated power and specific fuel consumption and governor's function. Performance test of engine in shop shall be done with actual job accessories for minimum four hours (three hours for full load and one hour for over load at 110% of full load). All the engine parameters like RPM, inlet air temp. and pressure, water inlet and outlet temp. And pressure, lube oil pressure, fuel consumption, ambient condition shall be measured and recorded for every half an hour. No positive tolerance shall be allowed on the specific fuel consumption (contractor to specify in the offer).

6.0 PRESSURE AND STORAGE VESSELS: Shop Test

6.1 Atmospheric Tank

a) All weld joints shall be DP Tested and complete tanks shall be water fill tested.

b) All atmospheric storage tanks fabricated and erected at site shall be subjected to all tests (Hydro, NDT, and Vacuum) according to design code as applicable.

6.2 Pressure Vessel

a) Each finished vessel shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.

b) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below:

(i) 100 % DPT on root run of butt weld.

(ii) 10% DPT on all finished butt welds and fillet welds.

(iii) 10% RT (covering all 'T' / cross joints) of butt welds.

6.3 Butt welds of dished ends shall be stress relieved and subjected to 100% RT.

7.0 PACKAGE AIR COMPRESSOR

In addition to Hydraulic tests of pressure parts, performance run test of the compressor shall be done for FAD, pressure , power consumption, as per relevant code.

8.0 PIPING, VALVE AND SPECIALITIES

8.1 Shop Tests

a) All pipes and fittings shall be tested as per applicable code.

b) DPT of pipe welds (in case of rolled and welded pipes only) shall be carried out for root and finished welds.

c) All strainers shall be subjected to Hydraulic pressure test for leakage and Pressure drop v/s Flow for each type and size.

d) All valves shall be hydraulically tested for body, seat and back-seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

e) Valves shall be offered for hydro test in unpainted condition.

f) Functional checks of the valves for smooth opening and closing shall also be done.

g) Anti-corrosive protection shall be tested as per applicable code.

9.0 **FOAM SYSTEM:**

9.1 Shop Test

a) For tanks, pipes, fittings, valves and specification refer respective section of the specifications.

b) System shall meet test requirements as specified in TAC / UL / FM / NFPA etc.

10.0 **PORTABLE & MOBILE FIRE EXTINGUISHERS**

10.1 Shop Test

a) All Fire Extinguishers shall be tested as per relevant standard.

b) Performance / function test shall be carried out on sampling basis as per relevant code /standard.

11.0 **EOT/HOT Crane**

a) Chain pulley Blocks shall be tested as per IS: 3832.

b) Electrical wire rope hoists shall be tested as per IS: 3938

c) Following NDT requirements shall be met:

(i) 100% RT of Butt welds in tension and 10% RT of butt welds in compression.

(ii) DP at random on all weldments.

d) Deflection, load, overload & travel check on EOT/ HOT crane assembly shall be carried out as per IS: 3177.

12.0 SITE TESTS

a) **Fire Extinguishers:** A performance demonstration test at site of five (5) percent or one (1) number, whichever is higher, of each type and capacity of the extinguisher shall be carried out by the contractor. All consumables and replaceable items require for this test would be

supplied by the contractor without any extra cost to employer.

b) **Foam System:**

(i) The operation of the foam generation shall be demonstrated by the vendor after installation either in the tank to be protected or in the dyke area.

(ii) Any other equipment found necessary for the demonstration of the above testing like portable foam water monitor hose etc. shall be provided by the contractor during testing.

c) **Piping Protection:**

(i) Thickness, Holiday spark test, Adhesion test shall be carried out as per relevant standard.

(ii) Complete piping shall be Hydro pressure tested, at 1.5 X DP or 2 X MWP whichever is higher, before protection.

d) **Welding of Pipes:**

(i) ERW Black / rolled welded

100% DPT on root of butt and finish weld of butt and fillet.

RT on 10% randomly selected joints shall be carried out (for underground piping).

(ii) GI Pipes

Welding on GI Pipes in general shall not be done. Welding of GI Pipes, if permitted by design, (butt / socket / fillet weld) shall be done strictly as per approved drawing and procedure approved by OWNER.

SECTION M13
ASH HANDLING SYSTEM

1.0 **Bottom Ash Hopper**

1.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DPI tests as applicable shall be done on welds to ensure freedom from defects. RT shall be done on load bearing weld/weld under tension as per relevant codes and standard.

1.2 Fit up assembly checks shall be carried out at shop for at least critical segments of bottom ash hopper before dispatch to site.

2.0 **BA Hopper Discharge Gates**

2.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard.

2.2 Barrel/ casing of Hydraulic/pneumatic Cylinder shall be hydro tested. UT at proof machined condition (for dia/thickness >= 50 mm) shall be done on shafts. Assembled cylinders shall be tested for port leakage.

2.3 MPI/DPT shall be carried out on welds of BA hopper discharge gates.

2.4 Functional checks of the BA hopper discharge gate along with actuator shall be carried out to check for smooth opening and closing.

3.0 **Jet Pumps**

3.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Jet pumps shall be visually inspected and checked for dimensional accuracy at manufacturer's works.

3.2 Jet pump assemblies /components shall be subjected to Hydraulic pressure test at shop at 1.5 x design pressure for 2 x working pressure whichever is higher for 30 minutes duration

4.0 **Slurry Line Valves**

4.1 All material shall be tested for chemical & mechanical properties as per relevant standard etc.

4.2 The valves shall be hydraulically tested for body & seat leakage test as applicable as per relevant standard/code at shop. Functional checks of the valves for smooth opening and closing shall also be done. Actuator operated valves shall be tested for above along with the job actuators.

5.0 **Clinker Grinder**

5.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Grinding rolls/elements shall be checked for hardness at manufacturer's works.

5.2 UT at proof machined condition (for dia/thickness >= 50 mm) and MPI/DPT after machining shall be done on shafts. MPI/DPT shall be carried out on welds.

5.3 No load run test for minimum 2 hours continuous operation of clinker grinder shall be done to ensure trouble free operation.

6.0 **ACI Fittings Pipes & Fittings**

6.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard.

6.2 DPT of welds shall be carried out on root and finished welds of fabricated fittings.

6.4 Fittings shall be hydraulically tested as at twice the operating pressure or 1.5 times the design pressure whichever is higher for 30 min duration.

7.0 **Flushing Boxes & Trough Type Expansion Joints**

7.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP tests shall be done on welds to ensure freedom from defects. Water fill test on assembly shall be carried out.

8.0 **Gear Box**

8.1 In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.

8.2 MPI to be carried out on Gears/Pinions after machining. Case depth, hardness and MPI after hard-facing shall be checked to ensure freedom from defects.

8.3 Gear boxes shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.

9.0 **Metallic Expansion Joints**

9.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leak test shall be carried out 1.1 times design pressure in case of vacuum application.

9.2 DPT shall be carried out on welds before and after forming to check cracks. Spring rate shall also be measured.

9.3 Proof of design test shall be carried out on one of the expansion joint as per (EJMA) relevant standards. In case the bidder have already carried out the same on the expansion joint of the type and rating being offered, the test certificate shall be submitted for review.

10.0 **Fly Ash Branch Segregation Valves, Fly Ash Feed Valves, Vacuum Braker, Air Intake Valve and Knife Gate Valve for Hopper Isolation**

10.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Functional checks of the valves for smooth opening and closing shall also be done. Valves shall also be tested for allowable leakage rate, as

applicable. Actuator operated valves shall be tested along with actuators.

11.0 **Ash Vessel**

11.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Ash Vessel shall be tested hydraulically for 1.5 times the design pressure or 2 times working pressure, whichever is higher, for 30 min duration at manufacturer's works. NDT on welds shall be as per requirement of design code/standard.

12.0 **Bag Filters**

12.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Leakage test shall be carried out for casing and other pressure parts. Pulsing and sequential test on bag filter shall be done.

13.0 **Dry Fly Ash Storage Silo, Buffer Hopper, BA Overflow Tank and Settling/Surge Tank**

13.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP test on welding shall be carried out. Fit up assembly checks shall be carried out at shop for all despatchable segments.

14.0 **Ash Slurry Sump Isolation Plug Valves, Sump/Trench Liners and Trench Jetting/Agitating Nozzles**

14.1 All material shall be tested for chemical and mechanical properties as per relevant standard. Sump/Trench Liners and Nozzle Tip shall be checked for hardness.

14.2 Sump isolation Plug valves shall be water-fill tested.

15.0 **Fluid Coupling**

15.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. Static and dynamic balancing shall be carried out for all rotating parts. Check for leak tightness of the coupling shall be carried out

15.2 Functional test on fusible plug for each type of coupling shall be conducted at shop. All couplings to be run tested at shop.

15.3 Check for temperature rise, torque speed, torque slip characteristics and over speed test on one coupling of each size and type during load test (preferably at Full load) at shop.

16.0 **Slurry Disposal Line Valves (At Dyke End)**

16.1 All material shall be tested for Chemical & Mechanical properties as per relevant standard. All valves shall be hydraulically tested for body and seat leakage test at shop.

17.0 For items/components like pipes, valves, pumps, compressors, specialities etc., refer table below:

S. No.	**Tests/Checks** **Items / Components**	Material Test	WPS/ WQS/PQR	DPT/MPI	Ultrasonic Test	Radiographic Test	PWHT	Assembly / Fit up	Dimensions	Hydraulic	Pneumatic Test	Balancing	Functional/operational Test	Performance Test	Other Tests	All Tests as per relevant Std
1	Pipes & Fittings	Y[a]							Y	Y[20]						Y
2	Diaphragm Valves	Y[a]							Y	Y[5]			Y		Y[6]	Y
3a	Cast Butterfly Valves (Low Pressure)	Y[a]		Y[3]	b Y			Y	Y	5 Y			Y		Y[7]	Y
3b	Fabricated Butterfly Valves (Low Pressure)	Y[a]	Y	Y[3]	Y[12a]	Y[12b]	Y[12c]	Y	Y	5 Y			Y		Y[7]	Y
4	Gate/ Globe/ Check Valves	Y[a]		Y[3]	b Y			Y	Y	5 Y	Y		Y		Y[8]	Y
5	Dual Plate Check Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y		Y[4]	Y
6	Plug / Ball Valves	Y[a]		Y[3]	Y[b]			Y	Y	Y[5]	Y		Y			Y
7	Rolled & Welded Pipes/ Mitre fittings	Y[a]	Y	Y[3]		Y1			Y	Y[20]						
8	Coating & Wrapping of Pipes	Y[a]							Y							Y[2]
9	Strainers	Y[a]		Y[3]					Y	Y[20]					Y[9]	
10	Rubber Expansion Joints	Y[a]						Y	Y	Y[10]					Y[11]	
11	Site Welding		Y	Y[3]		Y[1]				Y[20]						
12	Submersible Pump	Y[a]							Y	Y[17]		Y		Y		Y
13	Pumps	Y[a]		Y[3]	Y[b]			Y	Y	Y[17]		Y		Y[16]	Y[15]	Y
14	Compressors/ Blowers / vacuum Pumps	Y[a]		Y[3]	Y[b]			Y	Y	Y[20]		Y		Y[18]	Y[19]	Y
15	Atmospheric Storage Tanks/Mixing Tanks	Y[a]	Y	Y[3]				Y	Y	Y[20]					Y[13]	Y
16	Pressure vessels & Heat exchangers	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]					Y[23]	Y
17	Air Drying Plant	Y[a]	Y	Y[3]		Y[21]	Y[22]	Y	Y	Y[20]	Y		Y		Y[24]	

18	Mixers	Y^a		Y^3	Y^b			Y	Y				Y		Y^{25}	
19	Fans	Y^a		Y^3	Y^b			Y	Y			Y		Y	Y^{14}	Y

Notes:	
a.	One per heat/heat treatment batch/lot
	Y-Applicable The S.nos. indicated below shall be subscript of Y as indicated in table above.
b.	For shaft/spindles/forgings diameter 50 mm
1.	Weld Joints not subjected to hydraulic test shall be subjected to 100% RT
2.	Tests for primer and enamel / Coal Tar Tapes as per AWWA-C-203 / IS 15557
3.	On machined surfaces of castings/shaft/spindles/forgings. DPT/MPI on root run (after back gouging/chipping – as applicable) for 100% and on finish butt & fillet welds for 10%
4.	Dry Cycle Test on Dual Plate Check valve spring for one lakh (10^5) Cycles shall be carried out as a type test
5.	Valves shall be tested for Body, seat & back seat leakage as applicable. Hydraulic test pressure shall be relevant standard. & shall be done as per relevant standard, Seat Leakage Test for Actuator Operated Valves shall be done with by closing the valves with actuator. Valves shall be offered for hydro test in unpainted condition
6.	Tests on rubber diaphragm such as hardness, bleed resistance test, rubber to fabric bond, flex test & type test for 50,000 cycles shall be carried out.
7.	In addition to Body & seat hydro test, disc-strength shall be carried out as per relevant standard
8.	Blue matching for metal-seated valves, Wear travel for gate valves, pneumatic seat leakage test & reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg absolute for valves to be tested for vacuum operation for internal pressure 25 mm of Hg absolute for a period of 15 minutes
9.	Pressure drop across the strainer for each type and size as a special test shall be carried out
10.	During hydraulic and vacuum tests in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.
11.	Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149, ageing test and adhesion strength of rubber to fabric & rubber to metal shall be carried out
12.	a) For fabricated butterfly valves: UT as per ASTM A-435 on plates for body and disc shall be carried out. b) 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc c) Post Weld Heat Treatment (PWHT) as per ASME, Section-VIII, Division-I on butt joints of body and disc of thickness above 30mm shall be carried out
13.	Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted
14.	All fans shall be subjected to run test and Vibration, noise, temperature rise, and current drawn shall be measured during the run test. Performance test of one fan of each type and size shall be carried out as per applicable standard for air flow, static pressure, speed, Efficiency, power consumption
15.	In case of diaphragm/plunger, only proven material shall be used and certificate in this regard shall be submitted for review
16.	All pumps to be performance tested as per Hydraulic Institute Standard/Relevant

	standard. Performance test to include check for noise, vibration level and bearing temperature rise.
17.	Pumps shall be tested at 200% of pump rated head or at 150% of pump shut-off head whichever is higher for 30 min duration. For Ash slurry pumps the Rated/shut off head for each slurry pump shall be taken after adding the rated/shut off head for all the pumps coming in a series. The testing for each pump shall be done at the above pressure
18.	Performance testing of each compressor/ Blower / Vacuum Pump shall be carried out at shop as per BS-1571/ IS: 5456 /ISO 1217/ Pneurop 6612/ equivalent as applicable. Noise & vibration shall also be measured during performance testing
19.	For Compressors capacity control and operation of safety valves shall be checked during inspection at shop
20.	Pressure retaining parts shall be hydraulic tested. Hydraulic test pressure shall be as per applicable std / 1.5 x design pressure or 2 x working pressure whichever is higher for 30 minutes duration. Atmospheric tanks shall be water fill tested
21.	RT on weld joints shall be as per respective code requirements. Heat Treatment of the Tank/Vessel shall be done as per fabrication code requirement
22.	Dished ends shall be stress relieved as per relevant code. However, dished ends welds (if manufactured by using welded plates) shall be subjected to 100% RT and stress relieved
23.	Tube to tube sheet joints of heat exchanger shall be subject to mock up test. Coolers/heat exchanger shall be hydro tested on tube side and shell side
24.	Refrigerant compressors shall be tested as per relevant std and certification from manufacturer for the same shall be submitted. Due point measurement & function of auto drain trap shall also be carried out
25.	Concentricity/ centering & Axial Run out Shall also be measured

Section M14: WATER TREATMENT & WATER SYSTEM

Tests/Check Items / Components	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Performance Test	Test as per relevant Std/ Appd.	Other Tests
1. Pumps				Y	Y			Y[1]	Y	
1.1. Casing	Y[a]		Y[b]		Y		Y			
1.2. Impeller	Y[a]		Y[b]		Y					Y[d]
1.3. Shaft	Y[a]		Y		Y				Y[c]	
2. Vertical Pumps				Y	Y			Y[1]	Y	
2.1. Casing	Y[a]		Y[b]		Y		Y			
2.2. Impeller	Y[a]		Y[b]		Y					Y[d]
2.3. Shaft	Y[a]		Y		Y				Y[c]	
2.4. Fabricated Parts	Y[a]	Y	Y[b]		Y	Y[2]	Y			
3. Dosing/ Metering Pumps	Y[a]						Y	Y[1]	Y	
4. Gate/ Globe/ Check Valves	Y[a]		Y[b]		Y		Y	Y	Y	Y[6]
5. Dual Plate Check Valves	Y[a]		Y[b]		Y		Y	Y	Y	Y[12]
6 Diaphragm Valves	Y[a]				Y		Y[3]		Y	Y[4]
7. Butterfly Valves (Low Pr.)				Y	Y		Y[3]	Y		Y[5]
7.1Body (Cast)	Y[a]		Y[b]							
7.2Disc (Cast)	Y[a]		Y[b]							
7.3 Shaft	Y[a]		Y[b]							Y[c]
8. Plug/ Ball Valves (Low Pr.)	Y[a]		Y[b]	Y	Y		Y	Y	Y	Y[3]
9. Blowers	Y[a]		Y[b]	Y	Y		Y	Y	Y	Y[dc]
10. Atmospheric Storage Tanks/ Pressure Vessels	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y		Y[c]	Y[7]
11. Rubber lining	Y[a]				Y				Y	Y[9]
12. Reactor Clarifier	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]
13. Clariflocculator/ Plate or Tube Settler	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]
14. Hoists & Cranes	Y[a]	Y	Y[b]	Y	Y	Y[8]		Y	Y	
15. Chlorine Tonner	Y[a]	Y	Y[b]	Y	Y	Y[8]	Y			
16. Chlorine Evaporator	Y[a]	Y	Y	Y	Y	Y	Y			
17. Chlorinator & injector	Y[a]			Y	Y		Y	Y		
18. Agitators /Flash Mixer/	Y[a]	Y	Y[b]	Y	Y			Y		Y[10]

Flocculator										
19. Pipes	Y[a]	Y	Y	Y	Y	Y[8]	Y		Y	
20. Ventilation/Exhaust Fan	Y[a]		Y[b]	Y	Y			Y[11]	Y	Y[dc]
21. Resins / Activated Carbon Filter	Y[a]	Y	Y[b]	Y	Y				Y	Y[10]
22.BUTTERFLY VALVES (HP)	Y[a]			Y	Y		Y	Y		
23.BALL VALVES (HP)	Y[a]			Y	Y		Y	Y		

LEGEND:

Y	Applicable
Y[a]	One per Heat/Heat Treatment batch/Lot
Y[b]	On machined surfaces only. Also 100% on Butt Welds & 10% on Fillet Welds.
Y[c]	UT shall be done for shafts with Dia 50 mm or above & Plates of Thickness 20 mm or above.
Y[d]	Dynamic Balancing per ISO: 1940, Grade 6.3 minimum.
Y[1]	As per HIS, USA
Y[2]	10% RT to be conducted on butt welds for Thk >10 mm.
Y[3]	Seat Leakage Test for actuator operated valves shall be done by closing the valve with job actuator.
Y[4]	Tests on Rubber Diaphragms per batch of Rubber mix such as Tensile, Elongation, Hardness, Thickness, Bleed Resistance, Flex Test for 1500 cycles etc. shall be conducted. In addition, Type Test for 50,000 cycles for each type of diaphragm shall also be conducted, if not carried out earlier
Y[5]	Seat Leakage Test is required to be done in both directions. Disc strength test as per relevant code shall be carried out.
Y[6]	Blue Matching, Wear Travel for Gate Valves, reduced pressure test for check valves shall be conducted per relevant standards
Y[7]	Heat Treatment of the Tank/Vessel shall be done per fabrication code requirement. Welded dished ends shall be stress relieved. Dished ends manufactured by cold working shall be stress relieved as per the requirement of code
Y[8]	RT as per fabrication code requirements. However, dished ends welds, if manufactured by using welded plates shall be subjected to 100% RT
Y[9]	Rubber Lining Mix shall be subjected to Bleed Resistance Test on mould sample. Adhesion Test, Spark Test and Hardness Test for the Rubber lined jobs shall also be conducted
Y[10]	Gear Boxes shall be checked for smooth No Load Operation at shop to verify noise and vibration levels. Gear Ratio and Kerosene Leak Test shall also be conducted
Y[11]	One Fan of each type & size shall be routine performance tested as per corresponding code fir air flow, static pressure, total pressure, speed, Efficiency, power consumption, noise & temperature rise. Also all Fans shall be subjected to run test of 4 hours during which noise, vibration, temperature rise and current drawn shall be measured
Y[12]	Blue Matching, reduced pressure test for check valves shall be conducted per relevant standards. Dry cycle test on valve spring for 1, 00,000 cycles shall be carried out as type test, if not carried out earlier, for the similar MOC, size and type of spring

SECTION M15: FLUE GAS DESULPHURISATION SYSTEM

1.0. LIME MILLS

1.1. Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.

1.2. Wear-resistant parts shall be UT/RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out.

1.3. Butt welds in the tube/separator/body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.

1.4.

1.5. All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.

2.0. LIME FEEDERS

2.1. Any welds in the casing/pulley fabrication shall be checked with MPI.

2.2. Routine tests shall be done as per relevant Indian Standards or equivalent International Standards.

2.3. All major items like plates for casing, head pulley, tail pulley, pulley shaft and major castings shall be procured with respective material test certificates.

2.4. Calibration check shall be carried out on all feeders.

3.0. PIPING, VALVE AND SPECIALITIES

3.1. All pipes and fittings shall be tested as per applicable code.

3.2. All valves shall be hydraulically/Air tested for body, seat and back-seat (if applicable) as per relevant standard.

3.3. NDT on valves shall be as per relevant standard.

3.4. Valves shall be offered for hydro test in unpainted conditions.

3.5. Functional checks of the valves for smooth opening and closing shall also be done.

4.0. TANKS/VESSELS

4.1. ATMOSPHERIC TANKS

i) All welds joints shall be DP tested and complete tanks shall be water fill tested.

ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to tests (Hydro, NDT and Vacuum) according to design code as applicable.

iii) Rubber lining shall be tested for hardness and spark test, as applicable.

4.2. **Pressure Vessels**

1) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below:

i) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds.

ii) 10% DPT on all finished butt welds.

iii) 10% RT (covering all 'T'/cross joints) of butt welds.

2) Butt welds of dished ends shall be stress relieved and subjected to 100% RT.

3) Each finished vessels shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.

5.0. **Pumps**

i) UT on shaft forgings (greater or equal to 40mm) and MPI/DPT shall be done on shafts and impeller to ensure freedom from defects.

ii) The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

iii) The pump rotating parts shall be subjected to static and dynamic balancing.

iv) All pumps shall be tested at shop for capacity, head efficiency and brake horse power at rated speed as per relevant/applicable standard.

v) Noise and vibration shall be measured during the performance testing at shop.

6.0. **STRUCTURES , DUCTS, HOPPERS**

i) All materials shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.

ii) Visual inspection of all welds shall be performed in accordance with AWSD1.1.

iii) NDT requirements of structural steel welds shall be as under:

a) 100% RT/UT on butt-welds of plate thickness>= 32mm.

b) For plates of 25mm<=thickness<32mm-10% RT and 100% MPI.

c) For plates of thickness <25mm-10% MPI/LPI.

iv) Edge for shop and field weld shall be examined by MPI for plate thickness >= 32mm.

7.0. **DAMPERS**

7.1. All the dampers shall be subjected to operational test/checks.

7.2. Gas tight Dampers shall be subjected to shop leakage test to demonstrate the guaranteed tightness for minimum one damper of each type and size offered.

8.0. **VACUUM BELT FILTER SYSTEM**

i) Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.

ii) UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.

iii) All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.

iv) Filter cloths and belts shall be tested for physical properties as per relevant standard

v) Hydro cyclones shall be checked by visual, dimensional etc.

9.0. **SPRAY NOZZLES**

i) Spray nozzles shall be tested for physical properties

ii) Spray nozzles also shall be subjected to performance test.

10.0. **AGITATORS**

i) Rubber lining shall be tested for hardness and spark test

ii) Impellers shall be tested for dimensional and balancing check

iii) Gear Boxes shall be tested for run test as per standard practice

11.0. **BRAKES AND CLAMPS**

Final testing of brakes shall include load, HV/IR & heat run tests.

12.0. **MONORAILS AND HOISTS**

All electric hoist shall be tested as per IS 3938 and chain pulley block shall be tested as per IS 3832.

13.0. HOPPERS & LINERS

Flap Gates

d) MPI/DP test shall be conducted on weld joint

b) Functional checks on the gates shall be carried out alongwith respective actuator, if applicable.

14.0. BELT CONVEYOR SYSTEM

The details of the checks to be carried out in the various equipment are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with the Owner.

15.1 Idlers

a) Check for run out and free movement shall be carried out on idlers. Run out shall be restricted as per IS: 8598

b) Test for dust proofness, water proofness and dynamic friction factor of the Idlers shall be conducted at shop. The detailed procedures for the same shall be submitted for review and approval.

15.2 Belting

a) Rubber cover of finished belt shall be checked for tensile strength and elongation at break before and after ageing. Rubber cover shall also be checked for abrasion, tear strength and hardness.

b) For finished belts, checks for elongation at 10% nominal tensile strength, tensile and elongation at break in longitudinal (warp) direction and tensile in transverse (weft) direction shall be carried out.

c) Adhesion test between ply to ply and cover to ply shall be carried out.

d) Trough ability test be carried out.

e) Test for procedure qualification for belt vulcanizing joint (at site) shall be done. Procedure for belt vulcanizing joint shall be discussed and finalized during FQP finalization.

f) There will be a limitation on the no. of repairs allowed on the belts. Following will be the acceptance norm for the cover repairs.

i) The maximum size of a repair shall be limited to a size equivalent to one fifth the belt width. No single dimension shall exceed one fifth (1/5) of belt width.

ii) Small local repair by dough filling of size 25mm x 25mm to a limited extent shall not be counted of repairs. However, in case of cluster of repairs, same shall be counted as a patch repair.

iii) The maximum number of patch repair shall not exceed 5 per 100 mts. However, the total number of patch and dough filling repairs shall not exceed 10 per 100 meters.

g) In no case shall the cover thickness or the width of belt be less than that given in specification.

h) For testing purpose, belt sample shall be taken from anywhere of the belt roll length offered

15.3 **Belt Vulcanizing Machine**

a) Check for tensile strength shall be carried out on a sample vulcanized belt joint for each type of belt in shop. However if such test has been done earlier, the report for same shall be submitted for verification.

b) Complete assembly shall be tested at shop for temp. and pressure developed

15.4 **Pulleys**

a) In addition to chemical, mechanical, hardness, microstructure as per applicable material specification, pulleys shaft forgings shall be subjected to ultrasonic testing.

b) 100% MPI/DPT on all welds shall be conducted and 10% RT/UT on butt welds shall be conducted.

e) Static balancing of pulleys shall be carried out after rubber lagging.

f) Checks on rubber lagging to include abrasion loss, shore hardness test, peel-off strength test and physical properties. Peel-off strength shall be 10 Kg/Cm, Abrasion loss shall be less than 250 cubic mm when tested as per DIN 53516.

15.5 **Pull Chord & Belt Sway Switches**

a) Acceptance tests

iv) Over all dimension and functional test
v) HV & IR test
vi) Degree of protection test report.

15.6 **Zero Speed Switch, Under Belt Switch and Chute Blockage Switch**

e) Acceptance test

iii) Burn in test at 50 degree C for 48 hours shall be done for electronic switches.
iv) Over all dimension and functional test shall be carried out.
iii) HV & IR
v) Degree of protection test

15.0. **DRIVE EQUIPMENT**

16.1 **Gear Boxes:**

d) In addition to checks for physical, chemical, hardness, microstructure as per relevant standard, the shaft and gear/pinion forgings shall be subjected to ultrasonic testing.

e) MPI to be carried out on Gears/ Pinions after machining. Case depth, hardness and MPI after hard facing shall be checked to ensure freedom from defects.

f) Gear reducer shall be checked for reduction ratio, backlash and contact pattern. No load shop trial run to be conducted on gear boxes to check for oil leakage, temperature rise, noise level and vibration.

16.2 **Flexible Coupling**

a) Ultrasonic testing shall be conducted on forgings for gear sleeve and gearhub, if gear coupling is provided.

f) MPI shall be carried out after machining to ensure freedom from cracks.

16.3 **Fluid Coupling**

a) Dynamic balancing shall be carried out for the rotating parts.
b) Check for leak tightness of the coupling shall be carried out.
g) Functional test on fusible plug for each type of coupling shall be conducted at shop.
d) All couplings to be run tested at shop on no load
e) Check for temperature rise, torque-speed, and torque-slip characteristics and over speed test shall be included during performance test of one coupling of each type preferably at full load.

17.0 **BELT SCALES**

The details of the checks to be carried out in the various equipments are to be submitted by the Contractor for Employer's approval. However, some indicative checks are given below which should necessarily form a part of the quality assurance plan to be agreed with the Employer.

b) Mounting arrangement/ Overall dimensional check shall be carried out on the Belt Scales.
c) Belt scale shall be calibrated with test weight/test chain in static at works and with test weight for dynamic condition at site.
d) All electronic modules shall be subjected to burn in test at 50 Degree C for 48 hours.
e) General check for load cell shall be carried out.
f) Test report for degree of protection on enclosure shall be furnished.
g) Accuracy/ performance check shall be demonstrated at site.

18.0 **DUST CONTROL & MISCELLANEOUS SYSTEMS (DUST EXTRACTION AND DUST SUPPRESSION)**

The details of the checks to be carried out on the various equipments are to be submitted by the Contractor for Owners approval. However some indicative checks on different items are given below which should necessarily form a part of the Quality Assurance Plan to be agreed with by the Owner.

19.0 Fans for Dust Extraction

e) All materials should be of tested quality and test certificates should be provided.
f) Dynamic balancing of the fan impellers to be carried out.
g) Shop run test shall be conducted on all centrifugal fans including check for noise and vibration level.
h) Performance test shall be conducted on one fan of each type at shop for capacity, pressure, efficiency and power consumption.

20.0 **Crushers**

The details of the checks to be carried out for various components are to be submitted by the Contractor for Owner's approval. However, some indicative checks on different items are given below which should necessarily form part of the Quality Assurance Plan to be agreed with the Owner.

h) All plates equal to or above 25mm thickness shall be ultrasonically tested.

i) Shaft forgings to be checked for ultrasonic testing in addition to check for chemical, mechanical, hardness, microstructure etc. As per applicable material specification.

j) Following minimum NDT requirements to be ensured for welds:

iii. Butt welds - 10% UT/RT and 100% MPI/DPT.
iv. Fillet Welds - 10% MPI/DPT.

k) Crusher rotor to be dynamically balanced. Procedure to be submitted for approval.

l) No-load trial run test to be carried out at shop to check for speed (RPM), temperature rise, noise level and vibration.

21.0 **In-Line Magnetic Separators**

i. Overall Dimensional, Visual check alongwith control panel

ii. HV & IR

iii. Operation, temperature rise, lifting capacity, force index and gauss strength.

22.0 **Metal Detectors**

i. Functional test including sensitivity, Burn in test, operation of liquid spray marker, detection of smallest piece of different materials as specified.

ii. Test report for Degree of protection test to be furnished.

23.0 **OTHER CRITICAL EQUIPMENTS (IF ANY / VENDOR TO SPECIFY)**

Checks/ NDTs shall be done as per relevant Indian Standards or equivalent International Standards

Add details for:

- Surface Feeder
- Vibrating Grizzly feeder

QUALITY ASSURANCE PLAN FOR ELECTRICAL

I N D E X

E1: GENERATOR & AUXILIARIES

1.00.00 PROCESS CHECK FOR STATIC PARTS GENERATOR / EXCITOR

ATTRIBUTES / CHARACTERISTICS → ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Visual & dimension	Chem.Prop.(raw material)	Heat treatment	Mech. Prop.(raw material)	Impact.(raw material)	Hydraulic test	Pneumatic test	RT/UT (10% for butt weld)for Hydrogen cooled machine	MPI/DPT(All welds)	Relative permeability	Ferrite content	DIN 43760, IS 2848,7358	DIN 48124
Sheet and Fabrication -END shield	Y	Y	Y	Y	Y	Y 1	Y 1	Y	Y				
-Stator casing	Y	Y	Y	Y	Y	Y 1	Y 1	Y	Y				
-Bushing boxes	Y	Y	Y	Y	Y	Y 1	Y 1	Y	Y				
-Terminal plates	Y	Y	Y	Y	Y	Y 1	Y 1		Y				
-Manhole and covers	Y	Y	Y	Y	Y	Y 1	Y 1		Y				
-Trunniuns	Y	Y	Y	Y	Y			Y	Y				
Corebar	Y	Y		Y									
Press ring	Y	Y		Y					Y				
Core bolt (insulated)	Y	Y		Y				Y	Y				
Gaskets	Y			Y									
Bearing and Hydrogen Seals	Y	Y		Y				Y2					
Terminal Bushing													Y
RTD/ Thermocouple												Y	
Additional checks for -Non magnetic Components										Y			
-Non magnetic Components welding											Y		
Y-Test applicable, Y1-For Hydrogen cooled machine, Y2-UT on babbit for bearing,													

1.01.00 Note:

a) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

b) All generators shall be assembled at works and shall be tested to verify/ensure design and workman ship in accordance with IEC-34, VDE 0530, IEEE 115, and IEEE 43. The manufacturer shall submit detailed test procedure which clearly specify test set up, instruments to be used, acceptance norms (wherever applicable) recording of different parameter, interval of recording, precautions etc.

c) Cooler, control panel and other auxiliaries (as applicable) to be suitably tested as per tests covered in the specification.

d) Test requirements of primary water system, seal oil system and Hydrogen cooling system shall be as per tests specified for similar items under respective tables covered in this section.

2.00.00 PROCESS CHECK FOR CORE GENERATOR/EXCITOR

ATTRIBUTES / CHARACTERISTICS → ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Specific loss before and after ageing	Magnetisation	Anotrophy of losses	Stacking factor	Burr level	Check for varnish, insulation (chem, elect., viscosity, cure time, solid content, dielectric properties	Dimension & surface (conifirmity of varnish coat	Spot weld check
Core lamination	Y	Y	Y	Y		Y	Y	
After punching Insulated core Laminations				Y	Y	Y	Y	
Ventilation Stamping								Y
Core assembly	Y	Y					Y	
	Process check including Heating & pressure application	Insulation test of core tension bolt & core bar	Functional check of ventilation ducts	Hot spot by infra red camera & ELCID	Location of temp. detectors	Iron loss at rated flux density		
CORE assembly (additional Checks for Generator)	Y	Y	Y	Y	Y	Y		

Y - Test Applicable

3.00.00 PROCESS CHECK CONDUCTOR (GENERATOR / EXCITOR)

STATOR CONDUCTOR AND WINDING

~~ATTRIBUTES~~ / CHARACTERISTICS ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Mech. prop (sample)	Chem. prop (sample)	Resistivity/Resistance	Metallography prop.	Eddy current & pr. test	Insulation adhesion	Flexibility of bending	Dielectric test	Dimension/visual	Electric test	Physical prop.	Brazing procedure	X-Ray of Water box	Process check	Flow test	Helium leak test & PR. test	Check on RTD + location	Partial Dischage Test
Winding copper and Connecting bus bars	Y	Y	Y	Y	Y1				Y									
Insulated conductor						Y	Y	Y	Y	Y								
Insulation material	Y	Y							Y	Y	Y							
Manufacturing Winding bar & phase bar								Y	Y	Y		Y	Y1	Y	Y 1	Y		Y
Winding laying								Y	Y	Y				Y			Y	
Water Supply Hoses	Y	Y						Y	Y							Y		
Winding support ring		Y							Y		Y							
Connection between bars												Y						
wound stator																Y1		

Y - Test Applicable
Y1 - For hollow conductor.

PROCESS CHECK CONDUCTOR (GENERATOR / EXCITOR)

STATOR CONDUCTOR AND WINDING (CNTD.)

ATTRIBUTES / CHARACTERISTICS → **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY** ↓	Tan delta and delta, tan delta upto 1.2 un	Corona protection resistance	Reactance of stator winding	Magnetic Test of metallic parts	Magnetic test and Vibration fatigue	Dielectric test at elevated and room temp.	Inter strand Insulation test	Thermal shock and boroscopic Examination of brazed water box	Slot wedge tightness & radial movement	Type test on two bars for Heating cycle test, Thermal stability test, Voltage endurance test	Support arrangement
Winding copper and connecting bus bars											
Insulated conductor						Y					
Insulation material											
Manufacturing Winding bar & phase bar	Y	Y					Y	Y1		Y	
Winding laying	Y										Y
Water Supply Hoses				Y	Y						Y
Connection between bars							Y				
wound stator	Y		Y						Y		

Y - Test Applicable

Y1- Applicable for hollow conductor

4.00.00 PROCESS CHECK FOR ROTOR AND ASSEMBLY

GENERATOR/EXCITOR

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Rep. sample tensile stress	Rep. sample 0.2 limit	Rep. sample elongation	Hardness on Sample	Impact & stress ruptureprop. check on sample	Rep. sample Chem. prop.	NDTT, FATT	Process check including heat treatment (as applicable)	Ultrasonic test/RT (at suppliers works and after preliminary machining)	Suplhur Prints Check	Flux carrying capacity / Magnetic prop.	Boroscopic Examination
Rotor forging & slip ring shaft	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rotor end retaining ring & cover, locking ring & Slip ring forgings,diode wheel	Y	Y	Y		Y	Y		Y	Y			
Rotor winding copper rotor wedges, damper Wedges, CC-bolts & D-leads	Y		Y			Y		Y	Y			
Rotor slot boxes/ insulating material						Y						
Coil manufacture												
Rotor winding								Y				
Winding connection studs & assembly												
Complete rotor								Y				
Test on completed rotor at various speed up to rated speed												
Test on completed rotor before & after over speed												
Fan hubs/blades						Y		Y	Y			
GENERATOR assembly												
Rectifier wheel	Y		Y					Y	Y			
Permanent magnet					Y						Y	
EXCITOR assembly												

Y- Test Applicable

ATTRIBUTES/ CHARACTERISTICS → / ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	MPI/DP/NDT test	Visual/Dimension/Cleanliness	Adhesion, thickness of Coat on silver plating	Electrical conductivity and Oxygen content	Mech. test on sample	Electrical test	Resistance measurement	Purge test on vents	Helium leak test forHydrogen cooled M/C	Inter turn test	Dielectric test	Gas tightness
Rotor forging & slip ring shaft	Y	Y										
Rotor end retaining ring & cover, locking ring & Slip ring forgings, diode wheel	Y		Y									
Rotor winding copper, rotor wedges, damper Wedges, CC-bolts & D-leads	Y		Y	Y	Y	Y						
Rotor slot boxes/ insulating material					Y	Y						
Coil manufacture		Y				Y	Y					
Rotor winding	Y	Y				Y	Y	Y	Y	Y	Y	
Winding connection studs & assembly	Y				Y						Y	Y
Complete rotor							Y				Y	
Test on completed rotor at various speed upto rated speed							Y			Y	Y 1	
Test on completed rotor before & after overspeed		Y								Y	Y	
Fan hubs/blades	Y	Y										
GENERATOR assembly		Y										
Rectifier wheel		Y				Y						
Permanent magnet		Y			Y							
EXCITOR assembly		Y				Y						

Y-Test Applicable

ATTRIBUTES/ CHARACTERISTICS → / **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Insulation Resistance	PI at 5 kV	Radial run out/alignment	Impedance measurement/ RSO (repetitive surgeoscillograph)	Dynamic balancing ISO5393, 5406,2372, 1940 including Air	Over speed test (120%)for 2	Functional test	Axial run out, seal ring holder	Metallography examination	Torque on joint bolts	Fitting and locking of Balancing weights	Brazer and brazing procedure
Rotor forging & slip ring shaft									Y			
Rotor end retaining ring & cover, locking ring & Slip ring forgings, diode wheel												
Rotor winding copper, rotor wedges, damper Wedges, CC-bolts & D-leads										Y		
Rotor slot boxes/ insulating material												
Coil manufacture												Y
Rotor winding												Y
Winding connection studs & assembly	Y											
Complete rotor	Y	Y	Y	Y	Y	Y				Y		
Test on completed rotor at various speed upto rated speed				Y								
Test on completed rotor before & after overspeed	Y	Y	Y	Y								
Fan hubs/blades											Y	
GENERATOR assembly	Y	Y	Y				Y		Y	Y	Y	Y
Rectifier wheel			Y					Y		Y	Y	
Permanent magnet												
EXCITOR assembly			Y				Y			Y	Y	

Y-Test applicable

ADDITIONAL CHECK FOR EXCITOR

ATTRIBUTES/ CHARACTERISTICS → / **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY** ↓	As per IEC-146	As per IEC-76	Pole parallelism & polarity	Mech. chem. &Magnetic prop.	Functional check	Insulation resistance	IEEE/ANSI-C37.18	IS-8084	As per specification	Dimensional and visual
Fuse diode & filter Circuit	Y									Y
Aux.Transformer (if applicable)		Y								
PMG & Exciter stator			Y	Y		Y				
Banding wire				Y						
Excitor field Breaker field discharge resistor					Y					
Bearing, exciter armature field, axis coil RTD						Y				
Excitation Transformer		Y								
Thyristors		Y								
Field breaker							Y			
Bus duct AC/DC								Y		
Voltage Regulator									Y	
Carbon brush holder & housing				Y	Y					
Cable									Y	
Carbon Brush				Y	Y				Y	Y

Y - Test applicable

5.00.00 FINAL ACCEPTANCE TEST GENERATOR/EXCITOR

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUBSYSTEM ASSEMBLY ↓	Gas tightness for Hydrogen cooled M/C	Resistance measurement	Rotor impedance at various speeds	Heat run test	Function check	Voltage regulation	OCC	SCC	Record Aux. parameters	Steady state reactance	Efficiency By separation of losses
Works test running on generator	Y	Y	Y	Y			Y	Y	Y	Y	Y
Without EXC, OC & SC with rated voltage & current for Generator				Y							
On total winding/phases at interval 0.2 Un for Generator											
Condition after dismantling											
Works test on brush less excitor		Y		Y			Y				
PMG works test		Y		Y		Y					
Full load for PMG & convertor assembly				Y							
Convertor assembly				Y	Y						
Static excitation system				Y	Y						

Y - Test Applicable

FINAL ACCEPTANCE TEST GENERATOR / EXCITOR (Contd.)

ATTRIBUTES/ CHARACTERISTICS → / ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Insulation resistance 5 kV	Polarisation index 5 kV	Phase seq. voltage balance	Shaft voltage & current	H.V. test (except electronic circuit)	RTD, BTD Check	Capacitance measurement	Tan delta, delta tandelta	Rotor journal	Bearing oil catcher
Works test running on generator	Y	Y	Y	Y	Y	Y	Y	Y		
Without EXC, OC & SC with rated voltage &current for Generator										
On total wdg / phases at interval 0.2 Un for Generator							Y	Y		
Condition after dismantling									Y	Y
Works test on brush less excitor	Y				Y					
PMG works test	Y		Y		Y					
Full load for PMG & convertor assembly										
Convertor assembly	Y				Y					
Static excitation system	Y				Y					

Y - Test Applicable

FINAL ACCEPTANCE TEST GENERATOR / EXCITOR (Contd.)

ATTRIBUTES/ CHARACTERISTICS → ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Seal rings, liners	Winding Overhang	Vibration measurement	Reduced voltage running and No load	Load characteristics	Characteristics of search coil, quad, axis	Ripple content	Visual & dimension	Partial discharge, DLA	Routine test as per IEC
Works test running on generator			Y					Y	Y	Y
Without EXC, OC & SC with rated voltage & current for Generator										
On total wdg / phases at interval 0.2 Un for Generator										
Condition after dismantling	Y	Y								
Works test on brush less excitor			Y	Y	Y	Y		Y		
PMG works test				Y	Y					
Full load for PMG & convertor assembly										
Convertor assembly										
Static excitation system							Y			

Y - Test Applicable

E2: SWITCHYARD

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per Owner Specification
Circuit Breaker (IEC: 56)	Y	Y	Y
Interrupter& hollow insulator (IEC: 233/ IS: 5284)	Y	Y	Y
Isolator (IEC: 129 / IEC: 694)	Y	Y	Y
Current Transformer (IEC: 185)	Y	Y	Y
Capacitor Voltage Trams former (IEC: 186 / 358)	Y	Y	Y
Bus Post Insulator (IEC: 168 / 273 / IS:2544)	Y	Y	Y
Disc,Pin & String Insulator (IEC: 383 / IS: 731)	Y	Y	Y
Long Rod Insulator (IEC: 433)	Y	Y	Y
Surge Arrestor (IEC: 99-4)	Y	Y	Y
Hardware fittings for Insulator (IS: 2486 / BS: 3288)	Y	Y	Y
Spacer Clamps & Connector (IS: 10162 / 5561)	Y	Y	Y
Aluminum Tube (IS: 5082 / 2673 / 2678)	Y	Y	Y
Wave Trap (IEC: 353 / IS: 8792 / 8793)	Y	Y	Y
Conductor (IS: 398-P-II)(V)	Y	Y	Y
Galvanised Steel Structures (IS: 2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS: 9708)	Y	Y	Y
Sag Compensating Spring DIN: 2089/2096 IS: 3195 / 7906	Y	Y	Y
Control & Relay Panel	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyser	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y
Protection Relays	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyser	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Tariff Metering System	Y	Y	Y

SynchronizingTrolley	Y	Y	Y
Relay Test Kit	Y	Y	Y
LT Switchgear /LT Panels (IEC:947 / IS:13947)	Y	Y	Y
Battery IS:1652	Y	Y	Y
Lighting Panels	Y	Y	Y
Surge Monitor	Y	Y	Y

Notes:

1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization for all items.

2) All major Bought Out Items will be subject to Owner/ Owner Engineer approval.

E3: GENERATOR BUS DUCTS AND NEUTRAL GROUNDING EQUIPMENTS

GENERATOR BUS DUCT											
ATTRIBUTES/ CHARACTERISTICS → / ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT (DP / MPI / UT/RT)	Painting /Silver Plating Quality & Adhesion Test	Galvanising Test as per IS: 2629 / 2633 / 6745	Electrical Clearance & Creepage	Functional/Operational check	Make / Type / Rating / Model / TC / General Physical Inspection	Trial Assembly at works.	Routine Test as per relevant standard
Enclosure	Y	Y		Y	Y		Y				
Bus bar Conductor/ Flexible Connector & Disconnector Link	Y	Y									
Galvanised Steel Structure & Plate	Y					Y					
Epoxy Seal off Bushing Post / Support Epoxy / Porcelain Insulator as per IS:5621 & 2544	Y	Y					Y		Y		Y
Welding on enclosure & conductor joint	Y		Y	Y							
Gasket, CT, VT, Surge Capacitor & Arrestor.	Y							Y	Y		Y
Enclosure Sheet	Y	Y									
Silver Plated Connectors					Y						
Bus Bar Pressurisation System	Y							Y			
Complete Bus Duct	Y				Y					Y	Y

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.
2) All major Bought Out Items will be subject to Owner/Owner Engineer approval.

5.01.00 ATTRIBUTES/ CHARACTERISTICS → ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Trial assembly at works : Heat run test and Milli volt drop measurement acrossbolted flexible joint	Trial assembly at works : Short circuit withstand test	withstand test Trial assembly at works: Impulse withstand tes	trial assembly at works: one minute high voltage power frequency withstand test	Trial assembly at works: Air leakage rateand water tightness tes
Enclosure					
Bus bar Conductor/ Flexible Connector & Disconnector Link					
Galvanised Steel Structure & Plate					
Epoxy Seal off Bushing Post / Support Epoxy / Porcelain Insulator as per IS:5621 & 2544					
Welding on enclosure & conductor joint					
Gasket, CT, VT, Surge Capacitor & Arrestor.					
Enclosure Sheet					
Silver Plated Connectors					
Bus Bar Pressurisation System					
Complete Bus Duct	Y	Y	Y	Y	Y
Note: Trial assembly set-up shall include 3-phase straight run, 90° bend, set of flexible connection of each type, metallic bellow on enclosure, CTs mounted in position (asapplicable), bolted link and necessary inspection covers					

NEUTRAL GROUNDING RESISTOR

ATTRIBUTES / CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Visual & Dimensional check	Mechanical properties	Electrical strength	Chemical Composition	Make / Type / Rating / Model / TC / General Physical Inspection.	Insulation Resistance Measurement before and after HV Test	HV Test	Degree of Protection Test	Routine Test as per relevant standard	Functional / Operator Check	Painting / silver Plating Quality & Adhesion Test	Galvanisng Test	Routine Test
Resistor	Y	Y	Y	Y		Y							
Cubicle	Y		Y					Y			Y		
Galvanised Steel Structures (IS:2633/2629/ 6745) (IS:2062)	Y	Y										Y	
Bushing / Post & Support Insulator (IS:2544 / 5621)	Y	Y	Y		Y	Y			Y				Y
NGT, NGR, Elastomer Spring Head, Panel Mounted Items & NG Cubicle.	Y				Y	Y			Y	Y			
Complete NGR (IEEE-32)	Y					Y	Y	Y	Y				Y
Complete Cubicle	Y										Y		

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.

2) All major Bought out Items will be subject to Owner/ Owner Engineer approval.

E4: GENERATOR TRANSFORMERS

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual & Dimensional Checks	Mechanical properties/Endurance	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	10 kV Isolation test on core	WPS & PQR	Routine Test as per relevant standard	Vacuum& Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y					Y			Y		Y		Y
Conservator / Radiator / Cooler / Pipes	Y	Y					Y							
Copper Conductor (IS:191)	Y	Y	Y		Y									
Insulating Material	Y	Y	Y	Y	Y	Y								
CRGO Lamination & Built Core	Y	Y	Y		Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y								Y			Y	
Gasket	Y	Y			Y	Y		Y		Y				Y
Air Cell	Y													Y
Transformer Oil (IS:335)													Y	
On Load/Off Circuit Tap Changer (IEC :214)	Y	Y	Y							Y			Y	
Core Coil Assembly & Pre-tanking	Y								Y		Y			
Marshalling Box	Y	Y					Y							
WTI, OTI, MOG, Bucholz Relay, PRD, Thermistor, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Impact Recorder, Globe & Gate Valve, PD Detector FRA and DGA Equipment										Y			Y	
Welding (ASME Sect-IX)	Y						Y					Y		

ATTRIBUTES/ CHARACTERISTICS → **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓**	Oil Leakage Test	Jacking test followed by DP Test om load bearing Member	DGA of Oil for main tank and OLTC Chamber	Measurement of capacitance and tan delta	Partial Discharge measurement (long duration)as per IEC-76 clause No. 12.4	Temperature Rise Test	Routine Test	Nitrogen Dew Point Measurement before final packing on transformer at receipt at site.	Paint Shade Thickness and Adhesion & finish.
Complete Transformer (IS: 2026 / IEC: 60076)	Y	Y	Y	Y	Y		Y		Y

Notes:

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to Owner / Owner Engineer approval.

E5: ST & UNIT TRANSFORMERS

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Visual & Dimensional Checks	Mechanical properties/Endurance	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss (on first job only), Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	10 kV Isolation test on core	WPS & PQR	Routine Test as per relevant standard	Vacuum & Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y			Y		Y		Y
Conservator / Radiator / Cooler / Pipes	Y	Y						Y							
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y									Y			Y	
Gasket	Y	Y			Y	Y			Y		Y			Y	Y
Air Cell	Y													Y	Y
Transformer Oil (IS:335)														Y	
On Load / Off-Circuit Tap Changer (IEC :214)	Y	Y	Y								Y			Y	
Core Coil Assembly & Pre-tanking	Y									Y		Y			

Marshalling Box	Y	Y						Y						Y	
WTI, OTI, MOG, PRD, Thermistor, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Impact Recorder, Bucholz Relay, Globe &Gate Valve, PD Detector, FRA andDGA Equipment											Y			Y	
Welding (ASME Sect-IX)	Y							Y					Y		

ATTRIBUTES / CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Oil Leakage Test	Jacking test followed by DP Test om load bearing Member	DGA of Oil for main tank and OLTC Chamber	Measurement of capacitance and tan delta	Partial Discharge measurement (long duration)as per IEC-76 clause No. 12.4	Routine Test	Paint Shade, Thickness and finish	Nitrogen Dew Point Measurement before final packing on transformer at receipt at site.
Complete Transformer (IS: 2026 / IEC:76)	Y	Y	Y	Y	Y	Y	Y	Y

Notes :

1) This is an indicative list of checks / tests. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalisation for all items.
2) All major Bought Out Items will be subject to Owner / Owner Engineer approval.

E6: AUXILIARY POWER TRANSFORMERS

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Visual & Dimensional Checks	Mechanical properties/Endurance	Electrical strength	Thermal properties	Chemical Composition	compatibility with oil	Core Loss (on first job only), Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	10 kV Isolation test on core	WPS & PQR	Routine Test as per relevant standard	Vacuum & Pressure Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y			Y		Y		Y
Conservator / Radiator / Cooler / Pipes	Y	Y						Y							
Copper Conductor (IS:191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS:2544 / 5621)	Y	Y									Y			Y	
Gasket	Y	Y			Y	Y			Y		Y			Y	Y
Air Cell	Y													Y	Y
Transformer Oil (IS:335)														Y	
On Load / Off-Circuit Tap Changer (IEC :214)	Y	Y	Y								Y			Y	
Core Coil Assembly & Pre-tanking	Y									Y		Y			
Marshalling Box	Y	Y						Y						Y	

WTI, OTI, MOG, PRD, Thermistor, Breather, Terminal Connector, Bushing CT, Fan & Pumps with Drives, Impact Recorder, Bucholz Relay, Globe &Gate Valve, PD Detector, FRA andDGA Equipment											Y			Y	
Welding (ASME Sect-IX)	Y							Y					Y		

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Oil Leakage Test	Jacking test followed by DP Test om load bearing Member	DGA of Oil for main tank and OLTC Chamber	Measurement of capacitance and tan delta	Partial Discharge measurement (long duration)as per IEC-76 clause No. 12.4	Routine Test	Paint Shade, Thickness and finish	Nitrogen Dew Point Measurement before final packing on transformer at receipt at site.
Complete Transformer (IS: 2026 / IEC:76)	Y	Y	Y	Y	Y	Y	Y	Y

Notes :

1) This is an indicative list of checks / tests. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalisation for all items.
2) All major Bought Out Items will be subject to Owner / Owner Engineer approval.

E7: NEUTRAL GROUNDING RESISTOR

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual & Dimensional check	Mechanical properties	Electrical strength	Chemical Composition	Make / Type / Rating / Model / TC / General Physical Inspection.	Insulation Resistance Measurement before and after HV Test	HV Test	Degree of Protection Test	Routine Test as per relevant standard	Functional / Operator Check	Painting / silver Plating Quality & Adhesion Test	Galvanisng Test	Routine Test	WPS & PQR
Resistor	Y	Y	Y	Y		Y								
Cubicle	Y		Y					Y			Y			Y
Galvanised Steel Structures (IS:2633/2629/ 6745) (IS:2062)	Y	Y										Y		
Bushing/Post & Support Insulator (IS:2544 / 5621)	Y	Y	Y		Y	Y			Y				Y	
NGR, Elastomer Spring Head, Panel Mounted Items & NG Cubicle.	Y				Y	Y			Y	Y			Y	
Complete NGR (IEEE-32)	Y					Y	Y	Y	Y				Y	
Complete Cubicle	Y										Y			

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.

2) All major Bought out Items will be subject to Owner/ Owner Engineer approval.

E8: 11 KV &6.6 KV SWITCHGEAR

ATTRIBUTES / CHARACTERISTICS → / ↓ **ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY**	Make, Type, Model, Rating & TC	Electrical Properties	Mechanical properties	Chemical Properties	Dimensions & Finish	Functional & Operational Features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion	Functional Checks	HV & IR Test	Degree of Protection Routine test	CB Routine Operation Timing check	All Routine Tests as per IS
Aluminum Bus bar material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar material (IS : 613)	Y	Y	Y	Y	Y		Y							
Bus bar Support Insulator	Y	Y	Y		Y		Y				Y			
HT Circuit Breaker (IEC : 62271-100)	Y				Y	Y	Y			Y			Y	Y
HT Contactors (IS : 9046)	Y				Y	Y	Y			Y				Y
Protection & Auxiliary Relays(IS:3231 / 8686/IEC 60255/IEC 61850)	Y				Y	Y	Y			Y				Y
HT CT's & PT's (IS : 2705 / 3156)	Y				Y		Y							
HT Fuses (IS : 9385)	Y				Y	Y	Y							
Surge Arrester (IEC : 99 –4)	Y				Y		Y							
LT Contactors (IS : 13947)	Y				Y	Y	Y			Y				
Control & Selector Switches(IS : 6875)	Y				Y	Y	Y			Y				
Indicating Meters (IS : 1248)	Y				Y	Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y				Y	Y	Y			Y				
Push Buttons (IS : 4794)	Y				Y	Y	Y			Y				
Control Transformer (IS : 12021)	Y				Y	Y	Y			Y				Y
LT Fuses (IS : 13703)	Y				Y	Y	Y							
Energy Meters (IS : 722)	Y				Y	Y	Y			Y				Y
Transducers (IEC: 60688)	Y				Y	Y	Y			Y				Y

Diodes	Y	Y				Y	Y			Y				
Terminal Blocks	Y	Y				Y	Y							
Synthetic Rubber Gasket (IS : 11149 / 3400)	Y	Y			Y		Y							
Breaker Handling Trolley	Y				Y	Y			Y	Y				
HT Switchgear Panel (IEC : 62271-100)	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E9: OIL TYPE TRANSFORMER

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Visual & Dimensional Checks	Mechanical properties	Electrical strength	Thermal properties	Chemical Composition	Compatibility with oil	Core Loss*, Hot Spot	NDT / DPT / MPI / UT	Ageing Test.	Voltage Ratio, Vector Group & Polarity, Magnetic Balance Test	Make / Type / Rating / Model / TC / General Physical Inspection.	WPS & PQR	Routine Test as per relevant test	Vacuum & Pressure Test	Routine Test
Tank, H.V. & L.V. Cable Box / Flange throat	Y	Y						Y			Y	Y		Y	
Conservator / Radiator / Cooler / Pipes	Y	Y						Y				Y			
Copper Conductor (IS: 191)	Y	Y	Y		Y										
Insulating Material	Y	Y	Y	Y	Y	Y									
CRGO Lamination & Built Core	Y	Y	Y		Y	Y	Y								
Bushing / Insulator (IS: 2544 / 5621)	Y	Y									Y		Y		
Gasket	Y				Y	Y			Y				Y		
Transformer Oil (IS: 335)													Y		
Off-Circuit Tap Changer	Y										Y				Y
Core Coil Assembly & Pre-tanking	Y									Y					
Marshalling Box	Y	Y						Y					Y		Y

WTI, OTI, MOG, PRD, Breather, Terminal Connector, Bucholz Relay, Globe & Gate Valve,	Y										Y				
Welding (ASME Sect-IX)	Y											Y			
Complete Transformer (IS: 2026)	Y									Y	Y				Y
* Core Loss on first Job **Note:** 1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2) All major Bought Out Items will be subject to Owner/ Owner Engineer approval.															

DRY TYPE INDOOR TRANSFORMERS

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	Core Loss*, Hot Spote	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity, magnetic balance test	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box /Flange Throat	Y	Y							Y				
Copper Conductor	Y	Y	Y		Y								
Insulating Material	Y			Y	Y								
CRGO Lamination & Built Core	Y					Y							
Bushing /Insualtor (IS:2544 / 5621)	Y								Y		Y		
Gasket	Y								Y		Y		
Off-Circuit Tap Cahnger	Y								Y				
Core Coil Assembly	Y							Y					
Marshalling Box	Y												
WTI, Thermister, Terminal Connector	Y								Y				
Welding										Y			
Complete Transformer (IS: 2026)	Y							Y	Y			Y	Y

- Core Loss for first Job

Notes:

1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to Owner / Owner Engineer approval.

E11: LT SWITCHGEAR

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test	All Routine tests as per IS
Sheet Steel (IS : 513)	Y	Y		Y	Y		Y							
Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
Support Insulator (IS : 9431, IS : 10912, IEC : 660)	Y	Y	Y	Y			Y							
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS : 722, IS:13799, IS:13010)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				Y
Protection & Aux. Relays (IS : 3231, IS:60255, IS:61850)	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS : 6875, IS: 13947)	Y	Y				Y	Y			Y				Y
CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test	All Routine tests as per IS
MCCB (IS : 13947)	Y	Y					Y			Y				
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				Y
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							
Fuse (IS 13703)	Y	Y				Y	Y			Y				
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				Y
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				Y
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to Owner/ Owner Engineer approval.

E12: AC & DC MOTORS

ATTRIBUTES/ CHARACTERISTICS → / ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual	Dimensional	Make/Type/Rating/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722/IS 9283	Vibration	overspeed	Tan delta, shaft voltage and polarization index test
Tan Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y	Y				Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										Y
Castings, stator frame,terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y			Y	Y									
Wound stator	Y	Y					Y	Y										Y
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				

Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT, Space heater, antifriction bearing, gaskets etc.	Y	Y	Y															
Complete Motor	Y	Y	Y				Y								Y	Y	Y	Y1
Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for LT motors up to 50 KW. 2. Additional routine tests for flameproof motors shall be applicable as per relevant standard. 3. Makes of all major bought out items shall be subject to Owner/Owner Engineer approval. Y1 = for HT Motor / Machines only.																		

E13: BATTERY AND BATTERY CHARGER

ATTRIBUTES/ CHARACTERISTICS → / ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Teak Wood	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per specifications	Routine & Acceptance Test as per relevant standard
Container & Lids (IS : 1146)	Y	Y						
Vent Plugs	Y	Y						
Sealing Compound (IS : 3116)		Y	Y					
Positive & Negative Plates		Y	Y					
Separators (IS : 6071)	Y	Y						
Electrolyte (Water / Sulphuric Acid) (IS : 1069 / 266)		Y	Y					
Inter-cell Connectors & Fasteners	Y	Y		Y				
Battery Stand	Y	Y			Y	Y		
Cell Insulators	Y	Y						

Stack Assembly	Y	Y						
Lead Acid Battery (IS : 1652)	Y						Y	Y
Container & Lids	Y	Y	Y	Y				
Vent Plugs	Y		Y	Y				
Perforated Steel Strips	Y		Y	Y		Y		
Active Material for Positive & Negative Plates			Y		Y			
Separators	Y		Y	Y				
Electrolyte			Y		Y			
Inter-cell Connectors & Fasteners	Y		Y	Y		Y		
Battery Stand	Y			Y			Y	
Cell Insulators	Y		Y	Y				
Stack Assembly	Y		Y					
Ni-Cd Battery (IS: 10918)	Y						Y	Y
Container & Lids	Y	Y	Y	Y				

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.
2) All major Bought Out Items will be subject to Owner/Owner Engineer approval.

BATTERY CHARGER													
ATTRIBUTES/ CHARACTERISTICS → / ↓ **ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Make, Model, Type, Rating & Finish	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of Battery Charger as per approved drawings & specification.	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^{0}C for 48 hrs. in energized conductors.	Degree of Protection Test .	Verification of Routine Test Reports as per relevant IS
Rectifier Transformer and Reactors (IS : 2026/4540)	Y		Y			Y				Y			Y
Electronic Components including Potentiometer (Vernier Type)	Y		Y		Y								
Electronics Card	Y		Y								Y		
PCB & racks for Electronic Cards	Y				Y								
19" standard racks for electronic cards	Y				Y								

Control & Selector Switches (IS : 6875)	Y		Y						Y				
Indicating Meters (IS : 1248)	Y		Y						Y				
Indicating Lamps (IS: 13947)	Y		Y						Y				
Air Break Switches / Fuses (IS : 13947 / 13703)	Y		Y						Y				
Control Terminal Blocks (IS : 13947)	Y		Y										
Control Transformer (IS : 12021)	Y		Y						Y				
Push Buttons (IS : 4794)	Y		Y						Y				
MCB (IS : 8828)	Y		Y						Y				
PVC insulated Copper control wires (IS: 694)	Y		Y										
Sheet Steel (IS: 513)	Y	Y	Y										
Synthetic Rubber Gaskets	Y		Y										
Annunciator	Y								Y		Y		
Battery Charger	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.

2) All major Bought Out Items will be subject to Owner/Owner Engineer approval.

E14: HV CABLES

ATTRIBUTES / CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Type, Rating & T.C	Dimension/surface finish	Mechanial properties	Chemical Composition	Curing Properties	Electrical properties	Hot Set Test/ Eccentricity & Ovality	Lay length & Sequence	Armour coverage, cross over, looseness, gap between two wire	Sequential marking/surface finish/ cable length	T.S & elongation before & after ageing on sheath & insulation	Thermal stability on sheath	Anti Termite Test on wooden drums	Constructional requirements feature as per specification	Routine & Acceptance Test as per relevant standard	FRLS Test	Spark Test (as applicable) metallic (Cu) Screening (if applicable)
Aluminium (IS-8130, IEC 60228)	Y	Y	Y	Y		Y											
Semiconducting Compound	Y		Y		Y	Y											
XLPE Compound (IS-7098 Part-II, IEC 60502-2)	Y		Y		Y	Y					Y						
FRLS PVC Compound (IS-5831, ASTM-D2843, IS-10810 (Part 58), IEC-60754 Part-1)	Y		Y								Y	Y	Y			Y	
Triple Extrusion & curing /Manufacturing of Core		Y					Y	Y									Y
Copper Tape	Y	Y	Y			Y											
Polyster tape	Y	Y															

Armour wire/strip	Y	Y	Y														
Copper tapping	Y	Y				Y											
Inner sheath	Y	Y															
Armouring									Y								Y
Outer Sheathing		Y								Y	Y	Y		Y		Y	
Power Cable (Finished) (IS: 7098 Part II, IEEE: 383, IEC: 332, IS-5831, ASTM-D2843, ASTM-2863, IEC-754 Part-1)	Y							Y	Y	Y	Y	Y	Y	Y	Y	Y	
Wooden drum (IS -10418)/ Steel Drums		Y											Y				

1. **Notes:**is is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought Out Items will be subject to Owner/Owner Engineer approval.

3. Routine Tests

   Routing Tests shall be carried out on each drum of finished cables for all types & sizes. Following shall constitute routine tests:

   a) Conductor Resistance Test; b)High Voltage Test; c) Partial Discharge Test

4. ACCEPTANCE TEST

Following acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS:7098 Part1I

a) For Conductor

i) Tensile Test
ii) Wrapping Test
iii) Resistance Test

b) For Armour Wires / Formed Wires (If applicable)

i) Measurement of Dimensions
ii) Tensile tests
iii) Elongation test
iv) Torsion Test For Round wires only
v) Wrapping Test
vi) Resistance Test
vii) Mass of Zinc coating test For GS wires/ formed wires only
viii) Uniformity of Zinc coating For GS wires/ formed wires only
ix) Adhesion test For GS wires /formed wires onlyFreedom from defects

c) For XLPE insulation & PVC Sheath

i) Test for thickness
ii) Tensile strength & Elongation before ageing
iii) Hot set test (for XLPE insulation)

d) For completed cables

i) Insulation resistance test (Volume resistivity method)
ii) High voltage test
iii) Partial discharge test (for Screened Cables only)

e) Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-

i) Thermal stability test **on PVC insulation and outer sheath**
ii) Oxygen index test **on outer sheath**
iii) Smoke density rating test **on outer sheath as per ASTM-D 2843**
iv) Acid gas generation test **on outer sheath as per IEC-60 754 (Part1)**
v) Flammability test **as per IEC 60332 – Part-3 (Category –B) on completed cable**

f) Ageing test on XLPE insulation and PVC outer sheath a per following:

Samples as per relevant IS from every size & type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by OWNER. In case values of tensile strength & elongation (before ageing) of PVC insulation & outer sheath are within +/- 15% of the type test reports then 1 sample from sizes which meet the criteria will be put on accelerated ageing test. The accelerated ageing test procedure for PVC insulation & outer sheath: sample to be put in air oven at temperature of 130^c+/- 2^ for 5 hours, tensile strength & elongation acceptance norms as per relevant IS.

Samples as per relevant IS from every size & type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). 1 samples from every size & type of cable in the offered lot shall be tested for tensile strength & elongation after ageing test as per IS.

However in case the tensile strength and elongation values are not within +/- 15% of type test values then 1 sample of that particular size of cable will be tested for tensile strength & elongation after ageing test as per relevant IS.

For XLPE insulation: 1 sample of every size will be put on ageing test as per relevant IS.

g) Following tests shall be carried on one length of each size of offered lot:

i) Surface finish, length measurement, sequence of cores, armour overage, Gap between two consecutive armour wires / formed wires
ii) Measurement of Eccentricity & Ovality.
iii) Temperature index test as per ASTM- 2863/ 77
iv) Test for rodent and termite repulsion property.

v) Flammability test as per IEC 60332 has been mentioned as serial no. v), however, in the specifications of HT cables, Swedish chimney test for flammability has been specified.

vi) Smoke density rating test on outer sheath shall be as per ASTM- D 2843 an also as per UITP method.

vii) At serial no. f) sheet 50 of 65, para 1, temperature of 130 deg C and 2 deg C be properly indicated.

viii) Notes:

a) For smoke density rating test: If the test result without conditioning is within (-) 10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

b) For Acid gas generation test: if the test result without conditioning is within (-) 10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

c) For oxygen index test: if the test result without conditioning is within (+) 7% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

d) In case the test results without conditioning do not meet the maximum/ minimum specified value, the manufacturer may exercise the option of resting the samples after conditioning as per standard.

E15: LV CABLES

ATTRIBUTES / CHARACTERISTICS → / ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Hot set test (XLPE)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two	Sequential marking/surface finish	Tensile strength, elongation before & after ageing of insulation &	Thermal Stability of insulation and	Anti termite treatment test on	Constructional / requirement	Routine and acceptance test as per Relevant Standard	FRLS Test
Aluminum (IS-8130, IEC:8130, IEC 60228)	Y	Y	Y	Y	Y											
PVC Compound (IS-5831, IEC 60502)	Y		Y		Y						Y					
XLPE Compound(IS-7098 Part-I, IEC 60502-2)	Y		Y		Y		Y				Y					
FRLS PVC Compound (IS-5831)/ASTM-D-2843/IS-10810 (Part-58), IEC-60754 Part 1)	Y		Y								Y	Y				Y
Armour wire/ Formed wire (IS-3975)	Y	Y	Y													
Insulated Core		Y				Y	Y					Y				
Laid up core		Y						Y								
PVC Inner sheath	Y	Y														
Armouring		Y							Y							
Outer sheath		Y								Y	Y	Y				Y
Finish cable (IS-1554 & 7098 Part-1)/ASTM-D-2843/IS-10810 (Part-58)/IEC-60754 (Part-I) Swedish Chimney SEN SS 4241475 for (F3 category)/ Flammability test IEC-60332 Part-3 Cat-B	Y	Y						Y	Y	Y	Y	Y	Y	Y	Y	Y
Wooden drum (IS-10418) Steen Drum		Y											Y			

- Not applicable for XLPE insulation

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan/Routine Test/acceptance tests indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought out Items will be subject to Owner/Owner Engineer approval.

E16: CONTROL CABLES

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY	Make, Type, Rating, T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, gap between two armour	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation & outer	Thermal stability of insulation and outer sheath	Anti termite treatment on wooden	Constructional feature as per	Routine & Acceptance test as per relevant standard	FRLS Test
Copper Conductor (IS-8130, IS-60228)	Y	Y	Y	Y	Y										
PVC Compound (IS-5831, IS-60502)	Y		Y		Y					Y					
FRLS PVC Compound IS-5831 ASTM-D-2843 / IS-10810 (Part-58) / IEC 60754 (Part-1)	Y		Y							Y	Y				Y
Armour wire/ Formed wire (IS-3975)	Y	Y	Y												
Insulated Core		Y				Y	Y				Y				
Laid up core		Y					Y								
PVC Inner sheath	Y	Y													
Armouring		Y						Y							
Outer sheath		Y							Y	Y	Y				Y
Finish cable (IS-1554 (Part-1)/ASTM-D-2843/IS-10810 (Part-58)/IEC-60754 (Part-1) IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475 (F3 category) Flammability test IEC-60332 Part-3 Cat-B	Y	Y					Y	Y	Y	Y	Y		Y	Y	Y
Wooden drum(IS:10418) Steel Drums		Y										Y			

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents

2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

3. These tests are also to be carried out:-

ix) Temperature index test as per ASTM- 2863/ 77

x) Test for rodent and termite repulsion property.

xi) Flammability test as per IEC 60332 has been mentioned as serial no. v), however, in the specifications of HT cables, Swedish chimney test for flammability has been specified.

xii) Smoke density rating test on outer sheath shall be as per ASTM- D 2843 an also as per UITP method.

xiii) At serial no. f) sheet 50 of 65, para 1, temperature of 130 deg C and 2 deg C be properly indicated.

xiv) Following Note may be added:-

e) For smoke density rating test: If the test result without conditioning is within (-) 10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

f) For Acid gas generation test: if the test result without conditioning is within (-) 10% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

g) For oxygen index test: if the test result without conditioning is within (+) 7% of the maximum specified value, then, retesting is to be carried out with conditioning of samples as per standard and the test results after conditioning shall be final for acceptance/ rejection.

4. In case the test results without conditioning do not meet the maximum/ minimum specified value, the manufacturer may exercise the option of resting the samples after conditioning as per standard.

QUALITY ASSURANCE & INSPECTION

1. ROUTINE TESTS

Routine tests shall be carried out on each drum of finished cables for all types & sizes.

Following shall constitute routine tests:

1) Conductor Resistance test
2) High voltage test at room temperature
3) Partial Discharge test
4) Flammability Test

2 ACCEPTANCE TEST

Following acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part-1.

A) **For Conductor**

1) Annealing test For copper conductor only
2) Resistance test

B) For Armour Wires / Formed Wires (If applicable)

1) Measurement of Dimensions
2) Tensile Tests
3) Elongation Test
4) Torsion Test — For round wires only
5) Wrapping Test
6) Resistance Test
7) Mass of Zinc coating test — For GS wires/ formed wires only
8) Uniformity of Zinc coating — For GS wires/ formed wires only
9) Adhesion test — For GS wires /formed wires only
10) Freedom from defects

C) For PVC insulation & PVC Sheath

1) Test for thickness
2) Tensile strength& Elongation before ageing

D) For completed cables

1) Insulation resistance test (Volume resistivity method)
2) High voltage test at room temperature

E) Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-

1) Thermal stability test **on PVC insulation and outer sheath**
2) Oxygen index test **on outer sheath**
3) Smoke density rating test **on outer sheath as per ASTM-D 2843**

4) Acid gas generation test **on outer sheath as per IEC-60 754 (Part1)**

F) Ageing test on PVC insulation and PVC outer sheath as per following:

In case of regular manufacturers:

Samples as per relevant IS from every size & type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by OWNER. In case values of tensile strength & elongation (before ageing) of PVC insulation & outer sheath are within +/- 15% of the type test reports then 1 sample from sizes which meet the criteria will be put on accelerated ageing test. The accelerated ageing test procedure for PVC insulation & outer sheath: sample to be put in air oven at temperature of 130^c+/- 2^ for 5 hours, tensile strength & elongation acceptance norms as per relevant IS.

Samples as per relevant IS from every size & type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). 1 sample from every size & type of cable in the offered lot shall be tested for tensile strength & elongation after ageing test as per IS.

However in case the tensile strength and elongation values are not within +/- 15% of type test values then 1 sample of that particular size of cable will be tested for tensile strength & elongation after ageing test as per relevant IS.

G) Flammability test as per IEC 60332-Part-3 (Category-B) on completed cable as per following sampling plan/as per specification:-

The test shall be carried out on every size & type of control cable offered for inspection as an acceptance test. This test will be carried out using composite sampling i.e. irrespective of sizes of cables of a particular type, may be tested together as per calculations in line with the IEC (all sizes will be covered)

H) Following tests shall be carried on one length of each size of offered lot:

Surface finish, length measurement, sequence of cores, armour overage, Gap between two consecutive armour wires / formed wires.

E18: ILLUMINATION SYSTEM

ATTRIBUTES/ CHARACTERISTICS → / ITEMS, COMPONENTS, SUB-SYSTEM ASSEMBLY	Make, Type , Rating/ TC	Dimension	Pre-Treatment of sheet	Paint Shade Thickness Adhesion & Finish	Galvanise Test	IP Test	Boought Out Items/ Bill of Material	HV & IR	Functional Check as per spec.	Constructional Feature	Routine test as per relevant standard & specification	Routine & Acceptance Test Acceptance Test as per relevant std and spec	Item to conform to relevant standard
Luminaries (IS-10322 Part-5 Sec.1) including LED fixture	Y					Y		Y			Y	Y	Y
Electronic Ballast	Y										Y	Y	Y
Lighting Wire (IS-694)	Y										Y		
Fans (IS-374)	Y										Y		
Pole (IS-2713)	Y			Y						Y	Y	Y	
Lamps (IS-9800, IS-9974)	Y										Y	y	
Lighting Mast (with raise & lower lantern type)	Y	Y			Y					Y	Y	Y	
Wall Mounted Lighting Panel (IS-513, IS-5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Switch Box/ Junction Box/Receptacles/ Local Push Button Station, Lighting Panel (IS-513, 2629, 2633, 4759, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Cable Gland (BS-6121)	Y	Y									Y		
Cable Lug (IS-8309)	Y	Y									Y		
Flexible Conduit	Y										Y		
Lighting Transformer (IS-1117)	Y									Y	Y		
Epoxy & Galvanised Conduit (IS-9537, 2629, 2633, 4759, 6745)	Y	Y									Y		Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. LED driver make, model, type & rating maybe as per recommendation of LED module manufacturer
3. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E18: CABLING

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, Type, Rating/ TC	Dimension	Pre-treatment of sheet	Paint shade, paint thickness, adhesion	IP protection	Bought out items/Bill of material	HV & IR	Galvanise Test (If Applicable)	Functional Test as per spec	Proof Load	Deflection test	Constructional feature	Routine & acceptance test as per Relevant standard and	Item confirm to relevant standard
Switch box/junction box/ Receptacles (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y	
Cable glands(BS-6121)	Y	Y												Y
Cable lug(IS-8309)	Y	Y												Y
Lighting wire(IS-694)	Y	Y										Y		Y
Flexible conduits	Y	Y										Y		Y
Conduits(Galvanise & Epoxy) IS-9537 & IS-2629,2633 ,6745	Y	Y	Y					Y					Y	
RCC Hume Pipe (IS-458)	Y	Y												Y
Cable termination & straight through joint (VDE-0278, IS 13573)	Y	Y			Y	Y						Y	Y	
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y	Y	Y			Y		Y		Y	Y	Y	Y	Y
Trefoil clamp	Y	Y												Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E19: EARTHING & LIGHTNING PROTECTION

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, Type, Rating/ TC	Dimension	Pre-treatment of sheet	Paint shade, paint thickness, adhesion	IP protection	Bought out items/Bill of material	HV & IR	Galvanise Test (If Applicable)	Functional Test as per spec	Proof Load	Deflection test	Constructional feature Specification	Routine & acceptance test as per Relevant standard and specn.	Item confirm to relevant standard
GI flats for earthing & lightning protection (IS 2062, 2629, 6745,2633)	Y	Y	Y					Y					Y	Y
GI wire (IS-280)	Y	Y	Y					Y					Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E20: DIESEL GENERATORS

DIESEL ENGINE											
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Material Test	DP/MPI	UT(On forging and piston Bonding)	Balancing	Hydraulic/water fill test	Assy./fit up	Dimension	Functional/Operation test	Performance test as per BS-5514/or equivalent IS/ISO- Standard including Governing Test for 3 hors at full load and one hr at 10% overload	Fuel consumption, rated power measurement,rated speed	All other tests(if applicable) as per Spec./ relevant Std
Crank shaft	Y	Y	Y	Y							
Cylinder blocks/heads	Y				Y						
Liner/ Radiator	Y				Y						
Rotating/moving parts other than crank shaft	Y	Y									
Piston	Y	Y	Y								
Diesel Engine						Y	Y	Y	Y	Y	Y

Note:
This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

ALTERNATOR																		
ATTRIBUTES, CHARACTERISTICS → **↓** **ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment	Magnetic Characteristics	Hydrualic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y									
Shaft	Y	Y	Y	Y	Y	Y			Y									
Magnetic Material	Y	Y	Y	Y	Y		Y			Y		Y						
Rotor Copper/Aluminium	Y	Y	Y	Y		Y	Y		Y									
Stator copper	Y	Y	Y	Y			Y		Y			Y						
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating Material	Y		Y	Y			Y					Y						
Tubes for Cooler	Y	Y	Y	Y	Y				Y		Y							
Sleeve Bearing	Y	Y	Y	Y	Y				Y		Y							
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y									

ALTERNATOR																		
TESTS/CHECKS / ITEMS/ COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC /General Physical Inspection	Mech/Chem. Properties	NDT /DP/MPI/UT	Metallography	Electrical Characteristics	Welding/Brazing(WPS /PQR)	Heat Treatment	Magnetic Characteristics	Hydraulic/Leak/Press ure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-4722	Vibration	Over speed	Tan delta, shaft voltage & polarisation index test
Wound stator	Y	Y					Y	Y										
Wound Exciter	Y	Y					Y	Y										
Rotor complete	Y	Y					Y						Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD,CT,AVR. Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y															
Alternator (IS 4722)	Y	Y	Y												Y	Y	Y	Y1

Note:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalization.
2. Make of all major bought out items will be subject to Owner / Owner approval.

Y1= for HT Machines only.

FINAL ASSEMBLY										
ATTRIBUTES, CHARACTERISTICS → **↓ ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY**	Material Test	Dimension	WPS/PQR/Welding	NDT/DP/MPI/UT	Check completeness	Hydraulic/Leak/Pressure test	Functional Tests	All routine test as per Spec/ IS	No load test for one hour of the DG set assembly	Clearances & Alignment
Base frame	Y	Y	Y	Y	Y					
Fuel Tank	Y	Y	Y	Y	Y	Y				
Battery (IS – 1691)								Y		
Battery Charger								Y		
Control Panel								Y		
Assembled DG Set		Y			Y		Y	Y	Y	Y

NOTES:
1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E21: EHV CABLES

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, Type,Rating, TC	Dimension/surface finish	Mechanical Properties	Chemical Composition/Purity	Electrical Properties	Triple Extrusion & Curing / Hot Set Test/ Shrinkage Test	Eccentricity / ovality	Void & Contmination Test	Metallic (Cu) Screening	Moisture Barrier	Extrusion	Overlaping / Binding	Spark test on outer Sheatch	Thermal stability of Sheath	Constructional feature	Routine and acceptance test as per relevant standard
Copper (IS-8130)	Y	Y	Y	Y	Y											
Semiconducting compound	Y		Y		Y											
PVC Compound (IS-5831)	Y		Y		Y											
Swelling Tape(Water blocking tape)	Y	Y	Y													
Copper tape/Foil/Wire	Y	Y	Y		Y											
XLPE Compound(IS-7098 Part-III)	Y		Y		Y											
Lead Alloy	Y		Y	Y												
Laminated/ Binder Tape	Y	Y	Y													
Wooden Drum/Steel drum		Y														
Triple extrusion & Curing of Cores		Y	Y		Y	Y	Y	Y								
Semiconducting swellable tape over insulation screening	Y	Y	Y		Y					Y		Y				
Copper wire screening/copper tape		Y							Y							
Lead sheathing										Y	Y					
Laminated/ Binder Tape		Y										Y				

Inner Sheathing		Y									Y			Y		
OuterSheathing (Graphite Coated PVC)		Y									Y		Y	Y		
Power Cable Final inspection (IS – 7098 Part 3,		Y	Y		Y	Y	Y	Y			Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Make of all major Bought Out Items will be subject to Owner / Owner Engineer approval.

E22 :11/6.6 kV Segregated Phade BUS DUCT

11/6.6 kV BUS DUCT											
ATTRIBUTES/ CHARACTERISTICS → ↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Visual & Dimensional Checks	Electrical / Mechanical / Chemical Properties	WPS & PQR	NDT (DP / MPI / UT/RT)	Painting /Silver Plating Quality & Adhesion Test	Galvanising Test as per IS: 2629 / 2633 / 6745	Electrical Clearance & Creepage	Functional/Operational check	Make / Type / Rating / Model / TC / General Physical Inspection	Trial Assembly at works.	Routine Test as per relevant standard
Enclosure	Y	Y		Y	Y		Y				
Bus bar Conductor/ Flexible Connector & Disconnector Link	Y	Y									
Galvanised Steel Structure & Plate	Y					Y					
Bushing Post / Support Insulator as per IS:9431 & 2544	Y	Y					Y		Y		Y
Welding on enclosure & conductor joint	Y		Y	Y							
Gasket, SlicaGel Breather	Y							Y	Y		Y
Complete Bus Duct	Y				Y					Y	Y

Notes :

1) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.
2) All major Bought Out Items will be subject to Owner/Owner Engineer approval.

E23: Protection and relay panel for generator, generator transformer, ST, UAT and switchyard

ATTRIBUTES, CHARACTERISTICS → / ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY ↓	Make, Type, Rating, TC	Electrical Properties	Dimension/surface finish	Functional and operational features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint shade, thickness, adhesion and finis	HV and IR test	Degree of Protection - Routine test	Routine and acceptance test as per relevant standard
Protective relays (IS:3231/ 8686)	Y		Y	Y	Y				Y	Y
Auxiliary relays (IS:3231/ 8686)	Y		Y	Y	Y				Y	Y
Control and selector switches (IS:6875)	Y		Y	Y	Y					
Indicating meters (IS:1248)	Y		Y	Y	Y					Y
Indicating lamps (IS:13947)	Y		Y	Y	Y					
Push buttons (IS: 4794	Y		Y	Y	Y					
Control transformer (IS:12021)	Y		Y	Y	Y					Y
LT fuses (IS:13703)	Y		Y	Y	Y					
Energy meters (IS:722)	Y		Y	Y	Y					Y
Transducers (IEC:60688)	Y		Y	Y	Y					Y
Diodes	Y	Y		Y	Y					
Terminal Blocks	Y	Y		Y	Y					
Synthetic Rubber Gasket (IS:11149/ 3400)	Y	Y	Y		Y					
Complete Panel (IS:3427)	Y		Y	Y	Y	Y	Y	Y	Y	Y
Test realy kit	Y			Y						Y

E24: VFD

VFD MODULE				
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	ATTRIBUTES / CHARACTERISTICS			
	Visual & Dimensional checks	Make/Type/ Rating etc.	Final Inspection as ISS/IEC	Remarks
HT Breaker (IEC 56)	Y	Y	Y	
DC Reactor	Y	Y		
Transformer	Y	Y		For details refer table for LT Indoor Transformer & Auxiliary Transformer
Motor	Y	Y		For details refer separate table for Motor
VFD Panel	Y	Y		For details refer table for VFD Panel

Note:-

1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization.

Make of all major bought out Items will be subject to owner approval.

E25 – Roof Top Solar System

This is indicative List of tests/ checks. The manufacturer is to furnish a detailed quality Plan indicating the practice & procedure along-with the relevant supporting documents.

1. **PCU**
   a) Incoming Quality Checks on bought out items
   b) In-process quality checks
   c) Routine tests as per following on the assembled PCU:
      i. Test to demonstrate automatic / manual synchronization and connection to utility service
      ii. Functional check on all protections
      iii. Check on accuracy of all parameters measured by PCU
      iv. Test to demonstrate operation of start-up, stable operation of the PCU, disconnection and shutdown
      v. controls and response to other control signals
   d) Following sample tests assembled PCU: (1 Unit per offered lot)
      Heat run test including measurement of phase currents, efficiencies, harmonic content and power factor at four points preferably 25, 50, 75 and 100% of the rated nominal power.
2. **SPV module-** SPV modules quality plan should include the following:
   a) Incoming Quality Checks on bought out items (listed in third party test reports of relevant standard)
   b) In-process Quality Checks
   c) Sample tests as per following:
      i. SPV modules to be checked visually for following defects: (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1)
         - Scratches on the frame and/or glass
         - Excessive or uneven glue marks on glass or frame
         - Inconsistent cell colors
         - Completeness of module in all respects
      ii. Performance of SPV module at STC (sampling as per General Inspection Level II and AQL 1.5% as per IS2500 Part 1)
      iii. IR-HV-IR test (sampling as per General Inspection Level II and AQL 1.5% as per IS 2500 Part 1)
      iv. Robustness of terminations on 1 sample per offered lot
      v. Mechanical load test on 1 sample per offered lot

3. **Array Junction Box / String Monitoring Box-**Array Junction quality plan should include the following:

a) Checks on bought out items as per internal standards of the manufacturer

b) In-process checks, as per internal standards of the manufacturer

c) Sample tests as per following:1) IR-HV-IR test (sampling as per General Inspection Level-II and AQL

i. 1.5% as per IS 2500 Part 1)

ii. String Monitoring Card/ Power Supply card/ DC-DC Converter function check on one sample of SMB (In case of String Monitoring Box only)

iii. Communication Function Test on one sample (In case of String Monitoring Box only)

iv. Degree of protection visual checks like gasket profile, sealing arrangement, paper pull check

4. DC Cable-

Routine and Acceptance Test as per the relevant Standard applicable as per technical specifications

E26 – ESP ELECTRICAL PORTION

ESP ELECTRICAL PORTION				
ITEMS/COMPONENTS, SUB SYSTEM ASSEMBLY	ATTRIBUTES / CHARACTERISTICS			
	Visual	Make /Type / Rating etc.	Final Inspection as per ISS / IEC/BS	Remarks
TR Set	Y	Y		Refer table for Transformer Rectifier Set for ESP
ESP Insulator (IEC 168 / 273, IS 2544)	Y	Y	Y	ESP Insulators shall be additionally subjected to high temperature test on sample basis as per mutually agreed upon procedure.
Electrostatic Precipitation Management System	Y	Y		Refer table for Annunciation, control, PLC Panel
Microprocessor based Rapper Controller	Y	Y		Refer table for Annunciation, control, PLC Panel
Disconnecting switch (IS 13947)	Y	Y	Y	
Heaters (IS 4159 / BS 6351)	Y	Y	Y	

Note :

1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization.
2. Makes of all major Bought Out Items will be subject to owner approval

E27 – ELEVATORS

Elevators (GEAR TYPE)										
	TEST /CHECK									
ITEM	Material Test	DPI/MPI	Ultrasonic Test	Dimensions/Physical	Functional/ Operational Test/ Run Test	Performance Test	Other Tests	All routine tests as per applicable standard	Plain shade, thickness & adhesion	Assembly/fit up
Shaft/ Rack/Gears	Y	Y	Y	Y						
Plates	Y			Y						
Wire rope				Y			Y5			
Safety device								Y		
Geared Machine					Y					
VVVF Drive					Y		Y3	Y		
Power, Control & Trailing Cables								Y4		
Control Panel				Y					Y	
ARD System					Y			Y		
Electrical motor								Y		
Complete Elevator				Y	Y	Y1	Y2			Y

Y1 –Test to be done at site
Y2 - Load/overload test to be done at site as applicable.
Y3 – Burn in test on electronic card
Y4 – Routine tests including FRLS tests as per Tech. Spec.
Y5- Test report as per relevant std.

NOTE:

1. This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the applicable practices and procedures followed along with relevant supporting documents during QAP finalization.

Makes of all bought out items shall be subject to owner approval

E28 – DC STORAGE BATTERY

DC Storage Battery Lead-Acid type battery											
	ATTRIBUTES / CHARACTERISTICS										
ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY	Dimensions and finish	Conformance to relevant drawing	Chemical composition	Lead coating thickness (minimum 25 microns, IS:6848 and Adhesion check	Conformance to CPWD Specification for teak wood	Paint process checks, paint shade, thickness, adhesion and finish	Constructional requirements as per specification	Insulation Resistance	Marking (Routine and Acceptance test)	Checking of polarity and absence of short circuit (Routine and Acceptance test)	Test for capacities for 10 hours discharge rate alongwith the test for voltage during discharge (Acceptance test)
Container and Lids (IS:1146)	Y	Y									
Vent plugs	Y	Y									
Sealing compound (IS:3116)		Y	Y								
Positive and Negative plates		Y	Y								
Separators (IS:6071)	Y	Y									
Electrolyte (water/sulphuric acid) (IS:1069/266)		Y	Y								
Inter-cell connectors and fasteners	Y	Y		Y							
Battery stand	Y	Y			Y	Y					
Cell insulators	Y	Y						Y			
Stack assembly	Y	Y									
Lead-Acid battery (IS:1652)	Y						Y		Y	Y	Y

Y =Test applicable

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

QUALITY ASSURANCE PLAN for C & I

I N D E X

QUALITY PLAN SUBMISSION PROGRAMME FOR THE BIDDERS

The Quality Assurance Plans as conceived for the project are enclosed. Bidders to follow the NIT specification in totality i.e. both Volume II & Volume V to submit QAP for Approval.

CI.1. MAIN EQUIPMENT RELATED CONTROL AND INSTRUMENTATION SYSTEM

SG RELATED SPECIFIC INSTRUMENTATION AND CONTROL

TEST/ATRIBUTES CHARACTERISTICS / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	Make, Model, Type, Rating(R)	Visual Check(R)	Dimensional Check(R)	Drop Test (Sample)(A)	Physical & Chemical properties(A)	HV/ IR Test (R)	GA/BOM/Paint Shade Thickness, Adhesion (R)	Hydraulic Test(R)	IBR form III-C Certification(R)	RT/UT on welds(R)	Functional Checks(R)	Integrated test with Simulation (R)
ELECTRONIC DRUM LEVEL INDICATOR												
Electrodes	Y	Y	Y	Y	Y	Y		Y				
Pressure vessels	Y	Y	Y		Y			Y	Y	Y		
Valves/Key Interlock	Y	Y	Y				Y	Y			Y	
Final inspection of complete System(Panel, Cabinet ,Display Unit)	Y	Y	Y			Y	Y				Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

TG RELATED SPECIFIC INSTRUMENTATION & CONTROL

TESTS/ATRIBUTES CHARACTERISTICS / ITEMS	Linearity(R)	Frequency Response(R)	Calibration with simulated output.(R)	Spectrum(Harmonic Analysis (A)	Predictive Analysis Functions (A)	Storage & Comparative analysis of vibration(A)	Generation/analysis of plots (A)	Simulation test & generation of operator guidance (A)
TURBO SUPERVISORY/VIBRATION MONITORING SYSTEM								
Proximeter	Y	Y						
Accelerometer	Y	Y						
LVDT	Y							
Monitor	Y		Y*					
Overall system				Y	Y	Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

   * Applicable for monitor electronics.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.2. MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable									

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions.
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Calculation for accuracy (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
15. Cold junction compensation box	Y	Y	Y	Y					Y			
16. Orifice plate(BS-1042)	Y	Y	Y	Y *	Y	Y * *	Y * *			Y	Y * *	Y
17. Flow nozzle(BS-1042)	Y	Y	Y	Y *	Y	Y	Y			Y	Y	Y
18. Impact head type element	Y	Y	Y					Y				Y
19. Level transmitter/float type switch	Y	Y	Y	Y					Y	Y	Y	Y
20. Flue Gas analyser	Y	Y	Y	Y								
21. Dust emission monitors	Y	Y	Y	Y								
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.												
** If applicable												
R-Routine Test A- Acceptance Test Y – Test applicable												

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.3. DISTRIBUTED DIGITAL CONTROL, MONITORING & INFORMATION SYSTEM

1.01.00 REQUIREMENTS OF AUTHORISATION-TO-SHIP-TEST (ATST)/FACTORY ACCEPTANCE TEST (FAT) FOR DDCMIS

1.01.01 Authorization-to-ship-test (ATST) shall include all required tests to fully demonstrate to Owner's satisfaction that each equipment/sub-system/system as well as software modules furnished as per this specification as well as DDCMIS as a whole, fully meets the functional, parametric and other requirements of this specification and Owner's approved drawings/documents under all operating regimes. The parametric requirements shall be as per DDCMIS specifications. All tests pertaining to Control System shall be applicable to SG-C&I, TG-C&I and BOP-C&I also.

1.01.02 Bidder to note that ATST /FAT procedure given below in subsequent clauses are only indicative in order to help the Bidder in understanding the require-ments and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements. These requirements are in addition to those stipulated against DDCMIS integrated testing.

1.01.03 The results of the following activities shall be made available to the Owner's representative before start of FAT.

Compliance check & implementation for Major Design Feature (including Customisation if any), as per clause no. 17.02.04.16, QAP, Part-B, Vol-V, Ch-17: Quality Assurance and Testing and Guarantees.

1.01.04 Generally, the ATST / FAT shall be carried out with the equipment earmarked for the particular project and unit. However, for the following item, the testing can be carried out with similar / equivalent dummy equipment fulfilling the following condition, subject to Owner's approval.

S.No.	ITEM	CONDITION
1	LVS	Testing of LVS functionalities can be done by using monitors connected to the LVS Workstations. Despatch of LVS can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.
2	LVS WS / OWS	LVS WS / OWS for the first unit to be tested on the target machines. In case the testing carries over to next unit, dummy equipment may be used. Despatch of LVS WS / OWS of subsequent units can be allowed like a cat-III item, but only after successful testing of first unit as indicated above.
3	MASTER CLOCK	Can be directly despatched if alternate test set-up for time synchronisation can be arranged.
4	NETWORK COMPONENT	To be done with target machines only for first unit. In case the testing carries over to next unit, dummy equipment may be used. Despatch of network components of subsequent units / station can be allowed like a cat-III item, but only after successful testing of functionalities as indicated above.
S.No.	**ITEM**	**CONDITION**

5	VARIOUS BUS SYSTEM CABLES	For FAT, the target Main system bus shall be used. In case the testing carries over to next unit, dummy equipment may be used.

1.01.05 The Authorisation-To-Ship-Test (ATST) shall include all reasonable exercises which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

(a)	Pre power on checks / Power failure auto-restart tests	
(b)	Power on check	
(c)	Hardware tests	
(d)	Functional tests	To be done only for the first unit (in case of a multi-unit project). Only if, under any unavoidable situation, some exception remains, functional / parametric tests for only those shall be done in subsequent unit
(e)	Parametric test	---- do ----

1.01.06 **Pre power on checks**

These tests shall include but not be limited to the following:

(a.) Visual Checks:

These tests will include checking of individual cubicles, p eripherals, etc. for damages; proper inspection of cubicles, internal cabling, tuning, door arrangements, louvers, fans etc.

(b.) Hardware verification:

These tests will include verification of location of each card and module in Control System, MMIPIS, master clock systems, etc. Verification of no. of modules as per the approved BOM and corresponding layout drgs. on sub system basis. Verification of spare capacity in the cubicle for installation of new modules.

(c.) Verification of system technical documentation as per approved list.

(d.) Verification of degree of protection of various cabinets as per specification.

1.01.07 **Power on check** / Power failure auto-restart tests

To observe the start up and automatic loading initialization of software when system is energised. Verification of availability of all system functions

automatically after restoration of power after power failure to DDCMIS. Verification of restoration of all data which was stored in the system at the time of power loss.

1.01.08 **Hardware tests**

These tests shall include but not be limited to the following tests:

(a.) Verification of healthiness of all modules e.g., I/O modules, controller modules, processors, peripherals, etc.

(b.) System configuration:

1) Verification of system configuration with reference to approved configuration diagrams including verification of controller configuration, group/ sub-group segregation; grouping of controllers both for CLCS & OLCS, communication controller, I/O redundancy, verification of multiple measurement scheme, MMIPIS configuration, etc.

2) Verification of features of complete DDCMIS like on line removal of I/O and controller modules, etc. in line with specification requirements.

3) Verification of spare capacity w.r.t. spare wired-in space in cabinets/ cubicles, terminal blocks, peripherals, etc. in line with spec. requirements as stipulated under scope of work.

(c.) Simulation of inputs:

To verify conversion calculations, scan rates, operator's functions, corrections of calculations. For simulation of inputs for I/O modules, this test will be carried out for 10% of each type of modules or min. 1 no. of each type, whichever is more.

(d.) Accuracy test:

Accuracy for analog inputs/output shall be demonstrated for each type of analog input/output. The No. of samples shall be decided during detailed engineering.

(e.) Demonstration of the manual and auto switchover from master to standby system bus, controllers, I/Os, processors etc.

(f.) Diagnostics Tests:

Complete on-line diagnostic tests on MMIPIS, individual peripherals, Control System, programmer stations, etc.

1.01.09 **Functional Tests (also Refer Vol. V, Part B, Chapter 17)**

The following tests shall be carried out on Bidder's DDCMIS.

(a.) Functional tests of CLCS:

(1) Verification of proper signal acquisition, conditioning and distribution.

(2) Verification of proper realisation of controller functions like bumpless transfer from auto to manual and vice versa (as stated above), functional checking of bias circuit (wherever provided), etc.

(3) Verification of response of control system by simulating changes in the system inputs by using mathematical modelling of the process for control loops like CCS, fuel flow control, air flow control, furnace draft control, feed water control, SH/RH temperature control, etc., in line with the approved ATST procedure

(4) Sample verification of availability of all automatic CLCS functions without HMIPIS.

(5) Sample verification of availability of all CLCS functions within one Functional Group without System Bus.

(b.) Functional tests of OLCS:

(1.) Verification of proper signal acquisition, conditioning and distribution.

(2.) Verification of proper realisation of logic functions, sequence control func- tions, running of complete start up program sequence in all modes of operation, shut down program, etc.

(3.) Verification of logic computation in controller by simulating inputs.

(4.) Sample verification of availability of all automatic OLCS functions without HMIPIS.

(5.) Sample verification of availability of all OLCS functions within one Functional Group without System Bus.

(c). Functional tests for MMIPIS

(1.) Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.

(2.) Verification of event generation and handling capabilities of MMIPIS processors by simulating various types of events/data and observing associated event sequence display and alarm signalling boxes.

(3.) Calculations:

All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calcula- tions at low, mid and upper ranges of inputs) and submit them

for the Owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

(4.) Checking historical storage and retrieval functions including long term storage.

(5.) Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data,etc.

(6.) Verification of all programmer's stations functions for MMIPIS and Control System, as well as for documentation facility as specified.

(7.) For SER function, verification of resolution of SOE inputs, contact bounce filtering time, time synchronisation with master clock, data base modification, SOE report, printout, off-line & on line diagnostic features etc. For this purpose a test-simulator to generate sequences of 1 ms resolution for 100 points distributed in different panels shall be made available during testing.

(8.) Testing of each peripheral viz., LEDs, printers, optical disks, hard disk drive, DVD RW Combo etc.

(9.) Verification of compilation & execution of various compiler and assemblers in the system by running test programme.

(10.) Testing of power supply system to DDCMIS, tolerance of DDCMIS w.r.t. voltage & frequency limits as specified, performance of DDCMIS with power supply break as specified .

(11.) Verification of switchover of main processor/controller to stand by processor/controller.

(12.) Verification of switchover of peripherals on account of (9) & (10) above.

(13.) Verification of degree of protection of various cabinets as per specification.

(14.) Verification of spare capacity w.r.t. spare wired-in space in cabinets/ cubicles, terminal blocks, peripherals, etc. in line with spec. requirements as stipulated under scope of work.

(15.) Testing Master & slave clock system, checking synchronisation of system time with master clock, verification of synchronisation of master clock with external sources as specified.

1.01.10 **Parametric tests**

Following tests shall be carried out to test Bidder's DDCMIS w.r.t. specification requirements.

(a.) For control system (CLCS+OLCS):

(1.) CPU loading

(2.) Cycle time/controller reaction time.

(3.) Memory spare capacity

(b.) For MMIPIS

(1.) CPU loading

(2.) Spare duty cycle

(3.) Spare memory capacity

(c.) Spare duty cycle for system bus

(d.) Various display response time

(e.) System accuracy

(f.) Demonstration of system reliability

(g.) Display update time on OWS CRT/LVS

1.01.11 **Power failure auto restart test**

Verification of availability of all system functions automatically after restoration of power after power failure to DDCMIS. Verification of restoration of all data which was stored in the system at the time of power loss.

1.01.12 The Bidder shall submit a detailed ATST procedure for Owner's approval during detailed engineering stage based on the above guidelines. The ATST procedure to be submitted by the Bidder shall be detailed and exhaustive enough such that Owner is satisfied that all the DDCMIS System specification requirements and features are being tested andthe system meets these requirements. The test results obtained shall be properly documented by the Bidder and furnished in the Owner approved format as decided during detailed engg. And submitted in the requisite no. of copies with all annexures irrespective of the fact that Owner's representative was present during the tests.

1.01.13 The following minimum criteria shall be followed during all tests:

1.02.00 **Integrated Test Set-Up**

For integrated testing of the total DDCMIS system, the Bidder shall employ a test set-up, which will be capable of generating I/O signals in a requisite manner. It is preferable to adopt soft signal simulating device to avoid / minimise the cumbersome process of physical connection of I/Os through potentiometers, switches, Lamps/ LEDs etc. The exact configuration/ set-up shall be as finalised during detailed engineering.

1.02.01 The Bidder is to submit Authorisation-To-Ship-Test (ATST) procedure as a part of "Draft QA Programme fully meeting the intent and requirements of above and other applicable clauses of this specification. Since, the exact definition & extent / parameters of ATST can be finalised only when the engineering of DDCMIS has been finalised to a great extent, it is required that the detailed draft ATST procedure be submitted by the Bidder at a later date as intimated by the Owner during engineering stage for Owner's comment and finalisation. Bidder shall incorporate all modifications, additions/ deletions to the ATST procedure as indicated by the Owner. The ATST shall be conducted as per Owner approved procedure for ATST which will be included in the approved "QA Programme". The Owner reserves the right to ask the Bidder to conduct any other test also during the ATST which may be required to fully satisfy the Owner regarding full compliance with specification requirements. Bidder shall conduct all such tests also within the quoted lumpsum price for this contract

1.02.02 The results of all ATS Tests shall be properly documented by the Bidder and submitted to Owner in requisite number of copies with all annexures.

1.02.03 Following the tests, if in the opinion of the Owner, the system has not been adequately manufactured, programmed, tested or debugged the Bidder shall make good all deficiencies including system parametric specifications of display response time, processor duty cycle, SOE resolution, etc., and re-run the test to fully satisfy the Owner regarding full compliance with specification requirements and requisite quality standards.

1.02.04 The system shall not be shipped without approval of Owner in writing.

1.02.05 Upon successful completion of Authorisation-To-Ship Test, the Owner will provide the Bidder with a written authorisation for shipment of the system equipment to the project site.

1.02.06 All final documentation as per requirement of this specification shall be available at the time of Authorisation-To-Ship-Test and this shall be dispatched alongwith the equipment in required number of copies.

1.02.07 Bidder shall note that no payments towards dispatch of equipment and subsequent activities shall be due and payable to the Bidder till the Bidder is able to successfully demonstrate to Owner's satisfaction that the DDCMIS and parts thereof fully meet the Authorisiation-To-Ship Test requirements.

DISTRIBUTED DIGITAL CONTROL MONITORING & INFORMATION SYSTEM (DDCMIS)

ITEMS \ TESTS	Review of Pre ATST Report (R)	Pre Power on Check (R)	Dimensions,layout, Make of components,Electronic earthing (R)	Signal flow check in the Cubicles (R)	Internal cabling/Wiring (R)	Tuning (R)	Door Arrangement Locking (R)	Louvers, Fans (R)	Illumination (R)	Paint Shade, Thickness (R)	Hardware as per BOM (R)	Spare Capacity in Cabinet For New Modules (R)	System configuration as per approved documents (R)	Current/ Power Consumption (A)	Power Supply variation effect (A)	MS resolution,time stamping,view and printing of SOE log (R)
DDCMIS																
Integrated System	Y	Y	Y			Y					Y		Y			
DDCMIS CUBICLES	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
MMI	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Master Clock	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			
Programmer Station	Y		Y	Y	Y											
Peripherals	Y		Y													
Sequence of Event recorder	Y		Y													Y

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

DISTRIBUTED DIGITAL CONTROL MONITORING & INFORMATION SYSTEM (DDCMIS)														
TESTS / **ITEMS**	Healthiness of all modules (R)	Healthiness ,functional check for Peripherals (R)	Verification of System configuration(R)	On Line Removal of I/O modules. (R)	On line removal of controller modules (R)	Accuracy & repeatability test of analog cards (R)	Burn In and Elevated temp. test (R)	Diagnostic tests. (R)	Simulation of inputs (R)	Functional tests (signal acquisition , conditioning distribution controller functions)verifications of loop/logic functions. Bumbles transfer of A/M station response time of loops (A) Thickness (R)	Response time for displays (A)	Verification of Displays Logs, Format, graphs, Plots	Accuracy of Master clock system(R)	Check for brightness, sharpness, color/contrast adjustments, lamp life counter (R)
DDCMIS														
Integrated System			Y	Y		Y				Y	Y	Y		
DDCMIS CUBICLES	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y		
MMI	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		
Master Clock	Y	Y		Y			Y	Y						
Programmer Station	Y	Y						Y						
Peripherals	Y	Y						Y						
Large video screen	Y	Y	Y				Y	Y						Y
R-Routine Test	A- Acceptance Test									Y – Test applicable				

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

DISTRIBUTED DIGITAL CONTROL MONITORING & INFORMATION SYSTEM (DDCMIS)

ITEMS / TESTS	Calculations (R)	Event handling SOE, alarm functions (R)	Historical Longterm Storage & retrieval functions (R)	Redundancy of Controller (R)	Redundancy of Processor (R)	Redundancy of Power Supply (R)	Spare Memory Capacity (R)	CPU Loading Duty Cycle (R)	Redundancy of System Bus (R)	CRT up Date Time (R)	Power Failure Auto Restart (R)	System Accuracy (A)	System Reliability (R)	Engineers / Programming functions (A) Redundancy of other devices as defined on spec.	Time synchronization (A)
DDCMIS															
Integrated System	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CLCS & OLCS				Y	Y	Y	Y	Y	Y		Y	Y			
MMI	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
Master Clock						Y					Y				
Programmer Station									Y		Y				

R-Routine Test A- Acceptance Test Y – Test applicable

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.4. ELECTRIC POWER SUPPLY SYSTEM

Attributes / Characteristics → / Items / Components / Sub- assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion &	Complete physical examination for constructional features of Battery Charger	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs	Degree of Protection Test
BATTARY CHARGER													
Rectifier Transformer (IS : 2026)	Y			Y			Y				Y		
Electronic Components including Potentiometer (Vernier Type)	Y			Y									
PCB & Electronic Cards	Y			Y									
19" standard racks for electronic cards	Y					Y							
Control & Selector Switches (IS : 6875)	Y			Y						Y			
Indicating Meters (IS : 1248)	Y			Y						Y			
Indicating Lamps (IS: 13947)	Y			Y						Y			
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y			
Control Terminal Blocks (IS :13947)	Y			Y									
Control Transformer (IS : 12021)	Y			Y						Y			
Push Buttons (IS : 4794)	Y			Y						Y			
MCB (IS : 8828)	Y			Y						Y			
PVC insulated Copper control wires (IS : 694)	Y			Y									
Sheet Steel (IS : 513)	Y	Y	Y	Y									
Synthetic Rubber Gaskets	Y	Y		Y									
Annunciator	Y									Y		Y	
Battery Charger	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the Practice and procedure along with relevant supporting documents.
3) Makes of all major Bought out Items will be subject to approval.
4) Acceptance tests shall be carried out in presence of owner's representative.

CI.5. POWER SUPPLY FOR C&I SYSTEMS (UPS/BATTERY/BATTERY CHARGER/ACDB/DCDB)

POWER SUPPLY FOR C&I SYSTEMS (UPS/BATTERY/BATTERY CHARGER/ACDB/DCDB)

TESTS / ITEMS	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic ®	Efficiency ,regulation(R)	Input voltage variation (A)	Out put voltage and frequency adj.range(A)	Premilinary light load test(R)	Load transfer retransfer test (R) *	AC input faliure and return test (R)	Parralel operation and current divison(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)
UPS/CONVERTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y	
LEAD ACID BATTERY (TUBLAR)-IS-1651																	Y
LEAD ACID BATTERY (PLANTE)-IS-1652																	Y
NICKEL CADMIUM BATTERY (IS-10918/ IEC-623)																	Y
SMF BATTERY																	Y
ACDB/DCDB	Y	Y														Y	Y
BATTERY CHARGER	Y	Y	Y	Y	Y				Y					Y	Y	Y	Y

R-Routine Test A- Acceptance Test Y – Test applicable

* Transfer time and Over shoot /under shoot during load & system transfer shall be

recorded.

Note:

1) Detailed procedure of Environmental Stress Screening test shall be as per Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.6. PROCESS CONNECTION AND PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.
Note: R-Routine Test A- Acceptance Test Y – Test applicable
Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

CI.7. INSTRUMENTATION CABLES

INSTRUMENTATION CABLE															
TESTS / ITEMS	Visual, Surface finish (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	FRLS Test * (A)	Insulation Resistance (A)	High Voltage ®	Spark Test Report Review ®	Volume Resistively (A)	Conductor Resistance ®	Electrical Parameters ** (A)	Tensile Elongation before & after [illegible] (A)	Thermal Stability (A)	Overall/Coverage/Continuity (A)	Persulphate Test (A)	Flamability Test *** (A)
1. Instrument cable twisted and shielded															
Conductor (IS-8130)	Y	Y							Y						
Insulation (VDE-207)	Y	Y	Y				Y				Y	Y			
Pairing/Twisting	Y	Y	Y												
Shielding	Y	Y											Y		
Drain wire	Y	Y							Y				Y	Y	
Inner Sheath	Y	Y	Y	Y							Y	Y			
Outer Sheath	Y	Y	Y	Y							Y	Y			
Over all cable	Y	Y	Y		Y	Y		Y	Y	Y					Y
Cable Drums (IS-10418)	Y	Y													

Note: High Temp. Cables shall be subjected to tests as per VDE-207 (Part-6)
Compensating cables shall be checked for Thermal EMF

Note: This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all items.

Note: R- Routine Test A - Acceptance Test Y - Test Applicable

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characteristic Impedance, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

*** Flammability Test: Vertical Flame Test (IEEE-383), Swedish Chimney (SS-4241475).

Acceptance tests shall be carried out in presence of owner's representative.

CI.8. CONTROL VALVES AND ACTUATORS

CONTROL VALVE ACTUATORS AND ACCESSORIES.

TESTS / ITEMS	Make,model,tag (R)	Dimension®	Surface finish®	Heat Treatment®	Material Test Certificates®	IBR Certificates®	Hydraulic Test®	UT/Radiography for >900 lb rating®	MPI/DP®	Pressure Resistance®	Seat leakage®	Timeing Open/Close®	Linearity/Hysterisis®	Functional Test, review for make and TC of accessories®
CONTROL VALVE AND ACTUATOR														
Overall	Y	Y	Y			Y	Y				Y	Y	Y	Y
Body		Y	Y	Y	Y			Y	Y	Y				
Bonnet		Y	Y	Y	Y									
Trim		Y			Y			Y *						
Pneumatic actuator	Y	Y								Y				

R- Routine Test A - Acceptance Test Y - Test Applicable

Y* - UT on spindle dia >= 40 mm.

Note :

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme General Technical Conditions

2) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalisation for all item.

3) Acceptance tests shall be carried out in presence of owner's representative.

CI.9. ELECTRICAL ACTUATORS WITH INTEGRAL STARTER

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER													
Test/Attributes Characteristics / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard &	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

CI.10. PLC BASED CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS

PROGRAMMABLE LOGIC CONTRLLER															
TESTS / ITEMS	Visual ®	GA, BOM ,Lay Out of components ®	Dimensions ®	Paint Shade/ Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ Mosaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element , Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
1. PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
2. Control Desk With PLC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

*Applicable for PLC Y - Test Applicable, ® - Routine Test (A) - Acceptance Test

CI.11. CONTROL DESK, LVS PANEL, PLC PANEL, SMOKE DETECTOR, FIRE ALARM & CONTROL SYSTEM

CONTROL DESK, LVS PANEL, PLC PANEL, SMOKE DETECTOR, FIRE ALARM & CONTROL SYSTEM

ITEMS \ TESTS	Visual ®	GA, BOM ,Lay Out of components ®	Dimensions ®	Paint Shade/Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ osaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element , Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
1. Control Desk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
2. LVS Panel	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y
3. Annunciation, Control, PLC Panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
4.Smoke Detectors (UL-268,EN-54 PT-7), Heat Detectors(UL-521/EN 54 PT-5) Annunciation/ Control Panel (UL -864, EN-54, PT-2)															Y

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

- *Applicable for PLC
- Y - Test Applicable, ® - Routine Test (A) - Acceptance Test

CI.12. STEAM AND WATER ANALYSIS SYSTEM (SWAS)

STEAM WATER AND ANALYSIS SYSTEM																	
TESTS / ITEMS	Visual ®	GA, BOM, Layout of construction feature®	Dimension ®	Paint Shade/thickness ®	Alignment of Section ®	Component Ratings/Make/Type ®	Wiring ®	Make,Model,Type,Rating ®	IR&HV ®	Review of TC for instrument/devices/Valves/ fittings ®	Accessability of TBs/Devices ®	Illumination ®	Tubing ®	Leak/Hydro test (A)	Calibration test of analyser ®	Vacuumisation test of assembly (R)	Chilled water tank dimensions and insulation (R)
SWAS Panels/Racks *	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Chiller unit *	Y	Y	Y			Y	Y	Y	Y	Y				Y		Y	Y

Note: R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supplying documents.

3) Acceptance tests shall be carried out in presence of owner's representative.

* Applicable for BOP/STATION C&I

CI.13. MAINTENANCE AND CALIBRATION EQUIPMENT.

MAINTENANCE AND CALIBRATION EQUIPMENT				
Item / Test/Attributes Characteristics	`Make, Model, Type and Rating ®	Functional check®	Temp Stability Test (A)	Calibration®
Maintenance Calibration equipment				
Electronic test bench	Y	Y		Y
Dead Weight tester	Y	Y		Y
Vacuum tester	Y	Y		Y
Hydraulic Pressure gauge Tester	Y	Y		Y
Portable Pressure calibrator	Y	Y		Y
Secondary standard quality pressure Gauge	Y	Y		Y
Portable Electro Pneumatic Calibrator	Y	Y		Y
Fluidized Temp. Bath	Y	Y	Y	Y
Thermocouple test furnace	Y	Y	Y	Y
Portable Millivolt calibrator	Y	Y		Y
Resistance Thermometer Bridge	Y	Y		Y
Decade Resistance Box	Y	Y		Y
Portable thermocouple/RTD Calibrator/Simulator	Y	Y		Y
Portable Multifunction Counter	Y	Y		Y
Power pack	Y	Y		Y
RCL Bridge	Y	Y		Y
Portable Infrared Thermometer	Y	Y		Y

Note:

1. Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2. This is an indicative list of tests/checks. The manufacturer is to furnish a check lists for final inspection indicating the practices and procedure adopted along with relevant supplying documents.
3. Other Maintenance & Calibration equipment shall be checked for functional and calibration (as applicable).
4. Calibration to be done with the instrument having better accuracy than the item under test and whose calibration shall be traceable to International Standard.
5. Acceptance tests shall be carried out in presence of owner's representative.

® Routine Test, (A) Acceptance Test, Y - Test applicable

CI.14. CLOSE CIRCUIT TELEVISION

CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)									
Attributes/ Characteristics / **Item Components Sub System Assembly**	Make, Model, Type, Rating, TC®	Dimension/constructional requirement®	Functional/operational check®	Switching capability and sequence®	No. of inputs/outputs, display®	Provision for connectivity with the LVS®	Pan range/speed, tilt/tilt speed®	Operational check from key board/control panel®	Commands from Video switcher/control unit®
Video Switcher/control system	Y		Y	Y	Y	Y			
Key boards	Y		Y						
Cameras	Y	Y	Y						
Lens	Y	Y	Y						
Camera Housing	Y		Y						
Pan & Tilt unit	Y	Y	Y				Y		
On site receiver	Y		Y						
Monitor	Y	Y	Y						
Video Recorder	Y		Y						
Video Amplifier	Y		Y						
Complete System	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

R –Routine Test Y -Test Applicable

CI.15. PUBLIC ADDRESS SYSTEM

PUBLIC ADDRESS SYSTEM						
TESTS / ITEMS	Test as per standard (A)	Service feature like call station identification, page /party communication, communication	System band width (A)	Effect of input voltage variation (A)	Regulation of output (A)	HV/IR(R)
Public address system *						
Hand Set Stations(IS-9302 Part-III) /IEC-268-3/IS 2147	Y					
Amplifiers (IS-9302 Part-II)/ IEC-268-2/IS 10426	Y					
Loud Speaker(IS-9302 Part-IV) /IEC-268-3/ IS 2147	Y					
Power Supplies				Y	Y	Y
Central Exchange / Integrated testing		Y	Y	Y		
EPABX As per (DOT/TEC)/Spec	Y					
R-Routine Test A- Acceptance Test		Y – Test applicable				

Note:

1) Detailed procedure of Environmental Stress Screening test shall be as per Quality Assurance Programme in General Technical Conditions
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

QUALITY ASSURANCE PLAN FOR CIVIL

I N D E X

QUALITY ASSURANCE AND INSPECTION FOR CIVIL WORKS

1.00.00 INTRODUCTION

1.01.00 This chapter covers the sampling. testing and quality assurance requirement (including construction tolerances` and acceptance criteria) for all civil and structural works covered in this specification.

1.02.00 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.03.00 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans/contract documents shall be carried out at no extra cost to the owner.

1.04.00 The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer. If required, work methodology may be revised/reviewed at every stage of execution of work at site, to suit the site conditions by the contractor at no extra cost to the owner.

2.00.00 QUALITY ASSURANCE PROGRAMME

2.01.00 The contractor shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipment and services under the scope of contract whether manufactured or performed within contractors works or at his sub-contractor's premises or at the OWNER's site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined. by the contractor and shall be finally accepted by the OWNER or their authorized representative after discussions before the start of work. The QAP shall be generally in line with IS/ISO Systems.

The contractor shall furnish complete QA & QC programme for the work envisaged which may include the following

- Organization structure for the management and implementation of the proposed quality assurance program.
- Quality System Manual.
- Design Control System.
- Documentation and Data Control-System.
- Qualification data/details for Contractors key personnel.
- The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source, inspection, incoming raw-material inspection, verification of materials purchased, etc.
- System for shop manufacturing and site erection controls including

process, fabrication and assembly.

- Control of non-conforming items and system for corrective actions and resolution of deviations.
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring testing equipment.
- System for Quality Audits.
- System for identification and appraisal of inspection status.
- System for authorizing release of manufactured product to the OWNER.
- System for handling, storage and delivery.
- System for maintenance of records.
- Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work/ equipment/component.

3.00.00 **QA AND QC MANPOWER**

3.01.00 The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the- contractor's QA coordinator to OWNER. OWNER shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the contractor and their sub-vendors on one hand & with OWNER on the other hand.

3.02.00 The contractor shall appoint a dedicated, experienced and competent QA & QC in-charge at site, preferably directly reporting to the Project Managers supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of contractor's QA & QC manpower required to be deployed at site is enclosed at Annexure-1. Based on the finalized L4 network and the approved Field Quality plan, the contractor shall finalize and submit a deployment schedule of QA & QC personnel along with their details to OWNER for approval/acceptance and further shall ensure their availability well before the start of the concern activity.

3.03.00 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the contractor shall consist of qualified and experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.04.00 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the contractor based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.00.00 **SAMPLING AND TESTING OF CONSTRUCTION MATERIALS**

4.01.00 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications I quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.

4.02.00 The contractor shall carry out testing in accordance with the relevant IS/standards codes and in line with the requirements of the technical specifications/quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the engineer or his authorized representative.

4.03.00 Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as IIT's, etc. as agreed by the engineer. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the engineer.

4.04.00 The contractor shall timely initiate the action with regard to the evaluation of
aggregates and other building material including concrete mix design, so as to
ensure completion of these, tests before start of civil works at site, thereby not affecting any project work The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the engineer.

4.05.00 Evaluation of aggregate for potential alkali-aggregate reactivity shall be carried out as per following scope of work.

Evaluation of Aggregates for Mechanical/Physical Properties

a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and flakiness index, as per IS: 2386.

b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material, soundness, silt content, clay content and organic impurities as per IS: 2386.

c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates.

Evaluation of Aggregates for Potential Alkali Aggregate Reactivity:

a) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (In NAOH at 80^0 C for 14 days as per ASTM 1260, or the method established! developed by CSMRS for 22 days test).

b) If rock type is limestone, alkali carbonate reactivity test shall also be carried out wherein the parameters shall be reported in conjunction

with the petrographic analysis. Additionally, X-Ray diffraction test (XRD) shall be carried out to determine critical clay mineral in the rock for preliminary conclusions. For limestone aggregates to be used in dynamic foundations like TG, BFP, Fans, mills and crushers, repeated temperature cycle test shall also be carried out, to determine residual expansion of aggregate for concrete.

c) To prepare a report based on test results of a) and b) above and to: advise regarding suitability of aggregates to be used and further testing required if any.

5.00.00 **LABORATORY AND FIELD TESTING**

5.01.00 The field laboratory for QA and QC activities shall be constructed and set-up by tie contractor in line, with the indicative field QA&QC laboratory set-up enclosed at Annexure-II. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipment/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipment/instrument required to meet the planned/scheduled tests for the execution of works for OWNER acceptance/approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.02.00 All equipment and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the OWNER. The calibration certificates shall specify the fitness of the equipment and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipment and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to OWNER.

5.03.00 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute- This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by OWNER engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to OWNER.

5.04.00 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled / agreed.

6.00.00 **PURCHASE AND SERVICE**

6.01.00 The major items/equipment/components to be manufactured in the shop of the contractor i.e. in-house items and those procured from sub-vendors/sub-manufacturer/sub-contractors i.e. bought out items (BOIs).shall be listed out by the contractor in their bid proposal.

6.02.00 An indicative list of major bought out items (not exhaustive) and services for civil works is enclosed at Annexure- III for which the, contractor shall submit the requisite details/lists of manufacturer's in. their bid proposal. The list of manufacturers/ sub-vendors for all the BOIs envisaged in contract including shall be included in the .bid proposal by the contractor which shall be discussed I reviewed by the OWNER during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the contractor shall propose the manufacturer's / sub-vendor's details for review / approval of OWNER, prior to initiating the procurement of such materials.

6.03.00 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the OWNER for approval in the prescribed OWNER format no. QA-01-QAI-P-04/F1-RO (main supplier's evaluation report) and format no. QA-01-QAl-P-04/F2-RO (sub supplier questionnaire) within the period agreed at the time of post bid discussions. The contractor's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed- The formats for furnishing above details shall be given to the Contractor at post bid discussion stage. Monthly progress reports on sub-contractor detail submission I approval shall be furnished on format no. QS-01-QAI-P-02/F1. Such manufacturers / sub-vendors approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

6.04.00 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be dearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER. Approval of material / sample by the engineer shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.05.00 Structural steel supply if in the scope of the contractor shall be procured from main steel producers like SAIL, TISCO, IISCO, RINL, ESSAR Steel, Ispat Industries, JSW Steel, Lloyds Steel, Jindal Steel & Power. In case of non-availability of some of the sections with main steel producers the contractor may propose to procure the sections from the re-rollers of the main steel

producers, the name of such re-rollers: will have to be cleared by corporate quality assurance of OWNER. for which details such as" BIS approval, main steel producer's approval past experience for production of sections of specified material, details of machines plants testing, facilities etc., Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers, that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller.

6.06.00 Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch shall be the responsibility of the contractor and these shall be performed in presence of the authorized representative of the main Contractor.

6.07.00 Reinforcement steel supply if in the scope of the contractor shall be procured from main steel producers tike SAIL, TISCO, IISCO, RINL, Essar Steel, lspat Industries, JSW Steel, Lloyds Steel, Jindal Steel &. Power, Jai Balaji Industries Ltd, Durgapur (for 8-40mm reinforcement steel) and mill test certificates (TC) is to be obtained and submitted to OWNER for co-relation. In case any size /diameter specified is not available with main steel producers and are proposed to be supplied from the conversion agent of the main steel producer the name of such conversion agent / re-roller shall have to be approved by OWNER for which details such as BIS approval, Main steel producer's approval, Past experience for production of sections of specified material, details of machines, plants testing facilities etc., and confirmation that the process control and manufacturing of steel sections by re-rollers is the same as that of main steel producers, that billets for re-rolling are sourced from main steel producers only shall be furnished with regards to re-roller.

7.00.00 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.01.00 All materials/components and equipment covered under the scope of work, shall be procured by the contractor for the purpose of the contract, after obtaining the written approval of the OWNER, which are to be manufactured at shop/ factory of the vendor/sub vendor shah be covered under a comprehensive quality assurance programme. The contractor's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub- supplier/ sub-vendor- The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by contractor's I sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. Such quality plans of the vendors I sub-vendors shall be submitted to the OWNER for approval in the prescribed .format no. QS-01-QA1-P-09/F1-R1 for MQP and such approved quality plans shall form a part of the purchase order/contract between the contractor and-sub-contractor. The quality, plans shall be submitted on electronic form e.g. CD or E-.mail in addition to hard copy for review and approval of OWNER. After approval the same shall be submitted in compiled form on CD in addition to hard copy.

7.02.00 The contractor shall furnish copies of the reference documents/ plant standards/ acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference document/standards etc. will be subject to OWNER approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, OWNER shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the OWNER engineer or his authorized representative and beyond which the work shall not proceed without consent of OWNER in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to OWNER along with technical justification for approval and dispositioning.

7.03.00 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the OWNER for reference / record by the contractor along with a report of the purchase orders placed so far for the contract.

7.04.00 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) on the format No. QS-01-QAI-P-09/F2-R1, and obtain approval' of OWNER, which shall detail out for all the works, equipment, services, quality practices and procedures etc., in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items I activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure IV-A (Indicative FQP for civil works) & Annexure IV-13 (Indicative FQP for structural steel works).

7.05.00 Monthly progress reports on MQP/FQP submission/approval shall be furnished by the contractor on the format No. QS-01-QAI-P-02/F1-R0. List of items requiring quality plans and sub-supplier approval shall be finalized with the contractor on the format no. QS-01-QAI-P-01/F3-R1 during the post bid discussions.

8.00.00 DISPOSITIONING OF NON CONFORMITIES

8.01.00 The non-conformity for the site works on being detected / noted shall be reported by the contractor in the standard format no. QS-01-FQA-P-08/F1-RO (Issue 2) of OWNER under the system of dispositioning of non conformity report (NCR) to the engineer. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction/erection shall describe the proposed correct and also include the preventive/ corrective action plan for future.

9.00.00 QUALITY AUDIT

9.01.00 OWNER reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the contractor or their sub-contractor. The contractor shall provide all necessary assistance to enable the OWNER carry out such audit and surveillance- The contractor shall also take necessary measures, raise NCRs wherever required based on the audit findings I observations.

10.00.00 **QA DOCUMENTATION PACKAGE**

10.01.00 The contractor shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (4) mark. Typical contents of QA documentation pertaining to field activities as per approved IMP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non- destructive examination results / reports, Heat Treatment Certificate/Record, Non- conformance Reports, CHP, Certificate of Conformance (COC) and MDCC.

11.01.01 **STORAGE AND HANDLING OF CONSTRUCTION MATERIALS**

All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in OWNER Technical Specification.

11.01.02 **EXCAVATION AND FILLING WORKS**

The contractor shall submit a work methodology covering various items of works for all stages of excavation and filling works. This methodology shall broadly include the quantity, wise and classification wise identification of source of excavation and filling, suitability tests as per specification requirements, method, of stockpiling transportation, placement, spreading, compaction, equipment; list of protocols; in- situ tests, third party lab test if required, acceptance checks for final clearance.

For blasting work at site if required, the contractor shall associate themselves with the reputed specialized blasting agency such as CMRI, NIRM for trials blasts, design blasts, blasting pattern, monitoring of blast during the blasting operation sat site. The contractor shall install and operate equipment (such as tri-axial seismograph) for continuous monitoring and control. of blast induced vibrations; noise level/air pressure, dust, silica and noxious gases during all blasting operations in line with the technical specification requirements in association with the specialized blasting agency. The contractor shall submit the un-priced copy of the award on the specialized blasting agencies to OWNER, highlighting the scope of services / work awarded to them by contractor. The services of such specialized blasting agency shall be available throughout the period in which the blasting work is undertaken at site. The blasting operation shall remain in charge of a responsible, competent, authorized and experienced supervisor (man-in-charge) and thoroughly acquainted workmen- All blasting work shall be done as per approved blasting scheme/ design/ pattern in line with the technical specification requirements and all statutory laws, rules, regulations, relevant standards pertaining to the acquisition, transport, storage, handling along with use of explosives shall be strictly followed by the contractor.

Tolerance for finished surface level shall be within 20 mm of the level shown in the drawing. For an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the engineer. However, these tolerances shall be applicable for localized areas only.

Acceptance criteria shall be

a) When only one set of sample is tested, then all individual samples collected and tested should pass without any deviation.

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

11.01.03 **MASONRY AND ALLIED WORKS**

The execution, finishing, testing and acceptance of masonry related works shall be as per the provisions of technical specifications / relevant practices IS code. Local depressions on account of faulty workmanship, broken / chipped edges shall not be acceptable.

Al Masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry works shall be as below:

S. No	Type of Check	Tolerance
	Deviation in verticality in total height of any wag of a building.	Shall not exceed ± 12.5m m (move than one storey) ± 6mm per 3m height (within a storey
	Deviation from the position shown on the plan of any brickwork.	Shag not exceed 12.5mm (more than one storey)
	Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment.	Shall not exceed 6mm.
	Deviation of bed joint from horizontal in any length, and it.	Shall not exceed 6mm (upto 12m) Shall not exceed 12.5mm total (in any length over 12m)
	Deviation from the specified thickness of bed-joints, cross-joints or perpends.	Shall not exceed ± 3mm
	Finished plastered surface	Deviation not more than 4 mm when checked with a straight edge of 2 m length placed against the surface.
	The average thickness of plaster.	Not be less than the specified thickness
	The minimum thickness over any portion of the surface.	Not less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster.

11.01.04 **CONCRETE WORKS**

For concreting works provisions of technical specifications and IS: 466: shall apply. A detailed' methodology for concrete works shall be submitted by the contractor to OWNER for approval. The: methodology may require change/modification based on the site Conditions, for which suitable revisions shall be submitted.

The methodology for concrete works shall broadly contain the suitability of source of aggregates, cement, admixture, water and reinforcement steel, etc. The available concrete mix design recommended from a specialist institute, results of trial mix carried out at site, method / control of batching, mixing, transportation, layer wise placement, compaction, fixing / removal of form work, staging, fixing of water stops at appropriate locations along with specials, expansion joints, contraction joints and construction joints, cover blocks and method of curing, methodology of repair of newly placed hardened concrete, testing and sampling of concrete during production and placement and acceptance checks for final clearance.

The equipment, deployment of manpower and machinery shall arranged by the contractor to ensure the continuous rate of placement of specified grade of concrete so as to prevent segregation, bleeding, formation of cold joints, temperature control for concreting in extreme weather conditions and for mass concreting works.

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of .placing concrete in case of ordinary Portland cement, not be less than 10 days for concrete exposed to dry and hot weather conditions, at least 10 days or period may be extended to 14 days where mineral admixtures or blended cements are used. Approved curing compounds may be used in Lieu of moist curing with the permission of engineer-in-charge.

Reinforcement steel shall conform to relevant IS codes- Lapping / spacing of reinforcement shall be so staggered that under no circumstances more than 50% of bars at any cross section shall be lapped- Corrosion resistance Steel shall be used for the foundations wherever specified in the technical specification. Sample test for 3% of the number of mechanical bars grips subject to a minimum of three, shall be carried out up to the yield strength of reinforcement of bars.

Ultrasonic pulse velocities (UPV) test as per IS 13311 Part 1, for top deck and column of T.G. foundation, to ascertain the homogeneity and integrity of concrete. Test cubes © 150 cum of concrete, subject to minimum of 6 cubes, shall be additionally sampled for being used, for carrying out UPV test on cubes. UPV test shall be carried out by a specialized agency.

Test shall be conducted for the water tightness of the liquid retaining structures as per technical specifications, IS 3370 and IS 6494.

All the materials, equipment, processes used in pre cast concrete work shall conform to the requirements for the cast in-situ concrete.

If fly ash is used in concrete, source of supply shall be checked for suitability as per IS 3812 (Part I). Routine tests for retention of particles on 45p sieve and loss on ignition shall be carried out on each kit of fly ash before its use-

The storage of fly ash shall be similar to that of cement Separate Silo for fly ash shall be provided in t he batching plant Validation of Mix design using fly ash shall be carried out by an approved specialist agency, before start of concrete production.

The acceptance criteria of concrete shall be in accordance with clause no.16 of IS 456. However in exceptional circumstances and that too in non-critical areas, the engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS 456_ For such accepted work, payment shall be made at a reduced rate pro rata to the concrete cube strength obtained, against that stipulated.

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to owner for their record and future reference.

a. Testing data / report of aggregates including petrographic examination & potential reactivity of aggregate and repeated temperature cycle tests wherever specified.

b. Mix design details and record of trial mixes carried out at site.

c. Testing records of admixture as per IS-9103 / ASTM C494 including third party test reports.

d. Approved scheme for concreting.

e. Hourly records of concreting including pour card.

f. Protocol indicating the dimensional tolerance and details of inserts.

g. Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used

h. Bar bending schedule.

i. Location and details of mechanical anchoring used for reinforcement.

j. Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings.

k. Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification.

l. Temperature control record of concrete at the time of placement if applicable.

m. Details of curing, staging and fixing / removal of formwork, checklist for formwork as per Clause 9.9 and Annexure-C of IS 14687 including all machine foundations.

n. Batching Plant shall be calibrated regularly at least once in a 3

months. Computerized output shall be taken for each batch of production of concrete. For concreting works of ash pipe pedestals, mixer with weight batcher may be used. Production and supply of concrete from batching plant shall conform to the provisions of IS 4926.

o. Dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances for pre cast members as per OWNER Technical Specification. Load test on Pre cast members (except pre- cast tiles to be laid in the reservoir) shall be carried out @ 2% up to. 1000 nos., @1% from more than 1000 nos. precast members of one type. The load test shall be carried out as per the provisions of IS-456 and relevant IS code.

Tolerances			
Description of Item/Structural Element		**Max (mm)**	**Min (mm)**
Cast in Situ Concrete			
1.	Faces of concrete in foundations and structural members against which back fill is placed	+25	-10
2.	Eccentricity of footing as percentage of footing width in the direction of placement.	2 % but limited to 50mm	
3.	Top surfaces of slabs and similar structural elements	+5	-5
4.	Alignment of beams, lintels, columns, walls, slabs and similar structural elements	+5	-5
5.	Cross sectional dimensions of walls, slabs and similar structural elements	+5	-5
6.	Deviation from specified dimensions of Cross-section of columns and beams	+12	-6
7.	Alignment of holding down bolts without sleeves	+1.5	-1.5
8.	Alignment of holding down bolts with sleeves	+5	-5
9.	Level of holding down bolt assemblies	+1.5	0
10.	Embedment Parts (in any direction)	+5	-5
11.	Level of embedment for equipment support	+1.5	0
12.	Level of embedment for other embedded parts	+5	-5
13.	Centers of pockets or holes with greatest lateral dimension not exceeding 150mm	+10	-10
14.	Variation in Steps Riser Tread	 +1.5 +3.0	 -1.5 -3.0
	Pre Cast Concrete		

15.	Length :	± 0.1 percent	± 5	+ 10
16.	Straightness or Bow	1/750 of the length	± 5	± 10
17.	Cross – Sectional Dimensions	± 3 mm or ± 0.1 percent whichever is greater		
18.	Squareness:	When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.		
19.	Flatness:	The maximum deviation from a 1.5m straight edge placed in any position on anominal plant surface shall not exceed 5 mm.		

Placing of reinforcement and for (cover blocks shall be of same grade of concrete in which these would be embedded.	Clause 12.3.1 and 12.3.2 of IS:456.
Formwork	Clause 9.6 of IS 14687 and 11.1 of IS 456.
Batching	Clause 10.2.2 of IS 456.

11.01.05 **STRUCTURAL STEEL WORK**

For structural steel works provisions of technical specifications and IS: 800 shall apply. A detailed methodology for structural steel works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The contractor shall submit the welding procedures specification (WPS), heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection work at site. All welding and brazing shall be submitted to the OWNER and carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the OWNER.

All brazers, welders and welding operators employed on any part of the contract either in the contractor's / sub-contractor's works or at site or elsewhere shall be qualified as per AWSDI.1/ASME Section-EX or BS-4871 or other equivalent International Standards acceptable to the OWNER.

The records of welding procedure qualification and welder qualification test results shall be furnished to the OWNER for approval. However, where required by the OWNER, the test a shall be conducted In presence of OWNER / authorized representative.

No welding shall be carried out on cast iron components for repair. All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All Non-destructive examination shall be performed in accordance with written procedures as per International Standards and as mentioned elsewhere in the technical specification. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. The records of RT (Films) and UT (inspection records or printed reports if possible) shall be documented and produced to OWNER.

Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specification / approved WPS.

The requirements of pre-heating shall be

Thickness of thickest part at the area of welding/heat affected zone	Welding using other than low hydrogen welding electrodes IS 2062	Welding using low hydrogen welding electrodes or submerged arc welding IS 2062.
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	Not allowed	20^0 C
Over 40 mm to 63 mm (including)	Not allowed	66^0 C
Over 63 mm	Not allowed	110^0 C

The following tests/checks shall be carried out for structural steel works.

S. NO	TESTS/CHECKS	QUANTUM/STANDARD
1.	Physical and chemical properties of material if supply in the scope of contractor	As per relevant codes, review of correlated mill test certificates or check testing in absence of MTC.
2.	Ultrasonic test on plates above 40mm	As per ASTM A435
3.	Welding procedure & Welders qualification Test	AWSD1.1/ASME section – IX or BS-4871 or other equivalent international standards

S. NO	TESTS/CHECKS	QUANTUM/STANDARD
Fillet Welds		
4.	Macro-etch examination on production test coupons for main fillet welds	Minimum one joint per built up beams, columns and crane girder etc.
5.	Tension member of crane girder.	Dye penetration test on 25% weld length.
6.	All other fillet welds	DPT on 5% of weld length with minimum 300mm at each location.
Butt Weld		
7.	DPT	100% after back gouging on all butt welds except for coal bunker bins
8.	Mechanical testing of production test coupons	Minimum one joint per built up beam, column and crane girder.
9.	Radiography test on butt welds (in case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1. Wherever RT is not feasible UT to be carries out with the approval of the engineer)	100% RT on Butt welds of tension flange (bottom flange) of crane girders. 10% RT weld length of each welder on butt welds, except for crane girders and coal bunker. 5% sopt RT on butt welds/at inaccessible locations UT on butt welds for coal bunker bins.
10.	Ultrasonic testing on full penetration welds (other than butt welds)	100% UT on the web to flange joint of crane girder. 10% UT on other full penetration joints.
11.	Control assembly check in shop before erection	1st and further every 10th set of identical structure

S. NO	TESTS/CHECKS	QUANTUM/STANDARD
12.	Dimensional tolerances during fabrication and erection	As per IS—7215 and IS-12843
13.	Surface preparation and Paint thickness	SA 2 ½, By elcometer random after each coat, each member.
CW liners site fabrication (field shop) test		
14.	WPS, PQR & welder's qualification	100%
15.	DPT on root run	100% DPT for pipes up to 1200 mm diameter
16.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
17.	UT	Not recommended.
18.	RT	5% RT
19.	DPT on finished butt welds	10% DPT
20.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure whichever is higher.
CW liners erection site test		
21.	WPS, PQR & Welder's Qualification	100%
22.	DPT on root run	100% DPT for pipes upto 1200 mm diameter.
23.	DPT after back gouging	100% DPT for pies above 1200 mm diameter
24.	UT	Not recommended
25.	RT	5% RT
26.	DPT on finished butt welds	10% DPT
27.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure whichever is higher.

S. NO	TESTS/CHECKS	QUANTUM/STANDARD
		In exceptional cases where hydraulic test is not possible the same may be substituted with 100% RT.
28.	Tolerances	As per approved drawings, as per IS:7215 for fabrication and IS:12843 for erection of steel structures

11.01.05.01 **STOPLOG AND TRASH RACKS (IF APPLICABLE)**

Structural design shall be as per IS 5620 and IS 4622 and as per details given in technical specifications. The trash rack to be provided shall be Type-1 trash rack (removable section rack), conforming to IS: 11388 (latest). Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specification. The leakage measured shall not be more than 5 liters/minute /meter of length of seal under maximum head. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the contractor as per the technical specification requirements. The contractor shall submit a manufacturing and field quality plans in OWNER format incorporating all the quality aspects mentioned in the technical specifications. .

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS 13591 shall be referred for measurement of the deflection and acceptance criteria.

11.01.06 **PAINTING WORKS**

Painting works shall be carried out as per he provisions of technical specifications. A detailed methodology for painting works shall be submitted by the contractor to OWNER for approval. The methodology may require change /modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for painting works shall broadly contain the. source of approved brand of paints, shot / sand blasting as specified, minimum acceptable size of shot used for blasting, application of primer, intermediate coat and final coat, experience of applicator, etc. testing of painting work and acceptance checks for final clearance. For PU coating works if specified, material shall be procured from OWNER approved source and. the application of the PU coating shall be carried out by an experienced authorized applicator of the material supplier approved by OWNER. A separate quality plan and methodology for PU coating works shall be submitted by the contractor for approval of OWNER. Based on the approved quality plan, the tests on material and works shall be got conducted at specialist laboratories like IICT Hyderabad, CECRI Karaikudi.

11.01.07 **SHEETING WORKS**

All bought out items shall be procured from the manufacturer's approved by engineer and tested as per relevant IS Codes/ Specification. Raw material of colour coated sheets shall meet the chemical & physical properties as per relevant standards / codes referred in the approved data sheet. It shall be tested for bare metal thickness, thickness of coatings, type of coating/paint, hardness of painted surface as per AS2728/1S14246 (2H pencil hardness), flexibility test, bend test as per ASTM D 3281 IS 14246 at 180 degree, dimensional check after profiling of sheets, cross hatch test, salt spray test as per ASTM B-117/ IS 9844/AS2728 for minimum 1000 hrs one sample per batch at random. For true representative sampling, three samples shall be taken from each batch out of which one sample shall be sent for salt spray test, the samples may be chosen from the batches offered for inspection, one at the beginning of supply, another at the middle of supply and the third towards the end of the supply.

a) Requirements at Coil manufacturer works

i) Chemical & physical properties of raw material sheet as per relevant codes.
ii) Bare Metal Thickness
iii) Thickness of coatings
iv) Type of coating/paint
v) Hardness of painted surface (2H pencil Hardness)
vi) Bend test
vii) Salt spray test
viii) Cross hatch test
ix) Impact resistance test
x) Heat Resistance test

b) Requirements at profiler works

i) Dimensional check after profiling of sheets
ii) Visual examination & appearance of profiled sheets
iii) Video jet printing at interval of 2 m showing coil manufacturer's name, date & time of manufacturing.

Bonded Mineral Wool Insulation shall meet the requirements of thickness, density, thermal Conductivity, all other tests as per the technical specifications and IS-8183.

For sheet installation no gas cut opening shall be allowed at the site, whenever opening is specified these shall be properly cut in the factory and shall be filled with lipping / flashing for true shape / dimension etc. The sheets/ packets shall be stacked neatly clear off the ground at an angle to the ground, over a base pallet to provide drainage. Water I moisture should not be allowed to stagnate on surface, or in between layers. This can damage the coating, and cause corrosion.

11.01.08 **TILE WORKS**

The contractor shall submit the work methodology which shall include the type, grade and make of materials along with their technical data sheets,

details, etc, clearance from E-I-C regarding leak proofness and damp proofness of parent concrete surface, surface preparation, the procedure of application, curing, testing and acceptance.

The agencies having adequate experience to execute the acid / alkali resistant lining works shall be engaged for executing the acid I alkali resistant lining works after obtaining the approval from the E-I-C.

The execution, finishing, testing and acceptance of tile works shall be as per the provisions of technical specifications. The material for tile works shall be procured from the OWNER approved brand / source. Local depressions on account of faulty workmanship, tiles/natural stones with cracked or broken I chipped edges shall not be acceptable.

The tests shall be carried out on acid resistant bricks I file- water absorption, compressive strength, resistance to acid, flexural strength, dimensions and all. other tests as per IS 4860 and IS 4457, bitumastic ready mixed paint as per IS 158, bitumastic as per IS 9510, potassium silicate, resin type and sulphur type mortars as per IS:4832, part I, II and III, surface preparation for painting as per IS 2395, epoxy painting shall be carried for required coating thickness and dry film thickness.

11.01.09 FIRE PROOF DOORS

Fire Proof doors shall be tested for the requirements mentioned in the Technical Specification. The type test of the doors shall be carried out at CBRI Roorkee for minimum 2 hours fire rating and its Fabrication drawing shall also be approved by CBRI, Roorkee. DFT of paint of Fire Proof Doors and its fittings and fixtures as per BOQ shall be checked. The doors shall be finished with suitable fire retardant painting system

11.01.10 WATER PROOFING

The execution, finishing, testing and acceptance of water proofing works shall be as per the provisions of technical specifications. The material for the works shall be procured from the OWNER approved brand / source and the works shall be executed by the authorized applicator of the supplier.

Water proofing shall be tested for water tightness by creating a pond of water
minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces- Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel / drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and well junctions etc. which have been subjected for testing. The above testing shall be carried out prior to application of wearing course.

11.01.11 PILING WORK

For piling works provisions of technical specifications, approved drawings, BOQs and relevant IS codes / standards shall apply. The piling works shall be executed by the agency meeting the qualifying requirements as specified. A detailed methodology for piling works shall be submitted by the contractor to OWNER for approval- The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for piling works shall broadly contain the method of boring, stability of bore hole, termination criteria, tests / checks for termination level, fabrication of cage, cage lowering, concrete batching/ mixing, transportation, placing, recording of the time of construction operations, method of conducting initial and routine load tests, testing and sampling of concrete, during production and placement and acceptance checks on piles for final clearance.

The equipment, deployment of manpower, and. machinery shall be arranged by the contractor to prevent the collapse of bore hole and. to ensure continuous rate of placement of specified grade of concrete.

The piling works shall be executed as per the technical specifications, approved drawings, relevant codes / standards, FQP and BOQ. In addition to the requirements of technical specifications, the following shall also be ensured while execution of piling works:

a) Time gap between completion of pile boring and start of concreting should be kept to the minimum. However the maximum time gap shall not be more than 6 hours.

b) Muck Debris should be removed from the pile bore by air lift technique (by keeping the tremie & air pipe as close as to bottom of pile bore) i.e. after completion of boring, after completion of SPT(wherever applicable), after lowering reinforcement cage, but before start of concreting.

c) Density of bentonite slurry shall be checked from the sample taken from the bottom of pile bore (not at 1.0 m above the bottom of the pile bore).

d) Minimum two welding sets shall be kept ready to join the two cages of reinforcement by engaging 3 or more welders. This will ensure the lowering of R/F cage in minimum time.

e) While lowering the R/F cage into the pile bore, two hooks shall always be used to ensure balanced/symmetrical insertion of cage into the pile bore.

f) Concrete cover blocks at the junction of two R/F cage shall be ensured before lowering the second segment.

g) Surge concreting of about 1.0 cum shall be ensured at the start of concreting (i.e. in the first pour), by suddenly allowing to fall through the tremie pipe from the funnel. This will help in displacing left out muck/debris in the pile bore (by the impact).

h) Continuous feeding of concrete shall be ensured by deploying at least two transit concrete mixers (if required to be deployed) and mixing done through concrete batching plant (if deployed). Cold joints in the pile shall be avoided.

i) In a pile group, SPT shall be carried out at termination level in the pile, taken up first.

j) Bentonite slurry circulation to be ensured from start of boring to start of concreting. Flushing of bentonite slurry will only ensure maintaining of density of bentotite, slurry uniformly and will not allow bentonite jelly to settle at the bottom, whereas air lift technique with bentonite circulation will ensure removal of muck debris from the bottom of pile bore.

k) Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, minimum once per week or as found necessary by the engineer. One sample consisting of 3 specimens shall be tested for the above.

i) Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Technical Specification. This test shall be suitably used to identify the piles for routine tests. High Strain dynamic test shall be done as per the technical specification. The frequency of the test shall be as per the BOQ.

m) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days Cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength.

PILE LOAD TEST

Pile load testing shall conform to the requirements of IS-2991 (Part IV) and the technical specification. Initial load tests as specified in the contract documents shall be conducted to assess the safe load carrying capacity of pile before start of work to verify the load carrying capacity of the working piles, routine load test shall be conducted.

Pile load-testing procedure and the test setup / scheme shall be submitted for
approval of OWNER. The contractor shall use the test setup having arrangement for anchor piles / rock anchors alone or combination of anchor piles I rock anchors and kentledge for both vertical compression and uplift (tension) Load test (initial) on piles. The cost of reaction system / piles shall deem to be included in the cost of test piles.

All the gauges and instruments shall be calibrated before the start of the tests on test piles and working piles and the calibration record shall be verified before start of execution of the test.

11.01.12 **WATER SUPPLY DRAINAGE & SANITATION**

Material used for sanitary and. plumbing fittings and fixtures shall conform to and be tested as per the requirements of relevant" IS Codes specified in OWNER technical specification.

The obstructions in sewer lines shall be checked by inserting a smooth ball, of
diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yam or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at

the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under test / working condition of pressure and flow, when all draw-off taps are closed. The service pipes shall be checked for satisfactory support and protection from damage, corrosion and frost.

11.01.13 ARCHITECTURAL & MISC. WORKS

Material used for sanitary and plumbing fittings and fixtures, floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

Fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. shall be checked for correctness of locations and smoothness of operation and fixtures. All controls and locking devices shall give fault free performance. Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 2.5 mm.
Materials used in glass and glazing shall be procured from source approved by
OWNER and shall conform to the requirements of the Technical Specification and IS Codes.

False ceiling panels shall be best quality material in thickness and properties called for in the specification / schedule of items. Material Test Certificate to be submitted before bulk supply.

All bought items covered in the scope of contract shall be procured from sources approved by OWNER and shall conform to the requirements of the technical specifications and referred standards /codes.

11.01.14 ROAD WORK

Quality Assurance and testing requirements for roadwork shall be as per the MOSRTH specification (Section 900) IRC specifications or CPWD specifications as specified in-the technical specifications and BOQ of the contract.

The testing and sampling shall include the checks on earth work for embankment and subgrade, sub bases and bases and bituminous constructions. The sampling and testing of concrete pavements shall be as per the respective items of earthwork, subgrade / sub-base, concrete, etc.

12.00.00 **CATHODIC PROTECTION**

Quality of cathodic protection system shall be as per given table.

IMPRESSED CURRENT CATHODIC PROTECTION											
Transformer Rectifier Unit											
Attributes/Characteristics Items/Components/Sub-assembly	Make, model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet steel Pre-treatment & Painting	Operational & Functional Checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness,	Complete physical examination for	Efficiency Test on TRU & Transformer	Heat Run Test	Ratio & Polarity Test on TRU	HV & IR Test
Rectifier Transformer (IS:2026)	Y				Y						
Electronic Components	Y				Y						
PCB & electronic Cards	Y				Y						
Control & Selector Switches (IS:6875)	Y			Y	Y						
Indicating Meters (IS:1248)	Y			Y	Y						
Indicating Lamps (IS:13947)	Y			Y	Y						
Air Break Switches/Fuses (IS:13947/13703)	Y			Y	Y						
Control Transformer (IS:12021)	Y				Y						
Control Terminal Blocks (IS : 13947)	Y				Y						
Push Buttons (IS:4794)	Y			Y	Y						
MCB (IS:8828)	Y			Y	Y						
PVC insulated copper control wires (IS:694)	Y				Y						
Sheet Steel (IS:513)	Y	Y	Y		Y						
Synthetic Rubber Gaskets	Y	Y			Y						
Annunciator	Y			Y							

Transformer Rectifier Unit	Y				Y	Y	Y	Y	Y	Y	Y

Notes :

1. This is indicative list of tests/checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out items will be subject to Owner approval.

TYPICAL QA/QC LAB EQUIPMENT

Project Package		
S. No.	**Equipment**	**Nos.**
1.	Vicat Apparatus with deskpot	2
2.	Le Chatelier Flask	2
3.	Le Chatelier Mould	2
4.	Cube Moulds for cement testing	12
5.	Vibration Machine	1
6.	Length Comparator	2
7.	Shrinkage Bar Mould	2
8.	Sieve Shaker	1
9.	Sieves for sand, coarse & fine aggregate	1 set for each
10.	Sieves for coarse aggregate for Road	1 set
11.	Proctor testing equipment	2 set + 18 cores
12.	Slump testing equipment	6 sets
13.	Oven	2
14.	Physical Balance	1
15.	Rapid moisture meter	2
16.	Thermometer	4
17.	Burret	2
18.	Measuring cylinders	9
19.	Measuring flasks	3
20.	Compression testing machine	2 sets of 2000 kN capacity each
21.	Cube moulds	30
22.	Electronic balance	2 (12 kg capacity), 2 (200 mg capacity)
23.	pH balance	As per requirement
24.	Radiographic facilities	As per requirement, Party should deploy BARC approved agency for carrying out RT.
25.	Mechanical weighing machine	1 (100 kg capacity)
26.	Ultrasonic testing machine	As per requirement
27.	D. P Test Kit	10
28.	Vernier 300 mm, 600mm	2

Project Package		
S. No.	**Equipment**	**Nos.**
29.	Micrometer (0.25 mm) outside (25.00)	2
30.	Radiography film Viewer	2
31.	Inside Micrometer 25-750 dia	2
32.	Digital elcometer for paint thickness	2
33.	Baking oven for electrode	3
34.	Portable ovens	2
35.	Rebar detector to locate the reinforcement before core cutting operation	1
36.	Concrete coring machine (55mm, 60mm upto 150mm dia core bit)	1
37.	Rebound Hammer	1
38.	Ultrasonic	May be arranged from specialist laboratory.

Note:

1. The equipment listed above are indicative and required to be mobilized as minimum requirement. Additional equipment if any, required for successful completion of work shall be provided/arranged by the contractor.

2. All test reports/inspection reports have to be computerized and maintained on LAN with an access to the Owner.

3. Computers – 2 Nos shall be deployed with Windows operating system and connected to the Owner server.

4. Based on the schedule (L2/L3 network), quality control & quality assurance work plan shall be finalized by the contractor and the same shall be submitted to the engineer-in-charge for acceptance/approval. The finalized work plan shall be maintained on the computer to be accessed by the Owner for database and day to day monitoring.

	SUPPLIERS NAME AND ADDRESS:	**FIELD QUALITY PLAN**									
		ITEM : CIVIL WORK		QP No. :		1	PROJECT:	**1 x 8000 MW DCR Thermal Power Plant**			
		SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING,PILLING ETC.		REV. No. :		0	PACKAGE:	EPC package			
				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
1	GENERAL REQUIREMENTS										
A	Setting up of Field QA&QC laboratory		As required	A	Physical	Once prior to start of work	Tech Specs and Const. Drawings		SR	☐	Functioning of laboratory equipment in proper working condition to be verified on monthly basis
B	Avialablility of requisite laboratory set up and equipment in good working condition well before commencement of concerned activity		As required	A	Physical	Once prior to start of work and thereof monthly	Tech Specs and Const. Drawings		SR	☐	
C	Submission of QA & QC manpower deployment schedule based on agreed L-2 network.		-	A	Physical	Once prior to start of work	Tech Specs and Const. Drawings				
D	Availability of QA &QC manpower based on deployment schedule.		-	A	Physical	Once prior to start of work and there of monthly	Tech Specs and Const. Drawings		SR	☐	
E	Sampling for testing of building materials, concrete mix design etc.		As required	A	Physical	Once per each source	Tech Specs and Const. Drawings		SR/TR	☐	Test report along with the recommendations from specialist agency to be submitted to OWNER.
F	Submission of schedule of tests to be done monthly/ quarterly			A	Physical	Once prior to start of work and thereof monthly/ quarterly	Technical Spec and Construction Drawing		SR	☐	
G	Stacking and storage of construction materials and components at site		As per IS:4082	B	Physical	Random	Tech Specs and Const. Drawings and IS: 4082		SR	☐	

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
2	EXCAVATION AND FILLING IN FOUNDATION WORKS										
	Excavations-										
2.1		Nature, type of soil/rock before and during excavations	As required	B	Visual	Random in eah shift	Tech Specs and Const. Drawings		SR		
2.2		Initial ground level before start of excavations	As required	B	Measurement	100%	Tech Specs and Const. Drawings		SR	☐	
2.3		Final shape and Dimensions of excavations.	As required	B	Measurement	100%	Tech Specs and Const. Drawings		SR		
2.4		Final excavation levels	As required	B	Measurement	100%	Tech Specs and Const. Drawings		SR	☐	
2.5		Side slope of final excavation	As required	B	Measurement	Random in each shift	Tech Specs and Const. Drawings		SR	☐	
2.6		Excavation in hard Rock- If blasting required									
i		Receipt, storage, accountability of explosive	As required	B	Physical	Random in each week	Indian Explosive Act/all statutory norms/Tech Specs and Const. Drawings		SR	☐	OWNER approved blasting agency such as CMRI, NIRM shall be deployed at site for trial blasts, design blasts, blast vibration monitoring etc. Seismographs shall be deployed at site for blast operation vibrations.
ii		Execution of Blasting Operation	As required	B	Physical	Random in each shift	IS: 4081, Technical Specs and Const. Drawings				
iii											

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		Submission of blasting report to EIC	As required	C	Physical	Each blast	Technical Specs and Const. Drawings				
2.7		Excavation in hard Rock (Blasting Prohibited)	As required	B	Physical	100%	As per approved drawing/ scheme, Tech Specs and Construction Drawings				
	Fill/ Backfill -										
2.8 A	Suitability of borrow fill material - If earth is brought from area within the OWNER acquired area										
		Suitability	As required	B	Visual	For each source daily	As per technical specifications				
2.8 B	Suitability of borrow fill material- Applicable in case the earth is brought from an area, out of the OWNER acquired land area										
I		Grain size analysis	Set of Seives, Hydrometer etc.	B	Physical	Once in every 2000 Cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt.IV), Tech Specs and Const. Drawings	SR/TR	☐		The parameters should not be worse than the parameter of the existing soil in plant area
ii		Liquid & plastic limit	Mechanical liquid limit device, grooving tools, Evaporating Disc, Spatula, Palette knives, Balance oven containers, etc.	B	Physical	Once in every 2000 Cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt.IV) , Tech Specs and Const. Drawings	SR/TR	☐		The parameters should not be worse than the parameter of the existing soil in plant area
iii						Once in every 5000 Cum for each type and source of fill materials	IS:2720 (Pt.IV), Tech Specs and				The parameters should not be worse than the

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
		Shrinkage limit	-do-	B	Physical	subject to a min. of 2 samples	Const. Drawings		SR/TR	☐	parameter of the existing soil in plant area
.		Free Swell Index	Measuring cylinders, etc.	B	Physical	Once in every 5000 Cum for each type and source of fill materials.	IS:2720 (Pt.XI), Tech Specs and Const. Drawings		SR/TR	☐	The parameters should not be worse than the parameter of the existing soil in plant area
v		Chemical Analysis									
a		Organic Matter	Oven chemical balance, volumetric flasks, burettes, pipettes, conical flasks, set of sieves, measuring cylinders etc.	B	Physical	Once in every 5000 Cum for each type and source of fill materials.	IS:2720 Pt.XXII, Tech Specs and Const. Drawings		SR/TR	☐	
b		Calcium carbonate	Reagents and indicators, Burette, flasks, funnels etc.	B	Physical	Once in every 5000 Cum for each type and source of fill materials.	Part XXIII of IS-2720, Tech Specs and Const. Drawings		SR/TR	☐	
c		pH value	As required	B	Physical	Once in every 5000 Cum for each type and source of fill materials.	Part XXVI of IS-2720, Tech Specs and Const. Drawings		SR/TR	☐	
d		Total soluble sulphate	As required	B	Physical	Once in every 5000 Cum for each type and source of fill materials.	Part XXVII of IS-2720, Tech Specs and Const. Drawings		SR/TR	☐	
	Standard proctor Test										

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		SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING,PILLING ETC.		REV. No. :		0	PACKAGE:	EPC package			
				DATE :		-	CONTRACT NO.:				
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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
2.9											
		Optimum moisture content and max. dry density before fill	As per IS: 2720, Proctor needle apparatus, etc.	A	Physical	Once in every 2000 Cum for each type and source of fill materials.	IS 2720 (Pt.VII), Tech Specs and Const. Drawings		SR/TR	☐	
2.10	Moisture Content										
		Moisture content of fill before compaction	As per IS:2720, balance, oven etc.	A	Physical	Once in every 2000 Cum for each type and source of fill materials.	IS 2720 (Pt.II) Tech Specs and Const Drawings		SR/TR	☐	
2.11	Degree Of Compaction Of Fill / Backfill										
i		Dry density by core cutter method ---- OR---- Dry density in place by sand displacement method	As per IS: 2720/compaction test (core cutter), balance etc.	A	Physical	i) For foundation fill/ backfill one for every 10 foundations for each compacted layer.	IS 2720 (Pt. XXIX), Tech Specs and Const. Drawings		SR/TR	☐	
						ii) For area filling, one every 1000 SQM area for each compacted layer.	IS 2720 (Pt. XXVIII), Tech Specs and Const. Drawings		SR/TR	☐	
ii		Relative density (Density Index)	As per IS: 2720, balance oven etc.	A	Physical	----do----- (i) & (ii) above	IS 2720 (Pt. XIV), Tech Specs and Const. Drawings		SR/TR	☐	
iii		Dry Density by proctor needle penetration	As per IS-2720, proctor needle apparatus etc.	B	Physical	Random checks to be carried out for each compacted layer	Tech Specs and Const. Drawings		SR/TR	☐	

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
3	MATERIALS										
3.1	CEMENT										
		Testing of cement	as per IS:4031	A	Review of MTC and Testing	At Random	As per relevant IS Codes	Test Report	☐		Each consignment of cement shall be duly correlated with manufacturers' TC and one sample from each lot shall be tested for setting time and compressive strength. If cement is stored more than 90 days in godown of contractor same shall be retested for comp. Strength & setting time.
3.2	Coarse Aggregate										
i.		Moisture content	as per IS:2386	B	Physical	Once for each stack of 100 Cu.M. or part thereof except during monsoon when this has to be done every day before start of concreting	IS : 456 IS : 383/Tech Spec	SR/LB	☐		Accordingly water content of the concrete will be adjusted
ii		Specific gravity, water absorption	IS:2386	A	Physical	Once for each source & for every change of source	IS: 2386 Part-III, IS:456, IS:383/Tech Spec	SR/LB/ Test Report	☐		These tests will be carried out white establishing design mix and the results to be intimated to OWNER.
iii		Sieve analysis, flakiness index, elongation index,	IS:2386	B	Physical	One per 200 cum., or part thereof	IS: 2386 Part-I, IS:383/Tech Spec	SR/LB	☐		-do-
iv		Deleterious materials (coal & lignite, clay lumps, material finer than 75	IS:2386	A	Physical	Once per source/ on every change of	IS: 2386 Part-II,	SR/LB/	☐		Experts opinion regarding suitability of the aggregates shall be

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		micron sieve, soft fragment, shale)				source	IS:383/Tech Spec		Test Report		obtained from the specialized agency before start of work
v		Soundness	IS:2386	A	Physical	-do-	IS: 2386 Part-V, IS:383		SR/LB/ Test Report	☐	Experts opinion regarding suitability of the aggregates shall be obtained from the specialized agency before start of work
vi		Alkali aggregate reactivity		A	Physical	-do-	IS: 2386 Part-III, IS:384/ Tech Spec/ ASTM C-1260/ ASTM 1293		SR/LB/ Test Report	☐	The aggregate type (deleterious/ innocuous result should be supported by petrographic examination)
vii		Petrographic examination	IS: 2386 Pt VIII	A	Physical	-do-	IS: 2386 Part-III, IS:384/ Tech Spec		SR/LB/ Test Report	☐	Petrographic report shall be supported by the analysis and recommendation by a specialist institute.
viii		Crushing value, abrasion value and impact value	IS:2386	A	Physical	-do-	IS:383, IS-2386 Part IV/Tech Spec		SR/LB/ Test Report	☐	
3.3	Fine Aggregate										
i		Moisture content, water absorption	balance, oven etc	B	Physical	To be done every day before start of work	IS: 2386 Part-III IS:383		SR/LB/T R	☐	Accordingly water content of the concrete will be adjusted
ii		Deleterious materials (coal & lignite, clay lumps, material finer than 75 micron sieve, soft	IS:2386	B	Physical	Once per source& for on every change of source	IS: 2386 Part-II, IS:383		SR/LB/T R	☐	Acceptance limit as per relevant IS code

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		fragment, shale)									
iii		All other tests similar to coarse aggregates as mentioned above,					IS: 2386, IS:384		SR/LB/TR	☐	except test for flankiness index, elongation index, abrasion value, impact value
3.4	Water										
i		Test for acidity & alkalinity by using neutralization of water using indicator, and check for sulphate and chloride content.	Buret, conical flask, pipette etc	B	Testing	One per each source thereof quarterly .	IS:3025 part 22 and 23 (for test procedure), IS:456 (for acceptance criteria)		SR/LB/TR	☐	
ii		Tests for ascertaining limit of solids	As per IS Code	B	Physical	One per each source and thereof quarterly .	IS:3025 part 18 organic),IS:456		SR/LB/TR	☐	
iii		Tests for pH Value	pH meter	B	Testing	One per each source and thereof quarterly .	IS:3025, IS:456		SR/LB/TR	☐	
3.5	CONCRETE										
i		4 Trial mixes to ascertain the workability and cube strength	After receiving the recommended mix design from specialist agency,	A	Physical	One for each mix proportion	OWNER tech specification		SR/LB	☐	Necessary correction for moisture content , water absorption and admixture dose adjustment according to mix design recommendation may be carried out during the trial mix
ii		Crushing strength (works Tests cubes)	IS:516	A	Physical	One set of 6 cubes per 50 cum or part thereof for each grade of	IS:516, IS:456, OWNER Tech. Spec.		SR/LB/ Test	☐	Min. of 6 cubes for each mix, 3 specimen shall be tested at 7 days remaining

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1	2	3		4	5	6	7	8	9		10
						concrete per shift			Report		3 shall be for 28 days comp. Strength.
iii		Workability - slump test	IS:1199	B	Physical	At the time of concrete pouring at site every two hours	IS:456/OWNER Tech. Spec.		SR/LB/TR	☐	At the time of concrete pouring at site
iv		Water content		B	Physical	Once per shift	As per approved design mix.		SR/LB	☐	At batching plant
3.5.1	Admixtures for Concrete										
		Type of admixture	As per IS:9103	A	Testing	For each lot received at site	Designed mix and IS:9103		Test Report	☐	Admixture of appd. Brand and tested quality shall be used (each lot of admixture will included with brochure in which the type of admixture and its properties shall be clearly indicated)
		Complete testing of admixtures	As per IS:9104	A	Physical/ Chemical laboratory test	For each approved brand/ type of admixture	IS: 9103		Test Report	☐	Test report from OWNER approved laboratory for the jointly supplied admixture
		Suitability and review of MTC		A	Testing	For each lot received at site			SR/LB/TR	☐	Relative density, pH and slump retention on each batch/ lot of admixture and to compare these properties with MTC and test report of specialized agency
3.6	Concrete conveying, placing& compaction										
i	Mixing of Concrete	mixing of concrete shall be done in a approved mixer such as to produce a homogenous mix	Visual	A	Physical	To be calibrated at the time of starting and subsequently once in three months, and shall conform to IS:4925	Review of calibration chart/ Certificate, IS 4925/4926		Inspection Report		

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1	2	3		4	5	6	7	8	9	D*	10
ii		Arrangement for transportation & placement of concrete.	As required	C	Visual	100%	Before clearance for concreting		Inspection Report	☐	
iii		Calibration of Batching Plant	batcher should comply with requirement of IS 4926/IS:4925	A	Physical	To be calibrated at the time of starting and subsequently once in three months, and shall conform to IS:4925	Review of calibration chart/ Certificate		Calibration Certificate	☐	Cement consumption at batching plant shall also be obtained through computer output. Provision of online printer is mandatory
iv		Handling ,Transportation and Placement of concrete	As required	B	Physical	100%	As per construction/erection methodology once for entire concrete work(to be approved one week prior to start of work)		SR		Free fall or drop shall be limited to 150 cm unless permitted. Concrete should be placed within stipulated initial setting time of cement calculated from the time when water is added or 30 min whichever is earlier.
v		Placement of concrete	Visual	B	Physical	100%	As per construction/erection methodology and Tech Specs		SR	☐	No segregation
vi		Temperature control of concrete for top deck of TG Foundations	Thermometer	B	Physical	100%	As per technical specifications		SR	☐	
vii		Compacting	As required	B	Physical	At Random	IS:456		SR	☐	No bleeding and segregation
viii		Curing	As required	B	Physical	At Random	Period of curing as per IS 456		SR	☐	Exposed concrete surface shall be protected against heating and drying for atleast 72 hrs after placement. Curing

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
											compound and gunny bags may be used
3.7	TEST/CHECK ON RCC STRUCTURE IN HARDENDED CONDITIONS										
i		NDT (Rebound Hammer, Core Test and Ultrasonic Pulse velocity Test as applicable)	IS:13311, IS:516 & IS:456	A	Physical	As required by OWNER Engineer	IS:13311 & IS:456 and Technical Specification		Test report	☐	Shall be carried out by approved specialized agency.
ii		Ultrasonic test on top deck of TG foundation	IS:13311	A	Physical	As required by OWNER Engineer	IS:13311		IS:13311	☐	
iii		Core Test	IS:516	A	Physical	As required by OWNER Engineer	As per IS:456, IS:516		Test report	☐	
iv		Dimensional check on finished structures & Dimensional tolerances	As required	B	Measurement	Approved Drawing	As per IS:456/ Tech. Specification.		SR/LB	☐	
v		Water Tightness Test of liquid retaining structure/ tanks	As required	A	Test	Each water retaining structure	IS:3370/ Tech. Specification		SR/LB	☐	
3.8	REINFORCEMENT STEEL										
i		Physical and Chemical Properties for each lot as per relevant IS codes	As required	A	Review of MTC	Each batch of delivery	IS : 1786, IS:432, IS:1566, Tech Specs and Const. Drawings		MTC	☐	
ii											

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
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		Freedom from cracks surface flaws, Lamination.	As required	B	Visual	Random in each shift	IS: 1852, IS:432, IS:1786, Tech Specs and Const. Drawings		SR		To be checked at site. Steel collected from source should be free from rust. To be stored as per Technical Specs and IS 4082.
3.9	PLACEMENT OF REINFORCEMENT STEEL										
I		Bar bending schedule with necessary lap, Spacers & Chairs	As required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings, IS:2502		SR	☐	
ii		Bending of bars, cutting tolerance	As required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings		SR	☐	
iii		Acceptance - Cover, spacing of bars, spacers and chairs after the reinforcement cage is put inside the formwork	As required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings		SR	☐	
3.10	STAGING AND FORMS										
i		Materials and accessories	As required	B	Visual	Once before start of work	As per relevant IS, Tech Specs and Const. Drawings		SR		
ii		Soundness of staging, shuttering and scaffolding including application of mould oil / release agent	As required	B	Visual	Once before start of work	As per manufacturer's spec. and as per 3696,4014, 4990, Tech Specs and Const. Drawings		SR		
iii		Acceptance of formwork before start of concreting		B	Physical / visual	Before start of each concreting	As per provisions and tolerances, Tech Specs and Const. Drawings		SR	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
3.11	EMBEDDED PART(INCLUDING LAYING OF RAILS & ANCHOR FASTENERS)										
i		Position / alignment / levels of embedded parts / bolt hole / pipe sleeves / rails / PVC pipes / etc	As required	B	Physical/ measurement	100%	As per drawing, Tech Specs and Const. Drawings		SR/ Protocol	☐	Exposed surface of embedded parts other than holding down bolts are to be painted with primer (as mentioned in item description)
ii		Welding / tieing of embeddment to reinforcement	As required	B	Physical/ measurement	Random in each shift	As per drawing, Tech Specs and Const. Drawings		SR		
3.12	PRE-CAST CONCRETE										
i		Crushing strength	compression strength testing machine	A	Physical	one sample of six cubes per 50m m3 or part thereof	IS:516 & IS: 456		SR/LB	☐	A minimum of three specimen shall be tested each for 7 and 28 days compressive strength
ii		Workmanship and dimensions	Visual	B	Physical	100%	As per IS:456/ Tech. specification.		Register		
iv		Load Test	As required	B	Physical	5% or as desired by EIC	IS:456/ As decided by OWNER Site Engg. Incharge.		Inspection Report	☐	
3.13	JOINTS IN CONCRETE										
i		Joint material - bitumen impregnated fibre board, PVC water stops, Sealing compound, Expanded	As per manufacturer	A	Review of	Each batch of delivery	Tech Specs and Const. Drawings, IS 1838, IS		MTC	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		polystyrene board, Hydrophillic strip, Acrylic polymer etc.	Standards		MTC		1834, IS12200				
ii		Acceptance of installation	As required	B	Acceptance	Each installation randomly	Tech Specs and Const. Drawings				
3.14	DAMP PROOF COURSE										
i		Material - Hot bitumen and water proofing materials etc	As required	A	Review of MTC	Each batch of delivery at site	Tech Specs and Const. Drawings, IS 702		SR	☐	
ii		Acceptance of damp proof course	As required	B	Acceptance	100%	Tech Specs and Const. Drawings		SR		
3.15	GROUTING										
i		Material	As required	A	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings		SR	☐	
		Type of mix - fluid mix, plastic mix, stiff mix etc.	As required	B	Physical	Prior to start of work	Tech Specs and Const. Drawings		SR	☐	
ii		Mixing, placement, application and grout pressure	As required	B	Physical	Random in each shift	Tech Specs and Const. Drawings		SR		
iii		Compressive strength	As required	A	Physical	Random in each shift	Tech Specs and Const. Drawings		SR	☐	
iv		Acceptance of the grouts	As required	B	Physical	Each grout section	Tech Specs and Const. Drawings		SR		

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
4	BRICK MASONARY										
4.1	Test on Bricks										
		Dimensions, shape, compressive strength, water absorption, efflorescence.	As required	A	Measurement/ Physical Test	As per relevant IS Code/ One Sample for 30,000 nos. or part thereof	IS: 1077, IS:13757, IS: 12894 / Tech Specs and const. Drawings		Inspection Report	☐	Efflorescence shall be checked at each source.
4.2	Test on Mortar										
i		Compressive strength, consistency	As required	B	Test	At random	IS 2250-1981, Tech Specs and Const. Drawings		LB		
ii	Sand	Grading	As required	B	Test		IS:2116		SR/LB		
4.3	Masonry construction	Workmanship, verticality and alignment	As required	B	Visual/ Physical	100%	IS 2212, IS 1905 , Tech Specs and Const. Drawings		SR/LB		
5	FINISHING AND ALLIED WORKS										
5.1	PLASTERING- MATERIAL										
i	Sand	Deleterious Material	As required	B	Physical	Once per source	IS : 2386 (Part-I &II) & IS:2116, Tech Specs and Const. Drawings		SR		
ii		Grading	As required	B	Physical	50 Cum./or part thereof	IS:1542 & Apprd. drgs, Tech Specs and Const. Drawings		SR		Table –I of IS:2116
5.2	PLASTERING - WORKMANSHIP										

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
i		Curing	As required	C	Physical	100%	Tech specifications, construction drawings and agreed methodology		SR		
ii		Thickness and finishing of plaster, grooves etc	As required	B	Visual/ Measurement	Random in each shift	As per IS 1661 , Tech Specs and Const. Drawings		SR/LB		
iii		Trueness of plastering system	As required	B	Visual/ Physical	Random in each shift	Tech Specs and Const. Drawings		SR		Deviation not more than 4 mm when checked with straight edge of 2 m length
5.3	STONE GRIT PLASTER/ GRANULAR TEXTURED COAT FINISH										
		Material	As required	B	Approval of source and review of MTC	For each lot received at site	Tech. Specs and Construction Drawings		SR	☐	
		Thickness and finishing of plaster, grooves etc	As required	B	Visual/ Measurement	Random in each shift	Tech. Specs and Construction Drawings		SR	☐	
5.4	PAINTING SYSTEM - CONCRETE WORKS AND PLASTERED MASONRY SURFACES										
i	Materials and accessories - Oil bound, Acrylic Emulsion, Chemical Resistant, Oil Resistant Paint etc	Shade, type from brand and manufacturer as approved by EIC	As required	A	Review of MTC	Each batch of delivery	Tech. Specs and Construction Drawings		SR/MTC	☐	MTC shall be correlated with the consignment received.
ii	Surface Preparation	As required	As required	C	Physical / visual	Random in each shift	IS: 2935 (Part-I), Tech. Specs and Construction		SR		

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1	2	3		4	5	6	7	8	9	D*	10
							Drawings				
iii	Acceptance of painted surface	As required	As required	B	Physical	Each surface at random	Tech. Specs and Construction Drawings		SR		
6	DOORS , WINDOWS VENTILATORS & GRILL										
6.1	Steel doors										
i		Materials (MS sheet, fasteners, hinges, jambs, lock strike plate etc)	As required	A	Visual/ Physical / test report	For each lot received at site	Tech Specs and Const. Drawings		SR / LB	☐	Review of test report
ii		Flush Door shutters, teak beading	As required	A	EIC Approved source and review of MTC/ test reports	For each lot received at site	IS 2202, Tech Specs and Const. Drawings		SR	☐	Review of test report
iii		Hollow metal doors (material and dimensions)	As required	A	Visual/ Physical/Te st report	For each lot received at site	Tech Specs and Const. Drawings			☐	Review of test report
iv		Acceptance	As required	B	Visual/ Physical	Random	Tech Specs and Const. Drawings		SR/LB		
6.1.1	Painting system – Steel Works										
i		Painting materials and accessories	-	A	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings		SR/MTC	☐	Mfr.'s TC shall be correlated with the consignment received.
ii		Submission of painting methodology	-	B	For Review of painting system	Before start of painting work	Tech Specs and Const. Drawings			☐	
iii		Surface preparation	As agreed/require	B	Physical/Visu al	Each Erection Work	Tech Specs and Const. Drawings, Relevant		SR	☐	

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1	2	3		4	5	6	7	8	9	D*	10
			d				code/standards				
iv		Primer Thickness	Elcometer	B	Measurement	Each Erection Work	Tech Specs and Const. Drawings.		SR	☐	
v		DFT of paint	Elcometer	B	Measurement	Each Erection Work	Tech Specs and Const. Drawings.		SR	☐	
vi		Acceptance of painted surfaces	Elcometer	B	Visual and measurement	Each Erection Work	Tech Specs and Const. Drawings.		SR	☐	
6.2	Modular aerated panel	As required	As agreed/required	A	Review of test report	Each batch of delivery	Tech specs and const. drawings		SR/LR	☐	
6.3	Permanently colour coated sheets, metal decking										
i		Storage	As agreed/required	B	Visual	Random in each shift	Tech specs and const. drawings		SR		Prevention of distortion/blamishing/water staining
ii		Installation, lap alignment & workmanship	As agreed/required	B	Visual/ Physical	Random in each shift	Tech specs and const. drawings		SR		No gas cutting of sheets acceptable. FQP for structural steel shall also be applicable.
iii		Finishing and acceptance	As agreed/required	B	Visual/ Physical	Random in each shift	Tech specs and const. drawings		SR/LB	☐	Experienced workers under supervisors recommended/appointed by manufacturer to be deployed.
6.4	Insulation Works										
i	Material	Insulation material, galvanized wire net, aluminium foil, fasteners	As agreed/required	A	EIC approved source and review of MTC/test	For each lot received at site	Tech specs and const. drawings		SR/LB	☐	All tests as per specification.

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1	2	3		4	5	6	7	8	9	D*	10
					reports						
ii		Acceptance of each type of installation	As agreed/required	B	Visual/ Physical	Each installation	Tech specs and const. drawings		SR/LB		
6.5	Pre-Engineered Building	Installation and acceptance	As agreed/required	A	EIC approved source and review of MTC/test reports	For each building	Tech specs and const. drawings		SR/LB	☐	From approved source/fabricated as per MQP
6.6	Anodised aluminium works										
I		Materials- Aluminium sections,	As required	A	Visual/ Physical / test report	For each lot received at site	IS: 1948, IS: 1949, IS:733, IS1285, IS:1868, IS:11857/ Tech Specs and Const. Drawings		SR / LB	☐	Review of test report. For aluminium door/windows, check for anodisation as per Tech. Spec
Ii		Particle Door	As required	A	EIC Approved source and review of MTC/ test reports	For each lot received at site	IS:12823 (phenol formaldehyde synthetic resin, BWP type), Tech Specs and Const. Drawings		SR	☐	Review of test report
Ii		Acceptance	As required	B	Visual/ Physical	Random	Tech Specs and Const. Drawings		SR		
6.7	Fire proof doors										
i		Source of supply	As required	A	Review of purchase order (unpriced copy) / drawings of	For each source	IS:3614 (pt 1&2) Tech Specs and Const. Drawings		SR	☐	Procured from Approved parties as per relevant IS/Tech, The door drawing proposed for supply

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				DATE :		-	CONTRACT NO.:				
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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
					suppliers / certificate of CBRI						should have been tested and approved by CBRI Roorkee for the similar dimensions for minimum 2 hours fire rating.
ii		Receipt inspection	As required	A	Visual/ Physical/ Review of MTC	For each lot received at site	IS:3614 (pt 1&2) Tech Specs and Const. Drawings		SR	☐	
iii		Finishing and acceptance	As required	B	Visual / physical	Random	IS:3614 (pt 1&2) Tech Specs and Const. Drawings		SR		
6.8	Rolling shutters										
I		Surface finish and thickness of plate of approved make and DFT	As required	A	Physical / visual / review of MTC	Random for each lot of delivery	IS: 6248 / Tech Specs and Const. Drawings		SR	☐	
Ii		Finishing and acceptance	As required	B	Physical and acceptance	Random	Tech Specs and Const. Drawings		SR		
6.9	Steel windows / Grills/ Louvre										
I		Material fabrication and fixtures	As required	A	Physical / visual / review of MTC	Each lot of delivery	IS: 1038 / IS:1361, IS: 7452 and Tech Specs and Const. Drawings		SR	☐	
Ii							IS: 1038 / IS:1361, IS:				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
		Finishing and acceptance	As required	B	Visual / physical	Random	7452 and Tech Specs and Const. Drawings		SR	☐	
6.10	Glass and glazing										
i	Clear float glass, wired glass, tinted glass, curtain glass, hermetically sealed glass, toughened glass	Material	As required	B	EIC Approved source and review of MTC/ test reports	For each lot received at site	IS: 14900, IS:1081, IS: 3548, IS:5437 Tech Specs and Const. Drawings		SR	☐	
ii		Installation finishing and acceptance	As required	B	Visual/ Physical	Random	Tech Specs and Const. Drawings		SR		Leak proof installation with neoprene gasket
6.11	Poly Carbonate Sheet Roofing										
		Impact strength, K Value, light transmission value with class-1 fire rating	As required	A	EIC Approved source and review of MTC/ test reports	For each lot received at site	Tech. Specs and Construction Drawings		SR	☐	
		Installation finishing and acceptance	As required	B	Visual/ Physical	Random	Tech. Specs and Construction Drawings		SR		
6.12	Reflective Toughened Glass										
		Material	As required	A	Review of MTC	For each lot received at site	Tech. Specs and Construction Drawings		SR	☐	
		Installation finishing and acceptance	As required	B	Visual/ Physical	Random	Tech. Specs and Construction Drawings		SR		
7	False Ceiling										
i		Materials (gypsum glass,									

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		glass fibre membrane, fibre board acoustical tiles etc)	As required	A	Visual / physical / MTC	For each lot received at site	IS:2095, IS:8183, Tech Specs and Const. Drawings		SR	☐	Compare MTC with technical specification and requirement
ii		Installation finishing and acceptance	As required	B	Visual / physical	Random	Tech Specs and Const. Drawings		SR		
8	WATER PROOFING										
		Methodology for the application of water proofing system	As required	B	Review	for each type of treatment	Tech Specs and Const. Drawings		SR	☐	Experienced workers under supervisors recommended/ appointed by manufacturer to be deployed
8.10.1	General Requirement- Water Proofing										
i	Polyurethene based coating, polyester scrim cloth, extruded HD dimpled polyurethene	Material	As required	A	EIC Approved source and review of MTC/ test reports	For each lot received at site	ASTM C-836, ASTM C898 and Tech Specs /Const. Drawings		SR	☐	MTC shall contain all the parameters specified in the technical specifications
ii		Acceptance of water proofing work	As required	B	Physical	100%	ASTM C898, Tech Specs and Const. Drawings				
8.10.2	Roof / Basement Treatment										
i	Graded under bed	Levels / slopes	As required	C	Physical	100%	Tech Specs and Const. Drawings				
ii	Elastomaric coatings	Material- Primer coat, finishing coat	As required	B	EIC Approved source and review of MTC/ test reports	Each lot of delivery	Tech Specs and Const. Drawings		SR	☐	
iii	Wearing course	Materials - PCC, chicken wire mesh, elastomeric sealant	As required	B	Review of MTC	Each lot of delivery	Tech Specs and Const. Drawings		SR	☐	
		Acceptance of water proofing work					Tech Specs and Const.				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
iv			As required	B	Physical	100%	Drawings				
9	Fencing and Gates										
i	PVC coated chain link fencing (IS 2720), Welded wire mesh (IS 1566), Reinforced barbed tape galvanised (IS 2629) etc.	Materials	As required	A	OWNER Approved source and review of MTC/ test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR/MTC	☐	MTC shall contain all the parameters specified in the technical specifications
ii	Structural steel, painting system, caster wheel, ball and bearing, fixtures and fasteners	Materials	As required	A	EIC Approved source and review of MTC/ test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR/MTC	☐	MTC shall contain all the parameters specified in the technical specifications
iii		Alignments, erection painting, DFT etc.	As required	B	Physical / measurements	Each installation	Tech Specs and Const. Drawings		SR		
iv		Acceptance of the installation and working	As required	B	Physical / measurements	Each installation	Tech Specs and Const. Drawings		SR		
10	FLOOR FINISHES AND ALIED WORKS										
10.1	Cement Concrete Flooring										
i		Glass/ PVC strips in joints	As required	B	Physical	Random in each shift	Tech Specs and Const. Drawings		SR		
ii		Finishing and acceptance	As required	B	Physical	100 %	Tech Specs and Const. Drawings		SR		

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				DATE :		-	CONTRACT NO.:				
				PAGE :		-	CONTRACTOR:				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
10.2	Tiles										
i	Ceramic, vitrified, glass mosaic, acid alkali resistant, heavy duty cement concrete tiles	Materials	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery	IS:13755, IS:1237, IS:8042, Tech Specs and Const. Drawings		SR	☐	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As required	B	Physical	100%	IS: 1443, Tech Specs and Const. Drawings		SR		
10.3	Interlocking Blocks										
i		Materials	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery	BS:6717, Tech Specs and Const. Drawings		SR	☐	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As required	B	Physical	100%	BS:7533 (Pt 3), Tech Specs and Const. Drawings		SR		
10.4	Kota Stone, Granite and Marble										
i		Quality, texture, thickness, colour for each lot of delivery from approved source	As required	B	Physical	Each batch of delivery	Tech Specs and Const. Drawings		SR	☐	
ii		Finishing and acceptance	As required	B	Physical	100%	Tech Specs and Const. Drawings		SR		
10.5	Metallic / non-metallic hardener										
							Tech Specs and Const. Drawings				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
i		Material	As required	B	Physical	Each batch of delivery			SR	☐	
ii		Finishing and acceptance	As required	B	Physical	100%	Tech Specs and Const. Drawings		SR		
10.6	Acid / alkali and oil resistant high built seamless epoxy based resin and treatment										
i	Material	Bricks, vitreous tiles, mortar, sealing, paints, coatings, sheets, fillers etc	As required	A	EIC Approved source and review of MTC/ test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR	☐	Experienced workers under supervisors recommended/ appointed by manufacturer to be deployed
ii		Surface preparation	As required	B	Physical	Random in each shift	Tech Specs and Const. Drawings, IS 2395				
iii		Finishing and acceptance	As required	B	Physical	100%	Tech Specs and Const. Drawings		SR		DFT minimum 300 microns
10.7	Rubber Flooring										
i		Material	As required	A	EIC Approved source and review of MTC/ test reports	Each batch of delivery	IS:809, Tech Specs and Const. Drawings		SR	☐	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As required	B	Physical	100%	Tech Specs and Const. Drawings		SR		
11.0	Piling Work										
11.1	Execution										
i		100 mm Dia Borehole	As required	A	Physical	100%	Owner Tech Specs		SR/LB	☐	If carried out by the contractor
ii							As per appd. Drawings and technical				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		Pile Layout	Total Station	B	Measurement	100%	specification		SR/LB	☐	
iii		Recording ground level	As required	B	Measurement	Random	IS:2911, as per appd. Drawings and and tech spec.		SR/LB	☐	
iv		Cleaning/Flushing of pile bore	As required	B	Visual	Random	As per appd. Drawings and technical specification		SR/LB	☐	
v		Size of bore and during boring of pile record commencement of SPT/core recovery to ensure socketing length equivalent in terms of the diameter of the pile below the socketing horizon.	As required	B	Measurement	100%	As per appd. Drawings and technical specification		SR/LB	☐	
vi		Trial mix to ascertain the workability and cube strength	After receiving the recommended mix design from specialist agency.	B	Physical	One for each mix proportion	Owner technical specification		SR/LB	☐	
vii		Cement content	As required	B	Physical	Once per shift	As per appd. Design mix		SR/LB	☐	Necessary correction for moisture content and water absorption according to mix design recommendation may be carried out during the trial mix.
viii		Pouring of concrete to project above cutoff level.	As required	B	Measurement	100%	As per appd. Drawings ant technical specification		SR/LB	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
ix		Pile termination level.	SPT & core recovery	A	Soil data	As per Owner Technical specification	As per appd. Drawings ant technical specification		SR	☐	
11.2	Testing										
i		Bentonite.	IS:2720	A	Physical/testing	Once per source	As per IS:2720/Tech. Spec		SR/LB	☐	Review of test report
ii		Density check on sample of mud collected from pile bore bottom.	Sample collection	A	Physical	As per Tech. Spec.	As per Owner Tech Spec.		SR/LB	☐	Test to be done before placing concrete. Sample to be collected from pile bore bottom.
iii		Slump test of concrete	IS:1199	B	Physical	Every 2 hrs at pouring point of concrete	IS:2911, As per per appd. Drawings and technical specification.		SR/LB	☐	
iv		Cube sampling for works cube test	IS:456	B	Physical	One set of 6 cubes per 50 cum or part thereof for each grade of concrete per shift whichever is earlier.	IS:2911, As per appd. Drawings and technical specification		SR/LB	☐	
v		Initial pile load test, vertical (compression), Lateral (Horizontal) and pullout (Tension)	IS:2911/as required	A	Testing	100% for 3 nos. for each type or as specified in BOQ/Tech Spec.	IS:2911, As per appd, drawings and technical specification		SR/LB	☐	In case of compression test method the loading shall be cyclic.
vi		Routine pile tests, compression and horizontal	Callbrated dial gauges etc as required	A	Testing	100% for 0.5% of the total number of piles provided for each type of test/Tech Spec.	IS:2911, as per appd. Drawings and tech spec.		SR/LB	☐	Routine Test Shall be conducted by direct loading method.
vii		Integrity Tests.	PEM	A	Testing	100%	IS:2911, As per appd, drawings and technical specification and suppliers manual		SR/LB	☐	CHP

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1	2	3		4	5	6	7	8	9		10
11.3	WATER SUPPLY / SANITORY INSTALLATIONS										
11.3.1	Water supply fittings and fixtures										
i	Materials	GI/ MS pipes and fittings	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	IS:1239, IS:4736, IS:6745, IS:2633, IS:2629, Tech Specs and Const. Drawings		SR	☐	
ii	Disinfection	Before use	As required	B	Physical	Each installation	IS:2065, tech specs and const drawings		SR		
iii	Hydraulic test	Before use / leakage	As required	A	Physical	Each installation	Tech specs and const drawings		SR	☐	
iv		Acceptance and working	As required	B	Acceptance	Random	Tech Specs and Const. Drawings		SR		
11.4	Sand cast iron / cast iron pipes										
i	Material	SCI / CI pipes and fittings / joints	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	IS: 1729, IS:1536, IS:1538, Tech Specs and Const. Drawings		SR	☐	
ii		Acceptance and leakage	As required	B	Physical	Random	Tech Specs and Const. Drawings		SR		
11.5	Sanitary fittings and fixtures										
i	Material	Sanitory items and fixtures i.e. water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap containers, geyser, water cooler, etc, water supply	As required	B	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings		SR	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
		/ sanitation pipes, manhole cover and frames etc									
ii		Acceptance of installations of all sanitory items and fixtures	As required	B	Acceptance for Proper Working	100%	Tech Specs and Const. Drawings		SR		
11.6	RCC Pipes										
i	Material	RCC pipes	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	IS: 458, Tech Specs and Const. Drawings		SR	☐	
ii		Acceptance and leakage	As required	B	Physical	Random	Tech Specs and Const. Drawings		SR		
11.7	Water Storage Tanks										
i	Material	Over head / loft type	As required	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	IS:12701, Tech Specs and Const. Drawings		SR	☐	
ii		Aceptance and leakage	As required	B	Acceptance	Random	IS:12701, Tech Specs and Const. Drawings		SR		
12	SPECIAL ITEMS										
12.1	Bitumen layer for tank foundation										
					EIC Approved	Each lot of delivery as	IS :73, As per relevant IS				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
i	Material	Grade of bitumen	As required	A	source and review of MTC/ test reports	per Specifications	and Tech. Specs /MTC		SR/MTC	☐	
ii	Acceptance and workmanship	Application / workmanship	As required	B	Physical	Random	Tech Specs and Const. Drawings		SR		
12.3	ANTI WEED TREATMENT										
i		Anti-weed treatment materials	As required	A	Physical and MTC Review	Each batch of delivery	Tech Specs and Const. Drawings		SR	☐	
ii		Execution of treatment	As required	B	Physical	Random check for each treatment	Tech Specs and Const. Drawings		SR		
12.4	FOUNDATION SYSTEM										
12.4.1	SHALLOW FOUNDATIONS										
i		Foundation excavation - Location, Layout, size, depth etc	As required	B	Physical	Each location	As per technical specifications and construction drawings		SR		lines and levels to be checked
ii		Foundation casting - Layout, Shape, dimensitions, Reinforcement, concreting, curing etc	As required	B	Physical	Each foundation	As per technical specifications and construction drawings		SR		lines and levels to be checked. Concrete Grade to be checked as per Mix Design
12.5	EARTHING MAT / GROUNDING SYSTEM										
i	Material	Earthing Mat	As required	A	EIC Approved source and review of MTC/	Each lot of delivery as per	As per Tech. Specs / MTC, IS: 3403		SR/MTC	☐	

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					test reports	Specifications					
ii		Weld size and length	Visual / Tape	B	Visual / Measurement	100%	As per technical specifications and construction drawings				Low Hydrogen electrode as per OWNER approval shall be used
iii		DP Test	DP Test Kit	A	Physical	10% at random	As per technical specifications and construction drawings		TR	☐	
iv		Earth Test	Earthing Test Kit	A	Physical	100%	As per Tech. Specs / construction drawings, IS: 3403		SR	☐	
12.6	COMPOSITE ALUMINIUM PANELS AND STRUCTURAL GLAZING										
i	Material	Type of aluminium panels / structural glazing / fasteners and fixtures/silicon sealant	As Agreed	A	EIC Approved source and review of MTC/ test reports	Each lot of delivery as per Specifications	As per technical specifications and construction drawings		SR/MTC	☐	MTC shall cover all the profiles / parameters as per Technical Specifications
ii	Acceptance and workmanship	Installation finishing and acceptance	As Agreed	B	Physical	Random	As per technical specifications and construction drawings		SR		
13	ROAD WORKS										
13.1	Construction of Sub-Grade and earthen/hard shoulders										
1	2	3		4	5	6	7	8	9	D*	10
i		Standard proctor Test	As per IS: 2720	A	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS		SR/TR	☐	In cutting or existing levelled ground - quantum of check shall be one per 1000

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1	2	3		4	5	6	7	8	9		10
							2720 (Pt.VII)				SQM
ii		Moisture content of fill before compaction	As per IS: 2720	B	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 2720 (Pt.II)		SR/TR		In cutting or existing levelled ground - quantum of check shall be one per 1000 SQM
iii		Dry density by core cutter method ---- OR---- Dry density in place by sand displacement method	As per IS: 2720	A	Physical	One in every 500 SQM area for each compacted layer.	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 2720 (Pt. XXIX)/ IS 2720 (Pt. XVIII),		SR/TR	☐	Both for embankment and cut formation quantum of check - One in every 1000 SQM area for each compacted layer.
iv		Lines, grade and cross section	As required	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings		SR		Template, straight edge
13.2	Water Bound Macadam (Non-Bituminous) for base course and sub-base course										
i		Aggregate Impact value	Agrregate Impact value Test Apparatus	A	Physical	One test per 200 cum of Test aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
ii		Grading	Set of IS Sieves	B	Physical	One test per 100 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
iii		Flakiness index and elongation index	Flakiness test gauge	B	Physical	One test per 200 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
iv		Atterberg Limits of bindining material	Atterberg Limits determinatio	A	Physical	One test per 25 Cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
			n								
v		Atterberg Limits of portion of aggregate passing 425 micron sieve	Atterberg Limits determinatio n	A	Physical	One test per 100 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
vi		Camber, surface, slope	As required	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings		SR		Template, straight edge
13.3	Bituminous Macadam for Base and Binder Course										
i		Quality of binder	penetrometer with St. needle	A	Physical	No. of samples per lot & tests as per IS:73, IS:217,IS: 8887 as applicable	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 73		SR	☐	
ii		Aggregate Impact value/ Los Angeles abrasion value	Aggregate Impact Value Test Apparatus	A	Physical	Once per source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
iii		Flakiness index and elongation index	Flakiness test gauge	B	Physical	One test per 50 Cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
iv		Stripping value of aggregate (Immersion Tray Test)	As required	B	Physical	Initially one set of 3 representative specimen per source and every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
v		Water sensitivity of mix	As required	A	Physical	Initially one set of 3 representative specimen per source and every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	

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1	2	3		4	5	6	7	8	9		10
vi		Grading of aggregates	Set of IS Sieves	B	Physical	Two test per day per plant both on individual constituents and mixed aggregate from dryer	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
vii		Water absorption of aggregates			Physical	Initially one set of 3 representative specimen per source and every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
viii		Soundness (Magnesium and Sodium Sulphate)	As required as per IS:2386	A	Physical	Once per source by each method and on every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
ix		Percentage of fractured faces	As required	B	Physical	When gravel is used one test per 50 Cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
x		Binder content and aggregate grading	Bitumen extractor	A	Physical	Periodic, subject to a min of two tests per day per plant	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
xi		Control of temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
xii		Rate of spread of mixed materials	As required	B	Physical	Regular control through checks of layer thickness	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
						One test per 250 Sqm	As per Tech Specs and Const. Drawings, Section				

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
xiii		Density of compacted layer	As required	A	Physical	of area	900 of MORTH specification		SR	☐	
13.4	Bituminous Surfacing- open graded premix and Seal Coat										
i		Quality of binder	penetrometer with St. needle	A	Physical	No. of samples per lot & tests as per IS:73, IS:217,IS: 8887 as applicable	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification, IS 73		SR	☐	
ii		Aggregate Impact value/ Los Angeles abrasion value	Aggregate Impact Value Test Apparatus	A	Physical	One test per 50 Cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
iii		Flakiness index and elongation index	Flakiness test gauge	B	Physical	One test per 50 Cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
iv		Stripping value of aggregate (Immersion Tray Test)	As required	B	Physical	Initially one set of 3 representative specimen per source and every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
v		Water absorption of aggregates		A	Physical	Initially one set of 3 representative specimen per source and every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
vi		Water sensitivity of mix	As required	A	Physical	Initially one set of 3 representative	As per Tech Specs and Const. Drawings, Section		SR	☐	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
						specimen per source and every change of source	900 of MORTH specification				
vii		Grading of aggregates	Set of IS Sieves	B	Physical	One test per 25 Cum of agregate	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
viii		Soundness (Magnesium and Sodium Sulphate)	As required as per IS:2386	A	Physical	Once per source by each method and on every change of source	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
ix		Polished stone value	As required as per BS: 812 (Part 114)	B	Physical	As required	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
x		Temperature of binder at application	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
xi		Binder Content	Bitumen extractor	A	Physical	One test per 500 Cum & not less than two tests per day	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
xii		Rate of spread of mixed materials	As required	B	Physical	One test per 500 Cum & not less than 2 tests per day	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR		
xiii		Percentage of fractured faces	Bitumen extractor	A	Physical	When gravel is used one test per 50 Cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification		SR	☐	
13.5	Tack Coat/ prime Coat/ Fog Coat										

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1	2	3		4	5	6	7	8	9		10
i		Quality of binder	penetrometer with standard needle	A	Physical	No. of samples per lot & tests as per IS:73, IS:217,IS: 8887 as applicable	IS 73, As per Tech Specs and Const. Drawings, Section 900 of MORTH specification				
ii		Temperature of binder at application	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification				
iii		Rate of spread of mixed materials	As required/ agreed	B	Physical	Refer FQP for concrete Works	As per Tech Specs and Const. Drawings, Section 900 of MORTH specification				
13.6	RCC Pavements										
i.		Concrete - Material, Mix design, Trial Mixes, Production, Transportation, Placement, Compaction, Curing, Test on green concrete, Test on hardened concrete etc.	As required	-	-	Refer FQP for concrete Works	Refer FQP for concrete Works, , Tech Specs and Const. Drawings, IRC & MOST	-	☐		FQP for Concrete Works shall be application for all concrete works
13.7	Alignment, Level, Surface regularity and rectification										
i		Horizontal alignment, Surface levels and Surface regularity	As required	B	Physical	As per section 900 of MOSRTH specification	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification	SR			
ii		Rectification	As required	B	Physical	Each rectification	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH spec	SR	☐		
14.0	Geotechnical Investigation Work										

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i		Deployment of approved Geotechnical Investigation Agency – equipment, Manpower etc.	As required/ agreed	A	Physical	Once before commencement of work	As per Tech Specs and relevant IS Codes		SR	☐	
ii		Execution of Geotechnical Investigation – locations, type etc as per scheme.	As required/ agreed	B	Physical	Each location	As per Tech Specs and relevant IS Codes		SR	☐	
		Collection of disturbed and undisturbed samples, their packing and storage.	As required/ agreed	B	Physical	Each sampling	As per Tech Specs and relevant IS Codes		SR		
		Conducting filed tests as per investigation scheme – such as SPT/ERT /SCPT/PLT/PMT etc.	As required/ agreed	B	Physical	Each field test	As per Tech Specs and relevant IS Codes		SR		
		Submission of Field bore logs in approved format	As required/agreed	B	Review	Within 24 hours after completion of each BH	As per Tech Specs and relevant IS Codes		SR	☐	
		Submission if Laboratory test schedule and selection of samples for laboratory testing	As required/agreed	A	Review/ Acceptance	As per consultation with engineer during dispatch of samples ot approved laboratory	As per Tech Specs and relevant IS Codes		SR	☐	

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		ITEM : CIVIL WORK		QP No. :		1	PROJECT:	**1 x 8000 MW DCR Thermal Power Plant**		
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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
1	2	3		4	5	6	7	8	9 D*	10
		Submission of Final Geotechnical Investigation report along with recommendations.	As required/agreed	B	Physical	After completion of investigation work and review of draft reports	As per Tech Specs and relevant IS Codes		- ☐	
Manufacturer/ sub supplier	Main supplier	Legends to be used : Class # : A = Critical, B = Major, C = Minor, SR,TR,MTC Categorization Witnessing & Accepting by OWNER : Category 'A' FQA Engineer in association with Execution Engineer, Category 'B' Execution Engineer, Catagory 'C' Execution Engineer; SR = Site Register, TR = Test Report, MTC = Manufacturer's Test Certificate								
Signature		The document shall be read in conjugation with OWNER Tech. Specification, BOQ, Drawings					REVIEWED BY	APPROVED BY		APPROVAL SEAL

	SUPPLIERS NAME AND ADRESS:		**FIELD QUALITY PLAN**					**PROJECT: 1x8000 MW DCR Thermal Power Plant**		
			ITEM: Structural Steel Work (SITE FABRICATION , ERECTION)				**QP No. : 1**	**PACKAGE : EPC**		
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1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
1.00	**Structural Steel material**									
i	Procured by contractor	Structural steel procured from OWNER approved sources. Mechanical (YS,UTS,Elg, UT if specified). And chemical properties (CE as per IS	A	REVIEW	For each batch of each section delivered at site	Technical specification and construction Drawing, IS 2062,8500		SR	√	Correlated MTC shall be verified. In the event of non submission of MTC, sample shall be selected by FQA for testing
1.01	PRE-WELDING REQUIREMENT									
i		Welding Procedure Specification (WPS)	A	REVIEW	Each Welding Process	Technical specification and construction Drawing		WPS	√	To be approved by CQA
ii		PQR and Welder's Qualification	A	Physical	Each Welder (For WPQ)	PQR/WQR,AWS-D1.1/ASME-IX,IS:817, Technical Specification and construction drawings.		Test Reports	√	Ensure that the qualified welders and qualifying procedures are used for welding.
iii		Welding Consumables	B	Physical	Random in each shift	Approved WPS, OWNER Approved list of Electrodes.		S R	√	Ensure that the welding consumable are as per WPS and OWNER approved list of electrodes.
1.02	**FIT-UP**									

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
i		Marking and Cutting	Tape, ruler etc	B	visual and measurement	Each plate/Section	Technical specification and construction Drawings/ Approved cutting plan.		S R		
ii		Match markings for trial assembled components.		B	Physical	Each Fit Up	Technical specification and construction Drawing		S R		Ensure match markings are punched for all trial assembled components.
iii		Weld fit up - Edge preparation/Gap/Alignment	Tape , ruler , Bevel Protector etc	B	Physical	Each Fit Up	Technical specification , construction Drawing and IS 7215		S R	√	If reqd. suitable stiffners shall be provided to prevent deflection. Ensure that butt weld joint are properly aligned and the offset is not to exceed 5% of the thickness of Thinner part of the joint. Max. permitted value is 3.2mm.
1.03	**PRE-HEATING (where applicable)**										
i		Pre-Heating Temperature	Thermal chalk	B	Measurement	Each Pre heating	Technical specification and construction Drawing, approved WPS		S R	√	Ensure proper preheating temperature according to plate

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
											thickness as per specificatio n.
ii		Post weld Heat treatment (PWHT), if required	Thermocouple with the temperature recorder	A	Time & Temperature	Each PWHT	Technical specification and construction Drawing, approved WPS		S R	√	Ensure Post weld Heating carried where ever applicable.
1.04	**WELDING REQUIREMENTS**										
i		Sequence of welding		B	Physical	Random in each shift	Technical specification and construction Drawing, agreed scheme		S R		Ensure proper sequence of welding
ii		Removal / grinding of temporary attachment		B	Measurement	All cleats / attachments	Technical specification , construction Drawing and Approved Drgs.		S R		
iii		Completeness after welding dimensions /distortion	Weld gauge	B	visual	Each structure component	Technical specification and construction Drawing, IS 822		S R	√	
2.0	**NON DESTRUCTIVE AND DESTRUCTIVE TESTING**										
2.1	**FILLET WELDS**										
		size and visual	As required	B	Visual/		As per Technical specification , construction Drawing , IS 822 and	***SR***			As per requirement of

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
i		examination	/agreed		Measurement	100%	AWS D1.1				OWNER Engineer
ii		Micro- etch Examination on production test coupons	As required /agreed	B	Physical	Main Fillet weld with min one joint each for built up beam, columns and crane girders	As per Technical specification and construction Drawing, IS 822,AWS D1.1		***SR***	√	
iii		Dye Penetration Test	As required /agreed	B	Physical	25% weld length of tension member of crane girder and 5% of weld length with min.300mm at each location except crane girder to all other fillet welds.	As per Technical specification and construction Drawing, IS 822,AWS D1.1		S R		
2.2	**BUTT-WELDS**										
i		Visual examination	As required /agreed	B	Visual	Random in each shift	As per Technical specification and construction Drawing, IS 822,AWS D1.1		S R		As per requirement of OWNER Engineer
ii		DPT	As required /agreed	B	Physical	100% on all butt welds after back gouging on root run and 10% on final	As per Technical specification and construction Drawing, IS 822,AWS D1.1		I R		All Butt welds to be back gouged before DPT.

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
						welds.					
iii		Mechanical testing on production test coupon	As required /agreed	B	Physical	Min one joint each for built up beams, columns and crane girder.	As per Technical specification and construction Drawing, IS 822,AWS D1.1		I R	√	Test on production test coupons.
iv		Radiography Test	As required /agreed	A	Physical	100%radiography test on butt welds of tension flange of crane girder. All other butt welds shall be subjected to 10% weld length of each welder	As per Technical specification and construction Drawing, IS 822,AWS D1.1		IR	√	Where RT is not feasible UT to be carried out. In case of failure of any welds in SPOT/RT or UT the % of retesting shall doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.
2.3	**COAL BUNKER/BINS**										
		I) DPT	As required /agreed	B	Physical	10% DPT after back gouging	As per Technical specification and construction Drawing, IS 822,AWS D1.1		IR		
		ii) Spot radiography	As required			5% spot RT on butt welds	As per Technical specification and construction Drawing, IS				Where access not available UT

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
		test on butt welds	/agreed	A	Physical		822,AWS D1.1		IR	√	shall be carried out with prior approval of Engineer in charge.
2.4	**FULL PENETRATION WELDS (OTHER THAN BUTT WELDS)**										
		Ultrasonic testing	As required /agreed	**A**	Physical	i) 100% UT on web to flange joint of crane girder. ii) 10% UT on the other full penetration joints	As per Technical specification and construction Drawing, IS 822,AWS D1.1		IR	√	In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at the particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.
3.0	**Foundation checks**										
i		Dimensions and levels- Shape, lines (including diagonal checks)	Theodolite, tape, plumb, piano wires, etc	B	Physical /Measurement	Each foundation	As per Technical specification and construction Drawing,		SR	√	
ii		Foundation Bolts and Embedment's- Verticality. Levels, pitch distance	Theodolite, tape, plumb, piano wires, etc	B	Physical /Measurement	Each foundation	As per Technical specification and construction Drawing,		SR	√	
4.0	**PRE-ASSEMBLY CHECKS**										

	SUPPLIERS NAME AND ADRESS:		**FIELD QUALITY PLAN**					**PROJECT: 1x8000 MW DCR Thermal Power Plant**			
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			SUB-SYSTEM: FABRICATION & ERECTION				**DATE :**	**CONTRACT No. : ----**			
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S. No.	**Activity and operation**	**Characteristics/ Instruments**	**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**	
I		Punch Erection marks and match marks on members	B	Visual/ Physical	Each structural member	As per Technical specification and construction Drawing,				Markings for- Assembly designation, part number, weight, any other important identifications.	
ii		Pre-Assembly as per match mark	B	Visual/ Physical	Each structural member	As per Technical specification and construction Drawing,					
iii		Camber, sweep and total length after trial assembly of structure.	Theodolite, tape, plumb, piano wires, etc B	Visual/ Physical	Each structural member	As per Technical specification and construction Drawing,		SR	√		
iv		Control assembly check at shop.	Theodolite, tape, plumb, piano wires, etc	B	Visual/ Physical	Every first and tenth set of identical structure	As per Technical specification and construction Drawing,				
5.00	**ROOF TRUSS PREASSEMBLY CHECKS BETWEEN ROWS**										
i		Ensure roof trusses are pre assembled as per match mark and CG line punched on top and bottom angles	Theodolite, tape, plumb, piano wires, etc	B	Measurement	Each structural member	As per Technical specification and construction Drawing,				
ii		CAMBER	Theodolite, tape, plumb, piano wires, etc	B	Visual/Physical	Each structural member	As per Technical specification and construction Drawing,				

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1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
iii		SWEEP	Theodolite, tape, plumb, piano wires, etc	B	Visual/ Physical	Each structural member	As per Technical specification and construction Drawing,				
iv		Alignment of CG line punch mark given on the top & bottom angles, permitted deviation in C.G line matching is +/-5mm	Tape, plumb, piano wires, etc	B	Visual/Physical	100%	As per Technical specification and construction Drawing,				
v		Horizontal level of assembled roof truss with water level with respect to centre line punch mark on end gusset plate face permitted deviation +/-5mm	Tape, plumb, piano wires, etc	B	Visual/ Physical	100%	As per Technical specification and construction Drawing,				
vi)		Total length of assembled roof truss between faces of end gusset plates at top & bottom (Permitted deviation is +/-	Tape, plumb, piano wires, etc	B	Visual/ Physical	100%	As per Technical specification and construction Drawing,				

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1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
		5mm)									
vii)		End plates are aligned and in one plane on both ends.	Tape, plumb, piano wires, etc	B	Visual/ Physical	100%	As per Technical specification and construction Drawing,				
6.00	**ERECTION CHECKS**										
i		Alignment, slopes, level, tolerance of erected member.	Theodolite, tape, plumb, piano wires, etc	B	Measurement	ach structural member	As per Technical specification and construction Drawing,		SR	√	
ii		Tightening of bolts/Torque including foundation bolts with lock nuts.	Wrench/Torque wrench if specified	B	Visual/Physical	ach structural member	As per Technical specification and construction Drawing, IS: 7215 and IS: 12843		SR	√	
iii		Acceptance of erected structure	Theodolite, tape, plumb, piano wires, etc	B	Visual/Physical	ach structural member	As per Technical specification and construction Drawing, IS: 7215 and IS: 12843		SR	√	
7.00	**PAINTING SYSTEM**										
i		Painting materials and accessories.		A	Review of MTC	Each batch of delivery	As per Technical specification and construction Drawing,		SR/ MTC	√	Mfr's T.C shall be correlated with the consignment received
ii		Submission of Painting		B	For review of painting system	Before start of painting work	As per Technical specification and construction Drawing				

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1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
		methodology.									
iii		Surface preparation	As required /agreed	B	Visual/ Physical	Each erection mark	As per Technical specification and construction Drawing, Relevant code/Standards.		SR	√	
iv		Primer Thickness	Elcometer	B	Measurement	Each erection mark	As per Technical specification and construction Drawing,		SR	√	
v		DFT (Dry Film Thickness) of paint	Elcometer	B	Visual/ Measurement	Each erection mark	As per Technical specification and construction Drawing,		SR	√	
vi		Acceptance of paint surface	Elcometer	B	Visual/Measurement	Each erection mark	As per Technical specification and construction Drawing,		S R		
8.00	**PERMANENT BOLTS , NUTS AND WASHER**										
I		Material- permanent MS bolts, MS nuts, High strength structural bolts, washers- Dimensions, properties, class, storage along with MTC	Screw gauge, Vernier, tape, etc.	A	Physical and Review of MTC.	Once of each lot of delivery	As per Technical specification and construction Drawing,		SR/MTC	√	
ii		Contact surface before bolting		B	Physical	Random before asembly for bolting	As per Technical specification and construction Drawing,IS-4000		SR		
		Inspection of asembeled bolts				Random in each	As per Technical specification and				

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1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
iii				B	Physical	shift for assembled bolt.	construction Drawing,IS-4000		SR		
iv		Tensioning	As required /agreed	B	Physical	Randomly during snug tight test and after full tensioning	As per Technical specification and construction Drawing,IS-4000		SR	√	
v		Acceptance of installed bolts		B	Physical	Each bolts	As per Technical specification and construction Drawing		SR		
9.0	**ELECTROFORGED GRATINGS**										
I		Material from approved source	As required /agreed	A	Physical and Review of MTC.	Once for each lot of delivery	As per Technical specification and construction Drawing		SR/MTC	√	Also referred the Approved MQP
ii		Acceptance of erection alignment and each installation.	As required /agreed	B	Physical	100%	As per Technical specification and construction Drawing		SR		
10.00	**GALVANISED STEEL HAND RAILS**										
i		Materials		A	Physical and Review of MTC.	Once for each lot of delivery	As per Technical specification and construction Drawing Galvanised as per IS: 4736,IS:2062		SR/LB	√	Galvanizing shall be carried out as per the technical specifications.
ii		DPT	As required /agreed	A	Physical	Random	As per Technical specification , AWS D1.1		SR/LB	√	
11.	**Permanently colour coated sheets, metal decking**										

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S. No.	**Activity and operation**	**Characteristics/ Instruments**		**Class # of check**	**Type of Check**	**Quantum of Check**	**REFERENCE DOCUMENTS & ACCEPATNCE STANDARD**	**Acceptance Norms**	**FORMAT OF RECORD**		**REMARKS**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**D***	**10**
i)		STORAGE	As required /agreed	B	Visual	Random in each shift	Tech Specs and Construction drgs		SR	√	Prevention of distortion/blemishing/ water staining
ii)		Installation lap alignment & workmanship	As required /agreed	B	Visual/ Physical	Random in each shift	Tech Specs and Construction drgs		SR		No gas cutting of sheets acceptable.FQP for structural steel shall also be acceptable.
iii)		Finishing and acceptance	As required /agreed	B	Visual/ Physical	Random in each shift	Tech Specs and Construction drgs		SR/LB		Experience workers under supervisors recommended/ appointed by manufacturer to be deployed.
12.	INSULATION WORKS										
i)	Materials	Insulation material, galvanised wire net, aluminum foil ,fasteners.	As required /agreed	A	EIC Approved source and review of MTC/test report.	For each lot at site	Tech Specs and Construction drgs		SR/LB	√	All test as per specification.
13.00	**PTFE, Sliding Bearing and Elastomeric Bearings**										
i		Check for the material from approved source	As agreed/ required	A	Physical and MTC Review	Once for each lot of delivery	Tech. Spec and Const. Drawings		SR/ MTC	√	
ii		Acceptance of installation of bearings	As agreed/ required	B	Physical	Each Installation	Tech. Spec and Const. Drawings		SR		

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1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		**10**	
		LEGEND : D*-Records identified with "Tick"(√) shall be essentially included by supplier in QA documentation									
		Legend to be used: class # A = Critical, B = Major, C=Minor, SR, TR, MTC, LB									
	Main Supplier	Categorization witnessing & accepting (as per Owner QA & I system) Category 'A' FQA Engineer in association with executing Engineer, Category 'B' Executing Engineer, Category 'C' Executing Engineer, SR = Site Register, TR = Test Report, Mfr TC = Manufacturer's Test Certificate									
		This document shall be read conjunction with OWNER Tech. Specifications, BOQ, Drawing									
Manufacturer/ Sub supplier	Signature							For OWNER USE	Reviewed by	Approved by	Approval Seal

HPGCL

HARYANA POWER GENERATION CORPORATION LIMITED

1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR, HARYANA

EPC PACKAGE TENDER SPECIFICATION

VOLUME - II

GENERAL & SCHEDULES

PART B

Job No	D - 4041	Name / Sign	Date	
Prepared By		BHS/EVA/VNG/GR	24.12.2022	
Checked By		BHS/EVA	24.12.2022	
Approved By		BHS	04.01.2023	
Document No.		4100	REV. No.	0

SELF-RELIANCE IN ENGINEERING
DESEIN

DESEIN PRIVATE LIMITED
DESEIN HOUSE,
GREATER KAILASH – II.
NEW DELHI – 110 048

CONTENTS : GENERAL & SCHEDULES

PART -B

SCHEDULE – A

KEY INFORMATION

1.0	Bidder's Name and Address:	:	
2.0	Details of the responsible officer, to whom all correspondences regarding this proposal shall be made:		
	a) Name	:	
	b) Designation	:	
	c) Address	:	
	d) Telephone No.	:	
	e) Fax No.	:	
	f) E-mail address	:	
3.0	Indian Agent, if any:		
	a) Name	:	
	b) Address	:	
	c) Responsible officer:		
	i) Name	:	
	ii) Designation	:	
	iii) Address	:	
	iv) Telephone No.	:	
	v) Fax No.	:	
	vi) E-mail address	:	
4.0	Proposal Number & Date	:	

Signature :

Name :

Designation :

Date :

Seal of Company

STEAM GENERATOR & AUXILIARIES

S No.	Description	Unit		
1.0	**STEAM GENERATOR PRESSURE PARTS**			
1.1	**GENERAL**			
i.	Manufacturer			
ii.	Location			
iii.	Design code			
iv.	Type of steam generator			
v.	Type of firing			
vi.	Minimum load at which steam generator can be operated continuously with complete flame stability without oil support	% of BMCR		
vii.	Minimum load at which the Steam Generator can be operated continuously with complete flame stability with oil support	% of BMCR		
viii.	Fuel oil for start-up			
ix.	Maximum continuous output with one FD fan and one ID fan in operation	TPH		
x.	Minimum Steam Generator load at which the 1st mill is to be introduced	TPH		
xi.	Percentage load change per minute from 100% MCR downwards, without exceeding limits on unburnt combustibles or NOx while maintaining safe flame conditions			
			Coal	Oil
xii.	(a) Acid dew point temperature			
	(b) Margin over the acid dew point temperature adopted			
1.2	**FURNACE**			
i.	Type			
ii.	Explosion/implosion withstand capacity at 67% yield point	mmWC		
iii.	Residence time in the furnace (between middle level burner and platen entry)			
iv.	Furnace Size			
(a)	Height from top of furnace bottom ash hopper to furnace roof	m		
(b)	Depth	m		
(c)	Width	m		
v.	Furnace area			
(a)	Plan area	M^2		

S No.	Description	Unit			
(b)	EPRS (effective projected radiant surface)	M^2			
	Bidder should indicate the break-up of total EPRS area in different water walls, SH and RH panels location wise				
vi.	Furnace volume	M^3			
vii.	Furnace Performance Data (Bidder to give separate data for design, worst and best coals in the same format given below)		Best Coal	Design Coal	Worst Coal
viii.	Furnace volume heat release rate (BMCR)	KW/m^3			
ix.	Furnace plan area heat release rate (BMCR)	kW/m^2			
x.	Effective projection radiation heating surface heat release rate of the furnace (EPRS) (BMCR)	kW/m^2			
xi.	Burner zone heat release rate (BMCR)	kW/m^2			
xii.	Furnace Exit Gas Temperature, FEGT (BMCR)	°C			
xiii.	Designed pressure ofthe furnace	mmwc			
xiv.	Total heat duty	Kcal/hr			
xv.	Efficiency	%			
xvi.	Furnace gas temperature at inlet of convective zone	°C			
xvii.	Gas velocity in Furnace (1^{st} pass)	m/s			
xviii.	Gas velocity in convective zone (2^{nd} pass)	m/s			
1.3	**WATER WALLS-FRONT, REAR & SIDEWALLS, REAR WALLS ROOF**				
i.	Number				
ii.	Outside diameter	mm			
iii.	Design thickness	mm			
iv.	Pitch	mm			
v.	Design standard				
vi.	Material				
vii.	Design metal temperature				
viii.	Design pressure of tubes	Kg/cm2(a)			
ix.	Elevation of slag notch of the furnace hopper	m			
x.	Elevation of upper edge of the furnace hopper	m			
xi.	Designed pressure of spiral coil water wall	Kg/cm2(a)			
xii.	Mass flow rate of spiral coil water wall	$Kg/m^2.s$			
xiii.	Tube type of spiral coil water wall tube (Plain/rifled)				
xiv.	Spiral coil water wall tube outside diameter × wall thickness	mm x mm			

S No.	Description	Unit	
xv.	Tube spacing of spiral coil water wall tube	mm	
xvi.	Material of spiral coil water wall tube		
xvii.	Elevation of upper header center of spiral coil	m	
xviii.	Heating area spiral coil water wall	m^2	
xix.	Design pressure of vertical coil water wall	Kg/cm2(a)	
xx.	Tube type of vertical coil water wall tube (Rifled/plain)		
xxi.	Vertical coil water wall tube outside diameter × wall thickness	mm x mm	
xxii.	Tube spacing of vertical coil water wall tube	mm	
xxiii.	Material of vertical coil water wall tube		
xxiv.	Heating area of vertical coil water wall	m^2	
xxv.	Total heating area of the water cooled wall	m^2	
xxvi.	Water volume of water wall	m^3	
1.4	**WATER WALL HEADERS**		
i.	Outside diameter	mm	
ii.	Design thickness	mm	
iii.	Design standards		
iv.	Design pressure of header	Kg/cm2(a)	
v.	Material specification		
1.5	**STEAM-WATER SEPARATOR (s)**		
i.	Number		
ii.	Material Specification and composition		
iii.	Design metal temperature	°C	
iv.	Design pressure	Kg/cm2(a)	
v.	Design standard		
vi.	Design thickness for straight portion	mm	
vii.	Design thickness for dished ends	mm	
viii.	Overall length of separator	mm	
ix.	Outside diameter of separator	mm	
x.	Maximum permissible temperature differential between any two parts of the separator	°C	
(a)	During normal operation		
(b)	During accelerated starting		
xi.	Water capacity at MCR conditions between normal and lowest water level permitted		

S No.	Description	Unit	
1.6	**SUPERHEATER**		
	Following details shall be furnished for each individual section of super heater		
i.	Type		
(a)	Radiant/convention		
(b)	Drainable/non-drainable		
ii.	Number of tubes		
iii.	Outside diameter & thickness	mm x mm	
iv.	Material specification and composition		
v.	Maximum steam side metal temperature	°C	
vi.	Maximum gas side metal temperature	°C	
vii.	Design pressure	Kg/cm2(a)	
viii.	First stage spray desuperheating water quantity of the super heater (BMCR)	t/h	
ix.	Second stage spray desuperheating water quantity of the super heater (BMCR)	t/h	
x.	Surface area of super heater	m^2	
a)	SH-1	m^2	
b)	SH-2	m^2	
c)	SH-3	m^2	
d)	SH-4	m^2	
e)	SH-5	m^2	
f)	SH-6 (if applicable)	m^2	
g)	Final SH	m^2	
xi.	Flue gas temperature at the front part of the last stage super heater	°C	
xii.	Flue gas temperature at the rear part of the last stage super heater	°C	
xiii.	Flue gas temperature at the bottom part of the last stage super heater	°C	
xiv.	Lowest load for keeping rated main steam temperature	%	
xv.	Total pressure drop of the super heater (BMCR)	Kg/cm2(a)	
xvi.	Outside diameter, inner diameter, pitch, average flue gas velocity, material, and applicable temperature limit of each stage of super heater		(Please furnish as per Table-1)

S No.	Description	Unit		
xvii.	Maximum calculated steam temperature, calculated metallic wall temperature, wall temperature at highest temperature point, of each stage of super heater		(Please furnish as per Table-1)	
xviii.	Direction of flow (counter or parallel)			
	Material of tube support (Composition)			
1.7	**REHEATER**			
i.	Type			
ii.	Number of tubes			
iii.	outside diameter/thickness	mm x mm		
iv.	Material composition			
v.	Reheater Steam flow (BMCR)	t/h		
vi.	Design pressure	$Kg/cm^2(a)$		
vii.	Inlet pressure of the reheater (BMCR)	Kg/cm2(a)		
viii.	Outlet pressure of the reheater (BMCR)	Kg/cm2(a)		
ix.	Inlet temperature of the reheater (BMCR)	°C		
x.	Outlet temperature of the reheater (BMCR)	°C		
xi.	Total heating area of the reheater	m^2		
xii.	Total pressure drop across reheater (BMCR)	Kg/cm2(a)		
xiii.	Outside diameter, inner diameter, pitch, average flue gas velocity, material, consumption of the material, and applicable temperature limit of reheater		(Please furnish as per Table-2)	
xiv.	Lowest load at rated reheating steam temperature	%		
xv.	Maximum calculated steam temperature, calculated metallic wall temperature, wall temperature at highest temperature point of reheater (As per Table-2)		(Please furnish as per Table-2)	
xvi.	Main temperature regulating mode			
1.8	**HEADERS**		Super heater (s)	Reheater
i.	Number			
ii.	Material specification			
iii.	Design pressure	$Kg/cm^2(a)$		
iv.	Design temperature	°C		
v.	Design standard			

S No.	Description	Unit	
vi.	Outside diameter & thickness	mm x mm	
1.9	**SUPERHEATER TEMPERATURE CONTROL**		
i.	Type		
ii.	Number of stages of attemperation		
iii.	Position in steam circuit		
iv.	Specification of material		
v.	Super heater steam temperature that can be maintained between 50% of TMCR to 100% of BMCR	°C	
vi.	Method of Super heater Temperature Control		
1.10	**REHEATER TEMPERATURE CONTROL**		
	TILTING BURNERS	Yes / No	
i.	Maximum angle of tilt upwards		
ii.	Maximum angle of tilt downwards		
iii.	Type of tilt mechanism		
iv.	Reheat steam temperature that can be maintained between 60% TMCR to 100% BMCR	°C	
1.11	**ECONOMISER**		
i.	Type (Plain, Drainable, Non steaming, inline tube arrangement)		
ii.	Material specification and composition		
iii.	Number of tubes		
iv.	Gas side effective heating surface area	m^2	
v.	Provision made for economiser on load cleaning		Yes / No
vi.	Inlet flue gas flow rate (BMCR)	m^3/min	
vii.	Outlet flue gas flow rate (BMCR)	m^3/min	
viii.	Design pressure of tubes (BMCR)	Kg/cm^2(a)	
ix.	Outside diameter of tubes & tube thickness used	mm mm	
x.	Designed inlet temperature (BMCR)	°C	
xi.	Designed outlet temperature (BMCR)	°C	
xii.	Maximum gas side metal temperature	°C	
xiii.	Maximum water side metal temperature	°C	
xiv.	Minimum temperature of feed water that economiser can handle safely	°C	

S No.	Description	Unit	
1.12	**ECONOMISER HEADERS**		
i.	Design thickness	mm	
ii.	Outside diameter	mm	
iii.	Outside diameter of the economizer pipe	mm	
iv.	Inner diameter of the economizer pipe	mm	
v.	Pitch of the economizer pipe	mm	
vi.	Arrangingmode ofthe economizer pipe		
vii.	Design standard		
viii.	Maximum metal temperature	°C	
ix.	Design pressure	$Kg/cm^2(a)$	
1.13	**STEAM GENERATOR INTEGRAL PIPING, VALVE AND SPECIALITIES**		
i.	Following information shall be furnished for each category of piping included under the section Steam Generator and Accessories specification		
(a)	Service		
(b)	Piping and fittings		
(c)	Design code		
(d)	Material of construction		
(e)	Design pressure & temperature	$Kg/cm^2(a)$ & °C	
(f)	Velocity of flow		
ii.	Following information shall be furnished for each category of valves included in the said section of specification		
iii.	Service		
iv.	Type		
v.	Design pressure & temperature	$Kg/cm^2(a)$ & °C	
vi.	Material of construction Body, Trim etc		
vii.	Type of Operator (Manual/hydraulic/Electric/ pneumatic etc)		
1.14	**SAFETY VALVES**		
i.	Locations/Service		
ii.	Manufacturer		
iii.	Type and rating		
iv.	Number of safety valve of the superheater	set	
v.	Number of outlet safety valve of the reheater	set	

S No.	Description	Unit	
vi.	Specification of material		
(a)	Body		
(b)	Trim/spring		
(c)	Seat		
vii.	Set pressure	Kg/cm² (a)	
viii.	Flow capacities	Kg/hr	
2.0	**STEAM GENERATOR AUXILIARIES**		
2.1	**AIR HEATER**		
i.	Type and manufacturer		
ii.	Number		
iii.	Maximum handling capacity	Nm³/hr	
(a)	Flue Gas		
(b)	Air		
iv.	Handlingcapacity at 100% BMCR	Nm³/hr	
(a)	Flue Gas		
(b)	Air		
v.	Inlet flue gas temperature (BMCR)	°C	
vi.	Outlet flue gas temperature (BMCR)	°C	
vii.	Air		
a)	Inlet air temperature (BMCR)	°C	
b)	Primary air outlet temperature (BMCR)	°C	
c)	Secondary air outlet temperature (BMCR)	°C	
d)	Air leakage ratio of air preheated when putting into operation and after one year of operation		
viii.	Cleaning arrangement		
ix.	Design Flue gas temperature at air heater cold end	°C	
x.	Acid dew point adopted	°C	
xi.	Air heater heating surface	m²	
xii.	Thickness of the heat transfer element in high temperature range	mm	
xiii.	Thickness of the heat transfer element in intermediate temperature range	mm	
xiv.	Thickness of the heat transfer element in low temperature range	mm	
xv.	Gas velocity	m/s	
xvi.	Gas flow area	m²	
xvii.	Air flow area	m²	
xviii.	Area of the heat transfer element in high temperature range	m^2	

S No.	Description	Unit	
xix.	Area of the heat transfer element in intermediate temperature range	m^2	
xx.	Area of the heat transfer element in low temperature range	m^2	
xxi.	Rotational speed	rpm	
xxii.	Rotor speed of the air preheater	rpm	
xxiii.	Electric motor drive		
a)	Number of the motor in the automatic electronic control sealing system		
b)	Power of the motor in the automatic electronic control sealing system	kW	
xxiv.	Auxiliary motor		
a)	Power Rating	kW	
b)	Speed	rpm	
xxv.	Emergency drive		
xxvi.	Speed reducer		
xxvii.	Seals		
a)	Type		
b)	Materials of construction		
xxviii.	Material of the heat transfer element in high temperature range		
xxix.	Material of the heat transfer element in intermediate temperature range		
xxx.	Material of the heat transfer element in low temperature range		
xxxi.	Type of coupling		
xxxii.	Lubricating system		
xxxiii.	Air Heater leakage		
2.2	**STEAM COIL AIR PREHEATER**		
i.	Type		
ii.	Number		
iii.	Steam Pressure	Kg/cm^2	
iv.	Steam Temperature	°C	
v.	Air inlet temperature	°C	
vi.	Air outlet temperature	°C	
vii.	Quantity of Steam corresponding to design air flow	Kg/hr	
viii.	Effective Surface area	m^2	
ix.	Air flow	m^3/min	
x.	Primary air at the inlet of the air preheater	Nm^3/hr	
xi.	Secondary air at the inlet of the air preheater	Nm^3/hr	
xii.	Primary air at the outlet of the air preheater	Nm^3/hr	

S No.	Description	Unit	
xiii.	Secondary air at the outlet of the air preheater	Nm^3/hr	
2.3	**STEAM GENERATOR CIRCULATION PUMP**		
i.	Number of pumps operating		
ii.	Number of pumps standby		
iii.	Total circulation	TPH	
iv.	Circulation per pump	TPH	
v.	Location of pumps		
vi.	Pump speed	rpm	
vii.	Pump design capacity	TPH	
viii.	Suction pressure at rated capacity	$Kg/cm^2(a)$	
ix.	Discharge pressure at rated capacity	$Kg/cm^2(a)$	
x.	Total dynamic head	Kg/cm^2	
xi.	Maximum discharge pressure	Kg/cm^2	
xii.	NPSH available	MLC	
xiii.	NPSH required	MLC	
xiv.	Pump efficiency at design point	%	
xv.	Pump brake horse power	KW	
xvi.	Power consumption at design point	KW	
xvii.	Power consumption at shut off condition	KW	
xviii.	Pumps type		
xix.	Nozzle Orientation		
a)	Suction		
b)	Discharge		
xx.	Motor Type		
xxi.	Liquid Data		
a)	Liquid temperature	°C	
b)	Chemical composition		
xxii.	Material of Construction		
a)	Pump casing		
b)	Casing ring		
c)	Impeller		
d)	Shaft		
e)	Journal bearing		
f)	Motor housing cover		
g)	Thrust disc		
h)	Thrust bearing pads		
i)	Bearing sleeves		
j)	Motor housing		
k)	Stator		
l)	Rotor		
m)	Heat barrier		
n)	Bolt		
o)	Nut		

S No.	Description	Unit		
2.4	**DRAFT PLANT**		**Forced Draft Fans**	**Induced Draft Fans**
i.	Type			
ii.	Manufacturer			
iii.	Number of fans			
iv.	Number of blades/fan			
v.	Number of Air Inlets			
vi.	Cooling Water Consumption	t/hr		
vii.	Rating			
a)	Capacity	m^3/min		
b)	Pressure	mmWC		
c)	Efficiency at normal capacity	%		
d)	Motor rating	kW		
e)	Temperature	°C		
viii.	Test block rating			
a)	Capacity	m^3/min		
b)	Pressure	mmWC		
c)	Efficiency at normal capacity	%		
d)	Motor rating	kW		
e)	Temperature	°C		
ix.	Normal speed	rpm		
x.	Direction of rotation facing fan coupling (clockwise or anticlockwise)			
xi.	Impeller diameter	mm		
xii.	Shaft diameter	mm		
xiii.	Design tip speed of blades	m/s		
xiv.	Size of motor	kW		
xv.	Type of coupling/Material			
xvi.	Lubrication system for fan (forced/ring lubrication)			
xvii.	Lubrication system for motors (forced/ring lubrication)			
xviii.	Features of construction			
a)	Mode of gas flow control			
b)	Range of control			
c)	Blade angle variation			
xix.	Material of construction and thickness			
a)	Casing			
b)	Impeller blade			
c)	Inlet cone			
d)	Outlet diffuser			
e)	Impeller hub/shroud			
f)	Impeller wear plate (If any)			
g)	Inlet vane			
xx.	Bearings			
a)	Numbers and make			
b)	Type of bearings			
c)	Method of lubrication			
xxi.	Shaft sealing arrangement number, make and type			

S No.	Description	Unit	
xxii.	Minimum load of fan at which it can operate in parallel		
2.5	**SOOT BLOWERS**		
	Soot blower data furnished as per Table- 4		Yes / No
2.6	**PRESSURE REDUCING AND DESUPERHEATING STATION FOR AUXILIARY STEAM**		
i.	Pressure Reducing Valves		
a)	Location		
b)	Number of valves		
c)	Flow capacity of each valve	TPH	
d)	Type of valve		
e)	Body design		
	• Pressure	Kg/cm² (a)	
	• Temperature	°C	
ii.	Desuperheaters		
a)	Location		
b)	Type		
c)	Flow capacity	TPH	
d)	Desuperheating water		
	• Pressure	Kg/cm² (a)	
	• Temperature	°C	
	• Quantity	Kg/hr	
iii.	Pressure control valves (on spray water line)		
a)	Location		
b)	Number of valves		
c)	Body design		
	(i) Pressure	Kg/cm² (a)	
	(ii) Temperature	°C	
iv.	Temperature control valves (on spray water line)		
(a)	Location		
(b)	Number of valves		
(c)	Flow capacity of each valve	TPH	
(d)	Body design		
	• Pressure	Kg/cm² (a)	
	• Temperature	°C	
2.7	**BLOW DOWN VESSELS**		
i.	Number		
ii.	Design Code		
iii.	Design Pressure	Kg/cm2(a)	
iv.	Design Temperature	°C	
v.	Shell thickness	mm	
vi.	Corrosion allowance	mm	
2.8	**RAW COAL FEEDER**		

S No.	Description	Unit			
i.	Type				
ii.	Number				
iii.	Feeder inlet size	mm x mm			
iv.	Rated capacity	TPH			
v.	Method of output control				
vi.	Rated power	kW			
vii.	Motor rating	kW			
2.9	**PULVERISERS**				
i.	Type & Manufacturer				
ii.	Number				
iii.	Number working at BMCR with specified fineness of pulverized coal (70%) through 200 mesh and 98% through 50 mesh				
iv.	Mill speed	RPM			
v.	Maximum feed size to mill				
vi.	Capacity of each mill	TPH			
vii.	Main drive motor rating and rpm	kW & rpm			
viii.	Type of drive transmission				
ix.	Type of coupling				
x.	Whether the following accessories are provided				
a)	Coupling guards				
b)	Seals for mills (specify)				
c)	Lube oil coolers and pumps				
d)	Distributor at outlet of each classifier				
e)	Coal fineness sampling devices				
2.10	**PULVERISED COAL PIPING**				
i.	Outside diameter of the straight portion	mm			
ii.	Thickness of the straight portion	mm			
iii.	Material of the straight/bend portion				
iv.	Material of the liners				
v.	Pulverised coal piping number per mill				
vi.	Estimated life of pulverised coal pipes	Hrs			
vii.	Minimum and maximum velocities of the coal air mixture in the coal pipes	m/s			
viii.	Average life of the Rollers/ Grind rolls & bottom race liners before replacement				
2.11	**PRIMARY, SEAL AND SCANNER AIR FAN**		Primary air fan	Seal air fan	Scanner air fan
i.	Type				

S No.	Description	Unit			
ii.	Manufacturer				
iii.	Number of fans				
iv.	Arrangement				
v.	Rating				
a)	Capacity	M^3/min			
b)	Head	mmWC			
c)	Efficiency	%			
vi.	Test Block				
a)	Capacity	M^3/min			
b)	Head	mmWC			
vii.	Source of air supply				
viii.	Normal speed				
ix.	Direction of rotation facing fan coupling (clockwise or anticlockwise)				
x.	Impeller diameter	mm			
xi.	Shaft diameter	mm			
xii.	Size of motor	kW			
xiii.	Method of lubrication				
a)	For fans				
b)	For motors				
xiv.	Mode of air flow control adjustment				
xv.	Material of construction				
a)	Casing				
b)	Impeller blades				
c)	Inlet cone				
d)	Outlet diffuser				
e)	Coupling				
xvi.	Shaft sealing arrangement				
xvii.	Air temperature				
2.12	**COAL BURNERS**				
i.	Type				
ii.	Burner outlet diameter				
iii.	Quantity of the burner (number of each row × layer number)				
iv.	Height of the burner group	m			
v.	Overfire Air (OFA) elevation – 1	m			
vi.	Overfire Air (OFA) elevation – 2	m			
vii.	Overfire Air (OFA) elevation – 3 (If applicable)	m			
viii.	Overfire Air (OFA) elevation – 4 (If applicable)	m			
ix.	Dimension from lower layer burner center to main furnace hopper upper edge	m			
x.	Oil gun types for ignition and low load				
xi.	Equipped quantity of oil gun				

S No.	Description	Unit		
xii.	Distance from the center of highest row burner to lower end of the panel	m		
xiii.	Distance from the center of highest row burner to the furnace roof	m		
xiv.	No. of coal burners fed by each pulveriser			
xv.	Arrangement and number of elevations of burners			
xvi.	Total number of coal burners			
xvii.	No. of coal burners in operation up to 100% BMCR giving their locations and tilt			
xviii.	Position of burners in furnace			
	Burner -1			
	Burner -2			
	Burner -3			
	Burner -4			
	Burner -5			
	Burner -6			
	Burner-7			
	Burner -8			
xix.	Design data			
a)	Temperature of coal air mixture	°C		
b)	Turn down ratio			
c)	Temperature of hot combustion air	°C		
d)	Capacity of each burner at MCR	TPH		
e)	Velocity of secondary air at entry to burner	m/s		
xx.	Construction features			
a)	Angle of fuel entry (fixed/ variable)			
b)	Mode of adjustment of combustion air			
xxi.	Material of construction			
a)	Coal burner nozzle			
xxii.	Whether the following accessories are provided (State Yes/No)			
a)	Drive for tilting coal burners and for damper			
b)	Flexible connection between coal pipe and burner			
2.13	**OIL BURNERS**		Heavy Fuel Oil	Light Diesel Oil
i.	Type			
ii.	Number of oil burners			

S No.	Description	Unit		
iii.	Elevation of burners			
iv.	Atomising medium			
v.	Atomization pressure required	Kg/cm²		
vi.	Scavenging medium			
vii.	Temperature of oil at burner inlet	°C		
viii.	Atomising steam			
a)	Maximum flow rate	Kg/hr		
b)	Pressure range	Kg/cm²		
ix.	Atomising air			
a)	Maximum flow rate	Nm³/hr		
b)	Pressure range	Kg/cm²		
x.	Turndown ratio			
xi.	Combustion air temperature			
xii.	Capacity of each burner	(Kg/hr)		
xiii.	Maximum heat input per burner	Kcal/hr		
xiv.	Material of construction			
a)	Oil burner mixing plate/spray plate			
b)	Diffuser			
c)	Concentric tubes			
d)	Burner body			
e)	Burner tip			
2.14	**FUEL OIL IGNITORS**			
i.	Type			
ii.	Number of ignitor			
iii.	Capacity			
iv.	Retractable or stationary			
3.0	**INSULATING MATERIAL PROPOSED**			
i.	Type of insulating material			
ii.	Maximum temperature the insulating material can withstand	°C		
iii.	Insulating material standard			
iv.	Density of insulating material	Kg/m³		
4.0	**EQUIPMENT WEIGHTS**	tonnes		
i.	Supporting structure			
ii.	Galleries and stairways			
iii.	Interconnecting platforms			
iv.	Steam-Water separator			
v.	Separator Drain Tank			
vi.	Water walls			
vii.	Super heater			
viii.	Reheater			
ix.	Desuperheaters			
x.	Economiser			

S No.	Description	Unit	
xi.	Valves & fittings		
xii.	Air preheaters		
xiii.	Steam coil air preheater		
xiv.	Covering & insulation material for steam generator and other equipment		
xv.	Fabricated components for insulation of steam generator Equipment		
xvi.	Skin casing (if applicable)		
xvii.	Internal oil lines		
xviii.	FUEL OIL BURNERS		
a)	Heavy oil		
b)	Light oil		
	Igniter/Scanner air system		
xix.	Coal burners		
xx.	Coal piping		
xxi.	Cold air ducts		
xxii.	Hot air ducts		
xxiii.	Flue ducts		
xxiv.	Other ducting		
xxv.	Soot ducting		
xxvi.	Soot blowing equipment		
xxvii.	Pulverisers		
xxviii.	Pulveriser group piping		
xxix.	Fabricated components for insulation of milling system		
xxx.	Insulation of milling system		
xxxi.	ID fans with drives		
xxxii.	FD fans with drives		
xxxiii.	PA fans with drives		
xxxiv.	Other fans with drives		
xxxv.	Mill reject/disposal system		
xxxvi.	Coal feeder		
xxvii.	Fan duct		
xxviii.	Platforms and rails		
xxxix.	Supporting structure for flue gas system		
xl.	Dampers/Vanes		
xli.	Fabricated components for insulation of flue gas system		
xlii.	Total estimated weight of boiler unit		
5.0	**GENERAL TECHNICAL INFORMATION DATA / DRAWINGS**		
5.1	**PERFORMANCE DATA**		
i.	Steam Generator efficiency Vs. load curves		

S No.	Description	Unit	
ii.	Characteristic Curves showing the variation of superheated and reheated steam temperature with load, clearly indicating the regime of attemperation.		
iii.	Characteristic curves for both constant pressure and sliding pressure mode of operation, showing the variation of the parameters as below with load		
a)	SH outlet pressure		
b)	SH flow		
c)	SH outlet temperature		
d)	Excess air		
e)	Total air flow		
f)	Efficiency		
iv.	Correction curves for steam generator efficiency for variation in parameters such as		
a)	Load		
b)	Superheater outlet temperature		
c)	Superheater outlet pressure		
d)	Excess air (at economiser outlet /AH outlet) at 100% BMCR		
e)	Flue gas temperature (at AH outlet)		
f)	Ambient air temperature		
v.	Characteristic curves for the mill plant		
a)	Variation of pulveriser capacity with moisture content in raw coal		
b)	Variation in fineness of pulverised coal with moisture content in raw coal		
c)	Variation in quantity and temperature of primary air with moisture content in raw coal		
d)	Energy consumption per tonne throughput of pulveriser for varying pulveriser outlet		
e)	Relation between pulveriser output and HGI of coal		
i.	Temperature characteristic of the superheaters and Reheaters		
ii.	Characteristic curves showing the acid dew point temperature Vs. Sulphur content, moisture content in the coal/oil and percentage of excess air		
iii.	Characteristic curves for all fans		
i.	Total pressure vs capacity		
ii.	kW vs capacity		

S No.	Description	Unit	
iii.	Efficiency vs capacity		
5.2	**SUPPLEMENTARY DATA**		
i.	A complete list of all the equipment including the following shall be furnished indicating parameters such as pressure, pressure drop, temperature flow, heat load etc. as applicable for continuous requirement and the maximum requirement		
a)	Auxiliary steam		
b)	Cooling water		
c)	Service air		
d)	Instrument air		
ii.	A detailed list of steam generator auxiliaries with the respective continuous power consumption (in kW of each auxiliary)		Yes/ No
iii.	Start-up and shutdown procedures		
iv.	Start-up diagrams which will show the following quantities plotted vs time from ignition of first igniter to BMCR		.
a)	Igniter fuel input		
b)	Main fuel input		
c)	Separator pressure		
d)	Feed water flow		
e)	Steam flow through superheater		
f)	Superheater attemperator spray water flow		
g)	Final superheater outlet temperature		
h)	Steam flow through reheater		
i)	Reheater outlet temperature		
j)	Burner tilt position		
v.	The required start up diagrams shall be for a cold start, warm start, hot start, very hot start or any intermediate condition after a shut down		
vi.	Limiting condition if any for quick starting and loading		
vii.	Write up on the Steam Generator variable and constant pressure Operations		
viii.	Detailed write-up with supporting technical literature on the method proposed to limit NOx emission		
ix.	NOx effluent concentration		

S No.	Description	Unit	
x.	Dust concentration in the flue gas at the outlet of air preheater		
xi.	Complete list of mill wear parts with materials and anticipated life of each part		
5.3	**DRAWINGS**		
i.	Steam Generator		
a)	Plan of steam generator and its auxiliaries at ground floor level, at lowest burner level, Separator level, drain tank level and at an intermediate level (preferably at the long retractable soot blower level), indicating the galleries, platforms and stairways.		
b)	Front elevation, side elevation and cross section of the steam generating unit showing location of headers, separator and drain tank		
c)	Schematic diagram for following circuits in the Steam Generator island clearly indicating pipe duct size (OD's and ID's), operating parameters, maximum fluid velocities, insulation thickness and material specifications for the following systems		
	(i) Main Steam	Yes/No	
	(ii) Reheat Steam	Yes/No	
	(iii) Feed water flow	Yes/No	
	(iv) Turbine bypass	Yes/No	
	(v) Blow-down	Yes/No	
	(vi) Vents and Drains	Yes/No	
	(vii) Air, fuel and flue gas	Yes/No	
	(viii) Mill system	Yes/No	
	(ix) Fuel oil system	Yes/No	
	(x) Auxiliary steam system	Yes/No	
	(xi) Cooling water	Yes/No	
	(xii) Service air	Yes/No	
	(xiii) Instrument air	Yes/No	
d)	General arrangement drawing of the steam generator maintenance cradle (s)		
	(i) Access Doors/ Lifts/Platforms		
	(ii) Number of access doors provided		
	(iii)Elevations of access doors		
	(iv) Number of service lifts provided		

S No.	Description	Unit	
	(v) Number of passenger lifts provided		
	(vi) Number ofplatforms provided		
	(vii)Elevations of Platforms		
e)	Write up on		
	(i) Boiler start up and circulation	Yes/No	
	(ii) Light up	Yes/No	
	(iii) Soot blowing	Yes/No	

S No	DESCRIPTION								
	ANTICIPATED PERFORMANCE FOR DESIGN COAL	**UNIT**	**100% BMCR**	**100 % TMCR**	**80% TMCR**	**50% TMCR**	**HP-LP BYP ASS**	**One string of HP Heater out of service**	**Both string of HP Heater out service**
6.1	**GENERAL**								
i.	Steam flow at superheater outlet	TPH							
ii.	First stage water spray of the superheater	TPH							
iii.	Second stage water spray of the superheater	TPH							
iv.	Steam pressure at superheater outlet	$Kg/cm^2(a)$							
v.	Steam temperature at superheater outlet	°C							
vi.	Reheater outlet steam flow	TPH							
vii.	Water spray of the reheater	TPH							
viii.	Steam pressure at re-heater inlet	$Kg/cm^2(a)$							
ix.	Steam temperature at reheater inlet	°C							
x.	Steam temperature at reheater outlet	°C							
xi.	Feed water temperature	°C							
xii.	Steam generator efficiency based on the HHV of coal	%							
xiii.	Separator Design pressure	$Kg/cm^2(a)$							
xiv.	Heat liberated by fuel per unit furnace volume	$Kcal/m^3/hr$							
xv.	Burner zone heat release rate	$Kcal/m^2/hr$							

S No	DESCRIPTION								
	ANTICIPATED PERFORMANCE FOR DESIGN COAL	**UNIT**	**100% BMCR**	**100 % TMCR**	**80% TMCR**	**50% TMCR**	**HP-LP BYP ASS**	**One string of HP Heater out of service**	**Both string of HP Heater out service**
xvi.	Plan area heat release rate	Kcal/m^2/hr							
xvii.	Total number of coal pulverisers								
xviii.	Number of coal pulverisers in operation								
xix.	Weight of coal fired	TPH							
xx.	Furnish calculations for plan area heat release rate, burner zone heat release rate, volumetric heat release rate, heat input per burner								
6.2	**TEMPERATURE**								
i.	Air	°C							
(a)	Design Ambient								
(b)	Inlet to the APH (PA)								
(c)	Inlet to the APH (SA)								
(d)	Outlet of APH (PA)								
(e)	Outlet of APH (SA)								
(f)	Secondary air at Inlet to burners								
(g)	Hot primary air in the duct before pulverisers								

S No	DESCRIPTION								
	ANTICIPATED PERFORMANCE FOR DESIGN COAL	**UNIT**	**100% BMCR**	**100 % TMCR**	**80% TMCR**	**50% TMCR**	**HP-LP BYP ASS**	**One string of HP Heater out of service**	**Both string of HP Heater out service**
ii.	Fuel and air mixture	°C							
(a)	Fuel and air mixture leaving the pulveriser								
(b)	Fuel and air mixture entering the burner								
iii.	Flue gas actual temperature	°C							
(a)	Furnace exit gas temperature								
(b)	Entrance to superheater								
	(i) Primary								
	(ii) Secondary								
	(iii) Final								
(c)	Exit of superheater	°C							
	(i) Primary								
	(ii) Secondary								
	(iii) Final								
(d)	Lateral deviation of the superheating steam temperature	°C							
(e)	Entrance of reheater	°C							
	(i) Primary								

S No	DESCRIPTION								
	ANTICIPATED PERFORMANCE FOR DESIGN COAL	**UNIT**	**100% BMCR**	**100 % TMCR**	**80% TMCR**	**50% TMCR**	**HP-LP BYP ASS**	**One string of HP Heater out of service**	**Both string of HP Heater out service**
	(ii) Secondary								
	(iii) Final								
(f)	Exit of reheater	°C							
	(i) Primary								
	(ii) Secondary								
	(iii) Final								
(g)	Lateral deviation of the reheating steam temperature	°C							
(h)	Entrance of economiser	°C							
(i)	Exit of economiser	°C							
(j)	Entrance to air heater	°C							
(k)	Exit of air heater (corrected)	°C							
(l)	Exit of air heater (Uncorrected)	°C							
(m)	Entrance of electrostatic precipitator								
(n)	Exit of electrostatic precipitator								
(o)	Entrance of ID fans								
(p)	Entrance to Chimney								

S No	DESCRIPTION								
	ANTICIPATED PERFORMANCE FOR DESIGN COAL	**UNIT**	**100% BMCR**	**100 % TMCR**	**80% TMCR**	**50% TMCR**	**HP-LP BYP ASS**	**One string of HP Heater out of service**	**Both string of HP Heater out service**
iv.	Feed Water	°C							
(a)	Water entering economiser								
(b)	Water leaving economiser								
(c)	Desuperheating spray water temperature								
	(i) Superheater								
	(ii) Reheater								

S. No.	DESCRIPTION	Unit	
6.3	**PRESSURE**		
i.	Air	mmWC	
a)	Forced draft fan silencer outlet		
b)	Forced draft fan discharge		
c)	Air heater inlet (PA)		
d)	Air heater outlet (PA)		
e)	Air heater inlet (SA)		
f)	Air heater outlet (SA)		
g)	In burner windbox		
h)	Primary air fan inlet		
i)	Primary air fan discharge		
j)	Hot Primary air at the inlet to pulveriser		
ii.	Fuel Side	mmWC	
a)	At the pulveriser inlet		
b)	At the pulveriser outlet		
c)	At the burners inlet		
iii.	Feed Water	$Kg/cm^2(a)$	
a)	Feed regulating station inlet		
b)	Inlet to economiser		
c)	Outlet of economiser		
d)	Inlet of the startup circulating pump	$Kg/cm^2(a)$	
e)	Outlet of the startup circulating pump	$Kg/cm^2(a)$	
f)	Attemperation water for superheater		
g)	Attemperation water for reheater		
6.4	**PRESSURE DROP**		
A.	**Steam Path**		
a)	Separator (Spiral & Vertical)		
b)	Drain Tank		
c)	Pressure at the outlet of the superheater	$Kg/cm^2(a)$	
d)	Pressure drop of the first stage superheater	$Kg/cm^2(a)$	
e)	Pressure drop of the second stage superheater	$Kg/cm^2(a)$	
f)	Pressure drop of the third stage superheater	$Kg/cm^2(a)$	
g)	Pressure drop of the fourth stage superheater	$Kg/cm^2(a)$	
h)	Pressure drop of the fifth stage superheater	$Kg/cm^2(a)$	
i)	If any	$Kg/cm^2(a)$	

S. No.	DESCRIPTION	Unit	
j)	Total pressure drop of the superheater	$Kg/cm^2(a)$	
k)	Primary air pressure drop of the air preheater	mmwc	
l)	Secondary air pressure drop of the air preheater	mmwc	
m)	Resistance of the burner (primary/secondary)	mmwc	
n)	Pressure drop from the outlet of steam-cooled wall to the outlet of the super heater	$Kg/cm^2(a)$	
o)	Super heater attemperator	$Kg/cm^2(a)$	
p)	Pressure drop across reheater	$Kg/cm^2(a)$	
q)	Reheater attemperator	$Kg/cm^2(a)$	
B.	**Feed Water Path**		
a)	Valves and connected piping		
b)	Pressure drop of the economizer	$Kg/cm^2(a)$	
c)	Pressure drop from the inlet of the economizer to steam separator	$Kg/cm^2(a)$	
d)	Total pressure drop from the outlet of the economizer to the outlet of the super heater	$Kg/cm^2(a)$	
6.5	**VELOCITIES**	m/s	
i.	Furnace throat gas velocity		
ii.	Maximum gas velocity through tube banks of		
a)	Super heater		
b)	Reheater		
c)	Economiser		
iii.	Maximum gas velocity		
a)	Before gas flow changes direction		
b)	In convective pass		
iv.	Gas/Air Velocities through the air heater heating elements		
a)	Gas		
b)	Air		
v.	Air Velocities		
a)	Cold air ducts		
b)	Hot air ducts		
vi.	Gas Velocities in gas ducting sections		
a)	Economiser to AH		
b)	Economiser gas bypass duct (if applicable)		
c)	AH to ESP		

S. No.	DESCRIPTION	Unit	
d)	ESP to ID Fan		
e)	ID fan to stack		
vii.	Air-fuel mixture Velocity in the fuel Pipe Line		
6.6	**PERCENTAGE OF OXYGEN IN FLUE GAS**		
i.	At furnace exit	%	
ii.	At economiser outlet	%	
iii.	At air heater outlet	%	
6.7	**FLOW RATE OF AIR**	Kg/hr	
i.	FD fan outlet		
ii.	PA fan outlet		
iii.	Total air to each pulveriser		
iv.	Total combustion air		
6.8	**FLOW RATE FLUE GASES**		
i.	At the outlet of the furnace	m^3/h	
ii.	At the outlet of the last stage superheater	m^3/h	
iii.	At the outlet of final reheater	m^3/h	
iv.	At the outlet of the economizer	m^3/h	
v.	Air heater inlet	m^3/h	
vi.	Air heater outlet	m^3/h	
6.9	**Dust content in the flue gas at the outlet of the air preheater**	g/Nm^3	
6.10	**AIR LEAKAGE IN THE AIR PREHEATER**		
i.	Primary air leaked to flue gas	Nm^3/h	
ii.	Primary air leaked to secondary air	Nm^3/h	
iii.	Secondary air leaked to flue gas	Nm^3/h	
iv.	Total air side leaked to flue gas side	Nm^3/h	
v.	ESP inlet		
vi.	ID Fan inlet		
6.11	**VELOCITY OF FLUE GAS**		
i.	Platen superheater	m/s	
ii.	Last stage superheater	m/s	
iii.	High temperature reheater	m/s	
iv.	Low temperature superheater	m/s	
v.	Low temperature reheater	m/s	

S. No.	DESCRIPTION	Unit	
vi.	Economizer	m/s	
vii.	Air Heater	m/s	
6.12	**FLUE GAS TEMPERATURE**		
i.	Inlet of the platen superheater	°C	
ii.	Outlet of the platen type superheater	°C	
iii.	Inlet of the last stage (third stage) superheater	°C	
iv.	Outlet of the last stage (third stage) superheater	°C	
v.	Inlet of final reheater	°C	
vi.	Outlet final reheater	°C	
vii.	Inlet of screen tubes	°C	
viii.	Outlet of screen tubes	°C	
ix.	Inlet of the low temperature (first stage) reheater	°C	
x.	Outlet of the low temperature (first stage) reheater	°C	
xi.	Inlet of the low temperature (first stage) superheater	°C	
xii.	Outlet of first stage superheater	°C	
xiii.	Economizer inlet	°C	
xiv.	Economizer outlet	°C	
xv.	Inlet of the air preheater	°C	
xvi.	Outlet of the air preheater (uncorrected)	°C	
xvii.	Outlet of the air preheater (corrected)	°C	
6.13	**AIR PRESSURE DROP**		
i.	Primary air pressure drop of the air preheater	kPa	
ii.	Secondary air pressure drop of the air preheater	kPa	
iii.	Resistance of the burner (primary/secondary)	kPa	
6.14	**HEAT BALANCE (Based on GCV of coal fired)**		
i.	Total coal fired	TPH	
ii.	Gross Calorific value of coal	Kcal/kg	
iii.	Heat absorbed per Kg of coal in		
a)	Air preheaters	Kcal	
b)	Economiser	Kcal	
c)	Superheater	Kcal	
d)	Reheater	Kcal	
e)	Water Walls	Kcal	

S. No.	DESCRIPTION	Unit	
iv.	Total heat absorbed by the unit (per Kg of coal)		
6.15	**HEAT LOSSES IN THE STEAM GENERATOR**		
i.	Heat loss due to flue gases	Kcal	
a)	Dry gas loss		
b)	Hydrogen in the fuel		
c)	Moisture in the fuel		
d)	Moisture in the air		
ii.	Heat loss due to unburnt carbon (%) in		
a)	Furnace bottom ash		
b)	Fly Ash		
c)	Carbon Monoxide (CO)		
iii.	Sensible heat loss (%) in		
a)	Furnace bottom ash		
b)	Fly Ash		
iv.	Heat loss due to radiation	%	
v.	Unaccounted heat loss (%)		
vi.	Total heat losses		
6.16	**Heat credits (give details)**		
6.17	**Steam generator efficiency**	%	
6.18	**WEIGHT AND DISTRIBUTION OF ASH COLLECTED**		
i.	Furnace bottom hopper	Kg/hr	
ii.	Economiser hopper	Kg/hr	
iii.	Air heater hopper	Kg/hr	
iv.	ESP hoppers	Kg/hr	
v.	Total	Kg/hr	
6.19	**AUXILIARY STEAM CONSUMPTION**		
i.	Steam conditions		
a)	Pressure range	$Kg/cm^2(a)$	
b)	Temperature range	°C	
ii.	Fuel oil heating (Maximum)	Kg/hr	
iii.	Fuel oil line tracing (Maximum) (If applicable)	Kg/hr	
iv.	Steam coil air heater (Maximum)	Kg/hr	
v.	After eight hours shutdown		
vi.	After four hours shutdown		
vii.	Hot restart after trip out (Less than 1 hr. shutdown)		

S. No.	DESCRIPTION	Unit	
6.20	**START UPS**		
i.	Recommended time periods to bring Steam Generator on load with HP-LP bypass		
a)	After twelve (12) hours shut down	hours	
b)	After eight (8) hours shut down	hours	
ii.	Recommended number of start-ups over the life of the plant		
a)	Cold start ups		
b)	Warm start ups		
c)	Hot start ups		
iii.	Recommended number of daily load cycling between 40% to 100%		
6.21	**QUANTITY OF EXPECTED STEAM TO BE VENTED OUT IN RAISING FULL PRESSURE WHEN STARTING WITHOUT HP-LP BYPASS**		
i.	From cold start up	Tonnes	
ii.	From warm start up	Tonnes	
iii.	From hot start up hours	Tonnes	
iv.	From very hot start up	Tonnes	
6.22	**AUTOMATIC CONTROL LIMITS FOR MAXIMUM LOAD STEP CHANGE**		
i.	HP Steam Temperature		
ii.	Hot Reheat Steam Temperature		
6.23	**WIND BOX PERFORMANCE**		
i.	Free air area	M^2	
ii.	Secondary air flow in the wind box	m^3/s	
iii.	Secondary air density	Kg/m^3	
iv.	Secondary air temperature in the wind box	°C	
v.	Secondary air velocity	m/s	
vi.	Differential pressure with respect to the Furnace	mmWC	
6.24	**COMBUSTION DATA**		
i.	Stoichiometric air required	Kg/kg fuel	
ii.	Volume of flue gas produced by burning 1 Kg of fuel at Economiser outlet	NM^3	

S. No.	DESCRIPTION	Unit	
iii.	Weight of flue gas produced by burning 1 Kg. of fuel at Economiser outlet	kg	

TABLE – 1

The structural performances, velocity of flue gas, steam temperature and wall temperature of the heating surface of the superheater (@100 % BMCR)

S. No.	Part Name		Unit	Superheater						
				SH-1	SH-2	SH-3	SH-4	SH-5	SH-6 (if applicable)	FINAL SH
1.	Outside diameter of the pipe × wall thickness		mm							
2.	Pitch	Transverse pitch	mm							
		Longitudinal pitch	mm							
3.	Material of the pipe									
4.	Average flue gas flow rate		m/s							
5.	Highest design pressure		Kg/cm2(a)							
6.	Operating pressure		Kg/cm2(a)							
7.	Outlet working medium temperature									
8.	Highest calculated working medium		°C							
9.	Outlet metallic wall temperature		°C							
10.	Highest metallic wall temperature		°C							

TABLE - 2

The structural performances, velocity of flue gas, steam temperature and wall temperature of the heating surface of the reheater and the economizer (@100 % BMCR)

S. No.	Part Name		Unit	Reheater	Economizer
1.	Outside diameter of the pipe × wall thickness		mm		
2.	Pitch	Transverse Pitch	mm		
3.		Longitudinal Pitch	mm		
4.	Material of the pipe				
5.	Average rate of the flue gas flow		m/s		
6.	Highest design pressure		$Kg/cm^2(a)$		
7.	Operating pressure		$Kg/cm^2(a)$		
8.	Outlet working medium temperature		°C		
9.	Highest calculated working medium temperature		°C		
10.	Outlet metallic wall temperature		°C		
11.	Highest metallic wall temperature		°C		

TABLE 3 : START UP DATA

Starting mode and time table (min)

Sr. No.	Item	Cold state	Warm state	Hot state
1.0	Ignition → Start of rolling			
2.0	Start of rolling → synchronization to grid			
3.0	synchronization to grid → full load			

TABLE 4 : DATA ON SOOT BLOWERS

Sr. No.	Description	Furnace	Super-heater	Reheater	Economiser	Air-heater
1.0	Type					
2.0	Quantity					
3.0	Operating pressure					
4.0	Steam consumption per blower/ cycle					
5.0	Length of travel					
6.0	Blowing radius oblique angle					
7.0	Type of control					
8.0	Time required for one complete cycle					

2.0 ELECTROSTATIC PRECIPITATOR

S No	DESCRIPTION	UNIT		
1.0	**EQUIPMENT DATA**			
1.1	**GENERAL**			
i.	Manufacturer			
ii.	Location			
iii.	Dimensions			
a)	Width (across gas flow)	mm		
b)	Flange to Flange length (In direction of gas flow)	m		
c)	Height between bottom of hoppers to support level	m		
iv.	Number of electrical fields in series			
v.	Number of ESP casing			
vi.	Number of gas streams			
vii.	Maximum bus voltage	KV		
viii.	Average bus voltage	KV		
ix.	Proposal Standard for conducting the performance tests			
x.	Aspect ratio			
1.2	**PERFORMANCE DATA**		Design Coal	Worst Coal
i.	Coal fired			
ii.	Inlet dust concentration	mg/nm^3		
iii.	Outlet dust concentration	mg/nm^3		
iv.	Collection efficiency with one field out of service	%		
v.	Collection efficiency with two series fields out of service in each stream	%		
vi.	Collection efficiency with three series fields out of service in each stream	%		
vii.	Design gas flow rate	m^3/s		
viii.	Gas temperature drop across ESP at the guarantee point flow			
ix.	Pressure drop	mmWC		
x.	Specific collecting area of flue gas	$mm^2/m^3/sec$		
xi.	Gas velocity	m/s		
xii.	Design flue gas temperature	°C		
xiii.	Ash collection rate			
a)	First field			
b)	Second field			
c)	Third field			
d)	Fourth field			
e)	Fifth field			
f)	Sixth field			

S No	DESCRIPTION	UNIT		
g)	Seventh field			
h)	Eighth field			
i)	Ninth field			
1.3	**PRECIPITATOR CASING**			
i.	Material			
ii.	Plate thickness	mm		
iii.	Design pressure	mmWC		
iv.	Design temperature	°C		
v.	Maximum temperature withstanding capacity and duration			
vi.	Number of inspection doors			
vii.	Dimensions of access opening of inspection doors	mm x mm		
1.4	**GAS DISTRIBUTION SYSTEM**			
i.	Method of ensuring uniform gas distribution			
ii.	Number of distribution Plates/ screens			
iii.	Material			
iv.	Free area per gas screen	M^2		
1.5	**DISCHARGE ELECTRODES**			
i.	Type			
ii.	Material of the electrode			
iii.	Material of the frame			
iv.	Configuration			
v.	Diameter	mm		
vi.	Spacing of electrodes in the direction of gas flow			
1.6	**COLLECTING ELECTRODES**			
i.	Material			
ii.	Size of electrodes			
a)	Width	mm		
b)	Height	mm		
c)	Thickness	mm		
iii.	Type of construction			
iv.	Distance between collecting electrodes across gas path	mm		
v.	Number of collecting electrodes per gas stream			
vi.	Effective collection surface area per Electrode	M^2		

S No	DESCRIPTION	UNIT		
1.7	**RAPPING MECHANISM**		Discharge Electrode	Collecting Electrode
i.	Type			
ii.	Number of rapping gear shafts per gas stream			
iii.	Location of drive (top/side)			
iv.	Number of hammers per shaft			
v.	Location of rapping points			
vi.	(a) Maximum effective electrode Length and its percentage rapped at any time	M & %		
	(b) Number of plates rapped per rapper			
vii.	Rapper controller			
viii.	Type			
ix.	Method of frequency control			
x.	Nominal time interval between raps	minutes		
xi.	Time of single rapping cycle			
xii.	Accessibility/Location			
1.8	**INSULATORS**			
i.	Type			
ii.	Material			
iii.	Creepage distance			
iv.	Number of insulators per T/R set			
v.	Minimum flashover voltage	kV		
1.10	**DUST HOPPERS**			
i.	No. per field per stream			
ii.	No. per gas stream			
iii.	Material			
iv.	Plate thickness	mm		
v.	Valley angle	degrees		
vi.	Storage capacity of each hopper	hours		
vii.	Volumetric storage capacity of each hopper	m^3		
viii.	No. of access doors per hopper, dimension			
ix.	Height of the hopper bottom flange above the ground level	m		
x.	Size of hopper outlet flanges			
xi.	Hopper heating			
a)	Control temperature	°C		
b)	Hopper heating power per hopper	kW		
c)	No. of heating element			
d)	Name of manufacturer			
2.0	**INSULATION AND CLADDING**			

S No	DESCRIPTION	UNIT	
i.	List of areas to be insulated per casings of precipitators	M^2	
ii.	Material		
iii.	Insulating material standard		
iv.	Thickness	mm	
v.	Density	Kg/m^3	
3.0	EQUIPMENT WEIGHT	Kg	
i.	Structural Steel		
ii.	Precipitator casing including gas distribution system		
iii.	Hoppers (empty)		
iv.	Hoppers (full)		
v.	Collecting electrodes		
vi.	Discharge electrodes		
vii.	Rapping system for collecting electrodes		
viii.	Rapping system for discharge electrodes		
ix.	Insulators & Insulator compartments		
x.	Platforms, Walkways, Stairways		
xi.	T/R sets		
xii.	Insulation and cladding		
xiii.	Control and Instrumentation		
xiv.	Others		
xv.	TOTAL ESTIMATED WEIGHT		
•	Excluding dust		
•	Including dust		
4.0	**GENERAL TECHNICAL INFORMATION/ DATA/ DRAWINGS**		
4.1	**CHARACTERISTIC CURVES**		
i.	Gas flow rate vs. efficiency		
ii.	Gas temperature vs. efficiency		
iii.	Inlet dust concentration vs. efficiency		
iv.	Gas flow rate vs. pressure drop		
4.2	**SUPPLEMENTARY DATA**		
i.	Write up on ESP internals		
ii.	Detailed hopper sizing calculations		
iii.	Write up on rapping mechanism		
4.3	**DRAWINGS**		
i.	General arrangement drawings (plan and elevation) with appropriate dimensions		

S No	DESCRIPTION	UNIT	
ii.	Recommended size and general arrangement of ESP control room in plan and sections along with its location plan including equipment layout, inserts, cutouts and openings etc.		
iii.	Gas distribution system		
iv.	Collecting and discharge electrode system including support and alignment details		
v.	Insulator housing and heating system		
vi.	Proposed T/R set arrangement and connections to electrical bus sections including details of isolation and earthing		
vii.	Weather proof enclosure and lifting beam arrangement		

STEAM TURBINE & AUXILIARIES

S No	ITEM	UNIT	
1.0	TURBINE		
1.1	PERFORMANCE DATA		
1.1.1	Manufacturer		
1.1.2	Model No.		
1.1.3	Operating Life	Hrs	
1.1.4	Type		
1.1.5	Number of Cylinders		

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.1.6	Main steam temperature before stop valve at HPT inlet.	°C					
1.1.7	Main steam pressure before stop valve at HPT inlet	Kg/cm ² (a)					
1.1.8	Pressure of steam at inlet to reheat stop valves	Kg/cm² (a)					
1.1.9	Temperature of steam at inlet to reheat stop valve	°C					
1.1.10	Speed	rpm					
1.1.11	Operating frequency range for turbine and auxiliaries	Hz					
1.1.12	Flow Data	TPH					
(a)	Main steam throttle flow						
(b)	Reheat steam flow						
(c)	Exhaust flow to condenser						
1.1.13	Condenser pressure	mm Hg abs					
1.1.14	Output, MW	MW					
(a)	Turbo-generator rated output with extraction flow	MW					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(b)	Turbo-generator rated output with one string of HP Heater out of service	MW					
(c)	Turbo-generator rated output with both string of HP Heater out of service	MW					
1.1.15	Minimum continuous steam flow through turbine at rated speed	TPH					
1.1.16	Power generated during minimum steam flow	MW					
1.1.17	Maximum flow passing ability of turbine with valve wide open (VWO)	TPH					
1.1.18	Maximum continuous capacity of turbine, with VWO	MW					
1.1.19	Maximum allowable sustained pressure before turbine stop valve	Kg/cm²(a)					
1.1.20	Allowable time for the above	min					
1.1.21	Maximum momentary pressure before turbine stop valve	Kg/cm²(a)					
1.1.22	Maximum allowable temperature before turbine stop valve	°C					
1.1.23	Allowable time for the above	min					
1.1.24	Maximum allowable temperature at LP Turbine exhaust hood	°C					
1.1.25	Set Value for exhaust hood spray valve to open	°C					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.1.26	Coast down time after turbine trips						
(a)	With rated vacuum	min					
(b)	With vacuum breakers opened	min					
1.1.27	Type of Governor						
1.1.28	Percentage regulation and its range of adjustability of governing system	%					
1.1.29	Maximum allowable temperature before reheat stop valve	°C					
1.1.30	Allowable time for the above	min					
1.1.31	Load Change Ramp	(% per minute)					
1.2	**LAYOUT DATA**						
1.2.1	Total turbine-generator block length	mm					
1.2.2	Total turbine-generator block width	mm					
1.2.3	Total weight						
(a)	Turbine Generator	Tonnes					
(b)	H.P. Turbine	Tonnes					
(c)	I.P. Turbine	Tonnes					
(d)	L.P. Turbine	Tonnes					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(e)	Generator	Tonnes					
1.2.4	Weight of heaviest piece during erection other than generator stator	Tonnes					
1.2.5	Weight of following	Tonnes					
(a)	Upper casing with diaphragms						
	(i) H.P. Turbine						
	(ii) I.P. Turbine						
	(iii) L.P. Turbine						
(b)	Turbine rotor						
1.2.6	Distance required for rotor pulling beyond the turbine generator block	Metres					
1.2.7	Crane hook height elevation required for erection & maintenance from operating floor level	Metres					
(a)	Main Hook						
(b)	Auxiliary Hook						
1.3	**TURBINE DESIGN DATA**						
1.3.1	Critical Speeds						
(a)	First critical speeds of						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
	(i) Turbine rotor	rpm					
	(ii) Generator	rpm					
	(iii) Combined critical speed	rpm					
(b)	Second critical speeds of						
	(i) Turbine rotor	rpm					
	(ii) Generator	rpm					
	(iii) Combined critical speed	rpm					
1.3.2	Rotor Details						
(a)	No. of stages						
(b)	Diameter of the tips of the first row of blades						
(c)	Diameter of the tips of last row of blades						
(d)	Special protection against erosion due to moisture impingement						
(e)	Maximum wetness of steam that can be tolerated continuously by L.P. blading						
1.3.3	Materials of Construction						
(a)	Turbine casing						
(b)	Turbine rotor						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(c)	Control valve chest						
(d)	Blades						
	(a) Moving blades						
	(b) Fixed blades						
(e)	Shaft						
(f)	Bearings						
(g)	Casing Joint Bolts						
(h)	Gland Steam Condenser (Shell, tube, tube sheet)						
(i)	Gland Steam Exhauster (Impeller, shaft, casing)						
(j)	Main Oil Tank						
(k)	Main Oil Pump (Shaft, impeller, casing)						
(l)	Auxiliary Oil Pump (Shaft, impeller, casing)						
(m)	Oil Cooler (Shell, tube)						
(n)	Diaphragm						
(o)	Guide blade carriers						
1.3.4	Turbine Movements						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(a)	Location of turbine anchor point						
(b)	Movement of the connection flanges for main steam and extraction flanges during	mm					
	Indicate direction DEL X (Furnish for each DEL Y Joint separately) DEL Z						
1.3.5	Design Pressure and Temperature		HP TURBINE		IP TURBINE		LP TURBINE
(a)	Valve chest						
(b)	Casing						
(c)	Maximum noise level	dBA					
1.3.6	Bearings						
(a)	Journal Bearings						
	(i) Number						
	(ii) Size						
	(iii) Type						
	(iv) Optimum operating temp.	°C					
	(v) Lining material						
(b)	Thrust Bearings						
	(i) Number						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
	(ii) Size						
	(iii) Type						
	(iv) Optimum operating temp.	°C					
	(v) Lining material						
1.3.7	Couplings						
(a)	Number						
(b)	Location						
(c)	Type						
1.3.8	Casing Bolts						
(a)	Type						
(b)	Number						
(c)	Diameter	mm					
(d)	Heating of bolts provided?		Yes/No				
1.3.9	Turbine suitable for no. of starts and stops for the life cycle of the plant as specified		Yes/No				
1.3.10	Maximum peak to peak vibration						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(a)	Turbine bearing housing	microns					
(b)	Exciter bearing housing	microns					
(c)	Shaft	microns					
1.4	**TURBINE CONTROLS & PROTECTION**						
1.4.1	Main stop and throttle valve						
(a)	Number						
(b)	Size						
(c)	Type and method of actuation						
(d)	Provision for on-load testing						
(e)	Permanent strainer type						
(f)	Material of Construction						
	(i) Valve body						
	(ii) Valve internal						
	(iii) Valve seats						
(g)	Type of sealing						
1.4.2	Reheat stop and Interceptor Valve						
(a)	Number						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(b)	Size	mm					
(c)	Type and method of actuation						
(d)	Provision for on-load test						
(e)	Permanent strainer type						
(f)	Material of Construction						
	(i) Valve body						
	(ii) Valve internals						
	(iii) Valve seats						
(g)	Provision for remote operation						
(h)	Type of sealing						
(i)	Extraction valves including NRVs (Bidder to indicate depending on the number of extractions based on his turbine cycle configuration)						
	Number						
	Size						
	Type of method of actuation						
	Number of limit switches						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
	Provision for load testing						
	Material of construction: (Valve body, valve internal, valve seat)						
1.5	**OIL SYSTEM**						
1.5.1	Oil Reservoir						
(a)	Capacity	litres					
(b)	Size of Oil Reservoir						
(c)	Turbine Oil Specification						
(d)	Total oil volume in the circuit, pipe lines	litres					
(e)	Level indicator with alarm						
(f)	Mountings provided as specified						
(g)	Permissible suspended particle size (microns)						
(h)	Permissible water content in oil by volume (%)						
1.5.2	Shaft driven main oil pump						
(a)	Type						
(b)	Capacity	LPM					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(c)	Suction pressure	Kg/cm²(a)					
(d)	Discharge pressure	Kg/cm²(a)					
1.5.3	A.C. Motor driven Auxiliary Oil Pump						
(a)	Type and Number						
(b)	Capacity	LPM					
(c)	Discharge pressure	Kg/cm²(a)					
(d)	Drive motor rating	kW					
1.5.4	D.C. Motor Driven Emergency Oil Pump						
(a)	Type and Number						
(b)	Capacity	LPM					
(c)	Discharge pressure						
(d)	Drive motor rating	kW					
1.5.5	A.C. Motor Driven Jacking Oil Pump						
(a)	Type and Number						
(b)	Capacity	LPM					
(c)	Discharge pressure						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(d)	Drive Motor	kW					
1.5.6	D.C Motor Driven Jacking Oil Pump						
(a)	Type and Number						
(b)	Capacity	LPM					
(c)	Discharge pressure						
(d)	Drive Motor kW rating & voltage	kW & Voltage					
1.5.7	Turbine Oil Cooler						
(a)	Number (working + standby)						
(b)	(i) Tube side liquid						
	(ii) Shell side liquid						
(c)	Capacity of oil	LPM					
(d)	Water side design pressure	Kg/cm² (a)					
(e)	Maximum permissible cooling water temperature at inlet	°C					
(f)	Oil side design pressure	Kg/cm² (a)					
(g)	Tube size and material						
1.5.8	Oil Strainer						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
(a)	Number						
(b)	Type						
(c)	Location						
(d)	Filteration Size	microns					
1.5.9	Oil sight flow indicators at all bearings provided?	Yes / No					
1.5.10	Lube Oil Conditioning Equipment						
(a)	Type of Conditioner						
(b)	Capacity of Unit	m^3/hr					
(c)	Size of solids in the purified oil at the outlet of the polishing filter at rated	(microns)					
(d)	Size of solids in the oil at the outlet of the centrifuge but before the polishing filter at rated capacity (specify also the maximum water content in %):	(microns)					
(e)	Centrifuging temperature	(°C)					
1.5.11	Oil Pumps						
(a)	Type						
(b)	Capacity :	LPM					
(c)	Total Head	mmwc					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.5.12	Central Oil Storage Tank	(Lit.)					
(a)	Capacity						
(b)	No. of compartment						
1.6	**GLAND SEALING SYSTEM**						
(a)	Source of gland sealing system during normal operation and low load operation						
(b)	Type of shaft seals						
(c)	Type of seal rings						
1.6.1	Gland Steam Condenser						
(a)	Type						
(b)	Design gland steam flow	TPH					
(c)	Design condensate flow	TPH					
(d)	Water velocity (maximum) in the tubes	m/s					
(e)	Tube side design pressures	Kg/cm² (a)					
(f)	Tube size and materials used						
(g)	Gland seal system capable of operation with gland steam condenser out of service	Yes/No					
(h)	Heat Transfer surface area provided						
(i)	Exhauster for Gland Steam Condenser						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
	(i) Type						
	(ii) Number						
	(iii) Speed	(rpm)					
	(iv) Drive Motor Rating	(kW)					
1.7	**FLASH TANKS**						
1.7.1	Type						
1.7.2	Number						
1.8	**HIGH PRESSURE FLASH TANK**						
1.8.1	Size/Volume	m^3					
1.8.2	Material of Construction						
1.9	**LOW PRESSURE FLASH TANK**						
1.9.1	Size/Volume	m^3					
1.9.2	Material of Construction						
1.10	**AUTOMATIC SEAL REGULATOR**						
1.10.1	Quantity of sealing steam						
1.10.2	Pressure of sealing steam	Kg/cm^2 (a)					
1.10.3	Type of Seal Steam Pressure						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.11	**TURNING GEAR**						
1.11.1	Type						
1.11.2	Method of engagement and disengagement						
1.11.3	Drive motor rating, kW and Voltage (AC/DC) (if applicable)						
1.11.4	Turbine rotor speed on turning gear drive	RPM					
1.11.5	Provision of hand barring provided?	Yes/No					
1.12	**H.P. & L.P. BYPASS STATION**		**H.P. BYPASS**			**L.P. BYPASS**	
(a)	Capacity of system	TPH					
1.12.1	Pressure reducing valve						
(a)	Type & Manufacturer						
(b)	Number and Size						
(c)	Actuation type (hydraulic/pneumatic)						
1.12.2	Material of Construction (Specify Standard/Code & Grade)						
(a)	Valve body						
(b)	Valve seat						
(c)	Valve internals						

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.12.3	Capacity per Valve	(t/h)					
1.12.4	Opening time of each valve	Sec					
1.12.5	Closing time of each valve	Sec					
1.12.6	Spray valves type for HP/LP bypass						
1.12.7	Desuperheater						
(a)	Type & Manufacturer						
(b)	Spray quantity at different loads	TPH					
(c)	Spray water pressure	Kg/cm² (a)					
1.12.8	Type of pressure control						
1.12.9	Type of temperature control						
1.12.10	Duration of T.G. unit operation under house load running in parallel with HP-LP bypass system						
1.12.11	Range of TG unit load under operation in parallel with HP- LP bypass system						
1.13	**Characteristic Curve at rated condenser pressure**						
1.13.1	Reheat pressure drop and temperature correction curves Vs load and heat rate	Yes/No					

S No	ITEM	UNITS	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.13.2	Reheat spray and superheat spray Vs Load and heat rate.	Yes / No					
1.13.3	Turbine start up curves under COLD, WARM and HOT regimes	Yes / No					

CONDENSER ON–LINE TUBE CLEANING SYSTEM

S. No.	Description	Unit	Parameter	
1.0	**CONDENSER ON–LINE TUBE CLEANING SYSTEM**			
1.1	Name of Manufacturer	:		
1.2	Ball cleaning system	:		
1.2.1	Ball separator section	:		
	a) Design pressure / temperature	:		
	b) Water quantity	:		
	c) Pressure drop across screens in fouled condition	:		
	d) Pressure drop across screens in cleaned condition.	:		
1.3	**Material**			
	a) Outer shell	:		
	b) Flanges	:		
1.4	**Pump Particulars**		**Ball re-circulation pump**	**Pressure differential system**
	a) Type of pump	:		
	b) Capacity	:		
	c) Head	:		
	d) Power consumption	:		
	e) Speed	:		
1.5	**Material of Construction**			

S. No.	Description	Unit	Parameter	
	a) Shaft	:		
	b) Impeller	:		
	c) Casing	:		
1.6	**Motors**			
	a) Type & Rating	:		
	b) Voltage, phase & frequency	:		
	c) Speed	:		
	d) Type of enclosure	:		
	e) Class of insulation	:		
1.7	**Distributor with site glass**			
	a) No. & size of inlet of the distributor	:		
	b) No. & size of the outlet of the distributor	:		
1.8	**Cleaning balls per system**		**Abrasive**	**Normal**
	a) No. of balls required for each system	: nos.		
	b) Quantity of balls in re-circulation	: nos.		
	c) Self life/duration of cleaning balls	:		
	d) Expected replenishment of balls/ month	:		
	e) Diameter	:		

S. No.	Description	Unit	Parameter
	g) Material of ball	:	
1.9	**Differential Pressure Measuring System**		
	a) Automatic pressure measuring system with automatic flushing and control of electrical and mechanical function included.	:	
	b) Type make & Range of transmitter	:	
1.10	Type make and rating of flushing Pump	:	
1.11	Type make and rating of 3 way ball valve	:	

FEED WATER HEATERS AND DEARATOR

SR. NO.	ITEM	UNIT	
1.0	**DEARATOR AND FEED WATER HEATERS**		
1.1	DEAERATOR		
1.1.1	Type and manufacturer		
1.1.2	Operating pressure of deaerator	Kg/cm2 (a)	
1.1.3	Minimum pegging steam pressure of deaerator	Kg/cm2 (a)	
1.1.4	Capacity		
(a)	Capacity of storage tank and approx. dimension		

(b)	Effective storage capacity between normal level and lowest level	M^3	
(c)	Effective storage capacity below highest water level up to lowest level	M^3	
1.1.5	Oxygen Content		
(a)	Condensate inlet oxygen content over the entire load rang	ppm (cc/litre)	
(b)	Deaerator outlet dissolved oxygen content, (range under various operating condition)	ppm	
1.1.6	Material of Construction (Specify Std/Code & Grade)		
(a)	Deaerator & storage tank plate		
(b)	Trays		
(c)	Spray nozzle		
1.1.7	Trays		
(a)	No. of heating trays		
(b)	No. of air separating trays		
(c)	Area of trays	M^2	
1.1.8	Design Flows		
(a)	Condensate inlet	TPH	
(b)	Steam from turbine extraction	TPH	
(c)	Steam from other sources		
(d)	Drain inlet from HP heaters	TPH	

(f)	Feed Water Outlet flow				
1.1.9	Code followed for design and fabrication				
1.1.10	Gauge glass & other instruments as desired provided?		Yes/No		
1.1.11	Safety valve number, material & Capacity				
1.1.12	Overflow arrangement provided?		Yes/No		
1.1.13	Deaerator Pegging System				
(a)	Deaerator pegging steam pressure adjustable range	Kg/cm2 (a)			
(b)	Any additional feed heating arrangement provided during turbine by-pass system operation?				
1.1.14	Deaerator Storage Tank				
(a)	Centre line elevation from power house ground floor,	M			
1.1.15	All platforms & staircases around deaerator furnished as specified		Yes / No		
1.2	**HP FEED WATER HEATERS**		**Heater-5**	**Heater-6**	**Heater-7**
1.2.1	Type and Manufacturer				
1.2.2	Orientation – vertical/ horizontal				
1.2.3	Design pressure & temperature	Kg/cm2, °C			
(a)	Shell side				
(b)	Tube side				

1.2.4	Heat Transfer co-efficient				
(a)	Overall heat transfer co- efficient	kcal/m². hr. °C			
	(i) Desuperheating Zone				
	(ii) Condensing Zone				
	(iii) Drain Cooling				
(b)	Fouling factor considered				
1.2.5	Heat Transfer Area				
(a)	Extra surface area in % included for tube plugging over theoretical surface requirement corresponding to VWO Condition				
1.2.6	No. of tube passes				
1.2.7	No. of shell passes				
1.2.8	Code followed for design, fabrication and testing				
1.2.9	Design Data				
(a)	Terminal temp. difference (Rated condition)	°C			
1.2.10	Tubes				
(a)	Size	mm			
(b)	Length (mm) & number				
(c)	Diameter	mm			

(d)	Wall thickness	mm				
1.2.11	Material of Construction (Specify Std/Code & Grade)					
(a)	Shell					
(b)	Water box					
(c)	Tubes					
(d)	Tube sheet					
1.2.12	Overall dimensions diameter & length	M				
1.2.13	Shell side relief valve material and capacity					
1.2.14	Gauge glass and other instruments provided as specified?		Yes/No			
1.2.15	Individual H.P. heater by- pass provided for each heater?		Yes/No			
1.2.16	Quick acting H.P. heater group -bypass provided for HP heaters?		Yes/No			
1.2.17	Design Codes					
1.2.18	Thermal Design					
1.2.19	Mechanical Design					
1.2.20	Design of Pressure Parts					
1.3	**L.P. FEED WATER HEATERS**	**UNIT**	**Heater-1**	**Heater-2**	**Heater-3**	**Heater- 4**
1.3.1	Type and manufacturer					

1.3.2	Orientation - horizontal/ vertical					
1.3.3	Drain cooling zone provided integral with heaters?		Yes/No			
1.3.4	Design pressure & temp.	Kg/cm2 (a) & C				
(a)	Shell side					
(b)	Tube side					
1.3.5	Heat Transfer Co-efficient					
(a)	Overall heat transfer co- efficient	Kcal/m². hr. °C				
	(i) Condensing Section					
	(ii) Drain Cooling Section					
	(iii) Fouling factor considered					
1.3.6	Heat Transfer Area					
(a)	Extra surface area in % included for tube plugging over theoretical surface requirement, corresponding to VWO condition					
1.3.7	No. of tube passes					
1.3.8	No. of shell passes					
1.3.9	Code followed for design, fabrication and testing					
1.3.10	Design data					
(a)	Terminal temperature difference	°C				

1.3.11	Tubes					
(a)	Size	mm				
(b)	Length & number	(mm)				
(c)	Diameter	mm				
(d)	Wall thickness	mm				
1.3.12	Material of Construction (Specify Std/Code & Grade)					
(a)	Shell					
(b)	Water box					
(c)	Tube					
(d)	Tube sheet					
1.3.13	Overall dimensions, diameter & Length	M x M				
1.3.14	Shell side relief valve material and capacity					
1.3.15	Gauge glass and other instruments provided as specified?		Yes/No			
1.3.16	Individual L.P. Heater by- pass provided for each heater?		Yes/No			
1.3.17	Design Codes					
1.3.18	Thermal Design					
1.3.19	Mechanical Design					
1.3.20	Design of Pressure Parts					

1.4	**WEIGHT DATA**					
1.4.1	Deaerating heater including storage tank					
(a)	Empty	kg				
(b)	Flooded	kg				
1.4.2	H.P. Feed water heater		Heater-5	Heater-6	Heater-7	
(a)	Empty	kg				
(b)	Flooded	kg				
(c)	Tube bundle	kg				
1.4.3	L.P. Feed water heater		Heater- 1	Heater - 2	Heater - 3	Heater - 4
(a)	Empty	kg				
(b)	Flooded	kg				
(c)	Tube bund	kg				

POWER CYCLE PUMPS, DRIVES & ACCESSORIES

1.0	**STEAM GENERATOR FEED PUMPS & DRIVES**	**Unit**	
1.1	TURBINE DRIVEN PUMP		
1.1.1	Design Code		
1.1.2	Numbers offered x % capacity		

1.1.3	Type (Barrel/Ring section)			
1.1.4	Manufacturer			
1.1.5	Model number			
1.1.6	No. of stages			
1.1.7	Speed			
1.1.8	Type of drive			
1.1.9	If Booster pump			
1.1.9.1	Type (Barrel/Ring section)			
1.1.9.2	Manufacturer			
1.1.9.3	Model No.			
1.1.9.4	No. of stages			
1.1.9.5	Speed			
1.1.9.6	Directly driven by electric motor or, steam turbine			
1.1.10	Pump Performance		**Main Pump**	**Booster Pump**
1.1.10.1	Design Capacity	TPH		
(a)	Through inlet			
(b)	At main pump			
(c)	At inter stage			

(d)	At kicker stage			
(e)	Run out flow			
1.1.10.2	Design inlet condition			
(a)	Suction temperature	°C		
(b)	Suction pressure	Kg/cm2(a)		
(c)	Specific gravity			
1.1.10.3	Design discharge condition			
(a)	Discharge pressure	Kg/cm2(a)		
(b)	Discharge temperature	°C		
(c)	Discharge pressure for kicker stage	Kg/cm2 (a)		
(d)	Discharge temperature for kicker stage	°C		
(e)	Discharge pressure for inter stage bleed	Kg/cm2 (a)		
(f)	Discharge temperature for inter stage bleed	°C		
1.1.10.4	Total head developed by the pump, (at operating temperature)	mlc		
1.1.10.5	Operating speed and number of stages			
1.1.10.6	NPSH requirement at full capacity for			
(a)	3% head break down			
(b)	1% head break down			
(c)	0% head break down			
1.1.10.7	Shut off head, (cold water)	mlc		

1.1.10.8	Power Consumption at duty point and efficiency (Use separate sheet for turbine and motor)			
(a)	Main pump input shaft, including Kicker stage	kW		
(b)	Booster Pump input shaft	kW		
(c)	Losses at the gear box	kW		
(d)	Losses in hydraulic coupling	kW		
(e)	Total output required at the turbine shaft/motor shaft	kW		
(f)	Efficiency of the main pump	%		
(g)	Efficiency of booster pump	%		
(h)	Efficiency of drive motor	%		
(i)	Efficiency of drive turbine	%		
(j)	Overall efficiency of the pump set (not considering losses internal to the turbine)	%		
(k)	Total Power Consumption at run out flow (at drive end)			
(l)	Power consumption at pump shut-off	kW		
(m)	Motor rating provided	kW		
1.1.10.9	Transient Operating condition			
(a)	One pump tripped while other pump also in service and feed control valve stuck open			
	(i) Max. flow through operating pump without overloading motor	TPH		
	(ii) NPSH required at this flow	mlc		

	(iii) TDH, mlc, power consumption (kW) and efficiency (%) at this capacity			
(b)	Additional suction head requirement over NPSH at design capacity to prevent cavitations condition in case of full load throw-off	mlc		
(c)	Minimum deaerator static head required (at deaerator storage tank B.F. pump trip level) to meet all transient conditions that might be encountered under various operating conditions with respect to B.F. Pump centre line (Indicate B.F. pump centre line with respect to Power House ground floor level also)			
1.1.11	Material of construction (specify std/code & grade)			
1.1.11.1	Casing			
1.1.11.2	Impeller			
1.1.11.3	Shaft			
1.1.11.4	Shaft sleeve			
1.1.11.5	Wearing ring			
1.1.11.6	Radial bearing			
1.1.11.7	Thrust bearing			
1.1.12	Pump Data			
1.1.12.1	Critical speed	rpm		
1.1.12.2	Warm up arrangement required?	Yes/No		
1.1.12.3	Suction Specific speed			

(a)	First stage			
(b)	Other stages			
1.1.12.4	Head developed per stage	mlc		
1.1.12.5	Recirculation Control			
(a)	Type			
(b)	Manufacturer			
(c)	Minimum flow required (indicate % of design flow also)	TPH		
1.1.12.6	Lubrication System			
(a)	Type			
(b)	Capacity of oil sump	Litres		
(c)	Shaft driven and motor driven oil pumps provided?	Yes/No		
	(i) Type and manufacturer			
	(ii) Motor rating	kW		
	(iii) Material of construction for both shaft driven & emergency pump (Specify Std/Code & Grade)			
	a. Casing			
	b. Inner assembly			
	c. Shaft			
(d)	Oil Cooler			
	(i) Type			
	(ii) No. (working + standby)			

(e)	Filter type and make			
1.1.12.7	All necessary instruments for safety interlock provided?	Yes/No		
1.1.12.8	All instruments arranged in rack?	Yes/No		
1.1.12.9	Arrangement of Axial thrust balancing			
1.1.12.10	Mechanical seal provided at ends?	Yes/No		
1.1.12.11	Clearance between pump rotating and stationary part			
1.1.12.12	Pump Connection			
(a)	Suction connection size	mm		
(b)	Discharge connection size	mm		
1.1.12.13	Main Pump designed for reverse rotation? If so,			
(a)	% of rated head			
(b)	% of rated speed			
1.1.12.14	Maximum Noise level of the Pump - Coupling Motor assembly	dBA		
1.1.12.15	Maximum peak to peak vibration measured at bearing housings for the complete pump assembly	micron		
1.1.13	Main Drive Motor (*For booster pump if applicable)			
1.1.14	Auxiliary Turbine Drive			
1.1.14.1	Design Inlet Conditions			
(a)	Percent opening of steam admission valve	%		
(b)	Steam flow	Kg/hr		
(c)	Steam pressure	Kg/cm2 (a)		
(d)	Steam temperature	°C		
(e)	Minimum superheat required during start-up	°C		

(f)	Steam enthalpy	Kcal/kg.		
1.1.14.2	Design Exhaust Conditions			
(a)	Exhaust pressure			
(b)	Exhaust enthalpy	Kcal/kg		
1.1.14.3	Power Outputs			
(a)	Total power production	kW		
(b)	Internal Mechanical losses	kW		
(c)	Output at the drive shaft	kW		
(d)	Turbine overall efficiency	%		
1.1.14.4	Total Auxiliary Power Consumption	kW		
1.1.14.5	Material of Construction			
(a)	High pressure casing			
(b)	Exhaust casing			
(c)	Low pressure steam chest			
(d)	Low pressure nozzles			
(e)	High pressure steam chest			
(f)	High pressure nozzles			
(g)	Blades			
(h)	Shrouds			

(i)	Wheel			
(j)	Shaft			
(k)	High pressure governor valve chest			
(l)	Low pressure governor valve chest			
1.1.15	Weight Data			
1.1.15.1	Pump & drive assembly including base plate	Tonnes		
1.1.15.2	Individual pump	Tonnes		
1.1.15.3	Motor	Tonnes		
1.1.16	Complete Pump Characteristic Curves enclosed?	Yes/No		
1.1.17	B.F.P. Suction Strainer provided	Yes/No		
1.1.17.1	Type of element Duplex/ Simplex			
1.1.17.2	Pressure drop across strainer			
(a)	When clean	mlc		
(b)	Maximum allowable	mlc		
1.1.17.3	Material of Construction (Specify Std/Code & Grade)			
(a)	Body			
(b)	Straining element			
1.1.17.4	Ratio of opening area to pipe inside area			
1.2	**MOTOR DRIVEN STANDBY PUMP**			
1.2.1	Design code			

1.2.2	Numbers offered x % capacity			
1.2.3	Type (Barrel/Ring section)			
1.2.4	Manufacturer			
1.2.5	Model number			
1.2.6	No. of stages			
1.2.7	Speed			
1.2.8	Type of drive			
1.2.9	If Booster pump			
1.2.9.1	Type (Barrel/Ring section)			
1.2.9.2	Manufacturer			
1.2.9.3	Model No.			
1.2.9.4	No. of stages			
1.2.9.5	Speed			
1.2.9.6	Directly driven by electric motor or, steam turbine			
1.2.10	Pump Performance		**Main Pump**	**Booster Pump**
1.2.10.1	Design Capacity, Tonnes/hr			
(a)	Through inlet			
(b)	At main pump			

(c)	At inter stage			
(d)	At kicker stage			
1.2.10.2	Design inlet condition			
(a)	Suction temperature,	°C		
(b)	Suction pressure,	Kg/cm2(a)		
1.2.10.3	Design discharge condition			
(a)	Discharge pressure	Kg/cm2(a)		
1.2.10.4	Total head developed by the pump, (at operating temperature)	MLC		
1.2.10.5	Operating speed			
1.2.10.6	Number of stages			
1.2.10.7	NPSH requirement at full capacity			
1.2.10.8	Shut off head, MLC (cold water)			
1.2.10.9	Power Consumption at duty point and efficiency			
(a)	Main pump input shaft, including Kicker stage	kW		
(b)	Booster Pump input shaft	kW		
(c)	Losses at the gear box	kW		
(d)	Losses in hydraulic coupling	kW		
(e)	Total output required at the turbine shaft/motor shaft	kW		

(f)	Efficiency of the main pump	%		
(g)	Efficiency of booster pump	%		
(h)	Efficiency of drive motor	%		
(i)	Efficiency of drive turbine	%		
(j)	Motor rating provided	kW		
1.2.11	Material of construction (specify std/code & grade)			
(a)	Casing			
(b)	Impeller			
(c)	Shaft			
(d)	Shaft sleeve			
(e)	Wearing ring			
(f)	Radial bearing			
(g)	Thrust bearing			
1.2.12	Pump Data			
1.2.12.1	Critical speed	rpm		
1.2.12.2	Warm up arrangement required?	Yes/No		
1.2.12.3	Suction Specific speed			
(a)	First stage			
(b)	Other stages			

1.2.12.4	Head developed per stage	mlc		
1.2.12.5	Recirculation Control			
(a)	Type			
(b)	Manufacturer			
(c)	Minimum flow required (indicate % of design flow also)	TPH		
1.2.12.6	Hydraulic Coupling			
(a)	Type			
(b)	Manufacturer			
(c)	Response time of control element to move from one extreme position to other	Sec		
(d)	Material of Construction (Specify Std/Code & Grade)			
	(i) Impeller			
	(ii) Casing			
	(iii) Scoop tube			
1.2.12.7	Lubrication System			
(a)	Type			
(b)	Capacity of oil sump			
(c)	Shaft driven and motor driven oil pumps provided?			
	(i) Type and manufacturer			
	(ii) Motor rating			

	(iii) Material of construction for both shaft driven & emergency pump (Specify Std/Code & Grade)			
	a. Casing			
	b. Inner assembly			
	c. Shaft			
(d)	Oil Cooler			
	(i) Type			
	(ii) No. (working + standby)			
(e)	Filter type and make			
1.2.12.8	All necessary instruments for safety interlock provided?	Yes/No		
1.2.12.9	All instruments arranged in rack?	Yes/No		
1.2.12.10	Arrangement of Axial thrust balancing			
1.2.12.11	Mechanical seal provided at ends?	Yes/No		
1.2.12.12	Clearance between pump rotating and stationary part			
1.2.12.13	Pump Connection			
(a)	Suction connection size	mm		
(b)	Discharge connection size	mm		
1.2.12.14	Main Pump designed for reverse rotation? If so,			
(a)	% of rated head			

(b)	% of rated speed			
1.2.12.15	Maximum Noise level of the Pump - Coupling Motor assembly	dB A		
1.2.12.16	Maximum peak to peak vibration measured at bearing housings for the complete pump assembly	micron		
1.3	**STEAM TURBINE FOR BFP**			
1.3.1	Turbine details			
1.3.1.1	Design Code (IEC 45/API 611)			
1.3.1.2	No. of stages			
1.3.1.3	Moisture content at last stage			
1.3.1.4	No. of oil Pumps			
1.3.1.5	Steam Pressure at rated load of the Turbine	Kg/cm² (g)		
1.3.1.6	Steam Temperature at the rated load of the turbine	°C		
1.3.1.7	Steam flow at the rated Load of the Turbine	TPH		
1.3.2	Materials of Construction			
1.3.2.1	Turbine casing			
1.3.2.2	Turbine rotor			
1.3.2.3	Control valve chest			
1.3.2.4	Blades			
(a)	Moving blades			
(b)	Fixed blades			
1.3.2.5	Shaft			

1.3.2.6	Bearings		
1.3.2.7	Casing Joint Bolts		
1.3.2.8	Gland Steam Condenser: (Shell, tube, tube sheet)		
1.3.2.9	Gland Steam Exhauster (Impeller, shaft, casing)		
1.3.3	Details of Turbovisory Instrumentation		
1.3.4	Oil System		
1.3.4.1	Lube Oil Conditioning Equipment		
1.3.4.2	Type of Conditioner		
1.3.4.3	Capacity of Unit	m^3/hr	
1.3.5	Turning Gear		
(a)	Type		
2.0	**CONDENSATE PUMPS AND DRIVES**		
2.1	**PUMP**		
2.1.1	Numbers offered x % capacity each		
2.1.2	Type and manufacturer's name		
2.1.3	Model No.		
2.2	**PERFORMANCE DATA UNDER RATED CONDITION**		
2.2.1	Capacity	TPH	
2.2.2	Discharge pressure	kg/cm^2 a)	

2.2.3	Suction pressure	kg/cm^2(a)	
2.2.4	Temperature at pump suction	°C	
2.2.5	Total pump head	mlc	
2.2.6	Required NPSH for		
(a)	3% head break down		
(b)	0% head break down		
2.2.7	Static head at pump suction considering minimum hotwell level	mlc	
2.2.8	Speed	rpm	
2.2.9	Efficiency at rated point	%	
2.2.10	Drive power required under design condition	kW	
2.2.11	Design Specific Speed		
2.2.12	Suction Specific speed		
(a)	First Stage		
(b)	Other stages		
2.2.13	Shut-off discharge pressure	kg/cm^2(a)	
2.3	**DESIGN AND CONSTRUCTION**		
2.3.1	No. of stages		
2.3.2	1st stage Diameter of impeller	mm	

2.3.3	Shaft diameter	mm	
2.3.4	Pump shaft length	mm	
2.3.5	Pump column length	mm	
2.3.6	Method of fastening impellers to shaft		
2.3.7	Suction connection Size	mm	
2.3.8	Discharge connection Size	mm	
2.3.9	Maximum reverse runaway speed, rpm. and % of rated head for reverse rotation		
(a)	Critical speeds	rpm	
2.3.10	Pump Bearing		
(a)	Manufacturer		
(b)	Type		
2.3.11	Thrust bearing		
(a)	Manufacturer		
(b)	Type		
2.3.12	Material of Construction		
(a)	Casing		
(b)	Impeller		
(c)	Shaft		
(d)	Shaft sleeves		

(e)	Wearing rings		
(f)	Radial bearing		
2.3.13	Maximum peak to peak vibration	microns	
2.3.14	Maximum Noise level under all operating conditions of the Pump motor assembly	dBA	
2.3.15	Suction Strainer		
(a)	Type		
(b)	Differential pressure gauge provided across each strainer?		Yes / No
(c)	Pressure drop across strainer inlet & outlet terminal for		
	(i) Design Condition		
	(ii) When 50 % clogged		
2.4	WEIGHT AND DIMENSIONS		
2.4.1	Completely assembled pump	Kg	
2.4.2	Rotating assembly	Kg	
2.4.3	Motor	Kg	
2.4.4	Total shipping weight	Kg	
2.4.5	Dimensions		
(a)	Overall Dia	mm	
(b)	Overall height	mm	
2.4.6	Pump base plate bottom location level with respect to Power House ground floor level	mm	
2.4.7	Hotwell outlet pipe lowest level leading to pump	mm	

2.5	Complete pump performance curve furnished	Yes / No	

CONDENSER & AIR EXTRACTION SYSTEM

S No	ITEM							
1.0	**CONDENSER**							
1.1	GENERAL							
1.1.1	Manufacturer							
1.1.2	Type & Design Code							
		UNIT	VWO Condition	100% Load (Constant Pressure)	90% Load (Constant Pressure)	80% Load (Sliding Pressure)	50% Load (Sliding Pressure)	40% Load (Constant Pressure)
1.1.3	Performance data with 0% Make up, all Heaters in Service, 85% Tube Cleanliness with 33^0C CW temperature and all tubes Working							
(a)	Flow	TPH						
	(i) Exhaust section steam to condenser							
	(ii) Drain from heaters							
	(iii) System make-up							
	(iv) Drain from air ejector condenser							
	(v) Drain from gland steam condenser							
	(vi) Any other flow (specify)							

S No	ITEM							
	(vii) Maximumallowable airingress during rated load :							
(b)	Guaranteed Condenser Pressure	mm Hg abs						
(c)	Circulating water temperature at							
	(i) Inlet	C						
	(ii) Outlet	C						
(d)	Terminal temperature difference	C						
(e)	Overall heat transfer co- efficient and cleanliness factor used to obtain overall heat transfer co-efficient							
(f)	Temperatureofcondensate at hotwell outlet	C						
(g)	Maximum free oxygen content in the condensate coming out of the hotwell	cc/ltr						
(h)	Specify Standard/code followed for performance calculations, design fabrication and testing							
(i)	Design water velocity in tube	m/s						
(j)	Design cooling water flow	m^3/hr						
(k)	Water velocity when 10%tubes are in plugged condition							

S No	ITEM							
(l)	Circulating water pressure drop across condenser	mlc						
1.1.4	Performance data with 3% Make-up, all Heaters in service, 85% Tube Cleanliness with 33°C C.W. temperature & all tubes working							
(a)	Heat rejected to circulating water	Kcal/Hr						
(b)	Temperature rise of circulating water considering design cooling water flow	C						
(c)	Condenser back pressure	mm Hg abs						
(d)	Terminal temperature difference	C						
(e)	Total head drop across CW terminals for inlet & outlet	mlc						
	NOTE: Furnish the above information for 36^0C CW temperature separately							

S No	ITEM	UNIT	
1.2	**DESIGN PARTICULARS (CONDENSER)**		
1.2.1	No. of passes		
1.2.2	Arrangement with respect to turbine axis		

S No	ITEM	UNIT	
1.2.3	Heat transfer surface	M^2	
1.2.4	Shell Details		
(a)	Design pressure	Kg/cm2 (g)	
(b)	Design temperature	°C	
(c)	Thickness of plates	mm	
(d)	Nozzles provided in the shell as per requirement	Yes/No	
(e)	Expansion joint provided in the shell?	Yes/No	
1.2.5	Water Boxes Details		
(a)	Type of water boxes		
	(i) Design pressure	Kg/cm2(g)	
	(ii) Normal working pressure	Kg/cm2(g)	
(b)	Design temperature	°C	
(c)	Standard/Code used for water box design, fabrication and testing		
(d)	Method of attaching water-boxes to shell (specify all necessary details)		
(e)	Size of C.W. connections		
	(i) Inlet nozzles	mm	
	(ii) Outlet nozzles	mm	
(f)	Suitable drain and vent connections complete with necessary number of valves provided for all water box compartments?	Yes/No	

S No	ITEM	UNIT	
1.2.6	Tube Support Plates		
(a)	No. of tube support plates		
(b)	Spacing	mm	
(c)	Thickness	mm	
1.2.7	Tube Sheet Thickness	mm	
1.2.8	Tubes		
(a)	Manufacturer		
(b)	O.D. and Thickness		
(c)	Total no. of tubes		
(d)	Effective tube length	M	
(e)	Method of tube to tube sheet joint		
(f)	Tubes self draining on shutdown?	Yes / No	
(g)	Maximum allowable circulating water velocity through condenser tube without affecting life (indicate expected life)		
(h)	Expected interval between two successive retubing		
	(i) With design velocity		
	(ii) With maximum allowable velocity		
1.2.9	Hotwell		
(a)	Material & thickness	mm	
(b)	Capacity at normal operating level	kg	

S No	ITEM	UNIT	
(c)	Normal operating level (from the bottom of hotwell)	M	
(d)	Suitable arrangement for prevention of under cooling provided?	Yes/No	
(e)	Number and size of condensate outlet nozzles	mm	
(f)	Strainers at condensate outlet provided?	Yes/No	
(g)	Necessary level monitoring instruments provided?	Yes/No	
1.2.10	Condenser supports and neck expansion joints		
(a)	If spring supports are provided, then		
	(i) Total no. of supports		
	(ii) Arrangement of supports		
	(iii) Spring material		
	(iv) Total movement of the support from empty condition to filled up condition at full load operation	mm	
	(v) Load on each support,	kg	
	(vi) Spring gagging device supplied for hydro testing of condenser?	Yes/No	
(b)	If fixed supports are provided, then		
	(i) Type of supports		
	(ii) Total number of supports		
	(iii) Provision for adjustment of supports provided?	Yes/No	
	(iv) Load on each support, kg		

S No	ITEM	UNIT	
(c)	Condenser Neck Expansion joint (if applicable)		
	(i) Manufacturer and type of expansion joint at condenser neck		
1.2.11	Connections and Baffling		
(a)	All piping connections provided as specified?	Yes/No	
(b)	Necessary steam distribution and impingement baffling provided?	Yes/No	
1.2.12	Material of Construction (Specify Code/ Std & Grade)		
(a)	Condenser shell		
(b)	Hotwell		
(c)	Water boxes		
(d)	Thickness for corrosion protection		
(e)	Tube sheets		
(f)	Tubes		
(g)	Impingement baffles		
(h)	Shell expansion joint		
(i)	Neck expansion joint		
1.2.13	Allowable forces/moments data at condenser nozzle furnished?	Yes/No	
1.2.14	Circulating Water Piping		
(a)	Pressure Balanced Expansion Joints		

S No	ITEM	UNIT	
	(i) Number and size of Expansion Joints provided:		
	(ii) Orientation and location of Expansion Joint:		
	(iii) Make, model/catalogue number and type		
	(iv) Make, model/catalogue number and type of spring support of the expansion joint		
(b)	C.W. inlet/outlet pipe size (O.D. x thick.) at terminal point	mm x mm	
1.3	LAYOUT DATA		
1.3.1	Centre line elevation of C.W. Inlet and outlet flange	mm	
1.3.2	Water box cover can be removed for tube withdrawal without disturbing circulating water inlet & outlet piping connected to condenser?	Yes/No	
1.4	WEIGHT AND DIMENSIONS		
1.4.1	Weight of shell and water boxes (empty)	Tonnes	
1.4.2	Total weight of tubes		
1.4.3	Total weight of complete condenser assembly fully filled	Tonnes	
1.4.4	Size of tube sheet		
(a)	Width	M	
(b)	Height	M	
1.4.5	Size of hot well		
(a)	Length	M	

S No	ITEM	UNIT	
(b)	Breadth	M	
1.4.6	Depth of water box		
(a)	at the bottom	M	
(b)	at the top	M	
1.4.7	Width of water box	M	
2.0	**CONDENSER AIR EVACUATION SYSTEM**		
2.1	Make & model		
2.2	Number offered		
2.3	Numbers working		
2.4	Size and type		
2.5	Design code		
2.6	Capacity in free air delivered at standard conditions with pump operating at saturated inlet conditions of 25.4 mmHg (abs) and at design back pressure,	Nm3/hr.	
2.7	Suction pressure,	mm Hg(abs)	
2.8	Suction temperature	°C	
2.9	Suction line pressure drop	mm Hg.	
2.10	POWER REQUIRED AT PUMP		
2.10.1	25.4 mm Hg pump pressure	kW	

S No	ITEM	UNIT	
2.10.2	Condenser design pressure	kW	
2.11	Cooling water required for seal and heat exchanger	m^3/hr	
2.12	Design TTD	°C	
2.13	Design TTD heat exchanger	°C	
2.14	Volume of condenser and turbine steam space to be evacuated as basis of pump		
2.15	Time to evacuate the above volume under standard conditions (21.1 0C & 1.033 Kg/cm2 (abs)		
2.16	Whether air ejector is provided?	Yes/No	
2.17	Number of stages		
2.18	Compression ratio of each stage		
2.19	Cooling water pressure at inlet to heat exchanger		
2.20	Blank off suction pressure (at 36 0C cooling water inlet temp)		
2.21	MOTOR		
(a)	Make		
(b)	Rating	kW	
(c)	Rated voltage	KV	
2.22	Weight of each pump motor unit	Kg	
2.23	MATERIAL OF PUMP MOTOR UNIT		

S No	ITEM	UNIT	
(a)	Casing		
(b)	Shaft		
(c)	Impeller		
(d)	Shaft sleeves		
(e)	Cooler tubes		
2.24	WEIGHT & DIMENSIONS		
(a)	Total weight of each vacuum pump & drive assembly including base plate	Tonnes	
(b)	Individual Pump	Tonnes	
(c)	Motor	Tonnes	

CENTRAL LUBE OIL PURIFICATION & TRANSFER SYSTEM

SR. NO.	ITEM	UNIT		
1.0	**TURBINE OIL PURIFICATION SYSTEM**			
1.1	PERFORMANCE DATA		**Unit Oil System**	**Central Oil System**
1.1.1	Total Oil volume in complete oil system of T.G. Unit	litres		
1.1.2	Rated capacity of Purification Plant	litres/hr		

SR. NO.	ITEM	UNIT		
1.1.3	Maximum size of solids and maximum water content (in %) acceptable for T.G. oil system at purification plant outlet			
1.1.4	Suitable for continuous operation round the clock with one scheduled maintenance per year?		Yes/No	Yes/No
1.1.5	Total No. of Purification supplied			
1.2	OIL PUMPS			
1.2.1	Clean Oil Pump			
(a)	Type			
(b)	Manufacturer			
(c)	Number provided per purification unit			
(d)	Capacity	LPM		
(e)	Pump speed	rpm		
(f)	Power required at the rated operating condition	kW		
(g)	Material of Construction (Specify Std/ Code no./Grade)			
	(i) Casing			
	(ii) Shaft			
	(iii) Rotor			
	(iv) Relief valve			
1.2.2	Dirty Oil Pump			

SR. NO.	ITEM	UNIT		
(a)	Type			
(b)	Manufacturer			
(c)	Number provided per purification unit			
(d)	Capacity	LPM		
(e)	Pump speed	rpm		
(f)	Power required at the rated operating condition	kW		
(g)	Material of Construction (Specify Std/ Code no./Grade)			
	(i) Casing			
	(ii) Shaft			
	(iii) Rotor			
	(iv) Relief valve			
1.3	CENTRIFUGE			
1.3.1	Manufacturer			
1.3.2	Numbers offered per purification unit			
1.3.3	Type and Model No.			
1.3.4	Speed of the centrifuge	RPM		
1.3.5	Maximum Power requirement	kW		
1.3.6	Motor	kW		

SR. NO.	ITEM	UNIT		
1.3.7	Belt guard provided?			
1.3.8	Method of balancing			
(a)	Static			
(b)	Dynamic			
1.3.9	Heavy phase drain through anti-flood tanks?			
1.3.10	Materials of Construction (Specify Std/ Code no. Grade)			
(a)	Casing			
(b)	Bowl and internals			
(c)	Shaft			
1.4	OIL HEATER			
1.4.1	Manufacturer			
1.4.2	Number offered per purification unit			
1.4.3	Type and Model No.			
1.4.4	Rated capacity	litres/hr		
1.4.5	Design oil inlet temperature,	°C		
1.4.6	Design oil outlet temperature,	°C		
1.4.7	Water bath			
(a)	Dimensions	mm		
(b)	Water content	litres		

SR. NO.	ITEM	UNIT		
(c)	Gauge glass provided?			
1.4.8	Heating Elements			
(a)	Material and type of construction of the heating elements			
(b)	Two (2) 100% capacity heating element provided?			
1.4.9	Materials of Construction (Specify Std/ Code no. & Grade)			
(a)	Shell			
(b)	Tubes			
1.5	POLISHING FILTER			
1.5.1	Manufacturer			
1.5.2	Numbers offered			
1.5.3	Type & Model No.			
1.5.4	Rated capacity,	litres/hr		
1.5.5	Pressure drop at rated capacity			
(a)	Normal			
1.5.6	Filter Vessel			
(a)	O.D.	mm		
(b)	Height	mm		
(c)	Material of construction (Specify Std/Code no. & Grade)			

SR. NO.	ITEM	UNIT		
1.6	WEIGHT DATA			
1.6.1	Clean oil pump with drive	Kg		
1.6.2	Dirty oil pump with drive	Kg		
1.6.3	Centrifuge unit	Kg		
1.6.4	Oil heater	Kg		
1.6.5	Polishing Filter	Kg		
1.7	STORAGE TANKS			
1.7.1	Number and design code			
1.7.2	Capacity of each tank	m^3		
1.7.3	Size of each tank	mm x mm x mm		
1.8	OIL TRANSFER PUMP			
1.8.1	Number (working/standby)			
1.8.2	Make			
1.8.3	Capacity of each pump	Litres/hr		
1.8.4	Discharge pressure, of pump	$Kg/cm^2(g)$		
1.9	All necessary piping fittings and accessories provided as necessary?	Yes/No		

HYDROGEN GENERATION PLANT

1	**Hydrogen generation skid**			
i.	Number	Nos.		
ii.	Capacity of each skid			
iii.	Pressure at the out let of skid	Kg/cm^2		
iv.	H_2 Purity at generator outlet			
v.	H_2 Purity at purifier outlet			
vi.	H_2 Purity at comperssor outlet			
vii.	Dew point at comperssor outlet			
2	**Ractifier**			
i.	Number			
ii.	Type			
iii.	Capacity			
iv.	Transformer capacity			
3	**Chiller**			
	a) Number			
4	**Deoxy Purifier**			
i.	Number			
ii.	Type			
5	**H_2 Compressor**			
i.	Number			
ii.	Capacity			
iii.	Inlet Pressure	Kg/cm^2		
iv.	Outlet Pressure	Kg/cm^2		
6	**Hydrogen Gas Compressor drive Motor**			
i.	Number			
ii.	Type			

iii.	Voltage		
iv.	torgue		
v.	Rating		
vi.	rpm		
7	**Hydrogen Manifold**		
i.	Number		
ii.	Number of Connection		
8	**Vaccum Pumps**		
i.	Number		
ii.	Type		
iii.	Capacity		
9	**Vacuum Pump drive Motor**		
i.	Number		
ii.	Type		
iii.	Voltage		
iv.	Torgue		
v.	Rating		
vi.	RPM		
10	**DM water pump**		
i.	Number		
ii.	Type		
iii.	Capacity		
11	**DM water pump drive Motor**		
i.	Number		
ii.	Type		
iii.	Voltage		
iv.	torgue		

v.	Rating				
vi.	rpm				
12	**Cooling water pump**				
i.	Number				
ii.	type				
iii.	capacity				
13	**Cooling water pump drive Motor**				
i.	Number				
ii.	Type				
iii.	Voltage				
iv.	torgue				
v.	Rating				
vi.	rpm				
14	**Cylinders**		**H_2**	**N_2**	**CO_2**
i.	Number				

RAW WATER INTAKE PUMPS

S.No	Item	Units	Description
1.	Total no. of pumps	Nos.	
2.	Pump capacity	M^3/hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump Speed (max.)	RPM	
5.	Type of Pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Material of construction		
a.	Pump column pipe		
b.	Pump bowl and discharge elbow		
c.	Impeller		
d.	Shaft		
e.	Line shaft coupling		
f.	Line shaft bearing		
g.	All hardware under water		
h.	Base plate		
i.	Shaft sleeve		
j.	Thrust bearing cooling system pipes and valves		

RAW WATER PUMPS

S.No	Item	Units	Description
1.	Total no. of pumps	Nos.	
2.	Pump capacity	M^3/hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump Speed (max.)	RPM	
5.	Type of Pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Material of construction		
a.	Pump column pipe		
b.	Pump bowl and discharge elbow		
c.	Impeller		
d.	Shaft		
e.	Line shaft coupling		
f.	Line shaft bearing		
g.	All hardware under water		
h.	Base plate		
i.	Shaft sleeve		
j.	Thrust bearing cooling system pipes and valves		

AHP PUMPS

S.No	Item	Units	Description
1.	Total no. of pumps	Nos.	
2.	Pump capacity	M^3/hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump Speed (max.)	RPM	
5.	Type of Pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Material of construction		
a.	Pump column pipe		
b.	Pump bowl and discharge elbow		
c.	Impeller		
d.	Shaft		
e.	Line shaft coupling		
f.	Line shaft bearing		
g.	All hardware under water		
h.	Base plate		
i.	Shaft sleeve		
j.	Thrust bearing cooling system pipes and valves		

COARSE SCREENS & STOP LOG GATES

Coarse Screens

1. Clear Opening :
2. Material of Construction

a. Screen Wire :

b. Side guide-cum-track :

c. Frame :
d. Mechanical fasteners :

Stoplog Gates

1. Guides/ Anchors :

2. Gate leaf & lifting beam :
3. Rubber seals :

4. Lifting Beam :

WATER TREATMENT PLANT

Sr. No.	Description	Units	Parameter
1.0	**Raw Water Inlet Pipe and Valves**		
a.	Size of Raw Water inlet pipe	mm	
b.	Material of Construction of Pipe		
c.	Inlet valves		
i)	Number of control valve	No.	
ii)	Type		
iii)	Size	mm	
iv)	Number of isolating & By pass valve		
v)	Type		
vi)	Size	mm	
d.	Ends		
e.	Material of construction		
i)	Body & disc		
ii)	Valve spindle (Shaft)		
iii)	Bearing & Gland packing		
iv)	Valve seat		
v)	Disc seat		
vi)	Seal retaining ring		
vii)	Bolts and nuts		
viii)	Gear casing		
ix)	Gears		
x)	Pinions		
xi)	Pinion screw hardware		
2.0	**Cascade Aerator**		
a.	Type		
b.	Number required	No.	
c.	Construction		
d.	Design Flow	Cum/hr.	
e.	Surface Loading	M3/m2/hr	
f.	Residence time	Sec	
g.	Riser	mm	
h.	Tread	mm	
i	Free Board	mm	
j.	Size	M	
k.	**No. of Steps**		
3.0	**Stilling Chamber**		
a.	Number required	No.	
b.	Construction		
c.	Detention time	min.	
d.	Rated Capacity	Cum/hr.	
e.	Free Board	mm	
f.	Accessories		

Sr. No.	Description	Units	Parameter
4.0	**Parshall Flume**		
a.	Number required		
b.	Construction		
c.	Rated Capacity	Cum/hr.	
d.	Minimum Free board	mm.	
e.	Design Temp.	Deg C	
f.	Size	mm	
5.0	**Flash mixer**		
a.	Number required	No.	
b.	Rated Capacity	m3/hr	
c.	Construction		
d.	Detention time (approx.)	min.	
e.	Free-board	mm	
f.	Agitator		
g.	Protective cover of GI construction for motors and gear drives.		
h.	Accessories		
6.0	**Clariflocculator**		
a.	MOC of inlet pipe		
b.	Number required	No.	
c.	Type & Construction		
d.	Rated Effluent Capacity	Cum/hr	
e.	Effluent quality	NTU	
f.	Detention period- - Flocculation Zone - Clarification Zone	Min.	
g.	Rise rate	Cu.M/hr/ m2	
h.	Wier Loading rate	M3/day/m	
i.	Water Depth	M	
j	Walkway		
k.	Rake bridge:		
i)	Material		
ii)	Other features		
l.	Sludge blow-off:		
i)	Continuous		
ii)	Intermittent		
m.	Size:	m	
n.	Flocculation Agitator		
o.	Clarifier launder width	mm	
p.	Wier Plate		
q.	MOC of Wier Plate		
r.	Sampling Point		
s.	Torque switch for clarifier bridge drive		
7.0	**Chemical House**		
a.	Number	No	
b.	Type		

Sr. No.	Description	Units	Parameter		
c.	Ground Floor				
d.	First Floor				
e.	Handling Facility				
f.	Weighing scale for weighing chemicals capacity 500 Kg.	No.			
8.0	**Chemical Dosing System**				
8.1	**Dosing Tanks**		Alum Tank	Lime Tank	Polyelectrolyte Tank
a.	Numbers required				
b.	Construction				
c.	Internal lining		As per requirement		
d.	Minimum effective Capacity of each tank	Cum.			
e.	Solution strength	%			
f.	Agitator – type				
	- MOC				
g.	Dissolving basket				
h.	M.O.C. for piping valves, & fittings				
i.	Accessories:				
1.	Level Guages	No.			
2.	Level Switches	No.			
8.2	**Chemical Dosing Pumps**				
a.	**Alum Dosing Pumps**				
i.	Qty	Nos.			
ii	Type				
iii	Location				
iv.	Fluid to be handled				
v.	Service				
vi.	Duty:				
vii.	Suction Condition				
viii.	Rated Capacity				
ix.	Head				
x.	Design Temperature	☐C			
xi.	Range of operation				
xii.	Rated speed	spm			
xiii.	MOC:				
	- All Wetted Parts				
	- Diaphragm				
	- Nuts & Bolts				
	- Base Plate				
xiv.	Type of drive				
xv.	Criteria for selection of drive motor				
xvi.	Motor Rated Speed				
xvii.	Voltage , Phase & Frequency (± % variation)				
xviii.	Type of Coupling between				

Sr. No.	Description	Units	Parameter
	pump and motor		
xix	Noise level (for complete set of pump and motor)		
xx	Instruments		
	- Pressure Guage		
	- Numbers		
	- Location		
	- Type		
xxi	Start stop facility provided at both local and remote		
	- Trip Interlock		
xxii	Accessories to be provided		
	- Pulsation Dampner		
	- Pressure Relief Valve		
b.	**Lime Dosing Pumps**		
i.	Qty	Nos.	
ii.	Type		
iii.	Pump speed	rpm	
iv.	Fluid to be handled		
v.	Service		
vi.	Duty:		
vii.	Suction Condition		
viii.	Rated Capacity	lph	
ix.	Head		
x.	Design Temperature	□C	
xi.	Range of operation		
xii.	MOC:		
	- Pump Casing		
	- Stator		
	- Shaft & Shaft sleeve		
	- Eccentric Rotor		
xiii.	Type of drive		
xiv.	Criteria for selection of drive motor		
xv.	Motor Rated Speed		
xvi.	Voltage , Phase & Frequency (± % variation)		
xvii.	Speed Reducer		
xviii.	Noise level (for complete set of pump and motor)		
xix.	Instruments – Pressure Guage		
	- Numbers		
	- Location		
	- Type		
xx.	Start stop facility provided at both local and panel		
xxi.	Trip Interlock		
c.	**PE Dosing Pumps**		
i.	Qty	Nos.	

Sr. No.	Description	Units	Parameter	
ii.	Type			
iii.	Location			
iv.	Fluid to be handled			
v.	Design Code			
vi.	Service			
viii.	Duty:			
viii.	Suction Condition			
ix.	Rated Capacity	lph		
x.	Head			
xi.	Design Temperature	□C		
xii.	Range of operation			
xiii.	Rated speed	spm		
xiv.	MOC:			
	- All Wetted Parts			
	- Diaphragm			
	- Nuts & Bolts			
	- Base Plate			
xv.	Type of drive			
xvi.	Motor Rated Speed			
xvii.	Voltage , Phase & Frequency (± % variation)			
xviii.	Type of Coupling between pump and motor			
xix.	Noise level (for complete set of pump and motor)			
xx.	Instruments - Pressure Guage			
	- Numbers			
	- Location			
	- Type			
xxi.	Start stop facility provided at both local and panel			
xxii.	Trip Interlock			
xxiii.	Accessories to be provided			
	- Pulsation Dampner			
	- Pressure Relief Valve			
9.0	**Sump**			
a.	Number	No.		
b.	MOC & Type			
c.	Capacity (Effective) (min.)	Cu.m		
d.	Instruments			
e.	Inside Protection			
10.0	**Disposal Pumps**		Sludge	Filter Back Wash
a.	Numbers	No.		
b.	Type			
c.	Capacity rate	Cum/hr		
d.	Head	mwc		
e.	Type of lubrication			

Sr. No.	Description	Units	Parameter
f.	Material of Construction		
i.	Casing		
ii.	Impeller		
iii.	Shaft		
iv.	Shaft sleeves		
v.	Column pipe		
vi.	Packing		
vii.	Flexible coupling		
viii.	Bolts & Nuts		
	- In corrosive locations		
	- In other places		
ix.	Electric supply		
x.	Enclosure & insulation		
xi.	Speed of pump motor rating	rpm	
11.0	**Sludge Thickener**		
a.	Number	Nos.	
b.	Capacity	Cum/hr	
c.	Inlet solid concentration		
d.	Outlet Concentration		
e.	MOC		
12.0	**Thickened Sludge Sump**		
a.	Number		
b.	MOC & Type		
c.	Capacity	cum	
d.	Instrument		
e.	Inside Protection		
13.0	**Thickened sludge transfer pumps**		
a.	Number	Nos.	
b.	Type		
c.	Capacity & head	M3/hr & mwc	
d.	Liquid to handled		
e.	MOC i. Pump Casing ii. Stator iii. Shaft iv. Eccentric Rotor		
14.0	**Centrifuge**		
a.	Number	Nos.	
b.	Type		
c.	Capacity	Cum/hr	
d.	Inlet solid concentration		
e.	Outlet Concentration		
	MOC Bowl: Conveyor:		

Sr. No.	Description	Units	Parameter
15.0	**Clarified Water Tank**		
a.	Number	No.	
b.	Effective capacity	m^3	
c.	MOC		
d.	Type of tank		
e.	Inside protection		
f.	Free board	mm	
16.0	**Pumps**		**DM Plant Feed**
a.	Numbers	Nos.	
b.	Type		
c.	Capacity	CMH	
d.	Head	MWC	
e.	Type of lubrication		
f.	Speed of pump	RPM	
g.	Material of Construction		
i.	Casing		
ii.	Impeller		
iii.	Shaft		
iv.	Shaft sleeves		
v.	Column pipe		
vi.	Stuffing Box		
vii.	Gland		
viii.	Gland Packing		
ix.	Gaskets		
x.	Bolts & Nuts		
17.0	**Safety & supervisory equipments**		
17.1	Gas Mask Oxygen Breathing Equipment along with Breathing Apparatus		
17.1.1	Quantity	Nos.	
17.1.2	Capacity		
17.1.3	Accessories to be provided		
17.2.0	Canister type breathing Apparatus		
17.2.1	Number	Nos.	
17.2.2	Type		
17.3.0	Ammonia Bottles		
17.3.1	Number	Nos.	
17.3.2	Capacity	ml	
17.3.3	Accessories to be provided		
17.8.0	Weather Cock		
17.8.1	Number	Nos.	

FILTERED WATER SYSTEM

CW MAKE UP PUMPS

S. No.	Item	Units	Description
1.	Quantity	Nos.	
2.	Pump capacity (approx.)	M^3/ hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump speed (max.)	RPM	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Impeller		
c.	Shaft		
d.	Shaft Sleeve		
e.	All hardware under water		
f.	Stuffing Box Packing		
h.	Base Plate		
i.	Column Pipe		
j.	Discharge Elbow		

APH/ ESP WATER WASH PUMPS

Sr. No.	Item	Units	Description
1.	Quantity	Nos.	
2.	Pump capacity (approx.)	M^3/ hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump speed (max.)	RPM	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Impeller		
c.	Shaft		
d.	Shaft Sleeve		
e.	All hardware under water		
f.	Stuffing Box Packing		
h.	Base Plate		
i.	Column Pipe		
j.	Discharge Elbow		

SERVICE WATER PUMPS

Sr. No.	Item	Units	Description
1.	Quantity	Nos.	
2.	Pump capacity (approx.)	M^3/ hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump speed (max.)	RPM	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Impeller		
c.	Shaft		
d.	Shaft Sleeve		
e.	All hardware under water		
f.	Stuffing Box Packing		
h.	Base Plate		
i.	Column Pipe		
j.	Discharge Elbow		

AHP SEAL WATER PUMPS

Sr. No.	Item	Units	Description
1.	Quantity	Nos.	
2.	Pump capacity (approx.)	M^3/ hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump speed (max.)	RPM	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Impeller		
c.	Shaft		
d.	Shaft Sleeve		
e.	All hardware under water		
f.	Stuffing Box Packing		
h.	Base Plate		
i.	Column Pipe		
j.	Discharge Elbow		

DM FEED WATER PUMPS

Sr. No.	Item	Units	Description
1.	Quantity	Nos.	
2.	Pump capacity (approx.)	M^3/ hr	
3.	Pump total head excluding losses in the pump	MWC	
4.	Pump speed (max.)	RPM	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Impeller		
c.	Shaft		
d.	Shaft Sleeve		
e.	All hardware under water		
f.	Stuffing Box Packing		
h.	Base Plate		
i.	Column Pipe		
j.	Discharge Elbow		

DM PLANT

1.	**Dual Media Filters**	Nos.	
i)	Design Flow per unit (net)	m^3 / hr	
ii)	Design Surface Flow Rate	$m^3/m^2/hr$	
iii)	Free Board Space	%	
iv)	Fill Material		
v)	Media Trap	No.	
vi)	Design code for Shell & Dish		
vii)	Material of Construction for Vessel Internals		
viii)	Internal painting Primer: Finish:		
ix)	External painting Primer: Finish:		
x)	Manhole /Handhole	No. mm	
xi)	Sight windows.	No.	
xii)	Guaranteed Effluent		
	a. Turbidity		
xiii)	Back wash flow rate	m^3 / m^2/ hr	
xiv)	Filter Material depth	mm	
xv)	Under Drain System		

2.	**Activated Carbon Filters**	Nos.	
i)	Design Flow per unit (net)	m^3 / hr	
ii)	Design Surface Flow Rate	$m^3/m^2/hr$	
iii)	Free Board Space	%	
iv)	Fill Material		
v)	Media Trap	No.	
vi)	Design code for Shell & Dish		
vii)	Material of Construction for Vessel Internals		
viii)	Internal painting Primer: Finish:		
ix)	External painting Primer: Finish:		
x)	Manhole /Handhole	No. mm	
xi)	Sight windows.	No.	
xii)	Guaranteed Effluent		
	a. Free Chlorine		
	b. Organic Matte		
	c. Turbidity		
xiii)	Back wash flow rate	m^3 / m^2/ hr	
xiv)	Filter Material depth	mm	
xv)	Under Drain System		
xvi)	Characterstics of Activated Carbon		
a.	Grade:		
b.	Bulk Density:	Kg/m3	
c.	Particle Density wetted in water:	gm/cc	
d.	Uniformity Coefficient		
e.	Mean Particle Diameter	mm	
f.	Total Surface Area	m2/gm	
g.	Iodine No.	Min.	
h.	Moisture Content		
i.	Ash Content		

DATA SHEETS – DM PLANT

S. No.	Description	Units	Parameter				
			Cation		Anion		Mixed Bed
3.	Exchanger Vessels		**WAC**	**SAC**	**WBA**	**SBA**	
i)	Number of streams						
ii)	Service						
iii)	Design flow per stream (net)	m^3 / hr					
iv)	Output per stream between two consecutive regenerations - Nett - Gross	 m^3 m^3					
v)	Cycle time	Hrs.					
vi)	Regeneration time	Hrs.					
vii)	Design surface flow rate	$m^3/m^2/hr$					
viii)	Free board						
ix)	Design code Material of Construction						
x)	Shell lining (internal)						
xi)	External painting						
xii)	Manhole and hand Hole	mm					
xiii)	Sight windows.	Nos.					
xiv)	Resin						
	a. Type						
	b. Minimum Resin Bed Depth	mm					
xv)	Regeneration						
xvi)	Resin Trap						
xvii)	Material of Construction of Internals						

Guaranteed Effluent Quality from DM Plant:

S.No.	Description		Outlet Parameters
1.	SAC Outlet	Sodium Leakage ppm as NA	
2.	Degasser Unit	CO2 Content ppm as CaCo3	
3.	SBA Outlet	Total Silica ppm as SiO2	
		Conductivity Micromho	
		Total Electrolyte ppm	
4.	MB Outlet	Total Silica ppm as SiO2	
		Total Electrolyte ppm	
		Total Hardness	
		Conductivity Micromho	
		pH value at 25 Deg.C	

S. No.	Description	Units	Parameter
4.	**Degasser System**		
i)	**Degasser Tower**	No.	
	a. Normal flow rate	m^3 /hr	
	b. Packing Rings (Fill) Material.		
	c. CO_2 content in treated water	ppm as CaCo3	
	d. External painting		
	e. Shell material		
	f. Internal Distributors		
	g. All internal fittings, water distribution tray and hand holes for loading and removal of packing rings etc.		
ii)	**Degassed Water Storage Tank**		
	a. Useful capacity of tank	M^3	
iii)	**Degasser Control Valve**	No.	
	a. Location		
	b. Material of construction		
	1) Body		
	2) Stem		
	3) Actuator		
iv)	**Degasser Air Blowers**	No.	
	a. Type & Duty		
	b. Capacity		
	c. Location		
	d. Drive motor type		
v)	**Degassed Water Transfer Pumps**	Nos.	
	a. Type & Operation		
	b. Suction condition		
	c. Material of Construction		
	- Casing		
	- Impeller		
	- Shaft & Shaft sleeve material		

S. No.	Description	Units	Parameter	
	- Packing seal			
	- Drive motor			
	- Common base plate			
	d. Noise level			
	e. Vibration			
	f. RPM			
	g. Drive motor			
	h. Interconnecting Piping Material			
5.	**Regeneration System**			
5.1	**Acid / Alkali Unloading Pumps**			
i)	Numbers required	Nos.		
ii)	Type & Location			
iii)	Service			
iv)	Capacity and head	M3/hr., MWC		
v)	Material of Construction			
vi)	Liquid to be handled			
vii)	Suction condition			
viii)	Suction strainer			
ix)	Material of Construction.			
	a. Casing			
	b. Impeller			
	c. Shaft			
	d. Shaft Sleeves			
x)	Types of shaft sealing			
xi)	Pump speed	RPM		
xii)	Operating range	%		
xiii)	Drive motor			
xiv)	Accessories required between motor and pump			
xv)	Type of coupling between motor and pump			
5.2	**Bulk Storage Tank**		**Acid**	**Alkali**
i)	Numbers required	Nos.		

S. No.	Description	Units	Parameter					
ii)	Location							
iii)	Capacity	M^3						
iv)	Type							
v)	Material of Construction.							
	Protection							
	a. Inside							
	b. Outside							
vi)	Concentration							
vii)	Vent, overflow, Drain, fume absorber and sample connection							
ix)	Manhole, staircase, platform							
5.3	**Fume Absorbers**							
i)	Numbers Required							
ii)	Material of construction							
5.4	**Measuring Tanks**		**Acid**			**Alkali**		
			Cation Unit	**MB**	**NP**	**Anion Unit**	**MB**	**NP**
i)	Numbers required							
ii)	Type							
iii)	Useful capacity of each tank							
iv)	Material of Construction.							
v)	External protection							
vi)	Vent, overflow, Drain connection							
vii)	Agitator							
viii)	MOC for Shaft & Impeller							
ix)	Dissolving baskets No. & MOC							
5.5	**Preparation Tanks/Vessels**		**AC Filter**			**Hot Water tank**		**Brine Preparation Tank**
i)	Type							
ii)	Numbers Required	Nos.						
iii)	Liquid To be Handled							
iv)	Type Of Heater							
v)	Location							
vi)	Capacity	m3/hr/m3						

S. No.	Description	Units	Parameter		
vii)	Design Surface Flow Rate	m3/m2/hr			
viii)	Design Pressure				
ix)	Filter Media				
x)	Minimum Bed depth	mm			
xi)	Underdrain System				
xii)	Shell material				
xiii)	Shell Lining				
xiv)	External Painting				
xv)	Accessories				
5.6	**Concentration Meter**		**Acid**		**Alkali**
i)	Number				
ii)	Type				
iii)	Indication				
iv)	Location				
6.0	**Neutralising System**				
6.1	**Neutralisation Pit**				
i)	MOC & Protection				
ii)	Effective capacity of each compartment	M3			
iii)	Isolation gate valves				
6.2	**Neutralised Waste Disposal Pumps**				
i)	Capacity and Head	M3/hr, MWC			
ii)	Type				
iii)	Lubrication				
iv)	Noise Level				
v)	Material of Construction				
	- Column Pipe				
	- Base Plate				
	- Impeller				
	- Shaft				
	- Shaft coupling				
	- Shaft sleeve				
vii)	Drive motor				
6.3	**Blowers**		**MB/N-PIT**		**DMF**
i)	Quantity	Nos.			
ii)	Type				

S. No.	Description	Units	Parameter		
iii)	Location				
iv)	Duty				
v)	Capacity				
vi)	Drive motor				
6.4	**D.M. Water Storage Tanks**				
	i. Quantity	No.			
	ii. Capacity (effective)	Cu.m.			
	iii. M.O.C.				
	iv. Accessories				
7.0	**DM Water Pumps**		**DM Regeneration**	**DM Water Transfer**	**CPU Regeneration**
i)	Number				
ii)	Type				
iii)	Operation				
iv)	Suction condition				
v)	Capacity & head m^3/hr MWC				
vi)	Material of Construction				
	- Casing Casing				
	- Base plate				
	- Impeller				
	- Shaft				
	- Shaft coupling				
	- Shaft sleeve				
vii)	Vibration				
viii)	Lubrication				
ix)	Noise Level				
x)	RPM				
xi)	Drive motor				
8.0	**Condensate Storage Tanks**				
	i. Quantity	No.			
	ii. Capacity (effective)	Cu.m.			
	iii. M.O.C.				
	iv. Accessories				
9.0	**Air Receiver Vessel**				
i)	Quantity	No.			
ii)	Capacity	Cu.m.			
iii)	Design code				

S. No.	Description	Units	Parameter	
iv)	MOC			
v)	Design Pressure	Kg/hr		
vi)	Manhole	No.		
10.0	**Filter Water Tanks**		Ground	O/H
i)	Quantity	No.		
ii)	Capacity	Cu.m.		
iii)	MOC			
iv)	Accessories			
11.0	**Pumps**		Potable	Filter Backwash
i)	Number			
ii)	Type			
iii)	Operation			
iv)	Suction condition			
v)	Capacity & head	m^3/hr MWC		
vi)	Material of Construction			
	- Casing			
	- Base plate			
	- Impeller			
	- Shaft			
	- Shaft coupling			
	- Shaft sleeve			
vii)	Vibration			
viii)	Lubrication			
ix)	Noise Level			
x)	RPM			
xi)	Drive motor			

CONDENSATE POLISHING UNIT

1.0	**CONDENSATE POLISHING UNIT**	
i	No. of units	One (1)
ii	Capacity of unit	800 MW
iii	Total flow in all the service vessels	
2.0	**CONDENSATE POLISHER SERVICE VESSELS PER UNIT :**	
i	No. of condensate polisher service vessel	
ii	Capacity of each condensate polisher service vessel	
iii	Flow through each condensate polisher service vessel per unit	
iv	Operating pressure of each condensate polisher service vessel	
v	Design pressure of each condensate polisher service vessel	
vi	Design code of each condensate polisher service vessel	
vii	Design Temp.	
viii	Type of vessels	
ix	Emergency by-pass system	
x	Material of construction of service vessel	
xi	Resin traps at the outlet of each condensate polisher service vessel & rinse outlet	
2.1	**AIR-BLOWERS FOR RESIN MIXING (SERVICE VESSELS AREA)**	
i	Number	
ii	Type	
iii	Duty	
iv	Capacity and head / Noise Level	
v	Pressure gauge	
vi	Location	
vii	Material of construction	
viii	Dive motor	
3.0	**EXTERNAL REGENERATION FACILITIES**	
3.1	**REGENERATION VESSELS**	
i	Resin Separation & Cation Regeneration Vessel	
ii	Anion Regeneration Unit	
iii	Mixed Resin Storage Unit	
iv	Type	
v	Material of construction (shell & dished ends)	
vi	Design code	
vii	Minimum Design Pressure for Pressure Vessels	
viii	Resin traps at the common outlet header of regeneration vessels	
ix	Accessories	

3.2	**CHEMICAL HANDLNG, PREPARATION & DOSING SYSTEM**		
a)	**CHEMICAL TANKS**	**ALKALI PREPARATION CUM MEASURING TANK**	**ACID MEASURING TANK**
i	Number		
ii	Type		
iii	Useful capacity		
iv	Material (Shell, Dished end & top cover)		
v	External protection		
vi	Vent, Overflow, drain connection		
vii	Level indicator		
viii	Level transmitter per tank		
ix	Stirrer per tank		
x	MOC of Agitator		
xi	Drive motor of stirrer		
xii	Dissolving Basket		
xiii	MOC of Basket		
xiv	Accessories		
b)	**DOSING PUMPS**	**ACID DOSING**	**ALKALI DOSING**
i	Number		
ii	Type		
iii	Accessories		
a)	Pressure Dampener		
b)	External safety relief valve (in addition to inbuilt safety valve)		
c)	MOC of safety relief valve		
iv	Pressure gauge		
v	Maximum pump stroke speed per minute		
vi	**Material of construction**		
a)	Liquid End (Pump Head, Valves, Valve housing, valve spring etc.)		
b)	Diaphragm		
c)	Packing		
d)	Shaft		
e)	Worm & worm wheel (if applicable)		
f)	Connecting rod		
g)	Cross head guide		
vii	Capacity & head		
viii	Accessories required for each pump		
ix	Drive motor of pump		
3.3	**ALKALI DILUENT WATER HEATING TANK (HOT WATER TANK)**		
i	Number		
ii	Type/Capacity		
iii	Temperature of alkali to be heated		
iv	Temperature gauge		
v	Temp. transmitters		

vi	Burn out protection	
vii	**Material of construction of tank**	
viii	Shell & dished end	
ix	Design code	
x	Minimum Design Pressure	
xi	Accessories	
3.4	**CPU PUMPS FOR REGENERATION AND RESIN TRANSFER**	
i	Number	
ii	Type	
iii	Operation	
iv	Capacity & head	
v	Suction condition	
vi	**Material of construction**	
a)	Casing, impeller	
b)	Shaft	
c)	Shaft sleeve material	
vii	Packing seal	
viii	Pump Speed	
ix	Pressure gauge	
x	Recirculation line with motor actuated butterfly valve	
xi	Accessories required for each pump	
xii	Pressure dampener	
xiii	Dive motor	
3.5	**AIR-BLOWERS FOR RESIN MIXING (REGENERATION AREA)**	
i	Number	
ii	Type	
iii	Duty	
iv	Capacity and head/ Noise Level	
v	Pressure gauge	
vi	Location	
vii	Material of construction	
viii	Dive motor	
4.0	**PIPING & VALVES**	
(i	Resin Transfer piping (full Port Ball Valves)	
ii	DM water line	
iii	Piping-Service vessel Inlet	
iv	Piping-Service vessel Outlet	
v	Service vessel bypass piping Butterfly Valves of flangeless water type)	
vi	Service vessel rinse piping	
vii	Acid & Alkali Regeneration piping (Diaphragm Valves)	
viii	Acid / Alkali Transfer piping (Diaphragm Valves)	
ix	Instrument Air piping (Full Port Ball Valves)	

x	**BUTTERFLY VALVES**	
xi	**DIAPHRAGM VALVE**	
xii	**ECCENTRIC PLUG VALVE / BALL VALVE**	
5.0	**Flanges**	
i	Feed water / Condensate	
ii	DM water	
iii	Instrument Air	

SCHEDULE: HOTWELL MAKE UP PUMPS & BOILER FILL PUMPS

Sr. No.	Pump Designation Items	Units	Hotwell Make Up Pumps	Boiler Fill Pumps
1.0	**General Data**			
1.1	No. of Pumps			
1.2	Location	Indoor / Outdoor		
1.3	Duty of Pump	Continuous / Intermittent		
1.5	Liquid Handled			
2.0	**Design Data**			
2.1	Design Capacity	m^3/hr		
2.2	TDH	Mlc		
2.4	Max. Rated Speed	RPM		
2.5	Acceptable Noise Level			
3.0	**Construction Features**			
3.1	Type of Pump			
3.2	Type Impeller			
3.3	Drive Transmission			
3.4	Seal			
3.5	Type of Coupling			
3.6	Flange Drilling			
3.7	Prime Mover			
4.0	**Materials of Construction**			
4.1	Casing			
4.2	Impeller			
4.3	Shaft			
4.4	Shaft Sleeves			
4.5	Stuffing Box Packing			
4.6	Base Plate			
4.7	Flexible Coupling			
4.8	Bolts and Nuts			

SCHEDULE: EFFLUENT TREATMENT PLANT

S. No.	Description	Units	Parameter
1.00.00	**FUEL OIL HANDLING AREA EFFLUENT**		
1.01.00	**Waste Water from Fuel Oil Pump House & Unloading Area**		
1.01.01	Sump pit	Nos.	
i)	Type		
ii)	Effective capacity	M^3	
iii)	Material of Const.		
1.01.02	**Fuel Oil Area waste Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		
iv)	Type of Fluid		
v)	Rated Flow	M^3/hr	
vi)	Head	MWC	
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.01.03	**API Seperator**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M^3/hr	
iv)	Design Criteria		
v)	Channel Width		
vi)	Channel Depth		
vii)	Depth to width Ratio		
viii)	Material of Construction		
ix)	Body		

S. No.	Description	Units	Parameter
1.01.04	**Sludge disposal System**		
i)	Slop Oil Tank- API Seperator		
1.01.05	**Fuel Oil Oily Waste Sump pit**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3	
iv)	Material of Const.		
1.01.06	**Fuel Oily Waste Sump Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		
iv)	Type of Fluid		
v)	Rated Flow	M^3/hr	
vi)	Head	MWC	
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.01.07	**Treated water Sump**	Nos.	
i)	Type		
ii)	Effective capacity	M3	
iii)	Material of Const.		
1.01.08	**Treated Water Disposal Pumps**		
i)	Capacity and Head	M3/hr, MWC	
ii)	Type		
iii)	Lubrication		
iv)	Noise Level		
v)	Suction condition		
vi)	Material of Construction		
	Casing		

S. No.	Description	Units	Parameter
	Base Plate		
	Impeller		
	Shaft		
	Shaft coupling		
	Shaft sleeve		
	Drive motor		
1.02.00	**Turbine Area Oily Waste Sump**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3	
iv)	Material of Const.		
1.02.01	**Turbine Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iv)	Type of Fluid		
v)	Rated Flow	M3/hr	
vi)	Head	MWC	
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.03.00	**Boiler Area Oily Waste Area**		
i)	Numbers	Nos.	
ii)	Type		
iii)	Effective capacity	M3	
iv)	Material of Const.		
1.03.01	**Boiler Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		

S. No.	Description	Units	Parameter
iv)	Type of Fluid		
v)	Rated Flow	M3/hr	
vi)	Head	MWC	
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.04.00	**Switch Yard Area Oily Waste**		
1.04.01	**Sump pit**	Nos.	
i)	Type		
ii)	Effective capacity	M3	
iii)	Material of Const.		
1.04.02	**Switch Yard Area Oily Waste Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		
iv)	Type of Fluid		
v)	Rated Flow	M3/hr	
vi)	Head		
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.04.03	**Common Oily Waste Water Sump**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3	

S. No.	Description	Units	Parameter
iv)	Material of Const.		
1.04.04	**Common Oily Waste Water Transfer Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		
iv)	Type of Fluid		
v)	Rated Flow	M3/hr	
vi)	Head	MLC	
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	Casing		
	Rotor		
	Stator		
	Shaft		
1.04.05	**TPI Oil Water Seperators**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3/hr	
iv)	Treated Water Quality		
v)	Design Criteria		
	Angle of inclination		
	Rise Rate		
vi)	Material of Construction		
	Body		
	Plates or tubes		
	Oil skimmer System		
	Sludge disposal System		
1.04.06	Slop Oil Tank-TPI Seperator		
2.00.00	**Boiler Area Sump**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3	

S. No.	Description	Units	Parameter
iv)	Material of Const.		
2.01.02	**Boiler Area Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	
v)	Material of Construction		
	Casing		
	Column Pipe		
	Impeller		
	Shaft		
	Shaft Sleeve		
	Discharge Pipe & Flanges		
vi)	Electric Supply		
vii)	Enclosure		
viii)	Speed of Pump & motor		
3.00.00	**Effluent from CHP Dust Suppression & Coal Pile Area**		
3.01.01 a)	Coal Settling Ponds	Nos.	
i)	Type		
ii)	Type of fluid handled		
iii)	Effective capacity	M3	
iv)	Material of Const.		
v)	Inlet Arrangement		
b)	Overflow sump		
i.	Number	Nos.	
ii.	Type of fluid handled		
iii.	Effective capacity	M3	
iv.	Material of Const.		
3.01.02	**Settling Ponds Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	

S. No.	Description	Units	Parameter
v)	Material of Construction		
	Casing		
	Column Pipe		
	Impeller		
	Shaft		
	Shaft Sleeve		
	Discharge Pipe & Flanges		
vi)	Electric Supply		
vii)	Enclosure		
viii)	Speed of Pump & motor		
3.01.03 a)	**Central Monitoring Basin**		
i)	Numbers	Nos.	
ii)	Type		
iii)	MOC		
iv)	Minimum Effective capacity (Each Compartment)	M3	
v)	Inlet Arrangement		
b)	Overflow sump		
i.	Number	Nos.	
ii.	Type of fluid handled		
iii.	Effective capacity	M3	
iv.	Material of Const.		
3.01.04	**CMB Effluent Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	
v)	Material of Construction		
	Casing		
	Column Pipe		
	Impeller		
	Shaft		
	Shaft Sleeve		
	Discharge Pipe & Flanges		

S. No.	Description	Units	Parameter	
vi)	Electric Supply			
vii)	Enclosure			
viii)	Speed of Pump & motor			
3.01.05	**Measuring Tanks**		Acid	Alkali
i)	Type			
ii)	Useful capacity of each tank			
iii)	Material of Construction.			
iv)	External protection			
v)	Vent, overflow, Drain connection			
vi)	Agitator			
vii)	MOC for Shaft & Impeller			
viii)	Dissolving baskets No. & MOC			
4.00.00	**Condenser Waste Water Pit**	Nos.		
i)	Type			
ii)	Effective capacity	M3		
iii)	Material of Const.			
4.01.01	**Condenser Waste Transfer Pumps**			
i)	Number of pumps	Nos.		
ii)	Type of Pumps			
iii)	Capacity of each pump	M3/hr		
iv)	Head	MWC		
v)	Material of Construction			
vi)	Casing			
vii)	Impeller			
viii)	Shaft			
ix)	Shaft Sleeve			
x)	Electric Supply			
xi)	Enclosure			
xii)	Speed of Pump & motor			
4.01.02	**TG Wash Water Sump**	Nos.		
i)	Type			
ii)	Effective capacity	M3		

S. No.	Description	Units	Parameter
iii)	Material of Const.		
4.01.03	**TG Wash Water Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	
v)	Material of Construction		
	Casing		
	Impeller		
	Shaft		
	Shaft Sleeve		
	Electric Supply		
vi)	Enclosure		
vii)	Speed of Pump & motor		
5.00.00	**ESP Area Wash Water Sump & Pre- Settling Pits**	Nos.	
i)	Type		
ii)	Effective capacity	M3	
iii)	Material of Const.		
5.01.01	**Presettling Pit**		
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Effective capacity	M3	
iv)	Material of Const.		
5.01.02	**Presettling Pit Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	
v)	Material of Construction		
	Casing		
	Column Pipe		
	Impeller		
	Shaft		

S. No.	Description	Units	Parameter
	Shaft Sleeve		
	Discharge Pipe & Flanges		
vi)	Electric Supply		
vii)	Enclosure		
viii)	Speed of Pump & motor		
6.00.00	**Ash Silo Area Water Sump**	Nos.	
i)	Type		
ii)	Effective capacity	M3	
iii)	Material of Const.		
6.01.01	**Ash Silo Area Wash Water Transfer Pumps**		
i)	Number of pumps	Nos.	
ii)	Type of Pumps		
iii)	Capacity of each pump	M3/hr	
iv)	Head	MWC	
v)	Material of Construction		
	Casing		
	Column Pipe		
	Impeller		
	Shaft		
	Shaft Sleeve		
	Discharge Pipe & Flanges		
vi)	Electric Supply		
vii)	Enclosure		
viii)	Speed of Pump & motor		
7.00.00	**Flash mixer**		
7.01.01	Number required	No.	
7.01.02	Construction		
7.01.03	Detention time (approx.)	Sec.	
7.01.04	Agitator		
7.01.05	Protective cover of GI construction for motors and gear drives.		
8.00.00	**Clarifier**		
	a. MOC of inlet pipe		
	b. Number required	No.	

S. No.	Description	Units	Parameter	
	c. Type & Construction			
	d. Rated Effluent Capacity	Cum/hr		
	e. Effluent quality	NTU		
	f. Detention period:	minutes		
	g. Rise rate	Cu.M/hr/m^2		
	h. Rake bridge			
	i. Material			
	ii. Other features			
	. Sludge blow-off:			
	i. Continuous			
	ii. Intermittent			
	k. Flocculation Agitator			
9.00.00	**Chemical House**			
9.01.01	Number	No		
9.01.02	Type			
9.01.03	Ground Floor			
9.01.04	First Floor			
9.01.05	Handling Facility			
10.00.00	**Dosing System**		**Alum**	**Lime**
10.01.01	Numbers required	Nos.		
10.01.02	MOC			
10.01.03	Minimum Capacity (effective)	Cu.m		
10.01.04	Capacity of each pump	LPH		
11.00.00	**Sludge Sump**			
11..01.01	No. of sludge sump	No.		
11.01.02	Construction			
11..01.03	Sludge disposal pumps a) Number b) Type	No.		
12.00.00	**Dual Media Filters**	Nos.		
12.01.01	Design Flow per unit (net)	m^3 / hr		
12.01.02	Design Surface Flow Rate	m^3 /m^2 /hr		
12.01.03	Free Board Space	%		
12.01.04	Fill Material			

S. No.	Description	Units	Parameter
12.01.05	Media Trap	No.	
12.01.06	Design code for Shell & Dish		
12.01.07	Material of Construction for Vessel Internals		
12.01.08	Internal painting		
12.01.09	External painting		
12.01.10	Manhole	No. mm	
12.01.11	Sight windows.	No.	
12.01.12	Filter Material depth	mm	
13.00.00	**Ultra-Filtration (U.F.) Module**		
13.01.01	No. of Skid	Nos.	
13.01.02	Feed flow rate	cu.m/hr	
13.01.03	Permeate flow rate	cu.m/hr	
13.01.04	Recovery	%	
13.01.05	Membrane Material		
13.01.06	a) Molecular Wt. Cut off value		
13.01.07	b) Pore Size		
13.01.08	Average life of membrane	Years	
13.01.09	Membrane flow mode/ configuration		
13.01.10	Frontal pipes, valves, manifolds		
13.01.11	Chlorine Resistance (continuous)	ppm	
13.01.12	pH Range		
13.01.14	Feed water temperature range considered for the guaranteed outlet water quality	^{o}C	
14.00.00	**Ultra Filter Water Sump**		
14.01.01	Number	No.	
14.01.02	MOC		
14.01.03	Type of tank		
14.01.04	Level Indicator		
14.01.05	Inside protection		
15.00.00	**RO Feed Pumps**		
15.01.01	Numbers	Nos.	
15.01.02	Type		

S. No.	Description	Units	Parameter			
15.01.03	Head/Capacity	MWC/m³/hr				
15.01.04	Type of lubrication					
15.01.05	Speed of pump	RPM				
15.01.06	Material of Construction					
	i. Casing					
	ii. Impeller					
	iii. Shaft					
16.00.00	**Chemical Measuring / Solution Preparation Tanks**		**SMBS**	**Anti-scalant**	**Acid**	**Chemical Cleaning Skid**
16.01.01	NUMBER	No.				
16.01.02	Type					
16.01.03	Effective capacity	Cum.				
16.01.04	Tank – M.O.C.					
16.01.05	Agitator – Type					
16.01.06	Agitator - M.O.C.					
17.00.00	**Metering Pumps**					
17.01.01	Number	Nos.				
17.01.02	Type	-				
17.01.03	Duty	-				
17.01.04	Suction condition	-				
17.01.05	Head	MWC				
17.01.06	Pump speed	rpm				
17.01.07	Pump - M.O.C.	-				
18.00.00	**Micron Cartridge Filter**		**R.O.Module**		**C.I.P.**	
18.01.01	Number	Nos.				
18.01.02	Vessel – M.O.C.	-				
18.01.03	Filter Element - M.O.C.	-				
18.01.04	Efficiency of the Filter Element	% minimum				
18.01.05	Pore size	micron				
19.00.00	**High Pressure Pumps**					
19.01.01	Number	Nos.				
19.01.02	Head/Capacity	MWC/m³/hr				
19.01.03	Speed	rpm				
19.01.04	M.O.C.					

S. No.	Description	Units	Parameter
19.01.05	(i) Casing	-	
19.01.06	(ii) Impeller	-	
19.01.07	(iii) Shaft	-	
19.01.08	Efficiency	%	
20.00.00	**Reverse Osmosis System**		
20.01.01	No. of Modules	Nos.	
20.01.02	Type of Membrane	-	
20.01.03	Make of Membrane	-	
20.01.04	Membrane Life	Years	
20.01.05	Recovery rate	%	
20.01.06	Permeate capacity/Stream	m^3/hr	
20.01.07	Permeate – TDS	ppm	
21.00.00	**Degasser System**		
21.01.01	Number	Nos.	
21.01.02	Type	-	
21.01.03	Packing Rings (Fill) Material	-	
21.01.04	External painting	micron	
21.01.05	Shell material	-	
21.01.06	Rubber lining	mm	
21.01.07	Internal Distributors	-	
21.01.08	All internal fittings, water distribution tray and hand-holes for loading and removal of packing rings etc	-	
22.00.00	**Degassed Water Storage Tank**		
22.01.01	Number	Nos.	
22.01.02	Capacity	Cum	
22.01.03	Type & Material of construction	-	
23.00.00	**Degasser Air Blowers**		
23.01.01	Numbers required	Nos.	
23.01.02	Type	-	
23.01.03	Location	-	
23.01.04	Drive motor type	-	
24.00.00	**Pump RO Permeate Transfer**		
24.01.01	Number	Nos.	

S. No.	Description	Units	Parameter
24.01.02	Type		
24.01.03	Operation		
24.01.04	Suction condition		
24.01.05	Material of Construction		
	- Casing		
	- Base plate		
	- Impeller		
	- Shaft		
	- Shaft coupling		
	- Shaft sleeve		
24.01.06	Vibration		
24.01.07	Lubrication		
24.01.08	Noise Level		
24.01.09	RPM		
24.01.10	Drive motor		

SEWAGE TREATMENT PLANT

INLET/OUTLET PARAMETERS FOR STP

Sr. No.	Parameters	Unit	Inlet Parameters	Guaranteed Parameters
1.	pH			
2.	BOD	ppm		
3.	COD	ppm		
4.	Oil & Grease	ppm		
5.	Coliform	MPN/1000ml		
6.	Suspended Solids	ppm		

SCHEDULE : SEWAGE TREATMENT PLANT

Sr. No.	Description	Units	Parameter
1.0	**Common Collection Sump**		
i)	Numbers Required	Nos.	
ii)	Capacity	M3	
iii)	MOC:		
1.01	**Common Collection Sump Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
ii)	Flow	M3/hr	
iii)	Head	MWC	
iv)	Particle Size		
v)	MOC		
1.02	**Screen Chamber**		
i)	Numbers Required	Nos.	
ii)	Type		
ii)	Cleaning		
iii)	Angle of inclination		
iv)	Bar MOC		
v)	Velocity	m/s	
vi)	Spacing of Bar	mm	
1.03	**Oil & Grease Trap**		
i)	Numbers Required	Nos.	
ii)	Flow	M3/hr	
iii)	MOC:		
1.04	**Equalization Tank**		
i)	Numbers Required	Nos.	
ii)	Flow	M3/hr	
iii)	Detention Time	Hrs	
iv)	MOC of Tank		
v)	Depth	M	
vi)	Type of Aeration		
vii)	Type of Diffusers		
viii)	No. of Diffusers		
1.05	**Air Blowers for Equalization Tank/ Sludge Sump**		
i)	Numbers Required	Nos.	

Sr. No.	Description	Units	Parameter
ii)	Type of Blower		
iii)	Flow	M3/hr	
iv)	Head	Mtrs	
iv)	MOC		
v)	Accessories		
1.06	**FAB Feed Pumps**		
i)	Numbers Required	Nos.	
ii)	Type		
ii)	Flow	M3/hr	
iii)	Head	MWC	
iv)	MOC		
v)	Particle Size		
1.07	**FAB Reactor**		
i)	Numbers Required	Nos.	
ii)	Flow	M3/hr	
iii)	F/M Ratio	Kg BOD/ kg/ MLSS	
iv)	MLSS	mg/l	
iv)	MOC of Tank		
v)	Depth	M	
vi)	Type of Aeration		
vii)	Type of Diffusers		
viii)	No. of Diffusers		
ix)	Fab Media		
x)	Media Qty		
xi)	Free Board	mm	
xii)	Volume	M3	
1.08	**Air Blowers for FAB Tank**		
i)	Numbers Required	Nos.	
ii)	Type of Blower		
iii)	Flow	M3/hr	
iv)	Head	Mtrs	
v)	MOC		
vi)	Accessories		
1.09	**Secondary Settler**		
i)	Numbers Required	Nos.	
ii)	Flow	M3/hr	
iii)	Surface Flow Rate	M3/m2/ hr	
iii)	MOC of Settler		
iv)	Qty of Tube settler Media	M3	
v)	MOC of Media		
vi)	Free Board	mm	
1.10	**Hypo Contact Cum Filter Feed Tank**		
i)	Numbers Required	Nos.	
ii)	MOC		
iii)	Make		
1.11	**Hypo Dosing System**		
1.11.1	**Hypo Dosing Tank**		

Sr. No.	Description	Units	Parameter
i)	Quantity		
ii)	Capacity		
iii)	MOC		
iv)	Make		
1.11.2	**Hypo Dosing Pumps**		
i)	Quantity		
ii)	Capacity		
iii)	Type		
iv)	Make		
1.12	**Filter Feed Pumps**	Nos.	
i)	Type & Operation		
ii)	Suction condition		
iii)	Capacity & Head	M3/hr, MWC	
iv)	Material of Construction		
	• Casing		
	• Impeller		
	• Shaft & Shaft sleeve material		
	• Packing seal		
	• Drive motor		
	• Common base plate		
v)	Noise level		
vi)	Vibration		
vii)	RPM		
viii)	Drive motor		
ix).	Interconnecting Piping Material		
1.13	**Dual Media Filter**		
i)	Quantity	Nos.	
ii)	Capacity	M3/hr	
iii)	Surface Flow Rate	M3/hr/m2	
iv)	Size		
v)	Design Pressure	Kg/cm2	
vi)	MOC		
vii)	Media		
viii)	Rising Space		
ix)	Make		
1.14	**Activated Carbon Filter**		
i)	Quantity	Nos.	
ii)	Capacity	M3/hr	
iii)	Surface Flow Rate	M3/hr/m2	
iv)	Size		
v)	Design Pressure	Kg/cm2	
vi)	Media		
vii)	Supporting Media		
viii)	Minimum Bed Depth	mm	
ix)	Rising Space		
x)	Shell & Dish Material		

Sr. No.	Description	Units	Parameter
1.15	**Treated Water Tank**		
i)	Numbers Required	Nos.	
ii)	Flow	M3/hr	
iii)	Detention Time	Hrs	
iv)	MOC of Tank		
v)	Depth	M	
1.16	**Treated Water Pumps**	Nos.	
i)	Type & Operation		
ii)	Suction condition		
iii)	Material of Construction		
iv)	Casing		
v)	Impeller		
vi)	Shaft & Shaft sleeve material		
vii)	Packing seal		
viii)	Drive motor		
ix)	Common base plate		
x)	Noise level		
xi)	Vibration		
xii)	RPM		
xiii)	Drive motor		
xiv)	Interconnecting Piping Material		
1.17	**Sludge Sump (Waste Pit)**		
i)	Number	No.	
ii)	MOC & Type		
iii)	Capacity	Cu.m	
iv)	Instruments		
v)	Inside Protection		
1.18	**Sludge Transfer Pumps**	Nos.	
i)	Numbers Required	Nos.	
ii)	Type		
iii)	Location		
iv)	Type of Fluid		
v)	Rated Flow	M3/hr	
vi)	Head		
vii)	Service		
viii)	Pump Speed	RPM	
ix)	Material of Construction		
	• Casing		
	• Rotor		
	• Stator		
	• Shaft		
1.19	**Centrifuge**	Nos.	
i)	Type		
ii)	Inlet Concentration		
iii)	Outlet Concentration		
iv)	Capacity		
v)	Liquid Handled		
vi)	Material of Construction		
vii)	Motor		
viii)	Base Frame		

Sr. No.	Description	Units	Parameter
ix)	Acessories		
1.20	**PE Dosing System**		
i)	**Dosing Tank**	Nos.	
ii)	Capacity of Tank	lts	
iii)	MOC Of Tank		
iv)	Dosing Pumps	Nos.	
v)	Dosing Pump Capacity	lph	
vi)	Type		
vii)	MOC		

SCHEDULE: LAB EQUIPMENT

Sr. No.	Description	Parameters
1.0	**Water Analysis**	
1.1	**pH-meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.2	**Conductivity Meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.3	**Spectro Photometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.4	**Dissolved Oxygen Meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.5	**Turbidity meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with	

Sr. No.	Description	Parameters
	the instruments	
1.6	**Balances**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.7	**Flame Photometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.8	**Selective Ion-Analyser**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.9	**Oil Content Analyzer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.10	**Water Purification System**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.11	**Stirring hot plate**	

Sr. No.	Description	Parameters
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.12	**Water Bath**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.13	**Refrigerator**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.14	**Vacuum Pump**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.15	**Residual Chlorine Meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.16	**Jar Test Apparatus**	
a)	Make	

Sr. No.	Description	Parameters
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.17	**Potable Water Quality Checker**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.18	**Incubator**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.19	**Atomic Absorption Spectrophotometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.20	**TOC Analyser**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.21	**B.O.D. Analyser System**	
a)	Make	
b)	Model No.	

Sr. No.	Description	Parameters
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.22	**C.O.D Analyser System**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.23	**Gas Chromatograph**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
1.24	**Membrane Filter Holder Assembly**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.0	**Coal Analysis**	
2.1	**Coal Analyzer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.2	**Oxygen Bomb Calorimeter**	
a)	Make	
b)	Model No.	

Sr. No.	Description	Parameters
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.3	**Carbon & Sulphur Analyzer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.4	**Muffle Furnace**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.5	**Oven**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.6	**Lab Pulverizer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.7	**Sieve Shaker**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	

Sr. No.	Description	Parameters
d)	List of accessories included with the instruments	
2.8	**Ash fusion Furnace**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.9	**HGI Measuring Equipment**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.10	**Jaw Crusher and Double Roll Crusher**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
2.11	**Raymond Minimill**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.0	**Oil Analysis**	
3.1	**Red Wood Viscometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	

Sr. No.	Description	Parameters
d)	List of accessories included with the instruments	
3.2	**Automatic Flash Point Apparatus**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.3	**Dean & Stark Moisture Determination Apparatus**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.4	**Flash Shaker**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.5	**Centrifuge**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.6	**Heating Mantle**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	

Sr. No.	Description	Parameters
d)	List of accessories included with the instruments	
3.7	**Automatic K-F (Karl-Fisher) Titrimeter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
3.8	**Orsat Gas Analyser**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.0	**Meteorological & Pollution**	
4.1	**Electrical Amenograph**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.2	**Dew Point Meter**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.3	**Rain Gauge**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	

Sr. No.	Description	Parameters
d)	List of accessories included with the instruments	
4.4	**Mercury Barometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.5	**Maximum & Minimum Thermometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.6	**Dry & Wet bulb Thermometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.7	**High Volume Sampler**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.8	**Stack Monitoring Kit**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with	

Sr. No.	Description	Parameters
	the instruments	
4.9	**Portable Gas Analyser**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
4.10	**Stop Watch**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached	
d)	List of accessories included with the instruments	
5.0	**Miscellaneous**	
5.1	**Personal Computer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.2	**Sample cooler**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.3	**Density Hydrometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	

Sr. No.	Description	Parameters
5.4	**Hot Air Dryer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.5	**Hydrometers**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.6	**Heating Mantel**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.7	**Stainless Steel Filter Holder**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.8	**Hygrometer**	
a)	Make	
b)	Model No.	
c)	Technical Leaflet & operating description attached.	
d)	List of accessories included with the instruments	
5.9	**Gas Chromatograph**	

Sr. No.	Description	Parameters
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.10	**TSS Meter**	
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.11	**Deposition & Corrosion Meter**	
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.12	**Orsat Gas Analyzer**	
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.13	**Portable Purge Gas Analyzer**	
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.14	**Weather Monitotring Station**	
	Make	

Sr. No.	Description	Parameters
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	
5.15	**Asman Psychrometer**	
	Make	
	Model No.	
	Technical Leaflet & operating description attached.	
	List of accessories included with the instruments	

CIRCULATING WATER (CW) PUMPS

Sr. No.	Item	Unit	Description
1	Total no. of pumps	Nos.	
2.	Pump capacity	M^3/hr	
3.	Pump total head excluding losses in the pump	mwc	
4.	Pump speed (max.)	rpm	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Motor rating		
15.	Voltage Level		
16.	Materials of construction		
a.	Casing		
c.	Impeller		
d.	Shaft		
e.	Line shaft coupling		
f.	Line shaft bearing		
g.	All hardware		
h.	Shaft sleeve		
i.	Thrust bearing cooling system pipes and valves		
j.	Thrust Pads		
k.	Discharge Pipe & flanges		
l.	Gland Packing		

Note: (i) Pumps shall be capable of operating from shut-of point to a maximum flow of 10% over the point of intersection between system resistance curve and pump H-Q curve for single pump operation.

RUBBER EXPANSION JOINTS

Sr. No.	Item	Unit	Description
1	Total no. of RE joints	Nos	
2	Designation		
3.	Expansion joint ID/Pipe ID	Mm	
4.	Fluid handled		
5	Vacuum	mm of Hg	
6.	Operating temperature	Deg.C	
7.	Movements		**Max** **Min.**
	(i) Axial Compression	Mm	
	(ii) Axial elongation	Mm	
	(iii) Lateral movement	Mm	
8.	No. of arches		
9.	Controls unit to be provided		
10.	Companion flanges		
11.	Material of construction		
	(i) Main body		
	(ii) Reinforcement		
	(iii) Retaining ring		
	(iv) Outer cover		
	(v) Bolts & nuts		
	(vi) Stretcher bolt plates		

BUTTERFLY VALVES

Sr. No.	Item	Unit	Description
1	Service		
2.	Valve size	mm	
3.	Number of valves		
4.	Supporting legs required		
5.	Valve opening / closing time	Secs.	
6.	Frequency of vale operation		
7.	Location		
8.	Type of operation		
9.	Preferred face to face dimension	mm	
10.	Material of construction		
	(i) Body		
	(ii) Disc		
	(iii) Shaft		
	(iv) Body seat rings		
	(v) Disc seal rings		
	(vi) Seal retaining rings		
	(vii) Companion flange		
	(viii) Internal hardware		
	(ix) External hardware		
11.	Butterfly valves shall be provided with end limit switches, torque limit switches and adjustable limit switches as per the logics and interlock controls for electric valves actuated.		

AUXILIARY COOLING WATER PUMPS

Sr. No.	Item	Unit	Description
1	Total no. of pumps	Nos.	
2.	Pump capacity	M^3/hr	
3.	Pump total head excluding losses in the pump	mwc	
4.	Pump speed (max.)	rpm	
5.	Type of pump		
6.	Location		
7.	Type of internal element		
8.	Liquid handled		
9.	Type of line bearing lubrication		
10.	Liquid for lubrication		
11.	Type of pump motor coupling		
12.	Thrust bearing location		
13.	Pump operating range		
14.	Materials of construction		
a.	Casing		
b.	Column Pipe		
c.	Impeller		
d.	Shaft		
e.	Line shaft coupling		
f.	Line shaft bearing		
g.	All hardware		
h.	Shaft sleeve		
i.	Thrust bearing cooling system pipes and valves		
j.	Thrust Pads		
k.	Discharge Pipe & flanges		
l.	Gland Packing		
m.	Stuffing Box Housing		

SCHEDULE: PLATE HEAT EXCHANGERS

Material specification shall be as follows:-

Heat Transfer Plate		
Thickness of plate		
Plate gasket		
Carrying bar		
Guide bar		
Frame Plate/ Pressure Plate/ nozzle		
Nozzle Flange		
Overall friction factor (Minimum)		
Flow (m^3/hr)	**Primary**	**Secondary**
Temperature		

SCHEDULE: AUTOMATIC SELF CLEANING STRAINERS

Description	Unit	Values
Quantity	Nos.	
Flow rate	m^3/hr	
Inlet Size	NB	
Outlet Size	NB	
Liquid Handled		
Screen Opening Area		
DP Measurement System		
Degree of Filtration	mm	
Max. Pressure drop in fully choked condition	MWC	
Material of construction		
Body		
Basket		
Cover Flange/ Slipon Flange		
Filter		
Connection Pipe		
Connection Flange		
Filter Screen		
Gasket		
Fasteners		
Drain		
Vent with plug		
Support Legs		
Davit Arm		
Base Plate		

CW TREATMENT PLANT

1.0	**Bulk Sulphuric Acid Storage Tank**		
1.1	Numbers to be provided	:	
1.2	Description for each tank		
i)	Type	:	
ii)	Type of Fluid to be handled	:	
iii)	Effective capacity	:	
iv)	Minimum free board	:	
v)	Material of construction		
a)	Shell	:	
b)	Dished Ends	:	
vi)	Thickness	:	
vii)	Protection		
a)	Internal	:	
b)	External	:	
viii)	Manhole	:	
2.0	**Sulphuric Acid Day Tanks**		
2.1	Numbers to be provided		
2.2	Description for each tank		
i)	Type	:	
ii)	Type of Fluid to be handled	:	
iii)	Effective capacity	:	
iv)	Material of construction	:	
v)	Thickness	:	
vi)	Protection		
a)	Internal	:	
b)	External	:	
3.0	**Sulphuric Acid Injection Pumps**		
3.1	Number	:	
3.2	Description for each pump		
i)	Type of pump	:	
ii)	Fluid to be handled	:	
iii)	Service	:	
iv)	Duty	:	
v)	Suction Condition	:	
vi)	Rated Capacity	:	
viii)	Facility for Capacity Adjustment	:	
ix)	Range of Capacity Adjustment	:	
x)	Tentative head to be developed at rated capacity	:	
xi)	Pump speed	:	
xii)	Material of construction		
a)	Housing	:	
b)	Pump head	:	

c)	Plunger	:			
d)	Worm	:			
e)	Worm wheel	:			
f)	Shafts (worm)	:			
g)	Base plate	:			
h)	Foundation bolts	:			
xiii)	Motor				
a)	Electric supply	:			
b)	Class	:			
c)	Degree of protection	:			
d)	Speed	:			
xiv)	Type of coupling between Pump & Motor	:			
xv)	Painting for complete set of Pump & Motor				
a)	Primer	:			
b)	Finish paint	:			
xvi)	Accessories to be provided				
4.0	**Day Tank**		**Scale Inhibitor**	**Corrosion Inhibitor**	**Biocide**
4.1	Numbers	:			
4.2	Description of tank				
i)	Type	:			
ii)	Effective capacity	:			
iii)	Minimum free board	:			
iv)	Material of Construction	:			
v)	Thickness	:			
vi)	Dissolving Basket				
a)	Number	:			
b)	Material of Construction	:			
5.0	**Injection Pumps**		**Scale Inhibitor**	**Corrosion Inhibitor**	**Bioc ide**
5.1	Number	:			
5.2	Description for each pump	:			
i)	Type of pump	:			
ii)	Location	:			
iii)	Service	:			
iv)	Duty	:			
v)	Suction Condition	:			
vi)	Rated Capacity	:			
vii)	Facility for Capacity Adjustment	:			
viii)	Range of Capacity Adjustment	:			
ix)	Tentative head	:			
x)	Material of construction				
a)	Housing	:			

b)	Pump head	:	
c)	Plunger	:	
d)	Worm	:	
e)	Worm wheel	:	
f)	Shafts (worm)	:	
g)	Base plate	:	
xi)	Motor		
a)	Electric supply	:	
b)	Class	:	
c)	Degree of protection	:	
d)	Speed	:	
xii)	Type of coupling between Pump & Motor	:	
xiii)	Accessories to be provided	:	

CHLORINATION SYSTEM

RAW WATER CHLORINE DIOXIDE SYSTEM

1	**Unloading Pumps**		**Acid**	**Sodium Chlorite**
i.	Numbers required	Nos.		
ii.	Type & Location			
iii.	Service			
iv.	Capacity and head	M3/hr., MWC		
v.	Material of Construction			
vi.	Liquid to be handled			
vii.	Suction condition			
viii.	Suction strainer			
ix.	Material of Construction.			
	a) Casing			
	b) Impeller			
	c) Shaft			
	d) Shaft Sleeves			
x.	Types of shaft sealing			
xi.	Operating range	%		
xii.	Motor			
	a) Electric supply			
	b) Class			
	c) Degree of protection			
	d) Speed			
xiii.	Accessories required between motor and pump			

xiv.	Type of coupling between motor and pump			
2.	**Bulk Storage Tank**		**Acid**	**Sodium chlorite**
i	Numbers required	Nos.		
ii	Location			
iii	Total Useful capacity	m^3		
iv	Type of Vessel			
v	Material of Construction.			
vi	Protection			
	a) Inside	mm		
	b) Outside			
vii	Concentration	%		
viii	Vent, overflow, Drain, fume absorber and sample connection			
ix	Manhole, staircase, platform			
x	Fume Absorbers			
	a) Numbers Required	Nos.		
	b) Material of construction			
3.	**Metering Pumps**		**Acid**	**Sodium Chlorite**
i.	Number	Nos.		
ii.	Type	-		
iii.	Duty	–		
iv.	Suction condition	–		
v.	Rated capacity	LPH		
vi.	Head	MWC		
	a) Pump - M.O.C.	-		

vii.	Motor		
	a) Electric supply		
	b) Class		
	c) Degree of protection		
	d) Speed		
4.	**Chlorine Dioxide Generator**		
i.	Number		
ii.	Type		
iii.	Capacity		

PW/ SERVICE & CW CHLORINE DIOXIDE SYSTEM

1.	**Unloading Pumps**		**Acid**	**Sodium Hypochlorite**
i.	Numbers required	Nos.		
ii.	Type & Location			
iii.	Service			
iv.	Capacity and head	M3/hr., MWC		
v.	Material of Construction			
vi.	Liquid to be handled			
vii.	Suction condition			
viii.	Suction strainer			
ix.	Material of Construction.			
	a. Casing			
	b. Impeller			
	c. Shaft			
	d. Shaft Sleeves			
x.	Types of shaft sealing			
xi.	Operating range	%		
xii.	Motor			
	a) Electric supply			
	b) Class			
	c) Degree of protection			
	d) Speed			
	Accessories required between motor and pump			
xiii.	Type of coupling between motor and pump			

2.	**Bulk Storage Tank**		**Acid**		**Sodium Hypochlorite**	
i	Numbers required	Nos.				
ii	Location					
iii	Total Useful capacity	m^3				
iv	Type of Vessel					
v	Material of Construction.					
vi	Protection					
	a) Inside	mm				
	b) Outside					
vii	Concentration	%				
viii	Vent, overflow, Drain, fume absorber and sample connection					
ix	Manhole, staircase, platform					
x	Fume Absorbers					
	a) Numbers Required	Nos.				
	b) Material of construction					
3.	**Metering Pumps**		**Acid**		**Sodium Hypochlorite**	
			CW makeup SYSTEM	**POTABE/ SERVICE**	**CW makeup SYSTEM**	**POTABE/ SERVICE**
i.	Number	Nos.				
ii.	Type	-				
iii.	Duty	–				
iv.	Suction condition	–				
v.	Rated capacity	LPH				
vi.	Head	MWC				
vii.	a) Pump - M.O.C.	-				

vii.	Motor			
	a) Electric supply			
	b) Class			
	c) Degree of protection			
	d) Speed			
4.	**Chlorine Dioxide Generator**		**CW makeup SYSTEM**	**POTABE/SERVICE**
i.	Number			
ii.	Type			
iii.	Capacity			

NATURAL DRAUGHT COOLING TOWER

1.0	Total design capacity (per tower)	Cum/hr	:
2.0	Type of air flow to water flow		:
3.0	Water inlet temperature	Deg.C	:
4.0	Recooled water temperature	Deg.C	:
5.0	Design ambient wet bulb temperature	Deg.C	:
6.0	Design approach	Deg.C	:
7.0	Design atmospheric relative humidity	%	:
8.0	Wind velocity for performance	KM/PH	:
9.0	Cooling Range	Deg C	:
10.0	Evaporation loss (at design capacity)		:
11.0	Drift loss (at designed capacity)		:
12.0	**LEVELS**		
12.1	Finished grade level below sill	M	:
12.2	Level of basin bottom below sill at periphery	M	:
12.3	Level of basin bottom below sill at center	M	:
12.4	Normal working level of water in basin below sill	M	:
12.5	Free board above max. water level in basin.	M	:
12.6	**Velocity** of water at the CT outlet. connecting with CW lead channel	m/sec	:
13.0	**HEIGHTS**		
13.1	Height of top of tower above sill	M	:

13.2	Height of throat of tower above sill	M	:
13.3	Height of top of air inlet above sill	M	:
13.4	Height of top of fill above sill at periphery and center	M	:
13.5	Height at top of the drift eliminators	M	:
13.6	Height of bottom of fill above sill at periphery and center	M	:
13.7	Height of hot water riser center line above sill	M	:
13.8	Total weight of water in basin (maximum)	Metric tonne	:
13.9	Area of water surface in basin	Sq.M	:
13.10	Height of surge shaft		:
14.0	**DIAMETERS**		
14.1	Internal diameter of tower at sill level	M	:
14.2	Internal diameter at top of air opening	M	:
14.3	Internal diameter at throat of tower	M	:
14.4	Internal diameter at top of tower	M	:
14.5	Basin volume at maximum water level	M^3	:
15.0	**EFFECTIVE FILL VOLUME**	Cum	:
15.1	Effective cooling surface of fill	Sq.M	:
15.2	Cooling water flow (L) Kg per square meter fill area per hour	Kg/m^2/ hr	:
15.3	Dry air flow (G) Kg per metre fill area per hour	Kg/m^2/ hr	:

15.4	Correction in G or effect of cross flow, if any		:
15.5	Ratio of water to air weight	(L/G)	:
15.6	Is leaving Air saturated*	Yes/No	:
15.7	Temperature of leaving air wet bulb / dry bulb	Deg.C	:
15.8	Total dry air flow per tower	Kg/hr	:
15.9	Inlet air enthalpy above zero degree C	Kcal/kg	:
15.10	Sensible heat gain by dry air through tower	Kcal/kg	:
15.11	Latent heat gain by dry air	Kcal/kg	:
15.12	Exit air enthalpy above zero degree C	Kcal/kg	:
15.13	Total heat exchange per kg of dry air inlet	Kcal/kg	:
15.14	Total heat exchange per hour	Kcal/kg	:
15.15	Evaporation loss maximum (state conditions)	Kg/hr	:
15.16	Drift loss maximum (state conditions)	Kg/hr	:
15.17	Blow down for maintaining the required concentration (state conditions)	Kg/hr	:
15.18	Total loss	Kg/hr	:
15.19	Density of ambient air	Kg/m^3	:
15.20	Density of exit plume	Kg/m^3	:
15.21	Velocity of air	M/s	:
	a) above sill of basin		:
	b) air opening		:
	c) tower throat		:
	d) top of tower		:

Note : (* Furnish air flow, water flow and cooling tower characteristics curve on Psycometric chart).

16.1	Wetted fill surface per sq.metre tower area (enclose calculation) (film type)	M^2	:
16.2	Fill film type surface (enclose calculations)	M^2	:
16.3	Mass transfer co-efficient (K)	Kg/hr/sq.m	:
16.4	Tower co-efficient (enclose calculations)	$\frac{KaV}{L}$	:
16.5	Draft loss (static and dynamic)	mmwc	:
	a) Inlet of fill		:
	b) Through fill area		:
	c) Through eliminators		:
	d) Through distribution pipe /troughs etc.		:
	e) Total		:
16.6	Pumping head at hot water terminal head (enclose calculations)		:
	a) Friction losses in distribution system beyond terminal point	mmwc	:
	b) Static height from normal water level in basin to max. water level in distribution trough	mwc	:
	c) Total	mmwc	:
16.7	Draught factor (enclose calculations)		

Draught factor

$$\frac{P}{1.64 \times 10^{-8}}$$

P = density difference in air at inlet and exit of tower in lbs/cu.ft

h = total enthalpy difference of air at inlet and exit of tower in Btu/lb

16.8	Equivalent packing surface area per cubic metre of packing (a)	M^2/m^3	;
16.9	Depth of packing (V)	M	:
16.10	Performance coefficient		

$$C = \frac{M}{(L/GN)^{1/3}}$$

M = Merkels factor (furnish separately)

N = Resistance of tower to air flow through it, in number of velocity heads lost (furnish separately)

16.11	Duty coefficient (D)		:
	D = A/H		:
	A = Pond area at sill level		:
	H = Performance co-efficient		:
16.12	Pressure loss co-efficient of water	$(kg/cm^2)/m^3/hr)$	:
17.0	**SHELL**		:
17.1	Material		:
18.0	**BASIN**		:
18.1	Material of basin		:
18.2	Area of basin at normal water level	Sqm	:
18.3	Volume of basin	Cum	:
19.0	**FILL**		
19.1	Type		:

19.2	Total height	m	:
19.3	Total surface area	Sq.M	:
19.4	Fill louver span	M	:
19.5	Packing deflection	mm	:
19.6	Material of fill		:
19.7	Material of fill supports		:
19.8	Shape and thickness (enclose dimensional sketch)		:
19.8.1	Margin for wear and tear	mm	:
19.9	Manner of support and jointing		:
19.10	Packing for preventing vibrations (furnish details)		:
20.0	**DRIFT ELIMINATORS**		:
20.1	Type		:
20.2	Arrangement		:
20.3	Material		:
20.4	Size and thickness		:
21.0	**WATER DISTRIBUTION SYSTEM**		
21.1	Primary troughs/pipe		:
21.1.1	Material		:
21.1.2	Shape and size (cross sectional area for water flow)	(Sq.cm)	:
21.1.3	Thickness		:
21.1.4	Velocity of flow	M/sec	:
21.2	Secondary trough / pipe		:
21.2.1	Material		:
21.2.2	Shape and size (cross sectional area for water flow)	(Sq.cm)	:
21.2.3	Thickness	mm	:

21.2.4	Velocity of flow	M/sec	:
21.3	Orifice / Nozzle		:
21.3.1	Material		:
21.3.2	Size – capacity each (enclose cross-sectional drawing)	Litres/ sec	:
21.3.3	Thickness	mm	:
21.4	Feed Pipes		:
21.4.1	Material		:
21.4.2	Size (D)	mm	:
21.4.3	Thickness	mm	:
21.4.4	Velocity of flow	M//sec	:
21.4.5	Number		:
21.5	Splash Plates or Cups		:
21.5.1	Material	Sq.M	:
21.5.2	Size	mm	:
21.5.3	Thickness	mm	:
21.5.4	Margin for wear and tear	mm	:
21.6	Surge shaft height dia	mm	:
22.0	**TREATMENT PROPOSED FOR CENTRE INTERNAL SURFACES (FURNISH DETAILS)**		
23.0	**MISCELLANEOUS MATERIALS**		:
23.1	Drain valves		:
23.1.1	No. of valves included		:
23.1.2	Size		:
23.1.3	Specification		:
23.2	Drain Piping		:
23.2.1	Material		:
23.2.2	Specification		:

23.2.3	Size		:
23.2.4	Quantity included		:
23.2.5	Type of joints		:
23.3	Hot Water Pipework		:
23.3.1	Piping as per code		:
23.3.2	ID x Thickness	mm	:
23.3.3	Design pressure	Kg/cm^2	:
23.3.4	Enclosed cross section drawing of pipe		:
23.3.5	End connection details at TP		:
23.4	Slide Gates		:
23.4.1	Type and conforming to IS		:
23.4.2	Overall dimensions		:
23.4.3	Total weight		:
23.4.4	Ref. To dimensional drawings enclosed Lifting Arrangement		:
23.5	Coarse Screen		
23.5.1	Type and conforming to IS		:
23.5.2	Overall dimensions		:
23.5.3	Size of mesh and dia of perforations		:
23.5.4	Total weight		:
23.5.5	Ref to dimensional drawing enclosed lifting arrangement		:
23.6	Description of Hardware		
23.6.1	Materials		:
23.6.2	Corrosion protection treatment		:

S-1 **Belt Conveyor**

S. No.	Conv. No.												
1	Qty	2	2	2	2	2	2	2	2	2	2	4	4
2	Do Belt Conveyors conform to the requirements of spec. [Yes/ No]												
A	**Conveyor Data**												
A.1	Guaranteed Capacity, tph												
A.2	Operating Speed, m/s.												
A.3	Belt Width, mm												
A.4	No of roll x troughing Angle (deg) carrying side												
A.5	No of roll x troughing Angle (deg) return side												
A.6	Conveyor Inclination max												
A.7	Horizontal Length, c/c pulley (m)												
A.8	Lift, (m)												
A.9	Installed Power, kw												
A.10	Angle of wrap (deg) for single snub drive												
A.11	Skirt Plate as per spec./drgs. Provided [yes/no]												
A.12	Skirt board length to suit effective dust suppression by dry fog nozzles considered [yes/no]												
A.13	Deck Plate as per spec provided [yes/no]												
A.14	Seal Plate as per spec provided [yes/no]												
A.15	Gallery/ tunnel section as per enclosed drgs. Provided [yes/no]												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
B	**Take-up**												
B.1	Type												
B.2	Access platform provided complete with stair/ ladder [yes/no]												
B.3	Counter weight material												
B.4	Safety guard provided [yes/no]												
C	**Drive Unit**												
C.1	Motor Type (LT/ HT)												
C.2	Motor RPM												
C.3	Weight of Motor, kgf												
C.4	Type of Gearbox												
C.5	Make of Gearbox												
C.6	Service factor on belt kw for selection of Gearbox												
C.7	Type of cooling arrgmt												
C.8	Weight of Gearbox, kgf												
C.9	Type of lubrication for gear box												
C.10	Type & Make of HS Coupling												
C.11	Service factor for selection of HS Coupling												
C.12	Weight of HS Coupling, kgf												
C.13	Type & Make of LS Coupling												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
C.14	Service factor on belt kw for selection of LS Coupling												
C.15	Weight of LS Coupling, kgf												
C.16	Whether Coupling guards Provided [yes/no]												
C.17	Type & Make of holdback												
C.18	Rating of holdback, kN-m												
C.19	Location of holdback												
C.20	Brakes as per spec considered [yes/no].												
D	**Belting**												
D.1	Type												
D.2	Moulded or cut edge construction												
D.3	Make												
D.4	Standard followed												
D.5	Maximum operating tension [T1] as %age of RMBT {max allowable work tension of belt} …N/N belt												
D.6	Safety factor for steel cord belt												
D.7	Heavy duty belt considered, [yes/no].												
D.8	Belt rating/ no of ply [for N/N belt]												
D.9	ST rating/ UTS for steel cord belt												
D.10	Top cover thickness, (mm)												
D.11	Bottom cover thickness, (mm)												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
D.12	Grade of cover												
D.13	Type of Joint												
D.14	Rips detection system for steel cord belt provided.												
E	**Idlers (Carrying/ Return/ Impact)**												
E.1	**General**												
E.2	Make												
E.3	Roller Tube Material/ its IS												
E.4	Roller tube OD,(mm) x thk(mm) [impact idler]												
E.5	Roller tube OD,(mm) x thk(mm) [for other type of idlers except impact]												
E.6	Standard followed for Idler set construction												
E.7	Type, Make & Size of Bearing												
E.8	Idler Shaft Material												
E.9	Bearing Life, L_{10}, Hrs.												
E.10	Type of Lubrication												
E.11	Furnish type & detail of seal provided												
E.12	Friction factor at work (Max.)												
E.13	Normal tr. Idler spacing												
E.14	SAC idler spacing, mm												
E.15	Self Cleaning idler shall be provided,[Yes/No]												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
E.16	Normal return Idler spacing												
E.17	SAR idler spacing, mm												
E.18	**Impact Idler**												
E.19	No of impact idler set x spacing, (mm) at each loading point												
E.20	OD/ ID rubber disc												
E.21	Material of rubber disc & its Hardness												
E.22	Wt of one impact idler set [kgf] x wt of its rotating parts, [kgf/set]												
E.23	Reference to arrangement drg. enclosed												
E.24	Wt of one carrying idler set [kgf] x wt of its rotating parts, [kgf/set]												
E.25	Reference to arrangement drg. Enclosed [Carrying Idler set ...all types]												
E.26	No of roller per idler set [Return Idler]												
E.27	Spacing, (mm) [Return Idler]												
E.28	Wt, of one Return idler set [kgf] x Wt, of its rotating parts, [kgf/set]												
E.29	Reference to arrangement drg. Enclosed [Return Idler set ...all types]												
F	**Pulleys (Drive/ Head/ Tail/ Take up/ Snub/ Bend/ Tripper)**												
F.0	**General [pulleys]**												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
F.1	Type of Pulley construction												
F.2	Standard followed for pulleys												
F.3	Make												
F.4	Face width of Pulley												
F.5	Bearing Center, (mm)												
F.6	Type of bearings and minimum bearing life {drive pulley}												
F.7	Type of bearings and minimum bearing life {non-drive pulley}												
F.8	Material of shell												
F.9	Material of end disc												
F.10	Material of hub												
F.11	Material of shaft												
F.12	Type, Material & thk of lagging on drive pulley												
F.13	Type, Material & thk of lagging on non drive pulley												
F.14	Type of shaft fixing arrangement with hub												
F.15	Max Shaft deflection at end disc - Drive Pulley, minute												
F.16	Max Shaft deflection at end disc - Non Drive Pulley, minute												
F.17	Whether safety guard included where required.												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
F.18	Head/ drive Pulley [Drum dia. OD steel]												
F.19	Tail/ TU/ bend Pulley [Drum dia. OD steel]												
F.20	Snub Pulley [Drum dia. OD steel]												
F.21	Tripper head/ Bend Pulley [carrying side] [Drum dia. OD steel]												
F.22	Tripper Bend (Top) / Bend Pulley(Bottom) [return side] [Drum dia. OD steel]												
F.23	Deflector roller at each end of conveyor considered as per spec												
F.24	Reference to arrangement drg. enclosed												
G	**Belt Cleaning Arrangement**												
G.1	Manufacturer												
G.2	Are blade replaceable type												
G.3	Type & Make of primary cleaner												
G.4	Qty. of Primary Cleaner provided per discharge pulley												
G.5	MOC of blade for primary cleaner												
G.6	Type & Make of Sec. Cleaner												
G.7	Qty. of Sec. cleaner provided for discharge pulley												
G.8	MOC of blade for Sec. cleaner												
G.9	Type & Make of plow cleaner												

S-1 **Belt Conveyor**

S. No.	Conv. No.												
G.10	Qty. of plow cleaner provided per conv. & its location												
G.11	MOC of blade for plow cleaner												
H	**Conveyor Safety Switches**												
H.1	**Pull Cord Switches (in Pair)**												
H.2	Type & Make												
H.3	Amp Rating, A												
H.4	Spacing of Switch, m												
H.5	**Belt Sway Switches (in Pair)**												
H.6	Type & Make												
H.7	Amp Rating, A												
H.8	Spacing of Switch, m												
H.9	**Zero Speed Switch (in Pair)**												
H.10	Type & make												
H.11	Amp Rating, A												

S-2	**Chutes**			
S. No.	**Description**	**Hood [above discharge pulley]**	**Main Chute**	**Floor cleaning/ tramp metal chute**
1	Do Chutes conform to the requirements of specifications -2 [Yes/ No]			
2	Material & thk, mm of parent plate			
3	Minimum Sloping angle (degree) of chute inclined part			
4	Rubber curtain at entrance to hood (above discharge pulley) provided, [Yes/ No]		NA	NA
5	Gasket material & thk, mm			
6	Inspection door/ poking door/ removable covers provided [Yes/ No]			

S-3	**Gates**	
S. No	**Description**	
A.0	**Flap Gate**	**FG**
1	Does Flap Gate conform to the requirements of specifications [Yes/ No]	
2	Type & make	
3	Alternate manual operation provided [Yes/ No]/effort reqd,kgf	
4	MOC of flap	
5	MOC of gate shaft	
6	Type of bearing, its life,L_{10} ,hr	
7	Type of lubrication arrangement	
8	No of consecutive starts/ stops per hr	
9	No of switching per hr	
10	Max thrust (kgf)	
11	Motor kw rating & type	
12	Limit Switches Provided[Yes/ No]	
13	Estimated weight of one gate, (kgf)	
B.0	**Diverter Gate**	**DG**
1	Does **Diverter** Gate conform to the requirements of specifications M-3 [Yes/ No]	
2	Type & make	
3	Travel speed of gate, mm/sec	

4	Alternate manual operation provided [Yes/ No]/effort reqd,kgf	
5	MOC for Housing	
6	MOC & thk, mm for Triangular prism body[of travelling gate]	
7	MOC for rack/pinion	
8	Type of bearing, its life,L_{10} ,hr	
9	Type of lubrication arrangement	
10	No of consecutive starts/ stops per hr	
11	No of switching per hr	
12	Motor kw rating & type	
13	Limit Switches Provided[Yes/ No]	
14	Estimated weight of one gate, (kgf)	
C.0	**Rack & Pinion Gate**	**RPG**
1	Does Rack & Pinion Gate conform to the requirements of specifications as per Tech Spec. M-3 [Yes/ No]	
2	Type &Make	
3	Alternate manual operation provided [Yes/ No]/effort reqd,kgf	
4	MOC for Housing	
5	MOC for rack/pinion	
6	Type of bearing/ its life,L_{10} ,hr	
7	Type of lubrication arrangement	
8	No of consecutive starts/ stops per hr	
9	No of switching per hr	
10	Motor kw rating & type	
11	Limit Switches Provided[Yes/ No]	
12	Estimated weight of one gate, (kgf)	
D.0	**Rod Gate**	**RG**
1	Does Rod Gate conform to the requirements of specifications -3 [Yes/ No]	
2	Type & Make	
3	Qty	
4	MOC of Gate Frame	
5	MOC of ROD & ROD dia, mm	
6	No. of Rows of Rod	
7	Spacing of Rods in a row	
8	End Stopper/ Sleeve etc. provided as per specification Yes/No	
9	Estimated weight of one gate, (kgf)	

S-4	Monorail & Hoists				
A.0:	**Electric Hoist with Monorail**				
S.No.	**Description**	**3 tonne Capacity**	**6 tonne Capacity**	**10 tonne Capacity**	**15 tonne Capacity**
1	Does Electric Hoist with monorail conform to the requirements of specifications [Yes/No]				
2	Make of Hoist				
3	Quantity as per Tech. Spec. included [Yes/No]				
4	Construction to Indian Standard (I.S.)				
5	Max Safe Working Load, tonne				
6	Trolley speed (m/min)				
7	Hoisting speed (m/min)				
8	Radius of curvature of monorail/ Section size				
9	Construction of rope and No. of falls of Rope				
10	Breaking strength of rope, kgf/mm^2				
11	Type and material of load hook, Furnish I.S. No.				
12	Pendant push button control detail				
13	Type and arrangement of lubrication				
14	Installed Power, (Hoist Motor), kw				
15	Installed Power (Trolley Motor), kw				
16	Total installed power, kw				
17	Weight of Electric Hoist, Kgf (excluding Monorail)				
18	Is Hoist tested to 125% of SWL before dispatch (Yes/No)				

B.0	**Chain Pulley Block with Geared Trolley[manual hoist]**		
S.No.	**Designation No.**	**2T Chain Pulley Block**	**3T Chain Pulley Block**
1	Does Chain Pulley Block with Geared Trolley conform to the requirements of specifications [Yes/No]		
2	Make		
3	Quantity as per Tech. Spec. included [Yes/No]		
4	Construction to I.S. standard		
5	Section size of Monorail/max radius, m		
6	Wt. of Manual Hoist with Trolley, kgf		
7	Is Hoist tested to minimum 125%times SWL before dispatch (Yes/No)		

S-5	**Belt Vulcanizing Machine**		
S.No.	**Designation No.**	**BVM-1 (Steel Cord Belt)**	**BVM-2 (N/N Belt)**
1	Does Belt Vulcanizing Machine conform to the requirements of specifications [Yes/No]		
2	Type		
3	Qty offered, no.		
4	Make		
5	Minimum / Maximum Belt width that can be vulcanized by above machine, mm/mm		
6	Type of Temperature Controller provided		
7	Size of Platen ,mm x mm and its thickness ,mm		
8	MOC of Platen		
9	Temperature range, ^{o}C		
10	Operating Pressure range, bar		
11	Detail of Mechanism for application of pressures & heat etc.		
12	Method of heating		
13	Connected load, kW		
14	Whether Power receiving plug, Switch & Cable provided (Yes / No)		
15	Cable length, m		
a)	Socket to temperature control box		
b)	Between Control Box & Platen		
16	Operating Voltage		
17	Furnish Detail of Tool Kit / Vulcanizing accessories		
18	Weight of Machine, kgf		
19	Qty & Capacity (tonne) of Portable Winch		
20	Make of Winch / Wt, kgf		

S-6	Magnetic Separator (ILMS)						
S.No	**Designation No.**	**ILMS-1A**	**ILMS-1B**	**ILMS-2A**	**ILMS-2B**	**ILMS-3A**	**ILMS-3B**
1	Does magnetic separator conform to the requirements of specifications [Yes/No]						
2	Type						
3	Manufacturer						
4	Qty/Location						
5	Operating height, mm						
6	Minimum wt. & size of tramp iron that can be picked from belt at specified operating height						
7	Maximum wt. & size of tramp iron that can be picked from belt at specified operating height						
8	Size of magnet, mm x mm x mm [W x L x H].						
9	Force Index						
10	Gauss strength at specified operating height						
11	Required voltage (DC/AC)						
12	Material of Coil						
13	Type of cooling arrangement.						
14	Rectifier						
a.	Type & make						
b.	Input Power supply to Rectifier						
15	Material of magnet /IS standard						
16	Tramp Iron Chute provided at operating floor (Yes / No)						
17	Tramp Metal Trolley provided, (Yes / No)						
18	Tramp Metal chute near main chute provided, (Yes / No)						
19	DC Power consumption in hot condition, kw						
	a) After 24 hours of continuous operation						

S-6	Magnetic Separator (ILMS)						
S.No	**Designation No.**	**ILMS-1A**	**ILMS-1B**	**ILMS-2A**	**ILMS-2B**	**ILMS-3A**	**ILMS-3B**
	b) After 8 hours of continuous operation						
20	a) Belt Rating & Cover Grade						
	b) Top Cover x Bottom cover thk,(mm x mm)						
	c) Built in ribs provided in the belt (Yes / No)						
21	Drive motor rating, kw						
22	Non-Magnetic Pulley as per Spec. provided (Yes / No)						
23	Total wt. of Magnetic Separator, tonne.						
24	Reference arrangement drawing/catalog enclosed (Yes / No)						

S-7	Suspended Electro Magnet (SEM)		
S.No	**Designation No.**	**SEM-1A/1B**	**SEM-2A/2B**
1	Does Suspended Electro Magnet conform to the requirements of specifications [Yes/No]		
2	Type		
3	Manufacturer		
4	Qty/Location		
5	Operating height, mm		
6	Minimum wt. & size of tramp iron that can be picked from belt at specified operating height		
7	Maximum wt. & size of tramp iron that can be picked from belt at specified operating height		
8	Size of magnet, mm x mm x mm [W x L x H]		
9	Force Index		
10	Gauss strength at specified operating height		
11	Required voltage (DC/AC)		
12	Material of Coil		
13	Type of cooling arrangement.		
14	Rectifier		

	a. Type & make		
	b. Input Power supply to Rectifier		
15	Material of magnet/ IS standard		
16	Tramp Iron Chute provided at operating floor (Yes / No)		
17	DC Power consumption in hot condition, kw		
	a) After 24 hours of continuous operation b) After 8 hours of continuous operation		
18	Tramp Metal Trolley provided, (Yes / No)		
19	Non-Magnetic Idlers as per Spec. provided (Yes / No)		
20	Total wt. of Suspended Electromagnet, tonne.		
21	Reference arrangement drawing/ catalog enclosed (Yes / No)		

S-8	**Metal Detector**		
S.No	**Description**	**MD-1A/1B**	**MD-2A/2B**
1	Does Metal Detector conform to the requirements of specifications [Yes/ No]		
2	Qty		
3	Location		
4	Operation Details		
5	Material to be examined		
6	Belt Width, mm x Troughing angle		
7	Belt Speed, m/s		
8	Type of Detector		
9	Capacity for detection [size of Aluminium ball it can detect]		
10	Capacity for detection [size of MS bolt it can detect]		
11	Type of Annunication/ Hooter provided		
12	Furnish details of hooter		
13	Details of sand bag marker system		
14	Audible range of hooter		
15	Indication type		
16	Power Supply		
17	Max Power Consumption (kw)		

18	Installed Power, kw		
19	Please conform if metal detector will work in conjunction with coal scooper [Yes/ No]		
20	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-9	**Coal Scooper**		
S. No.	**Description**	**CS-1A/ 1B**	**CS-2A/ 2B**
1	Do Coal Scooper conform to the requirements of specifications [Yes/ No]		
2	Type		
3	Make		
4	Qty./ Location		
5	Material handled		
6	Max lump size,mm		
7	Type of cutter		
8	Size of cutter opening,mm [min 2.5 times of max lump size]		
9	Material of construction of cutter body		
10	Material of construction of cutter lips		
11	Minimum four(4)no of 5-roll idler set at cutter location provided on conveyor to suit the cutter profile for scooping out metal contaminated coal mass on belt. Pl. confirm		
12	Cutter operates in conjunction with metal detector to scoop out metal contaminated coal mass on belt without belt stoppage.Pl confirm.		
13	Material {MOC} & thk of discharge chute from hammer type cutter to receptacle.		
14	Material {MOC} & thk of receptacle[for receiving tramp metal contaminated coal from belt via scoop hammer of coal scooper].		
15	Type of drive motor		
16	Motor kw x RPM		
17	Description of machine offered.		
18	Wt of machine including discharge chute & complete drive unit.,kgf		
19	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-10	**Belt Weigher**

S.No	Description	BW-1A/1B	BW-2A/2B	BW-3A/3B
1	Does Belt Weigher conform to the requirements of specifications [Yes/ No]			
2	Location/ Qty			
3	Type			
4	Make			
5	No. of Weigh Idlers Provided			
6	Weigh Idler Machined [Yes/ No]			
7	Belt Width mm x Tr. Angle (Deg)			
8	Weigh Range (tph)			
9	Belt Speed, m/s			
10	Furnish detail of weighbridge/ weigh frame			
11	Furnish detail of sensor			
12	Accuracy (%) at full load			
13	Accuracy (%) at minimum load			
14	Type of feed rate indicator			
15	Location of feed rate indicator			
16	Whether microprocessor based/ Totaliser unit provided			
17	Type of load cell & its detail			
18	Power consumption, kw			
19	Calibrating instrument including in supply [Yes/ No]			
20	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]			

S-11	Fixed Tripper		
S. No.	Description	FT-1A/1B	FT-2A/2B
1	Does Fixed Tripper conform to the requirements of specifications? [Yes/ No]		
2	Location/ Qty		
3	Type of belt cleaner provided		
4	Flap gate/ Skirt board/ other items as per spec. provided [Yes/ No]		
5	Belt width		
6	Discharge chute as per spec. provided [Yes/ No]		
7	Access platform with ladders hand rail provided? [Yes/ No]		
S-12	Travelling Tripper		

S. No.	Description	TRT-1A/ 1B	TRT-2A/ 2B
1	Do Travelling Tripper conform to the requirements of specifications? [Yes/ No]		
2	Type		
3	Location/ qty, no		
4	Manufacturer		
5	Rail size & gauge, mm/mm		
6	Belt width, mm		
7	Travel speed, m/min		
8	Tripper travel length, m [approx]		
9	Flap gate complete with 2-way chute &linear actuator as per spec. provided. [Yes/ No]		
10	Installed power, [flap gate], kw		
11	Skirt board as per spec. provided [Yes/ No]		
12	Discharge chute/ external belt cleaner provided [Yes/ No]		
13	Access cum operator platform/ ladder/ inspection door etc provided [Yes/ No]		
14	No & type of Rail clamps provided per tripper		
15	Type & location of Rail cleaners		
16	Type/ Location/ qty of limit switches provided at travel end [per tripper]		
17	Rail stopper provided at travel ends		
18	Type/ details of buffer & its post at travel ends		
19	End stop provided? [Yes/ No]		
20	Type & make of cable reeling drum		
21	**Travel Wheel Assembly**		
i.	Type of wheel[double or single flange]		
ii.	MOC of wheel & tread hardness [BHN]		
iii.	Tread width, mm/tread dia. mm		
iv.	Flange dia, mm		
v.	Max spacing of axle, mm		
vi.	MOC of axle		
vii.	Type and make of bearings & minimum bearing life,		

	L_{10}(hr)		
22	**Tripper car travel drive**		
i.	Type/ make of motor		
ii.	kw x rpm of motor		
iii.	Type & make of gear box		
iv.	Type & make of couplings		
v.	Installed motor kw		
vi.	Type & details of brake		
vii.	Type & Detail Of Emergency Stopping Device		
23	Total installed power for tripper		
24	Total weight of one travelling tripper		
25	Arrangement Drawing/ Catalogue enclosed [Yes/ No]		

S-13	**Wagon Tippler & Accessories**	
S. No.	**Description**	**WT-1A/1B**
1	Does Wagon Tippler conform to the requirements of specifications [Yes/ No]	
2	Material handled	
3	Qty, no	
4	Type of tippler offered	
5	All equipment including tippler conform to the requirements of RDSO[Yes/ No]	
6	Type of Wagons that can be handled [per RDSO]	
7	Max Gross weight of one wagon, Tonne	
8	Rail Gauge, mm	
9	Mode of placement of wagon on tippler	
10	No. of tippling/ hr	
11	Coal unloading rate per tippler , tph [tippler operating in conjunction with its side arm charger]	
12	Average cycle time, min… tippler operating in conjunction with its side arm charger	
13	Break up of cycle time ,sec	
14	Angle of rotation, degree	
15	Angle of rotation, degree[maximum]	
16	Speed of rotation, radian/sec	
17	Type of clamping & no of clamps	
18	Type & no. of Drive Motor installed for clamping	

	operation	
19	Installed Power, for clamping operation	
20	Consumed Power, for clamping operation, kw	
21	Furnish safety features for clamping operation	
22	Type & no. of Drive Motor for tippling operation	
23	Furnish type of Power Transmission Arrangement	
24	Installed power for tippling operation, kw	
25	Consumed Power, for tippling operation, kw	
26	Furnish safety features for tippling operation	
27	Mode of Control	
28	Type of lubrication arrangement	
29	Furnish special features of machine	
30	Total installed power, kw	
31	Break-up of installed power, kw	
32	Wt of machine, kgf [excluding all power packs/motors]	
33	Arrangement Drawing/ Catalogue enclosed, Yes/ No	

S-14	**Side Arm Charger**	
S.No.	**Description**	**SAC-1A/1B**
1	Does Side Arm Charger conform to the requirements of specifications [Yes/ No]	
2	Qty	
3	Type	
4	Make	
5	Max. Pulling capacity[with load] , kgf & its pulling speed (m/s)	
6	Max track radius it can negotiate at above mentioned magnitude of pull & speed ,m	
7	No of loaded wagons [i.e coal loaded rake] it can pull [at above mentioned magnitude of pull, speed & track radius]	
8	Max mass of coal loaded rake, kg it can pull [at above mentioned magnitude of pull, speed & track radius]	
9	Max. wt. of one Wagon, Tonne, [considered in above mentioned coal loaded rake]	
10	Side Arm Charger speed (reverse), m/sec	
11	Track Gauge, mm	

S-14	**Side Arm Charger**	
S.No.	**Description**	**SAC-1A/1B**
12	Rail size	
13	Travel Length , m[stroke]	
14	C/C distance b/w wagon track & side arm charger track, mm	
15	Mode of control / operation of charger	
16	Arrgmt. of Power supply	
17	MOC of rack & pinion [for travel]	
18	Raising/lowering mechanism of arm	
i.	Installed kw	
ii.	Hydraulic arrgmt. provided for arm raising/lowering operation [Yes/ No]	
iii.	Type of drive & its location	
iv.	MOC of arm	
19	Charger travel mechanism[carriage drive]	
i.	Installed kw	
ii.	Type of drive & its location	
iii.	No & type of travel wheel	
iv.	Wheel dia x tread hardness[BHN]	
v.	MOC of Wheel	
vi.	No. of Guide Rollers[thrust] provided	
vii.	Type of Roller x MOC x roller OD x BHN[Guide Rollers]	
viii.	Type of lubrication for roller [Guide Rollers]	
20	Make of Power Pack [for arm operation]	
21	Make of Power Pack [for carriage travel]	
22	Weight of single heaviest component / assembly, kgf	
23	Type and arrangement of lubrication	
24	Type of Brakes Provided	
25	Limit switches provided [Yes/ No]	
26	Necessary safety features incorporated on machine [Yes/ No]	
27	Total installed power, kw	
28	Breakup of installed power , kw	
29	Total Weight of Machine, kgf	

S-14	Side Arm Charger	
S.No.	**Description**	**SAC-1A/1B**
30	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	
31	Description of side arm charger operation for tippler operation	

S-15	EOT Crane for Tippler		
S. No.	**Description**	**EOT-1A**	**EOT-1B**
1	Does EOT Crane conform to the requirements of specifications [Yes/ No]		
2	Type & Make		
3	Code followed		
4	Qty, no		
5	Location		
6	Safe working load (Main Hoist), tonne x lift, m [approx]		
7	Safe working load (Auxiliary Hoist), tonne x lift, m [approx]		
8	Approx. Span (m)		
9	Duty Class		
10	Speed m/min		
i.	Main hoist (normal/ creep)		
ii.	Aux. Hoist (normal/ creep)		
iii.	Cross travel		
iv.	Long travel		
11	Max wheel load (t)		
12	Type & Material of hook		
i.	Main hook		
ii.	Aux. hook		
13	Main Hoist rope		
i.	No. of rope falls		
ii.	Size & Construction		
iii.	Breaking strength, UTS, kgf/mm^2		
iv.	Rope grade/ IS		
14	Aux. hoist		
i.	No. of rope falls		
ii.	Size & Construction		
iii.	Breaking strength, UTS, kgf/mm^2		
iv.	Rope grade/ IS		
15	Test Load, tone [for main hoist]		

S-15	**EOT Crane for Tippler**		
S. No.	**Description**	**EOT-1A**	**EOT-1B**
16	Test Load, tone [for aux. hoist]		
17	Gantry rail size		
18	Crab rail size		
i.	Installed kw [Main hoist]		
ii.	Installed kw [Aux. hoist]		
iii.	Installed kw [Cross travel]		
iv.	Installed kw [Long travel]		
19	Type & arrangement of lubrication		
20	Type of brakes & limit switches provided		
21	Details of DSL		
22	Wt of crane [excluding rails]		
23	Arrangement Drawing/ Catalogue enclosed [Yes/ No]		

S-16	**Wagon Tippler Hopper**		
S. No.	**Description**		
1	**Location**	**Tippler Complex# WTC-1**	**Reclaim Hopper Complex # RH-1/2/3/4**
2	Application	Tippler	Reclaim hopper
3	RCC Hoppers designation no	WTH-1A/1B	RH-1A/1B/2A/2B /3A/3B/4A/4B
4	Qty	2	8
5	Do RCC Hoppers conform to the requirements of specifications -16? [Yes/ No]		
6	Water Filled Volume, (Cum)		
7	Coal Holding Capacity, tonne (Maxi.)		
8	Bar grid on top of hopper provided as per spec. [Yes/ No]		
9	Liners provided as per spec. [Yes/ No]		

S-17	**Apron Feeder with Dribble Conveyor**		
S. No.	**Description**	**AF-1A**	**AF-1B**
1	Does Apron Feeder conform to the requirements of specifications[Yes/ No]		
2	Qty, no/location		
3	Make		
4	Material handled		
5	Max lump size, mm		
6	Variable capacity feeder provided? [Yes/ No]		
7	Type of arrgmt provided for variable capacity		
8	Max Capacity, (tph) and its corresponding speed ,m/s		
9	Minimum Capacity, (tph) and its corresponding speed ,m/s		
10	Method of speed variation		
11	Material(MOC) & thk of skirt board		
12	Furnish location & type of control gate [if provided]		
13	Clear Width of apron pan, mm [to achieve 2000tph capacity]		
14	Length C/C, m(approx),		
15	Installed Power, kw		
16	Type of drive motor		
17	Type & make of HS coupling		
18	Type & make of gear box[water cooled gear box not acceptable]		
19	Type & make of LS coupling		
20	Material(MOC) & thk of pan		
21	Type of chain x no of strand		
22	Safety factor considered for chain selection		
23	Chain roller pitch, mm		
24	Material(MOC) & thk of link x hardness[BHN]		
25	Roller of Chain		
i.	Type of roller & its lubrication arrgmt.		
ii.	MOC of roller x BHN		
iii.	Roller dia, mm		

S-17	**Apron Feeder with Dribble Conveyor**		
S. No.	**Description**	**AF-1A**	**AF-1B**
26	Roller [for pan supports]		
i.	Type of roller & its lubrication arrgmt.		
ii.	MOC of roller x BHN		
iii.	Roller dia., mm		
27	Roller on return side for chain support		
i.	Type of roller & its lubrication arrgmt.		
ii.	MOC of roller x BHN		
iii.	Roller dia, mm		
28	Type of take up device		
29	Drive sprocket assly.		
i.	PCD x no of teeth x MOC of sprocket		
ii.	Hardness of teeth, BHN		
30	Tail sprocket assly		
i.	PCD x no of teeth x MOC of sprocket		
ii.	Hardness of teeth, BHN		
31	Type of lubrication arrgmt.		
32	Weight of heaviest part, kgf		
33	Weight of machine (total),kgf excluding drive unit		
34	Matching dribble conveyor provided, Yes/ No		
35	Arrangement Drawing/ Catalogue enclosed		

S-18	**Primary Crusher (Rotary breaker Type)**	
S. No.	**Description**	**RB-1A/1B**
1	Does Primary Crusher conform to the requirements of specifications [Yes/No]	
2	Number	
3	Type	
4	Manufacture and Model	
5	Guaranteed Crushing Capacity, (tph) for specified coal	
6	Guaranteed coal output size, mm (at above Guaranteed capacity)	

7	Diameter of Machine	
8	Length of Machine	
9	RPM of drum	
10	Does required interlocks provided?	
11	Nature of Interlocks and safety measures, if required.	
12	**Drive Motor**	
a)	Type	
b)	Make & Model No.	
c)	Motor kW rating x RPM	
d)	Abssorbed power at driven shaft, kW	
e)	Maximum Starting Current / Maximum Starting torque	
f)	Insulation Type	
g)	Type of Cooling arrangement provided	
13	**Type/ Size of Bearing**	
a)	Qty. of Lubrication of Bearing	
b)	Life (working hours)	
14	Normal Life of: i. Frame Liners ii. Teeth	
15	**Material of Construction**	
a)	Main Frame	
b)	Rotating Drum	
c)	Shelves / Deflector plate	
d)	Tie Beam	
e)	Hood Cover	
f)	Spiders	
g)	Roller / Roller Shaft	
16	Is product size adjustment device provided?	
17	Type of dust seal provided	
18	Type of coupling provided (Make & Model No.)	
19	Weight of heaviest part	
20	Weight of machine (total)	
21	Furnish Details of Vibration Monitoring System	
22	Furnish Details of Temperature Monitoring Device for Primary	

	Crusher & Motor Bearing	
23	Guaranteed Vibration Levels i. For Crusher ii. For Supporting Structure	
24	Noise Level	
25	Arrangement Drawing/ Catalogue enclosed (Yes/ No)	

S-19	**Secondary Crusher (Ring Granulator Type)**		
S. No.	**Description**	**CR-1A/2A**	**CR-1B/2B**
1	Do Secondary Crusher conform to the requirements of Tech Spec. [Yes/ No]		
2	Number		
3	Type		
4	Manufacturer & Model no		
5	Guaranteed Crushing Capacity, (tph) for specified coal		
6	Guaranteed coal output size, mm (at above Guaranteed capacity)		
7	Feed opening size, mm x mm		
8	Rotor speed, rpm		
9	Are required Interlocks provided?		
10	Nature of interlocks & safety measures		
11	Hydraulic power pack for door opening/closing provided.		
12	Drive Motor		
a)	Type		
b)	Make & Model no.		
c)	Power Supply		
d)	Maximum starting current		
e)	Maximum starting torque		
f)	Insulation Type		
g)	Rated Power		
h)	Type of cooling arrangement provided		
i)	Maximum KVA demand		
13	Type/ Size of Bearing		
14	Bearing Life,L_{10} (hours)		
15	Normal life of:		
a)	Suspension disc		
b)	Breaker plate		

S-19	Secondary Crusher (Ring Granulator Type)		
S. No.	**Description**	**CR-1A/2A**	**CR-1B/2B**
c)	Crushing rings		
d)	Frame liners		
16	Material of Construction (MOC)		
a)	Frame (MOC) & thk, mm		
b)	Frame liners (MOC) & thk, mm		
c)	Cage Frame (MOC)		
d)	Screen bars or plates (MOC) & thk, mm		
e)	Rotor Shaft(MOC)		
f)	Suspension disc(MOC)		
g)	Crushing rings(MOC)		
h)	Suspension bars(MOC)		
17	Is product size adjustment device provided?		
18	Is tramp iron trap provided?		
19	Type of dust seal provided		
20	Type & make of speed reduction gearbox(if applicable)		
21	Material of construction (MOC) ------ Gearbox		
a)	----Gears		
b)	----Shaft		
22	Type of cooling arrangement provided (for Gearbox)		
23	Type of coupling provided		
24	Coupling Make & Model no		
25	Weight of heaviest part, kgf		
26	Weight of machine (total),kgf including drive unit & motor		
27	Break up of above machine wt,kgf		
28	Anti Vibration Gerb Spring System as called for provided [Yes/ No]		
29	Details of Gerb spring system		
30	Furnish details of Vibration Monitoring System		
31	Furnish details of Temperature Monitoring Device for Crusher & Motor Bearings		
32	Guaranteed Vibration Levels after using GERB Spring		
a)	For Crusher		
b)	For Supporting Structure		
33	Arrangement Drawing/ Catalogue enclosed [Yes/ No]		

S-20	Vibrating Grizzly Feeder		
S. No.	**Description**	**VGF-1A/ 1B**	**VGF-2A/ 2B**
1	Do Vibrating Grizzly Feeder conform to the requirements of specifications [Yes/ No]		
2	Type		
3	Make		
4	Type of mounting		
5	Location & Number		
6	Capacity, tph		
7	Maximum lump size of coal that can be handled, mm		
8	Segregation size, mm [i.e. lump size of under size material]		
9	Overall dimension of feeder L x W x H, mm/mm/mm		
10	Max/ minimum Inclination of deck with horizontal, (deg)		
11	Can Inclination of deck can be varied post installation		
12	Frequency & Amplitude of vibration		
13	Type of vibrating mechanism		
14	Type of drive mechanism		
15	No/ kw rating of drive motor [per feeder]		
16	Decks		
i.	Thickness & material of solid deck section		
ii.	Thickness & Material of Liner plate on Solid Deck Section		
iii.	Method of Liner fixing (on solid deck)		
iv.	Type of Grizzly deck [perforate plate or grizzly bar], [stepped or continuous]		
v.	Material of grizzly bars		
vi.	Furnish size of gap (clear) between Grizzly Bars		
vii.	Material of supporting springs		
17	Furnish details/ type of sealing arrangement		
18	Weight of heaviest component, kgf		
19	Estimated weight of one Vibrating Grizzly Feeder, kgf		
20	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-21	**Vibrating Feeder**				
S. No.	**Description**	**VF-1A/1B**	**VF-2A/2B**	**VF-3A/3B**	**VF-4A/4B**
1	Does Vibrating Feeder conform to the requirements of specifications [Yes/No]				
2	Number				
3	Type				
4	Manufacture and Model				
5	Location				
6	Capacity				
7	Drive margin over Design Capacity				
8	Lump Size				
9	Power Supply				
10	Provision for capacity variation				
11	Local feed rate control to be provided				
12	Vibrator tray				
13	Deck Size				
14	Angle of inclination of deck				
15	Amplitude of variation				
16	Frequency of variation				
17	Type of Mounting				
18	Material & Construction				
i	Tray				
ii	Liner				
iii	Spring				
iv	Frame				
19	Type of Drive				
20	Type of Control				
21	Indication of operation				
22	Arrangement Drawing/ Catalogue enclosed (Yes/No)				

S-22	**Stacker cum Reclaimer**	
S. No.	**Description**	**SR-1A/1B**
1	Does Stacker cum Reclaimer conform to the requirements of specifications [Yes/No]	
2	Make and Model Number	
3	Type	
4	**Guaranteed capacity**	
i	While Stacking (tph)	
ii	While Reclaiming (tph) based on 4 hours average (Block cutting operation)	
iii	Peak reclaiming capacity, (tph)	
5	Boom length, m	
6	Stockpile height (above Ground)	
7	Travel Length, m	
8	Stockpile width at base, m x Stockpile length, m	
9	**Max. Wind velocity considered**	
i	While Operating machine (m/s)	
ii	Non-Operating condition of machine (m/s)	
10	**Stability Factor**	
i	For operating conditions of machine with max. permissible wind velocity & maximum live load	
ii	For operating conditions of machine with max. permissible wind velocity & without any live load	
iii	For non-operating conditions of machine with max. permissible wind velocity	
11	**Rails for travel of Stacker cum reclaimer**	
i	Rail Size (kg/m)	
ii	Maximum wheel load considering impact (tonnes)	
iii	Track gauge, m (Rail CRS.)	
iv	Maximum permissible variation in rail level vertical, (±)mm	
v	Maximum permissible track variations, (Rail Centres), (±) mm	
vi	Method of fixing rails	
vii	Type of foundations provided for rail supports	
viii	Are all required fixing / foundation / anchor bolts, nuts, sleeves, inserts, concrete included (Yes/No)	
12	**Machine Body**	
i	Material of construction	

S-22	Stacker cum Reclaimer	
S. No.	**Description**	**SR-1A/1B**
ii	Type of construction	
iii	Codes followed for design and construction	
13	**Long Travel Mechanism**	
i	Travel Speed ,Maximum / Minimum (m/min)	
ii	Method of speed variation	
iii	Number of trucks under each carriage support	
iv	Supporting Mechanism of the carriage with M/C Body	
v	Details of wheels	
	-Number per Carriage	
	-Travel Wheel Tread Dia., mm	
	-Material of wheel x Tread Hardness (BHN)	
	No. of Drive wheels / No. of non drive wheels	
vi	Type of lubrication system provided	
vii	Furnish brief description of travel drive arrangement	
14	**Slewing Mechanism**	
i	Slewing angle of boom (± in degree).....Range	
ii	Slewing speed at centre of bucket wheel, m/min	
iii	Are speed controls step less?	
iv	Type of Drive	
v	Brakes, location, torque rating, type and make	
vi	Bearings type and size	
vii	Type of lubrication system provided	
viii	Furnish brief description of slewing mechanism and turn tables	
15	**Luffing Mechanism**	
i	Luffing speed(Lowering/Hoisting) at centre of bucket wheel, m/min	
ii	Luffing range (± in degree)	
iii	Are speed controls step less	
iv	Type of Drive x No. of Hydraulic cylinder provided	
v	Type / Location / Make of Brakes	
vi	Type of lubrication system provided	
vii	Furnish brief description of luffing arrangement	
16	**Bucket wheel Assembly**	
i	Type	

S-22	Stacker cum Reclaimer	
S. No.	**Description**	**SR-1A/1B**
ii	Diameter of Bucket Wheel, m	
iii	No. of buckets in the assembly	
iv	Capacity of each bucket ,m^3 (Nominal)	
v	Size of bucket (length, width, depth)	
vi	No. of discharges per min	
vii	Material of Construction	
	-Bucket Wheel	
	-Bucket	
	-Teeth and tips	
viii	Bucket attachment method	
ix	Is it possible to remove any bucket for replacement	
x	Bucket wheel RPM	
17	**Bucket Wheel drive**	
i	Drive type and mounting arrangement	
ii	Is Bucket wheel drive reversible (Yes/No)	
iii	Is Bucket RPM variable	
iv	Brakes, location, torque rating, type and make	
v	Bearings type and size	
vi	Weight of the heaviest part to be removed for replacement	
vii	Type of lubrication system provided	
18	**Boom conveyor**	
i	Capacity, tph	
ii	Length of the Conveyor (Pulley Centres)	
iii	Belt Width, Speed & Trough	
iv	Belt Rating: Type x Duty x Rating x No. of Ply.	
v	Type of Conveyor Drive	
19	**Belt Weigher**	
i	Type & Make	
ii	Location	
iii	Weighing range, tph	
iv	Accuracy, %	
20	**Operators Cabin**	
i	Type & Location	
ii	Are the controls required for controlling all motions provided (Yes/No)	

S-22	**Stacker cum Reclaimer**	
S. No.	**Description**	**SR-1A/1B**
iii	Type of Control Panel & Desk	
iv	Type/ Make / Capacity of Air conditioning unit for operator cabin	
v	Are all equipment required to be provided in operator's cabin as specified provided (Yes/No)	
21	Vent fan for Electric House (on Board M/C) provided (Yes/No)	
22	Air changes / hr in Electric House	
23	**Hoist with Monorail for servicing**	
i	No. Provided	
ii	Type & Make	
iii	Location	
iv	Capacity, tonne	
24	**Anti Collision Device**	
i	Type & Make	
ii	Qty & Location	
iii	Furnish brief description of Anti Collision operation	
25	Total Installed Power, KW	
26	Break-up of Installed Power	
27	Largest Single Motor Installed, KW	
28	Weight of Stacker cum Reclaimer Machine	
29	MOC of Counterweight	
30	Dust Suppression System provided as per Tech. Spec. (yes/No)	
31	Rail Clamps (Manual & Automatic) provided (Yes/No)	
32	Limit Switches, Probe Switch, Safety Switches & Over-Travelling Switches provided (Yes/No)	
33	3-D stockpile volume / Qty measurement device provided (Yes/No)	
34	Communication system and public address system provided as per Tech. Spec. (yes/No)	
35	Arrangement Drawings / Catalogue enclosed (Yes / No)	

S-23	**Bunker Level Transmitter**	**BLT**
S. No.	**Description**	
1	Does Bunker level transmitter conform to the requirements of specifications [Yes/ No]	
2	Type	
3	Make	
4	Number per coal storage hopper	
5	Location	
6	Accuracy	
7	Furnish details of mechanism for level indication	
8	Details of protection	
9	Location of Annunciation/ indication/ Alarm at Bunker floor/ Central control room (Bldg# ER-2) provided, [Yes/ No]	
10	Material of construction for important components	
11	Whether unit is dust and weather proof	
12	Reference drawing/ catalogue enclosed	
13	List of previous installation [Power Plant]	

S-24	**Reject Bin**	**RJHN-1**
S. No.	**Description**	
1	Does Reject Bin indicator conform to the requirements of specifications [Yes/ No]	
2	Type of construction	
3	Material handled/stored	
4	Maximum Lump Size, mm	
5	Water filled volume of Reject Bin, m^3	
6	Sloping Angle of Inclined Portion, degree	
7	Material of Parent Plate [vertical portion]	
8	Material of liner Plate [vertical portion]	
9	Material of parent plate [inclined portion]	
10	Material of liner plate [inclined portion]	

S-25	**Plain water DS System for Crushed Coal Stockpiles**	
S. No.	**Description**	**PWDS-1**
1	Do Plain Water DS System for Stockpile conform to the requirements of specifications [Yes/ No]	
2	Water Tanks# WTK- 3A	
i.	Location/ Qty/ all the needed / inlet/ outlet/ drain etc as per requirements provided... for water tank# WTK- 3A [Yes/ No]	
ii.	Water holding Capacity of each tank	
iii.	Type of water tank construction	
3	**Pump**	
i.	Designation no	
ii.	Location & Qty	
iii.	Duty	
iv.	Type & Make	
v.	Total Discharge Head, m(water column)	
vi.	Discharge capacity (m^3/hr)	
vii.	Pump (RPM)	
viii.	Motor rating (kw) x RPM	
ix.	MOC of pump... Casing	
x.	MOC of pump... Impeller	
xi.	MOC of pump... Shaft	
xii.	ID inlet/ ID outlet size, mm	
4	**Duplex Filter**	
i.	Type & Make of filter	
ii.	Qty & Location	
iii.	Size of Particle removed by filter	
5	**Sprinkler**	
i.	Type & Make	
ii.	Spacing (along length of stockpile)	
iii.	Max. throw radius, m	
iv.	Capacity range, lpm	
v.	Range (Water Pressure) at nozzle tip, kgf/cm^2	

S-25	Plain water DS System for Crushed Coal Stockpiles	
S. No.	Description	PWDS-1
vi.	MOC of sprinkler items	
a)	Body & Flag	
b)	Spring	
c)	Base	
d)	Washer	
e)	Nozzle Tip	
6	Pipe work/ Valves/ Fittings/ Solenoid Valve/ Main Water Header/ sprinklers etc per requirements provided [Yes/ No]	
7	Indian Standard followed for piping work etc	
8	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-26	Prespray System Plain Water Type for Waiting Wagon [Tippler Complex]	
S. No.	Description	PSS-1
1	Do Prespray System for Waiting Wagon conform to the requirements of specifications [Yes/ No]	
2	No of waiting wagons considered for one Prespray system	
3	Water Tank # WTK-1A	
i.	Location/ Qty/ all the needed nozzles/ inlet/ outlet/ drain etc as per requirements provided... [For Water Tank# WTK-1A] [Yes/ No]	
ii.	Water holding capacity of tank # WTK-1A, cum	
iii.	MOC of water tank	
4	Pump	
5	Designation no	
i.	Location & Qty	
ii.	Duty	
iii.	Type/ Make	
iv.	Discharge capacity,cum/hr	
v.	Total Discharge Head (m,W C)	
vi.	Pump (RPM)	
vii.	Motor rating (kw) x RPM	
viii.	MOC of pump... Casing	
ix.	MOC of pump... Impeller	
x.	MOC of pump... Shaft	

S-26	Prespray System Plain Water Type for Waiting Wagon [Tippler Complex]	
S. No.	Description	PSS-1
xi.	ID Inlet/ ID outlet size, mm	
6	**Duplex Filter**	
i.	Type & make of Filter	
ii.	Qty & Location	
iii.	Size of Particle removed by filter	
7	**Nozzles**	
i.	Type	
ii.	Make	
iii.	MOC of nozzle body & its tip	
iv.	Capacity range, lpm	
v.	Range (Water pressure) at nozzle tip, kgf/cm^2	
8	Pipe Work/ Valves/ Fittings/ Solenoid Valve/ Header Bar/ Nozzles etc as per requirements provided [Yes/ No]	
9	Indian Standard followed for piping work etc	
10	Field instrumentation as per requirements included [Yes/ No]	
11	Supporting Structure/ Ladder/ etc. provided [Yes/ No]	
12	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-27	DS System for Wagon Tippler Hopper Top only	
S. No.	Description	DST-1
1	Do DS System for Track Hopper conform to the requirements of specifications [Yes/ No]	
2	Water Tank# WTK- 2A	
i.	Location/ Qty/ all the needed nozzles/ inlet/ outlet/ drain etc as per requirements provided... for water tank# WTK- 2A [Yes/ No]	
ii.	Water holding Capacity of tank, cum	
iii.	Type of construction of water tank	
3	**Pump**	
i.	Designation no	
ii.	Location & Qty	
iii.	Duty	
iv.	Type & Make	
v.	Total Discharge Head, m(water column)	
vi.	Discharge capacity (m^3/hr)	

S-27	DS System for Wagon Tippler Hopper Top only	
S. No.	**Description**	**DST-1**
vii.	Pump (RPM)	
viii.	Motor rating (kw) x RPM	
ix.	MOC of pump... Casing	
x.	MOC of pump... Impeller	
xi.	MOC of pump... Shaft	
xii.	ID inlet/ ID outlet size, mm	
4	**Duplex Filter**	
i.	Type & Make of filter	
ii.	Qty & Location	
iii.	Size of Particle removed by filter	
5	**Nozzles**	
i.	Type	
ii.	Make	
iii.	Spacing, mm	
iv.	MOC of nozzle body & its tip	
v.	Capacity range, lpm	
vi.	Range (Water pressure) at nozzle tip, kgf/cm^2	
6	Pipe Work/ Valves/ Fittings/ Solenoid Valve/ Header bar/ Nozzles etc per requirements provided [Yes/ No]	
7	Indian Standard followed for piping work etc	
8	Field instrumentation as per requirements included [Yes/ No]	
9	Pipe supports/ Supporting Structure/ etc. provided [Yes/ No]	
10	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-28	Dry Fog Dust Suppression System				
S No	**Description**	**DFDSS-1**	**DFDSS-2**	**DFDSS-3**	**DFDSS-4**
1	Do Dry Fog Dust Suppression System conform to the requirements of specifications [Yes/ No]				
2	Water Tank# WTK- 1C/ 2 / 3B / 4				
i.	Location/ Qty/ all the needed nozzles/ inlet/ outlet/ drain etc as per requirements provided... for water tank# WTK- 1C/ 2 / 3B / 4 [Yes/ No]				
ii.	Water holding Capacity of each tank, cum				

S-28	**Dry Fog Dust Suppression System**				
S No	**Description**	**DFDSS-1**	**DFDSS-2**	**DFDSS-3**	**DFDSS-4**
iii.	Type of construction of water tank				
3	Guaranteed dust level (Air cleanliness within 5m radius of application point).				
4	**Pump**				
i.	Designation no				
ii.	Location & Qty				
iii.	Duty				
iv.	Type & Make				
v.	Total Discharge Head, m(water column)				
vi.	Discharge capacity (m^3/hr)				
vii.	Pump (RPM)				
viii.	MOC of pump... Casing				
ix.	MOC of pump... Impeller				
x.	MOC of pump... Shaft				
xi.	ID inlet/ ID outlet size, mm				
xii.	Motor rating (kw) x RPM				
5	**Duplex Filter**				
i.	Type & Make of filter				
ii.	Qty & Location				
iii.	Size of Particle removed by filter				
6	**Nozzles**				
i.	Type				
ii.	Make				
iii.	MOC of nozzle body & its tip				
iv.	Capacity range (Water), lpm				
v.	Range (Water pressure) at nozzle tip, kgf/cm^2				
vi.	Capacity range (compressed air), cum/min				
vii.	Range (air pressure) at nozzle tip, kgf/cm^2				
7	**Air Compressor**				
i.	Type				
ii.	Make & Model no				

S-28	**Dry Fog Dust Suppression System**				
S No	**Description**	**DFDSS-1**	**DFDSS-2**	**DFDSS-3**	**DFDSS-4**
iii.	Qty & Location				
iv.	Free air delivery (m^3/min)				
v.	Delivery pressure, kg/cm^2				
vi.	Capacity of Air Receiver, cum				
vii.	Type of Lubrication system				
viii.	Type of cooling provided				
ix.	Motor rating (kw) x RPM				
x.	MOC [air compressor component]				
xi.	a) Housing b) Receiver c) Shaft d) Screw				
xii.	Weight of compressor set (including motor), kgf				
xiii.	Noise level, dB (A)				
8	Flow activation cum Regulating Station etc provided as per requirement of Tech Spec. (Yes/ No)				
9	Spray Headers / Nozzles etc per requirements provided [Yes/ No]				
10	Solenoid Valves/ Pressure Switch & Gauges/ Relief valves/ Sequence Timer etc of reputed & proven make provided (Yes/ No)				
11	Air & Water line filter provided for FARS [Yes/ no]				
12	Type & make of air filter [for FARS]				
13	Application of air filter[for FARS]				
14	Type & make of water line filter[for FARS]				
15	Application water line filter[for FARS]				
16	Total installed power, kw				
17	Break-up of Total installed power, kw				
18	Compressed air piping/ water piping including fittings/ valves/pipe supports etc. provided.				
19	Indian Standard followed for piping				

S-28	Dry Fog Dust Suppression System				
S No	**Description**	**DFDSS-1**	**DFDSS-2**	**DFDSS-3**	**DFDSS-4**
	work etc				
20	Field instrumentation as per requirements included [Yes/ No]				
21	Arrangement Drawing/ Catalogue enclosed [Yes/ No]				

S-29	Dust Extraction System including Bin Vent Filters for Coal Bunker	DE-1A	DE-1B
S.No	**Description**		
1	Does Dust Extraction System conform to the requirements of specifications [Yes/ No]		
2	Type		
3	Qty & Number		
4	Location for DE Unit		
5	Dust emission level in clean air exhaust from fan outlet (mg/Nm^3)		
6	Fan		
i.	Capacity, m3/hr		
ii.	Fan Speed, rpm		
iii.	Type & make		
iv.	Casing material & thk.		
v.	Impeller material & thk.		
vi.	Are the following accessories provided?		
	a. V-belt drive		
	b. Belt guard		
	c. Pair of slide rails		
	d. Common base frame		
	e. Vibration isolators (spring type)		
	f. Foundation bolts		
	g. Drain plug		
	h. Canvas connection		
	i. Motor, starter and other electricals		
	j. Any other accessories		

S-29	Dust Extraction System including Bin Vent Filters for Coal Bunker	DE-1A	DE-1B
vii	a. Motor kW x RPM		
	b. Static/total pressure(mmwg)		
	c. Power consumption (hp/kw)		
	d. Weight of fan unit , tonne		
7	Ducting & Suction Hood		
	a. Ducting Material / construction / thickness		
	b. Max. spacing of support for Ducting, m		
	c. Velocity through duct, m/sec		
	d. Material & thickness of Exhaust Ducting		
8	Damper as per requirement provided, Yes/No		
9	Bag filter Unit		
	a. Collecting efficiency (%)		
	b. Dust collecting hopper material & thk.		
	c. Effective Dust Holding Capacity,m^3		
	d. Type & Make		
	e. Air to cloth ratio, cum/ (m^2 x hr)		
	f. Bag material and its life in working hours		
	g. Overall size of filter unit (W x L x M) ,m x m x m		
	h. Weight of Unit, tonne		
9	Air compressor		
	a. Type & Make		
	b. Motor kW x RPM		
	c. Free air delivery (Nm^3/hr)		
	d. Power consumption (hp/kw)		
	e. Weight of air compressor unit , tonne		
	f. Reference to the arrangement drawing / catalogue enclosed		
10	Rotary feeder		
	a. Type & Make		
	b. Type of Drive Unit		
	c. Capacity, tph (Coal Dust)		
	d. Motor kW x RPM		
	e. Reference to the arrangement drawing / catalogue enclosed		

S-29	Dust Extraction System including Bin Vent Filters for Coal Bunker	DE-1A	DE-1B
11	Screw Conveyor		
	a. Type & Make		
	b. Type of Drive Unit		
	c. Capacity, tph (Coal Dust)		
	d. Motor kW x RPM		
	e. Reference to the arrangement drawing / catalogue enclosed		
12	Cowl and bird screen provided, Yes/No		
13	Reference to the flow scheme of DE system enclosed, Yes/No		
14	Arrangement Drawing/ Catalogue enclosed, Yes / No		
15	Do the Vent Filter conform to the Technical Spec. Yes/No	Vent Filter for Coal Bunker of Unit-10	
a.	Total Qty provided, No.		
b.	Location		
c.	Type & Make		
d.	Air to cloth ratio		
e.	Capacity, cum/hr.		
f.	Construction Details		
g.	MOC of Filter bag		
h.	MOC of Housing & its thk, mm		
16	Arrangement Drawing/ Catalogue enclosed, Yes / No		

S-30	**In Motion Weigh Bridge (IMWB)**		
S.No	**Description**	**IMWB-1A**	**IMWB-1B**
1	Does In Motion Weigh Bridge conform to the requirements of specifications [Yes/ No]		
2	Qty		
3	Gross Weighing Capacity, tonne		
4	Type & Make		
5	Range of Weighing speed (of rake), kmph		
6	Range of Non Weighing speed (of rake), kmph		
7	Suitable for type of wagons		
8	Type of Load Cells		
9	Weigh Bridge detail		
10	Rolling load that can pass over it (tonnes) with speed		
11	Type of Over speed indication		
12	Track Switches details		
13	Weighing Accuracy % (for each wagon)		
14	Weighing Accuracy % (for full rake)		
15	Resolution		
16	Details of Calibration System		
17	Detail of electronic console/ indicator		
18	Bi-directional weighing facility provided (Yes/No)		
19	Details of computer		
20	Detail of software/ report type		
21	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-31	**Tunnel ventilation System**							
S. No.	**Description**	**VS-1A**	**VS-1B**	**VS-1C**	**VS-1D**	**VS-2**	**VS-3A**	**VS-3B**
1	Does Tunnel Ventilation System conform to the requirements of specifications [Yes/ No]							
2	Number of system/ Location as per Tech Spec. provided [Yes/ No]							
3	No. of air changes per hr							
4	Supply air Fan							
a)	Fan room provided [Yes/ No]							
b)	Type of fan							
c)	Type of drive provided for fan							
d)	Make of fan							

S-31	**Tunnel ventilation System**							
S. No.	**Description**	**VS-1A**	**VS-1B**	**VS-1C**	**VS-1D**	**VS-2**	**VS-3A**	**VS-3B**
e)	Model number							
f)	Max. Capacity of fan considered, m^3/hr [qty as per requirement]							
g)	Casing/ Impeller material							
h)	Impeller Dia., mm x rpm							
i)	Total Installed power, KW							
j)	No of fans provided for the system							
k)	Static pressure, [mm,WC]							
l)	Total pressure, [mm,WC]							
m)	Noise level, dB							
n)	Drive unit/ v-belt/ guard/ pair of slide rails/ base frame/ vibration isolator/ fdn bolts/ other fan accessories etc [per sound engg practice included] [Yes/ No]							
o)	Motor/ starter/ other electricals etc [per sound engg practice included] [Yes/ No]							
p)	Catalogue/ drawing enclosed, [Yes/ No]							
5	Ducting							
a)	MOC/ thickness, mm							
b)	Type of section							
c)	Standard followed							
d)	Max Air velocity through duct, m/s							
6	Grills							
a)	MOC							
b)	Air velocity, m/s							
c)	Spacing (maximum), m							
7	Louvers							
a)	Type/ location/ MOC							
b)	Air velocity, m/s							
8	Filter							
a)	Catalogue/ drawing enclosed, [Yes/ No]							
b)	Type & make							
c)	MOC x no of plies							
d)	Efficiency of filter/ Particle size							

S-31	**Tunnel ventilation System**							
S. No.	**Description**	**VS-1A**	**VS-1B**	**VS-1C**	**VS-1D**	**VS-2**	**VS-3A**	**VS-3B**
	(micron)							
e)	Velocity through filter							
f)	Type of Dampers							
g)	Frame for filters with support provided [Yes/ No]							
h)	Duct support provided [Yes/ No]							
9	Power consumption for the system, kw							
10	Acoustic Enclosure/ Equal method to control & limit Noise level considered for the fan.							

S-32	**Unitary Type Pressure Ventilation System**	
S.No.	**Description**	
1	Does Unitary Type Pressure Ventilation System conform to the requirements of specifications [Yes/No]	
2	Make	
3	Type of System	
4	Location as per spec. provided	
5	Number of air changes per hr	
6	Air velocity ,m/s….filter face	
7	Air velocity ,m/s…fan outlet	
8	Air velocity ,m/s….air washer section	
9	Air velocity ,m/s…. ducting	
10	Air velocity ,m/s…. grills	
11	Positive pressure maintained within the area	
12	Type/ make/size of supply air fan	
13	Air intake cowl details	
14	Air filtration unit	
14.1	Type & make of Filter	
14.2	Material of construction of filter x no of plies	
14.3	Filter efficiency,%,/particle size	
14.4	Furnish Details of water spray system	
14.5	Details of water collecting trough	
14.6	Efficiency of Louvers	
	(i)At AC coarse (20 to 200 microns)	

	(ii)At AC fine test dust (1 to 70 microns)	
15	Type/capacity(lpm)/head,m(WC) of water pump	
16	Ducting	
16.1	Material & Thk, mm of ducting	
16.2	Furnish Indian Standard followed for ducting	
17	MOC of Grills	
17.1	Material & Thk, mm of grills	
17.2	Spacing of Grills, m (Max.)	
17.3	Furnish Indian Standard followed for grills	
18	Power Consumption, kw	
19	Total Installed Power, kw	

S-33	**Tunnel Ventilation System**				
S. No.	**Description**	**SP for WTC-1A /1B/JT's**	**SP for PCH-1**	**SP for stockpiles**	**SP for JT/s**
1	Do Sump Pump conform to the requirements of specifications [Yes/ No]				
2	Type & Model No				
3	Manufacturer				
4	Location				
5	Number				
6	Discharge Capacity (m^3/hr)				
7	Head (m)				
8	Type of mechanism for automatic starting/ stopping				
9	Type of strainer at impeller inlet provided?				
10	Sump level for starting/ stopping				
11	Type of lubrication				
12	Type of drive				
13	Piping, valve & accessories as specified provided, [Yes/ No]				
14	Grating over sump pit provided, [Yes/ No]				
15	Material of construction				
16	Casing				
17	Impeller				
18	Shaft				
19	Strainer				

S-33	**Tunnel Ventilation System**				
S. No.	**Description**	**SP for WTC-1A /1B/JT's**	**SP for PCH-1**	**SP for stockpiles**	**SP for JT/s**
20	Motor kw rating of each sump pump				
21	Arrangement Drawing / Catalogue enclosed? [Yes/ No]				

S-34	**COAL SAMPLING SYSTEM**		
A.0	**Technical Data**		
1	Designation No.	**CSU-1A**	**CSU-1B**
2	Does Coal Sampling System conform to the requirements of specifications -37 [Yes/No]		
3	Qty.	1	1
4	Make		
5	No of Stages		
6	Input material	Coal, (-)20mm	
7	Conv. No.	BC-7A	BC-7B
8	Belt width, mm X Tr. Angle	1600 X 35^0	1600 X 35^0
9	Coal flow rate per conveyor, tph	2002	2002
10	Belt Speed, m/s		
11	Run time, hrs [per system]		
12	Consignment size, tonne [per system]		
13	Total installed power [per system]		
14	Max consumed power [per system]		
15	Qty, kg of final sample collected in the run time given above		
A.1	**Primary Sampler**		
1	Designation No.	**PSC-1A**	**PSC-1B**
2	Qty.		
3	Type of sampler offered		
4	Make /model no		
5	Input material	Coal, (-)20mm	
6	Location/ conveyor No	BC-8A	BC-8B
7	No. of primary cuts per consignment [based on consignment size] as per ASTM i.e.no of increments		
8	No. of primary cuts/hr [per conveyor]		

S-34	**COAL SAMPLING SYSTEM**		
9	Qty. of sample per cut, kg		
10	Primary sample flow rate, kg/hr		
11	Description of M/C		
12	Size of Cutter opening, mm		
13	Is cutter opening adjustable?		
14	Whether no. of cuts per hour adjustable and its range		
15	Material of construction(MOC)		
i	MOC of cutter		
ii	MOC of cutter lips		
16	Installed Power, kw		
17	Type of motor		
18	Consumed Power, kw		
A.2	**Secondary Sampler**		
1	Designation No.	**SSC-1A**	**SSC-1B**
2	Qty. / Location		
3	Type of sampler offered		
4	Make /model no		
5	Input material		
6	No of secondary cuts /hr [its shall not be less than 6 times primary cuts / hr]		
7	Qty. of sample per cut, kg		
8	Sec sample flow rate, kg/hr		
9	Description of M/C		
10	Cutter opening, mm		
11	Is cutter opening adjustable?		
12	Whether no of cuts per hour adjustable and range		
13	Material of construction(MOC)		
i	MOC of cutter		
ii	MOC of cutter lips		
14	Installed Power, kw		
15	Type of motor		
16	Consumed Power, kw		
A.3	**Sample Crusher**		

S-34	**COAL SAMPLING SYSTEM**		
1	Designation No.	**SC-1A**	**SC-1B**
2	Qty.		
3	Type of crusher offered		
4	Make /model		
5	Input material		
6	Product size, mm		
7	Capacity, tph		
8	Is product size adjustable?		
9	Installed Power, kw		
10	Consumed Power, kw		
11	Type of Drive		
A.4	**Belt Feeder**		
1	Designation No.	**SBF-1A/1B**	**SBC-2A/2B**
2	Qty.	2	2
3	Type / Make		
4	Model no.		
5	Material handled		
6	C/C pulley , m (approx.) x lift,m		
7	Capacity, tph (Max)		
8	Range Capacity, tph		
9	Type of T.U device		
10	Belt width, mm & tr. Angle		
11	Belt speed , m/s and its range		
12	Idlers		
i	Type of tube / lubrication type		
ii	Tube O.D x thk, [mm x mm]		
iii	Type & size of bearing		
13	Pulley		
13.1	Head Pulley		
i	Dia. x Face Width x Shell thk (mm x mm x mm)		
ii	Bearing Type		
iii	Lagging Type, MOC & thk, mm		
13.2	Tail Pulley		

S-34	COAL SAMPLING SYSTEM		
i	Dia. x Face Width x Shell thk (mm x mm x mm)		
ii	Bearing Type		
iii	Lagging Type, MOC & thk, mm		
16	Belting		
i	Type		
ii	Duty		
iii	Rating		
iv	No of plies		
v	Cover thk Top x Bottom mm x mm		
vi	Cover grade		
17	Type of Drive motor		
18	Installed Power, kw		
19	Consumed Power, kw		
A.5	**Rejects Bucket Elevator**		
1	Designation No.	**BE-1A**	**BE-1B**
2	Qty.	1	1
3	Type		
4	I.S. followed for design		
5	Material handled		
6	Lift, m (approx.)		
7	Capacity, tph (Max)		
8	Belt width, mm		
9	Belt speed, m/s		
10	Belting		
i	Type x Duty x Rating x No. of Ply.		
ii	Cover thk, Pulley side/bucket side, mm x mm		
iii	Cover grade		
11	Bucket		
i	Type / MOC / Thk, mm		
ii	Capacity, liter		
12	Pulley		
12.1	Boot Pulley		
i	Dia x Face Width x Shell thk (mm x mm x mm)		

S-34	**COAL SAMPLING SYSTEM**		
ii	Lagging Type, MOC & thk, mm		
12.2	Drive Pulley		
i	Dia. x Face Width x Shell thk (mm x mm x mm)		
ii	Lagging Type, MOC & thk, mm		
13	Installed Power, kw		
14	Consumed Power, kw		
A.6	**Rotary Sample Collector**		
1	Designation No.	**RSC-1A**	**RSC-1B**
2	Qty.	1	1
3	Type		
4	Make		
5	Input Material		
6	Sample collection Capacity, kg		
7	No of stations(each)		
8	Recommended RPM		
9	Is RPM adjustable		
10	Range of RPM		
11	No. of cans furnished per M/C		
12	Sample Holding capacity of one can, kg		
13	MOC of can		
14	Installed Power, kw		
15	Consumed Power, kw		
A.7	**Chute Work**	**Sample Carrying chute work**	**Rejects Carrying chute work**
1	Material and thk of parent plate		
2	Sloping angle of chute with horizontal, degrees		
3	Material & thk of gasket		
4	Radius considered, mm		

S-35	Air Conditioning Unit	
S.No.	**Description**	**AC**
1	Does Air Conditioning Unit conform to the requirements of specifications [Yes/No]	
2	Locations as per spec. considered [Yes/ No]	
3	Make	
4	Type of A.C Unit provided	
5	Capacity, TR	
6	Type of Refrigerant and other consumables	
7	Type of Compressor	
8	Type of Air handling fan	
9	Cooling thermostat range, degree	
10	Arrangement provided for noiseless operation of A.C. Unit	
11	Power Consumption, kw	
12	Installed Power, kw	
13	Wt. of one A.C. unit, kgf	
14	Reference catalogue provided (Yes / No)	

S-36	Exhaust Fans			
S.No.	**Description**	**Battery Room**	**Pump House**	**Toilet**
1	Does Exhaust Fan conform to the requirements of specifications [Yes/No]			
2	Make			
3	Type of fan			
4	No. of Exhaust fan provided			
5	Fan size, mm (Φ)			
6	Fan RPM			
7	Number of air changes per hr			
8	Material & Thk, mm of fan blade			
9	Back draft shutter, bird screen provided (Yes / No)			
10	Whether protected from rain water (Yes / No)			
11	Any special technical features			
12	Installed Power, kw			
13	Wt. of one Exhaust fan, kgf			
14	Reference catalogue provided (Yes / No)			

S-37	**Bulldozer**	
S. No.	**Description**	**Bulldozer**
1	Does Bulldozer conform to the requirements of specifications [Yes/ No]	
2	Type offered [tyre or crawler mounted]	
3	Make & Model no	
4	Qty, no	
5	Coal blade size, mm [L] x mm [H]	
6	Coal blade capacity, cum	
7	Technical features of machine as per spec provided [Yes/ No]	
8	Minimum net Power as per ISO: 9249, kw	
9	Spares as per spec included under supply	
10	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-38	**Elevator (Passenger cum Goods Lift)**		
S. No.	**Description**	**EL-1**	**EL-2/3**
1	Do Elevator conform to the requirements of specifications [Yes/ No]		
2	Type of Elevator		
3	Type of service		
4	Make & Model Number		
5	Qty/ Location		
6	Total travel (Approx.), m		
7	Carrying capacity (Payload), kgf		
8	Carrying capacity (no. of passenger)		
9	Car travel speed, m/min		
10	Necessary Safety Devices/ Alarm/ Lighting etc. incorporated in M/c		
11	Cab Floor size (L x W x H), mm x mm x mm		
12	Anti Skid Flooring provided (for cab)		
13	Total Installed Power (kw)		
14	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-39	Belt Sealing Arrangement for coal bunkers	
S. No.	**Description**	**BSA**
1	Do Belt Sealing Arrangement conform to the requirements of specifications [Yes/ No]	
2	Type	
3	Manufacturer	
4	Location	
5	Number	
6	Belt Type & make and its rating	
7	Belt Width (mm)	
8	No. of Plies	
9	Material of cover & cover grade	
10	Cover thickness (mm) Top/ Bottom	
11	Grating in slot opening[Below Bunker Sealing Belt] provided, [Yes/ No]	
12	Material of Construction of grating	
13	Clear Opening size of bunker slot opening, mm	
14	Edge protection angle/ channel for bunker slot opening provided, [Yes/ No]	
15	Clear Opening size in grating, mm	

S-40	Potable Water & Service Water System	
A.0	**Potable Water System**	
S. No	**Description**	**PW**
1	Does Potable Water conform to the requirements of specifications [Yes/ No]	
2	Over Head PVC Tank	
i.	Number / Location / Type of tank as per Tech Spec. provided, [Yes/ No]	
ii.	PW tank Capacity, litres	
3	Tap points	
i.	Number of tap points as per Tech Spec. provided [Yes/ No]	
ii.	Suspended Solid Particle Filter & RO purifier at each tap point provided [Yes/ No]	
iii.	Particle size separation by filter (microns)	
4	Type & Make of RO Purifier Unit	

B.0	**Service Water System**	
S. No	**Description**	**SW**
1	Does Service Water conform to the requirements of specifications [Yes/ No]	
2	Number & location of tap points as per Tech Spec. provided [Yes/ No]	
3	Quick release coupling / valves / hose at every tap point (as per spec.) provided [Yes/ No]	
4	Flow at each tap point, m^3/hr	
5	Minimum discharge pressure, kg/cm^2	
6	Length of hose pipe considered for bldg.	
7	Length of hose pipe considered for conv. tunnel/gallery	

SCHEDULE: MILL REJECT HANDLING SYSTEM

Sr. No.	Item	Units	Description
1.0	**MILL REJECT SYSTEM**		
a.	Max Lump size of mill rejects	Mm	
b.	Max Rate of Rejects Genrated per mil	TPH	
c.	Total No. of Coal Mills per unit	Nos.	
d.	Temperature of Mill Rejects	Deg C	
e.	Srorage Required for mill rejects	Nos.	
f.	Bulk Density of mill rejects		
	i) for volume considerations	T/m3	
	ii) for structural considerations	T/m3	
g.	Design Extraction rate of mill rejects from pyrite hopper		
h.	Mill reject conveying capacity Impeller	TPH	
2.0	**MILL REJECT HANDLING VALVES**		
a.	Type		
b.	Material of construction		
	i) Body		
	ii) Plate/ Disc		
	iii) Seat		
	iv) Method of operation		
3.0	**MILL REJECT VESSEL**		
a.	Location/ Quantity		
b.	Type		
c.	Material of Construction		
d.	Conveying Pipes		
e.	Bends/ Fittings/ Laterals		
4.0	**MILL REJECT STORAGE SILOS**		
a.	Quantity		
b.	Construction		
c.	Type of level measurementand indicator		
5.0	**AIR COMPRESSOR**		
a.	Type		
b.	Service		
c.	Cooling		
d.	Quantity		
	For other technical details of screw compressor refer Chapter 23 Volume III		
6.0	**BAG FILTER**		
a.	Location/ Quantity		
b.	Type		
c.	Material of Bags		
d.	Air to cloth ratio	m/min	
e.	Conveying air piping		

ASH HANDLING SYSTEM

1.0	**Bottom Ash Hopper**		
1.1	Quantity	:	
1.2	Type	:	
1.3	Overall size (LxBxH) (Meters)	:	
1.4	Effective ash storage capacity	:	
1.5	Size of hopper outlet (M)	:	
1.6	Material of Construction and thickness	:	
	a) Hopper plate	:	
	b) Refractory holding anchors	:	
2.0	**Hopper Refractory**		
2.1	Thickness (mm) (side walls/sloping)	:	
2.2	Type and materials (side/sloping)	:	
3.0	**Hopper Access Door/Panel**		
3.1	Quantity	:	
3.2	Material of construction	:	
3.3	Size (LxB) (Meters)	:	
3.4	Fixing arrangement	:	
3.5	Is door refractory lined?	:	Yes/No
4.0	**Poke Doors**		
4.1	Quantity	:	
4.2	Type	:	
4.3	Size	:	
5.0	**Inspection Windows**		
5.1	Quantity	:	
5.2	Type	:	
5.3	Size	:	
5.4	Material of construction:		
	a) Frame	:	
	b) Window glass	:	
	c) Flushing nozzles	:	
6.0	**Seal Trough**		
6.1	Material of construction and thickness	:	
	Trough	:	

	Set stops	:
	Flushing nozzles/nozzle tips	:
6.2	Quantity and size of connections for	:
	a) Drain	:
	b) Flushing	:
	c) Make up	:
6.3	Number, type of set stops and supports	:
7.0	**Hopper Flushing Header**	
7.1	Quantity per unit	:
7.2	Type and material of construction for nozzle tips.	:
7.3	Nozzles arrangement attachment (Fixed/Replaceable)	:
7.4	Quantity of access ladders for poke door/inspection window provided.	:
7.5	Operation cycle of flushing nozzle	:
8.0	**Hopper Overflow**	
8.1	Quantity and type	:
	a) Louvers	:
	b) Overflow seal box	:
8.2	Quantity and size of over-flow box discharge pipe to plant drainage.	:
8.3	Material of construction	:
	a) Overflow louvers	:
	b) Overflow seal box	:
	c) Connected piping	:
9.0	**Hopper Fill Connection**	
9.1	Number and size	:
9.2	Material of construction	:
10.0	**Feed Gate Assembly**	
10.1	Quantity	:
10.2	Size of gate opening	:

10.3	Material and thickness	:	
	a) Replaceable wear strips	:	
	b) Gate	:	
	c) Housing	:	
10.4	Gate operation method	:	
10.5	Flushing nozzles material/hardness	:	
11.0	**Air water converter**		
11.1	Quantity	:	
11.2	Type of operation	:	
11.4	Size	:	
11.5	Material of construction	:	
12.0	**Clinker Grinder**		
12.1	Quantity	:	
12.2	Removal capacity of clinker grinder	:	
12.3	No. of rolls per grinder	:	
12.4	Type of grinder drive and speed	:	
12.5	Number and type of bearings per roll	:	
12.6	Seal water quantity required for each grinder (M^3/hr)	:	
12.7	Material of Construction	:	
	a) Housing	:	
	b) Rolls	:	
	c) Roll teeth	:	
	d) Roll Shaft	:	
	e) Shaft sleeve	:	
	f) Wear plates	:	
	g) Sprocket	:	
12.8	Operating speed	:	
12.9	Motor rating	:	
12.10	Power consumption at motor terminals (kW)	:	
13.0	**Jet Pump**		
13.2	Quantity	:	
13.3	Type and size & make		:
13.4	Ash removal capacity (Tonnes/hr)	:	
13.5	Water requirement quantity	:	

	(cum/hr) and pressure (MWC)		
13.6	Quantity and type of jetting nozzles	:	
13.7	Material of construction	:	
	a) Inlet piece	:	
	b) Nozzle body	:	
	c) Nozzle tips	:	
	d) Throat	:	
	e) Tail Piece	:	
13.8	Feed sump - Size, Material and Thickness	:	
13.9	Minimum guaranteed life of throat and nozzles.	:	
14.0	**Wetting Head**		
14.1	Quantity	:	
14.2	Type, size & make	:	
14.3	Capacity (TPH)	:	
14.4	Operating fluid quantity and pressure	:	
14.5	Material of construction	:	
15.0	**Expansion Joints**		
15.1	Type and size	:	
15.2	Make	:	
15.3	Quantity	:	
15.4	Material of construction	:	
	a) Bellow	:	
	b) Flange	:	
	c) Sleeve	:	
16.0	**Fly Ash Extraction Valves**		
16.1	Quantity	:	
16.2	Type and size & make		:
16.3	Method of valve operation	:	
16.4	Are worn out parts easily replaceable?	:	Yes/No
16.5	Air quantity and pressure needed for valve operation	:	

	(Nm3/hr & MWC)		
16.6	Materials construction and hardness (BHN)		
	a) Body	:	
	b) Valve seat	:	
	c) Valve outlet	:	
	d) Slide gate	:	
17.0	**Branch Air Intake Valves**		
17.1	Quantity	:	
17.2	Type, size and make	:	
17.3	Materials of construction		
	a) Body	:	
	b) Flap/disc	:	
18.0	**Branch Isolation Valves**		
18.1	Quantity	:	
18.2	Type and size & make		:
18.3	Method of valve operation	:	
18.4	Quantity, type and make of limit switch	:	
18.5	Type and connections	:	
18.6	Valve working pressure (MWC)	:	
18.8	Construction materials & hardness		
	a) Body	:	
	b) Slide gate	:	
19.0	**Vacuum Breaker**		
19.1	Quantity	:	
19.2	Type and size & make		:
19.3	Method of valve operation	:	
19.4	Materials of construction and hardness (BHN)		
	a) Body	:	
	b) Slide gate	:	
20.0	**Vacuum Pumps**		
20.1	Quantity (Number of pumps, operating/standby)	:	
20.3	Type	:	
20.4	Capacity and head	:	

20.5	Number of stages	:
20.6	Power required at motor input terminals at rated capacity & head	:
20.7	Maximum power required at any point on the characteristic curve	:
20.8	Motor rating (kW)	:
20.9	Water requirement for liquid ring exhauster (quantity and head)	:
20.10	Efficiency of exhauster	:
20.11	Materials of construction and hardness (BHN)	:
	a) Casing	:
	b) Shaft	:
	c) Impeller	:
	d) Shaft sleeve	:
	e) Nuts & Bolts	:
	f) Belts	:
20.12	Type of drive	:
20.13	Selected Exhauster speed	:
21.0	**Fluidizing Pads**	
21.1	Quantity	:
21.2	Size	:
21.3	Materials of construction	
	a) Frame work	:
	b) Element	:
21.4	Air quantity needed per pad (NM3/hr) and pressure (MWC)	:
22.0	**Buffer Hoppers**	:
22.1	Quantity	:
22.2	Type	:
22.3	Effective ash removal capacity (tonnes)	:
22.4	Are needed pressure & vacuum relief valves are provided ?	:
22.5	Are needed gates are provided?	:
22.6	Efficiency of dust collection	:

22.7	Material of construction & thickness	:				
23.0	**Ash Vessel**	:				
23.1	Quantity	:				
23.2	Type	:				
23.3	Location & size	:				
23.4	Effective ash removal capacity (tonnes)	:				
23.5	Are needed pressure relief valves provided ?	:				
23.6	Are needed valves are provided ?	:				
23.7	Material of construction hardness & thickness:					
	a) Body	:				
	b) Inlet segment	:				
	c) Wear segment	:				
24.0	**Knife Gate Valves**					
24.1	Quantity	:				
24.2	Type and size	:				
24.3	Method of valve operation	:				
24.4	Air quantity and pressure needed for valve operation (Nm3/hr & MWC)	:				
24.5	Materials construction and hardness (BHN)					
	a) Body	:				
	b) Slide plate	:				
25.0	**Ash Duty Valves**		Ash intake	Ash discharge	Air intake	Air vent
25.1	Type	:				
25.2	Nos. offered	:				
25.3	Size	:				
25.4	Flow rating	:				
25.5	Pressure rating	:				
25.6	Type of jointing with pipe	:				

25.7	Actuators for remote operation	:
25.8	Actuators make and type	:
25.9	Quantity of air reqd. for each valve	:
25.10	Pressure of air reqd (kg/cm^2 (g)	:
25.11	Material of construction	:
25.11.1	Valve body	:
25.11.2	Gate	:
25.11.3	Seat	:
25.11.4	Gland	:
25.11.5	Packing	:
26.0	**Fly Ash Storage Silos**	:
26.1	Quantity	:
26.2	Effective storage capacity (M^3)	:
26.3	Overall size (Dia x Ht.)	:
26.4	Quantity and location of access ladders	:
26.5	Density of ash considered for storage calculations	:
26.6	List of accessories mounted on the silo	:
26.7	MOC of casing and hopper	
27.0	**Rotary Feeder**	:
27.1	Quantity	:
27.2	Type & size & make	:
27.3	Removal Capacity (tonnes/hr)	:
27.4	Material of construction & thickness	:
	a) Body	:
	b) Shoe	:
	c) Rotor	:
	d) Shaft	:
27.5	Speed of rotary feeder	:
28.0	**Ash Conditioner**	
28.1	Quantity	:
28.2	Type & size	:
28.3	Removal Capacity (tones/hr)	:

28.4	Material of construction & thickness		:			
	a)	Body	:			
	b)	Blades	:			
	c)	Discharge chute	:			
	d)	Suppressor	:			
	e)	Nozzle body & tip	:			
29.0	**Silo Vent Filter**		**:**			
29.1	Type of Vent Filter		:			
29.2	Quantity		:			
29.3	Make		:			
29.4	Location		:			
29.5	Designed standard		:			
	a)	Air Flow Capacity (M^3/ hr)	:			
	b)	Maximum ash content of the air coming out from the vent filter (mg/NM^3)	:			
29.6	Material of construction					
	a)	Body	:			
	b)	Filter element	:			
29.7	Filtering area of bags (M^2)		:			
29.8	Net cloth to air ratio		:			
29.9	Cleaning arrangement of bags		:			
29.10	Motive force to clean vent filter		:			
29.11	In case of compressed air used for cleaning of filter		:			
	i)	Quantity of air	:			
	ii)	Quantity of air per vent filter (M^3/hr.)	:			
	iii)	Pressure of compressed air (kg/cm^2 (g))	:			
30.0	**Fluidizing Blowers**		**:**	**ESP**	**Conveying**	**Silo**
30.1	Quantity (Working+Standby)					
30.2	Make & Type		:			
30.3	Capacity & discharge pressure		:			

	(cu.m/hr & MWC)				
30.4	Materials of construction				
	a) Casing	:			
	b) Sliding vanes (Rotor)	:			
	c) Shaft	:			
	d) Bearings	:			
	e) Suction filter	:			
30.5	Overall dimensions of blower unit with drives	:			
30.6	Blower BHP (KW)	:			
30.7	Motor rating (KW)	:			
31.0	**Air Slides:**				
31.1	Quantity	:			
31.2	Size	:			
31.3	Materials of construction				
	a) Frame work	:			
	b) Element	:			
31.4	Air quantity needed (NM^3/hr) and pressure (MWC)	:			
32.0	**Fluidizing Air Heaters**	**:**	**ESP**		**Silo**
32.1	Quantity	:			
32.2	Make & type	:			
32.3	Capacity (KW rating)	:			
32.4	Construction materials	:			
32.5	Overall dimensions (mm)	:			
32.6	Are heaters provided with thermostats and other needed controls as specified ?	:	Yes/No		
33.0	**Flushing Apparatus**				
33.1	Quantity	:			
33.2	Capacity	:			
33.3	Materials of construction				
	a) Body	:			
	b) Nozzle	:			
34.0	**Collector Tanks**				
34.1	Quantity per unit	:			
34.2	Type and size	:			

34.3	Quantity of replaceable liners/ impingement plate	:
34.4	Size and type of slurry inlet connection	:
34.5	Size and type of slurry outlet connection	:
34.6	Materials of construction and thickness :	
	a) Tank shell	:
	b) Liners	:
	c) Impingement plate	:
35.0	**Pumps** (Bidder shall fill in the data for each type of pump)	
35.1	Manufacturer	:
35.2	Number of pumps offered	:
35.3	Number of pumps operating	:
35.4	Number of pumps standby	:
35.5	Number of pumps connected in series (as applicable)	:
35.6	Type of pumps and Model Number	:
35.7	*Rated capacity (cum/hr)	:
35.8	*Total dynamic head (TDH), MWC at rated capacity	:
35.9	Type of suction (flooded/ suction lift)	:
35.10	Shut-off head, MWC/MLC (as applicable)	:
35.11	Number of stages	:
35.12	Pump internal losses (MWC/MLC)	:
35.13	*Efficiency at rated capacity	:
35.14	Tolerance on (+)% efficiency	:
35.15	Pump input power at rated capacity and head (KW)	:
35.16	Power required at motor input terminals at rated capacity and head (KW)	:
35.17	Power required at shut-off head (KW)	:

35.18	Motor rating (KW)	:	
35.19	Max. power required at any point on characteristic curve (KW)	:	
35.20	Pump Speed (RPM) (rated/maximum/minimum)	:	
35.21	Materials of Construction (specify hardness BHN of each item along with materials)	:	
35.21.1	Pump casing (shell)		:
35.21.2	Impeller	:	
35.21.3	Discharge flange		:
35.21.4	Base plate/Skirt base		:
35.21.5	Wearing rings (Impeller/casing)	:	
35.21.6	Casing liners	:	
35.21.7	Suction sleeve	:	
35.21.8	Impeller nuts	:	
35.21.9	Shaft units	:	
35.21.10	Couplings	:	
35.21.11	Bolts and nuts at corrosive location	:	
35.21.12	Bolts and nuts at other locations	:	
35.21.13	Shaft	:	
35.21.14	Bushings	:	
35.21.15	Stuffing boxes	:	

1.0	**AIR COMPRESSORS**			**:**
1.1	a.	Quantity (Working+Standby)		:
	b.	Capacity of each compressor (Nm^3/min)		:
	c.	Capacity considering design ambient conditions (free air discharge FAD) (cum/min)		:
1.2	a.	Discharge pressure at compressor HP outletkg/cm^2(g)		:
	b.	Discharge pressure at ADP outlet (kg/cm^2g)		:

1.3	a.	Air temperature at outlet of high pressure stage of compressor at design capacity (°C)	:
	b.	Air temperature at outlet of after cooler (°C)	:
	c.	Air temperature at outlet of ADP (°C)	:
1.4	a.	kW input required at the compressor shaft at fully loaded design condition	:
	b.	kW input required at the compressor shaft at fully unloaded condition	:
	c.	Guaranteed power consumption at motor input terminals at rated conditions (i.e. without any tolerance)	:
	d.	kW rating of drive motor	:
1.5	a.	Drive motor speed (rpm)	:
	b.	Compressor speed (rpm)	:
1.6	Material of construction		
	a.	Compressor chamber	:
	b.	Rotors	:
	c.	Inlet throttle valve	:
	d.	Housing of valve	:
	e.	Timing gears	:
1.7	Maximum weight to handled/lifted during erection and during maintenance		:
1.8	Cooling water required for air compressor		:
	a.	Quantity at 36°C	:
	b.	Cooling water outlet temp °C	:
	c.	Cooling water pressure, kg/cm^{2}g required at inlet - max/min	:
	d.	Cooling water pressure	:

	drop across jackets (kg/cm^2g)		
1.9	Companion flanges, bolts, nuts, and gaskets furnished ?	:	Yes/No
1.11	Intake Air Filter cum Silencer	:	
1.12	Intercooler, After cooler & ADP	:	
2.0	**Air drying unit**		
2.1	Type	:	
2.2	Design air flow at plant inlet Nm^3/min	:	
2.3	Inlet and outlet air temperature °C	:	
2.4	Inlet and outlet air pressure $kg/cm^2(g)$	:	
2.5	Relative humidity	:	
2.6	Pressure drop through drier assembly at maximum flow	:	$kg/cm^2(g)$
2.7	Guaranteed dew point at the outlet throughout the operating cycle at 1 kg/cm^2	:	
	a. Referred to pressure condition	:	
	b. Referred to atmospheric condition	:	
2.8	Net air flow to the dryer	:	
2.9	Electrical connections required	:	
2.10	Power consumption	:	
3.0	**Air Receiver**	:	
3.1	Total No. furnished	:	
3.2	Design standards/codes	:	
3.3	Design pressure, kg/cm^2 (g)	:	
3.4	Water capacity each M^3	:	
3.5	Dimension & weight	:	
3.6	Diameter, mm	:	
3.7	Height/Length of straight shell (mm)	:	
3.8	Shell and Dish end thickness (mm)	:	
3.9	Material of construction	:	
	i) Shell	:	
	ii) Dished end	:	

FUEL OIL SYSTEM

S. No.	Description	Unit	Parameter	
1.0	**FUEL OIL SYSTEM**			
1.1	Oil Pumps		**Light Oil**	**Drain Oil**
	a) Type, make, quantity			
	b) Flow	lpm		
	c) Discharge pressure	kg/cm^{2}g		
	d) Impeller material			
	e) Shaft material			
	f) Motor rating	kW		
1.2	Oil Tanks		**Light Oil**	**Drain Oil**
	a) Type, Number & capacity of each			
	b) List accessories provided			
	c) Overall dimensions (diameter x height of each tank)			
	d) Oil heating arrangement:			
	i) Media for heating			
	ii) Type			
	iii) Surface area provided			
	e) Thermal insulation & cladding details			
1.3	Fuel Oil Suction Heaters			
	a) Quantity, type			
	b) Heat transfer area	Sq.M		
	c) Operating data:			
	i) Flow	kg/hr		
	ii) Operating pressure	kg/cm^{2}g		

COMPRESSED AIR SYSTEM

			Service Air	Instrument Air
1.0	**Air Compressors**			
1.1	Quantity (Working and Standby)	:		
1.2	Type	:		
1.3	Capacity	:		
1.4	Material of Construction			
	a. Compressor chamber	:		
	b. Rotor	:		
	c. Timing gears	:		
	d. Inlet throttle valve & housing	:		
	e. Shaft seals	:		
	f. Unloading cylinder header	:		
	g. Water separator	:		
	h. Non return valves	:		
	i. Blow off valve	:		
	j. Safety valve	:		
	k. Tube of blow off cooler	:		
	l. Cooler casing	:		
	m. Gear box casing	:		
	n. Gears	:		
	o. Bearings	:		
	p. Shaft seals	:		

			Service Air	Instrument Air
2.0	**Air Receiver**			
2.1	Quantity	:		
2.2	Type	:		
2.3	Water capacity	:		
2.4	Material of construction	:		

2.5	Safety relief valves	:
2.6	Automatic drain trap	:
2.7	Standard	:
3.0	**Air Drying Plant**	
3.1	Quantity	:
3.2	Capacity	:
3.3	Type	:

FIRE PROTECTION & DETECTION SYSTEM

S No	Item Description	
A	**Hydrant & Spray System**	
1	**Hydrant and Spray Pumps**	
	For Hydrant	
	No. of Pumps & Rated capacity	
	Total discharge head and total dynamic head	
	Motor/Diesel engine rating	
	Construction materials:	
	a) Impeller	
	b) Casing	
	c) Shaft	
	Diesel engine:	
	a) No. of cylinders	
	b) Rated speed	
	c) Number of strokes	
	d) List of accessories provided	
	e) material of construction of various components	
	For Spray System	
	No. of Pumps & Rated capacity	
	Total discharge head and total dynamic head	
	Motor/Diesel engine rating	
	Construction materials:	
	a) Impeller	
	b) Casing	
	c) Shaft	
	Diesel engine:	
	a) No. of cylinders	
	b) Rated speed	

S No	Item Description	
	c) Number of strokes	
	d) List of accessories provided	
	e) material of construction of various components	
	Jockey Pumps	
	No. of Pumps & Rated capacity	
	Total discharge head and total dynamic head	
	Motor rating	
	Construction materials:	
	a) Impeller	
	b) Casing	
	c) Shaft	
2	**Pipes & Fittings**	
	Pipes (Make & Type)	
	Fittings (Make & Type)	
3	**Hydrant Valves (Make)**	
	Type	
	Code/Standard	
	Material of Construction	
	Body, Stop Valve, Spindle & Seat	
4	**Water Monitors (Make)**	
	Type	
	Code/Standard	
	Flow	
	Rotation of Body	
	Horizontal	
	Vertical	
	Throw of Monitor	
	Horizontal	
	Vertical	

S No	Item Description	
	Material of Construction	
	Base Flange	
	Reducer	
	Water Nozzle	
5	**Fire Hose for Internal and Outdoor Hydrants (Make)**	
	Type	
	Code/Standard	
	Weight	
	Coil Diameter	
6	**Fire Hose for First Aid Protection System (Make)**	
	Type	
	Code/Standard	
7	**Branch Pipe & Nozzle (Make)**	
	Type	
	Code/Standard	
	Material of construction	
	Branch pipe	
	Nozzle	
8	**Hose Cabinet** (Make & Type)	
	Material of construction	
	Size	
	Mounting	
9	**Strainer (Make)**	
	Type	
	Material of Construction	
	Body	
	Internal	
10	**Valves**	
	Gate Valves (Make)	

S No	Item Description	
	Code/Standard	
	Material of Construction	
	Body, Trim ,Disc and bonnet cover	
	Stem	
11	**Butterfly Valve (Make)**	
	Size Range	
	Type & Code/Standard	
	Rating	
	End Connection	
	Operating Condition	
	Working Pressure	
	Working Temperature	
	Service	
	Material of Construction	
	Body & Disc	
	Shaft	
	Seat Rings	
12	**Deluge Valve (Make)**	
	Type	
	Code/Standard	
	Material of Construction	
	Body	
	Valve Internal	
13	**Spray Nozzles (Make)**	
	Type	
	Discharge Angle	
	K-Factor	
	Flow Rate	
	Material of Construction	
	Body & Insert	
14	**QB Detectors/Sprinklers (Make)**	

S No	Item Description	
	Type	
	Operating Temperature	
	Material of Construction	
	Frame	
	Bulb	
	Deflector	
	Cap	
	Seal	
	Working Pressure	
B	**Fire Detection & Alarm System**	
1	**Fire Alarm Panel (Make)**	
	Type	
	Loop Capacity	
	Input power	
	Output Power	
	Battery Charger range	
	Listing	
2	**Linear Heat Sensing Cable (Make)**	
	Type	
	Operating Voltage	
	Ambient Temperature	
	Operating Temperature	
	Cable Optical Parameter	
	Listing	
3	**Infra red Detectors (Make)**	
	Type	
	Operating Voltage	
	Ambient Temperature	
	Temperature Range	
	Nominal Response Time	
	Sensitivity	

S No	Item Description	
	Enclosure	
	Mounting	
	Quiescent Current	
	Alarm Current	
	Spectral Response	
	Half Power Cone Vision	
	Listing	
4	**Smoke Detectors (Make)**	
	Type	
	Operating Voltage	
	Ambient Temperature	
	Temperature Range	
	Nominal Response Time	
	Sensitivity	
	Enclosure	
	Mounting	
	Quiescent Current	
	Alarm Current	
	Listing	
14	Gun Metal Valve	
14.1	Make	
14.2	MOC	
•	Body	
•	Internal	
15	CI Check Valve	
15.1	Make	
15.2	MOC	
•	Body	
•	Internal	

AIR CONDITIONING & VENTILATION SYSTEM

S No	Description	Unit	Parameter		
			Main Control rooms	ESP control rooms	Other areas
1.0	**AIR CONDITIONING SYSTEM**				
1.1	Air-conditioning plant load condensing unit	(TR)			
a)	Make, model, Qty.				
b)	Refrigerant used				
c)	Tube material				
d)	List accessories provided				
1.2	Compressor unit				
a)	Make, model, Qty., Type, Method of starting.				
b)	Operating speed	(rpm)			
c)	Suction/condensing temp	(°C)			
d)	Capacity at operating conditions				
e)	Motor rating	(kW)			
f)	List accessories provided				
g)	Construction material				
1.3	Cooling tower				
a)	Qty., type, make				
b)	Number of cells:				
i)	Operating				
ii)	Standby				
c)	Cooling water flow	cum/hr			

S No	Description	Unit	Parameter		
			Main Control rooms	**ESP control rooms**	**Other areas**
d)	Approach temp.	(°C)			
e)	Cooling range	(°C)			
1.4	Air handling unit:				
a)	Type, make, quantity				
b)	Supply air fan parameter (static pressure and capacity)				
c)	Supply air motor rating				
d)	Cooling coil details:				
i)	Air quantity				
ii)	Face area				
1.5	Water Pumps		**Chilled water for A/C system**	**Condenser cooling**	**Evaporative cooling**
a)	Quantity, type, make				
b)	Capacity	cum/hr			
c)	Discharge pressure	kg/cm^2			
d)	Motor rating	kW			
e)	Construction materials:				
i)	Casing				
ii)	Impeller				
iii)	Shaft				
1.6	Filters		**Metallic**		**Dry fabric**
a)	Type, make, quantity				
b)	Rating	Nm^3/hr			
c)	Filter media				

S No	Description	Unit	Parameter		
			Main Control rooms	ESP control rooms	Other areas
d)	Efficiency and face velocity				
1.7	Fresh air assembly				
a)	Fan type, quantity & type				
b)	Capacity	cum/hr			
c)	Static pressure	mmwc			
d)	Speed	rpm			
1.8	Air distribution system				
a)	Ducting granting (gauge thickness wise material)				
b)	Supply air diffusers Qty., material				
c)	Return air diffusers Qty., material				
d)	Supply air grilles				
e)	Accoustic insulation				
1.9	Pipe work valves, specialities, instruments (list size, type, material, quantity for each system)				
1.10	Thermal insulation (List type, material, quantity for each system)				
1.11	Air washer:				
a)	Make, type, quantity				
b)	Number & material of spray/ flooding nozzles				
c)	List accessories provided				

S No	Description	Unit	Parameter		
			Main Control rooms	ESP control rooms	Other areas
d)	Air washer sump capacity				
e)	Number, size, thickness of spray header pipes				
1.12	**Ventilation System**		**Roof Extractors**	**Supply air fan**	**Exhaust fan**
a)	Type, Quantity, make & size				
b)	Location				
c)	Motor rating	kW			
2.0	**VENTILATION SYSTEM**				
2.1	Type of ventilation system as per spec provided	Yes/No			
2.2	Tunnel ventilation (VS-1/2)				
i)	Air changes per hour (guaranteed)				
ii)	Type & make of supply air fan				
iii)	Type & make of exhaust air fan				
iv)	Type of filter x its efficiency x standard				
v)	Material of construction of ducting x standard				
vi)	Material of construction of grills				
vii)	Air velocity units kept as per spec.	Yes/No			
2.3	Unitary type pressure ventilation in areas as per spec. provided	Yes/No			
2.4	Unitary type pressure				

S No	Description	Unit	Parameter		
			Main Control rooms	ESP control rooms	Other areas
	ventilation system:				
i)	Guaranteed number of air changes per hour				
ii)	Positive pressure (min.) maintained in the area (guaranteed)	Yes/No			
iii)	Type & make of fan				
iv)	Louvers/filter/ water spray system/ ducting/grills etc. as per spec. provided	Yes/No			
v)	Air velocity limits kept as per spec.	Yes/No			
2.5	Ventilation System: (Furnish Air changes considered per hour for the following areas):				
i)	Building (for DS system – chemical tank/ mixing/ metering pumps etc. for WT hopper complex)				
ii)	Battery Rooms				
iii)	Transfer Points				
iv)	Crusher house				
v)	Bunker floor area				
2.6	Ceiling fan with electronic regulators provided to suit in operator's cabin of SR-1/2				
2.7	Exhaust fan (propeller type or axial flow type) provided as per spec. in the specified areas	Yes/No			
2.8	Roof extractors provided as per spec. in the specified areas	Yes/No			

POWER CYCLE PIPEWORK

1.0	**POWER CYCLE PIPEWORK**	
1.1	Main steam pipe size (dia x thickness)	
	- No. of lines/unit; Material	
1.2	Cold Reheat (dia x thickness):	
	– No. of lines/unit; material	
1.3	Hot Reheat (dia x thickness):	
	– No. of lines/unit; material	
1.4	Feed discharge pipe size (dia x thickness):	
	- Material	
1.5	Aux. steam PRDS capacity, size	
1.6	Insulation material:	
	a) Type	
	b) Thickness	
	c) Density	/M^3

CRANES & HOISTS

(Bidder to fill different sheets for all Cranes & Hoists)

1.0	CRANES & HOISTS	Unit	Parameter		
1.1	Type & crane classification	:			
1.2	Rated capacity: Main/Auxiliary	: (tonne)			
1.3	Span & Lift	: (M)			
1.4	End carriage wheel base	:			
1.5	Crab wheel bay	:			
1.6	Gantry & Bridge rail size, length	:			
1.7	Motor rating:				
a)	Main hoist	:			
b)	Aux. hoist	:			
c)	Bridge travel	:			
d)	Cross travel	:			
e)	Pony motors:				
i)	Main hoist	:			
ii)	Aux. hoist	:			
iii)	Cross travel	:			
iv)	LT	:			
1.8 a)	Safe working load	:			
b)	Operating speed acceleration of host, CT, LT and for CT and LT	:			
c)	Brake type and number	:			
d)	Motor type and number	:			
e)	Rope diameter, stand and number of wire perstant	:			
1.9	Hoists	:	**Electric**	**Manual**	**Under slung**
a)	Type, make, location	:			
b)	Safe working load	: (Tm)			
c)	Lift	: (M)			
d)	Operating speed:	(m/min)			
i)	Hoisting	:			
ii)	Travel	:			

ELEVATORS

S. No.	Description	Unit	Parameter
1.0	ELEVATORS / Ares of installation		
1.1	Type, size, capacity		
1.2	Rated speed	(m/min.)	
1.3	Pay-load	(kg.)	
1.4	Machine type, gear, brake		
1.5	Motor rating	(kW)	
1.6	Voltage control (motor generator set) type		
1.7	Details of accessories provided inside the car		

FLUE GAS DESULPHURISATION (FGD)

Sl. No.	Description	Unit of measure-ments			
1.0	**FLUE GAS DESULPHURIZATION PLANT**				
1.1	**Drawings**				
	i) General arrangement drawing (Plan and elevation) with appropriate dimensions				
	ii) Process and Instrument diagrams				
	iii) Interconnecting wiring diagrams				
1.2	**Predicted Performance at 100% BMCR condition**		**Design Coal**	**Best Coal**	**Worst Coal**
	i) Ambient air condition				
	iii) Gas flow at the FGD inlet	Nm3/sec			
	iv) Gas temperature inlet of Absorber Outlet of Absorber	deg.C			
	v) Flue Gas Composition at FGD system inlet				
	a) O_2	% v/v wet			
	b) CO_2	% v/v wet			
	c) H_2O	% v/v wet			
	d) SO_2	% v/v wet			
	e) N_2	% v/v wet			
	f) Inlet SO2	mg/Nm^3-wet			
	g) NOx				
	h) Dust	mg/Nm3			
	vi) Flue Gas Composition at Absorber outlet (6% O2 dry)				
	a) O_2	% v/v wet			
	b) CO_2	% v/v wet			
	c) H_2O	% v/v wet			

Sl. No.	Description	Unit of measure-ments		
	d) SO_2	% v/v wet		
	e) N_2	% v/v wet		
	f) Outlet SO_2	mg/Nm^3-wet		
	g) NOx			
	h) Dust	mg/Nm3		
	vii) SO_2 removal Efficiency	%		
	viii) Gypsum Quality			
	a) Moisture content (free)	wt%		
	b) Purity of $CaSO_4 \cdot 2H_2O$	wt%-d		
	c) $CaSO_3$	wt%-d		
	d) $CaSO_3 \cdot 1/2H_2O$	wt%-d		
	e) Cl^-	ppm-d		
	f) Mg^{2+}	ppm-d		
	g) Na^+	ppm-d		
	h) pH			
	i) Color			
	j) Odour			
	ix) SO3 conversion from SO2	%		
	x) Pressure Loss			
	a) FGD Total	… mmwc		
	b) Absorber	… mmwc		
	xi) Limestone Consumption	kg/hr		
	xii) Gypsum Produced	kg/hr		
1.3	**Mass Balance Diagram & Data**		**Guarantee point**	**Design point**
2.0	**EQUIPMENT DATA**			
2.1	**Gas Ducts**		**Inlet to absorber**	**Absorber to Stack**
	i) Cross Sectional Area	m2		
	ii) Dimensions	m x m x m		
	iii) Material / Thickness of Duct	mm		

Sl. No.	Description	Unit of measure-ments		
	iv) Material / thickness of Lining	mm		
	v) Method of lining (Lining/Cladding)			
	vi) Estimated Life of liners	hrs		
	vii) Max. Velocity through ducts at Design Point	m/s		
2.2	**Guillotine Gates/Dampers**		**Motorized Gates**	**Power Cylinder Operated Dampers**
	i) Manufacturer			
	ii) Size	m x m		
	iii) Material / Thickness of			
	a) Plate			
	b) Flame			
	c) Seals			
	iv) Actuator Type			
	v) Actuator Rating	KW		
	vi) Sealing efficiency (without seal air fans)	%		
	vii) No. of Seal Air Fans provided			
	viii) Sealing Efficiency with Seal Air fans	%		
	ix) Seal Air Fan Flow / Head	M^3/hr/mmwc		
2.3	**Absorber**			
	i) Manufacturer			
	ii) Manufacturer's model number			
	a) Absorber Cross Sectional area	m^2		
	b) Absorber Dimension (Width x Depth x Height) or (Dia x Height)	mxmxm		
	c) Oxidation Tank Dimension Width x Depth x Height) or (Dia x Height)	mxmxm		

Sl. No.	Description	Unit of measure-ments	
	d) Height between support level to top of support steel	m	
	iii) Number of spray levels (Working + Stand-by)		
	iv) Number of spray nozzles per spray level per boiler		
	v) Number of redundant spray nozzles per level		
	vi) No. of slurry pumps per spray level		
	vii) Maximum slurry flow	m3/hr	
	viii) L/G Ratio		
	ix) No. of agitators		
	x) No. of redundant agitators		
	xi) No. of oxidation nozzles		
	xii) No. of redundant oxidation nozzles		
	xiii) Guaranteed SO2 removal efficiency	%	
	xiv) Dust Removal Efficiency	%	
	xv) Guaranteed pressure drop across Gas System	mmwc	
	xvi) Guaranteed Stack Inlet Temperature	mmwc	
	xvii) Limestone Consumption	kg/hr	
	xviii) Gas velocity through Absorber	M/sec	
	xix) Gypsum Residence time (sec) in oxidation Tank		
	xx) Aspect ratio		
	xxi) Proposed standard for conducting performance tests		……..... the performance tests
	xxii) SO2 removal efficiency with two spray level out of service (for multiple levels of spray)		
	xxiii) SO2 removal efficiency with max. SO2 concentration	%	

Sl. No.	Description	Unit of measure-ments		
	(from the range of specified coals)			
	xiv) Slurry pH under conditions			
	xv) Limestone consumption under conditions	kg/hr.		
	xvi) Gypsum flow under conditions			
	xvii) Material / Thickness of	mm	Base Material	Lining
	a) Absorber and lining			
	b) Wet Dry Interface and lining			
	c) Oxidation Tank and Lining			
	d) Absorber Inlet Duct and Lining			
	e) Absorber Outlet Duct and Lining			
	f) Mist Eliminators			
	g) Mist Eliminator Was Water Header and Nozzles			
	h) Spray Headers			
	i) Spray Nozzles			
	j) Oxidation Nozzles			
	k) Oxidation headers			
	l) Internal Supporting members of absorber, spray piping, mist eliminators etc.			
	xviii) Type of lining for absorber and ducts (Lining / Cladding)			
	xix) Design pressure	mmWC		
	xx) Design temperature	Deg.C		
	xxi) Max. temperature with stand capacity and duration	^{0}C		
	xxii) Number of inspection doors			

Sl. No.	Description	Unit of measure-ments	
	xxiii) Dimensions of access openings of inspection doors	mm x mm	
	xxiv) Emergency Storage tank Capacity	hrs. of operation	
	xxv) Spray Nozzle		
	a) Make / Model		
	b) Type		
	c) Spray cone angle		
	xxvi) Oxidation Nozzles		
	a) Make / Model		
	b) Type		
	xxvii) Spray Header Diameter	mm	
	xxviii) Oxidation Header Diameter		
	xxix) Distance between two consecutive spray levels	mm	
2.4	**Slurry Recirculation Pumps / Gas Cooling Pump (To be indicated for each level)**		
	i) No. of pumps		
	ii) Common stand-by pumps		
	iii) Manufacturer		
	iv) Model		
	v) Type		
	vi) Rated Capacity		
	a) Flow	m3/hr	
	b) Head	mmWC	
	c) Power	kW	
	d) Efficiency	%	
	e) Slurry concentration	% w/w	
	vii) Max. Slurry Concentration	% w/w	
	viii) Margin		
	a) Flow	%	
	b) Head	%	

Sl. No.	Description	Unit of measure-ments	
	ix) Motor Rating	kW	
	x) Motor Details	volts/H2	
	xi) Speed	rpm	
	xii) Synchronous Motor speed	rpm	
	xiii) Critical Speeds		
	xiv) Impeller		
	a) Impeller type		
	b) Impeller Diameters	mm	
	c) Shaft Material/Diameter	mm	
	d) Material / Thickness of Impeller	mm	
	e) Lining Material / Thickness	mm	
	xv) Casing Type		
	xvi) Casing Material/Thickness	mm	
	xvii) Casing Liner Materials/ Thickness	mm	
	xviii) Life of Impeller/Casing Liners	hrs	
	xix) Weight of Rotating Parts	Kg	
	xx) Weight of Static Parts	Kg	
	xxi) Type of Seal		
	xxii) Seal Water Flow	m^3/hr	
	xxiii) Cooling Water Flow	m^3/hr	
	xxiv) Bearings		
	a) Number		
	b) Type		
	xxv) Type of Coupling		
	xxvi) Reference Drg. Nos		
2.5	**Absorber Tank Agitators**		
	i) No. of Agitators in each absorber		
	ii) No. of redundant agitators in each absorber		
	iii) Make / Model		

Sl. No.	Description	Unit of measure-ments	
	iv) Type		
	v) Speed	rpm	
	vi) Drive Mechanism		
	vii) Shaft Material		
	viii) Material/Thickness of impeller/ Lining	mm	
	ix) Power Consumption	kW	
	x) Motor Rating	rpm	
	xi) Motor Speed	rpm	
2.6	**Oxidation Air Compressors(Blower)**		
	i) No. of compressors/Blower		
	ii) No. of stand-by compressors		
	iii) Manufacturer		
	iv) Model		
	v) Type		
	vi) Rated Capacity		
	a) Flow	m3/hr	
	b) Head / Discharge Pressure	mmWC/kg/ m^2	
	c) Power	kW	
	d) Efficiency	%	
	vii) Margin		
	a) Flow	%	
	b) Head	%	
	viii) Design Ambient Conditions (Temperature / Relative Humidity)	^oC / %	
	ix) Motor Rating	kW	
	x) Motor Details	Volts/H2	
	xi) Speed	rpm	
	xii) Synchronous Motor speed	rpm	
	xiii) Critical Speeds	rpm	
	xiv) Impeller		

Sl. No.	Description	Unit of measure-ments		
	a) Impeller type			
	b) Diameter	mm		
	c) Shaft Material /Diameter	mm		
	d) Material / Thickness of Impeller	mm		
	xv) Casing Type			
	xvi) Casing Material / Thickness			
	xvii) Casing Liner Materials / Thickness	mm		
	xviii) Weight of Rotating Parts	kgs.		
	xix) Weight of Static Parts	kgs.		
	xx) Type of Seal			
	xxi) Cooling Water Flow Requirement	m3/hr		
	xxii) Bearings			
	a) Number			
	b) Type			
	c) Lubrication			
	xxiii) Type of coupling			
	xxiv) Reference drg. no.			
2.7	**Slurry Pumps**		**Limestone slurry pump**	**Gypsum bleed pump**
	i) No. of pumps for each unit			
	ii) No. of stand-by pumps for each unit			
	iii) Manufacturer			
	iv) Model			
	v) Type			
	vi) Rated capacity			
	a) Flow	m3/hr		
	b) Head	mmWC		
	c) Power	kW		
	d) Efficiency	%		
	e) Slurry concentration	% w/w		

Sl. No.	Description	Unit of measure-ments	
	vii) Max. Slurry Concentration	% w/w	
	viii) Margin		
	a) Flow	%	
	b) Head	%	
	ix) Motor Rating	kW	
	x) Motor Details	volts/H2	
	xi) Speed	rpm	
	xii) Synchronous Motor speed	rpm	
	xiii) Critical speeds	rpm	
	xiv) Impeller		
	a) Impeller type		
	b) Diameters	mm	
	c) Shaft Material /Diameter	mm	
	d) Material/Thickness of Impeller	mm	
	e) Lining Material/Thickness	mm	
	xv) Casing Type		
	xvi) Casing Material/Thickness	mm	
	xvii) Casing Liner Materials/ Thickness	mm	
	xviii) Life of Impeller/Casing Liners	Hrs	
	xix) Weight of Rotating Parts	kgs.	
	xx) Type of Seal		
	xxi) Seal Water Flow	m3/hr	
	xxii) Cooling Water Flow	m3/hr	
	xxiii) Bearings		
	a) Number		
	b) Type		
	xxiv) Type of Coupling		
	xxv) Reference Drg. Nos		
2.8	**Limestone Grinding and Slurry Preparation system**		
2.8.1	Bunker shut off gates		

Sl. No.	Description	Unit of measure-ments	
	i) Manufacturer		
	ii) Type		
	iii) Material of the gates		
	iv) Motor rating	kW	
2.8.2	Down spout		
	i) Manufacturer		
	ii) Inside diameter	mm	
	iii) Thickness	mm	
	iv) Height	mm	
	v) Material		
	vi) Off set between feeder outlet and centre line of Limestone bunker, if any		
2.8.3	Raw Limestone feeders		
	i) Manufacturer		
	ii) Type		
	iii) Model Number		
	iv) Method of measurement		
	v) Range of measurement	Kg/hr	
	vi) Feeder size		
	vii) Normal capacity	Tonnes/hr	
	viii) Maximum capacity	Tonnes/hr	
	ix) Method of output control		
	x) Speed pulser allowable VA burden		
	xi) Feeder belt width	mm	
	xii) Auxiliary Power consumption	kW	
	xiii) Type of Drive		
2.8.4	Downspout from feeder outlet to mill		
	i) Manufacturer		
	ii) inside diameter	mm	
	iii) thickness	mm	
	iv) Material		

Sl. No.	Description	Unit of measure-ments	
	v) Height	m	
	vi) Off set between feeder outlet and centre line of limestone bunker, if any	m	
2.8.5	Limestone Pulverizers (Wet Ball Mill)		
A	Design Data		
	i) Manufacturer		
	ii) Type and model		
	iii) Total Number of mills		
	iv) Mill maximum capacity (kg/hr)		
	v) Size of raw limestone at mill inlet	mm	
	vi) Bond Index of Limestone		
	vii) Fineness of pulverized Lime stone through 325 mesh	%	
	viii) Mill Speed		
	ix) Total Limestone consumption with all units working at	kg/hr	
	x) 100% BMCR (DC/WC/Best of Range)		
	xi) 100% TMCR (DC/WC/Best of Range)		
	a) Number of mills working with all units working at		
	- 100% BMCR (DC/WC/Best of Range)		
	- 100% TMCR (DC/WC/Best of Range)		
	xii) Mill loading of working mills (% of maximum capacity) when no of mills as per (l) are operating		
	xiii) Mill Power Consumption		
	xiv) Mill Main Motor Rating	kW	

Sl. No.	Description	Unit of measure-ments	
	xv) Main Motor	Voltage/H2 /rpm	
	xvi) Overall dimensions		
	xvii) Total weight including motor		
	xviii) Solid Concentration in mill	w/w %	
	xix) Method of Classification		
	xx) Ball Consumption	kg per ton of limestone	
B	**Constructional Feature**		
	i) Material / Thickness of Mill Wear Liners		
	ii) Guaranteed Wear Life of Wear Liners		
	iii) Estimated labour (in man hours) for replacement of wear liners)		
	iv) Material / Diameter (mm) of Ball		
C	**Type of drive transmission**		
	i) Make / Model of Gearbox		
	ii) Speed Ratio		
D.	**Type of coupling**		
E	**Pulverizer lube oil system**		
	a) No. of lube oil pumps per pulverize		
	b) No. of lube oil pumps working		
	c) No. of oil coolers per pulverizer		
	d) No. of oil coolers per working		
F.	**Auxiliary Motor Rating**	**KW**	
G	**Mill speed with Auxiliary Motor**	rpm	
H	**Mill Separator Tank**		
	i) Capacity	m^3	
	ii) Material/Thickness	mm	

Sl. No.	Description	Unit of measure-ments	
	iii) Lining Material/Thickness	mm	
	iv) No. of Agitators		
I	**Mill circuit Pump**		
	i) No. per mill		
	ii) No. of stand-by pumps		
	iii) Make/Model		
	iv) Impeller Type		
	v) Material/Thickness of Impeller and lining	mm	
	vi) Casing Type		
	vii) Material/Thickness of Casing/Lining	mm	
	viii) Rated Flow Head	m3/hr / mWCI	
	ix) Slurry Solid concentration	w/w %	
J	**Agitators**		
	i) No./Make/Model		
	ii) Type		
	iii) Speed	rpm	
	iv) Drive Mechanism		
	v) Shaft material		
	vi) Material / Thickness of Impeller / Lining	mm	
	vii) Power Consumption		
	viii) Motor Rating	kW	
	ix) Motor Speed	rpm	
K	**Hydro-cyclone**		
	i) Make / Model		
	ii) Number working		
	iii) Flow Capacity	m3/hr	
	iv) Inlet Solid Concentration	% w/w	
	v) No. of Hydro-cyclone in each set		
	vi) No. of spare hydro-cyclone in each set		

Sl. No.	Description	Unit of measure-ments	
	vii) Under flow Volume	m3/hr	
	Solid Concentration	% w/w	
	viii) Overflow Volume	m3/hr	
	Solid Concentration	% w/w	
	ix) Size / Material / Thickness of base / Lining	Mm	
	a) Feed Chamber		
	b) Apex Stopper		
	c) Cone Casing		
	d) Under flow pipe		
	e) Overflow pipe		
	x) Pressure Drop at rated capacity	mmWCI	
	xi) Design Pressure		
2.9	**Limestone Slurry Preparation Tank**		
	i) No. of Tank		
	ii) Capacity	m^3	
	iii) Slurry Solid concentration	w/w %	
	iv) Tank Capacity at 100% BMCR (DC/WC/Best of range)	hrs.	
	v) Dimensions	WxDXH	
	vi) Material / Thickness	mm	
	vii) Lining Material / Thickness	mm	
	viii) No. of Agitators		
	ix) No. of Redundant Agitators		
2.9.1	**Limestone Slurry Tank Agitators**		
	i) No. of Agitators in each tank		
	ii) No. of redundant agitators in each tank		
	iii) Make / Model		
	iv) Type		
	v) Speed	rpm	
	vi) Drive Mechanism		

Sl. No.	Description	Unit of measure-ments	
	vii) Shaft Material		
	viii) Material / Thickness of Impeller / Lining	mm	
	ix) Power Consumption	kW	
	x) Motor Rating	rpm	
	xi) Motor speed		
2.10	**Gypsum Dewatering System**		
	i) No. of Streams		
	ii) No. of Streams Stand-by		
	iii) Primary Hydro-cyclone		
	a) Make / Model		
	b) Number working		
	c) Flow Capacity	m3/hr	
	d) Inlet Solid Concentration	% w/w	
	e) No. of Hydro-cyclone in each set		
	f) No. of spare hydro-cyclone in each set		
	g) Under flow Volume	m3/hr	
	Solid Concentration	% w/w	
	h) Overflow Volume	m3/hr	
	Solid Concentration	% w/w	
	i) Size (mm) / Material / Thickness	mm	
	- Feed Chamber Apex Stopper		
	- Cone Casing Under flow pipe Overflow pipe		
	j) Pressure Drop at rated capacity	mmWC	
	k) Design Pressure	kg/cm2	
	iv) Vacuum Belt Filters		
	a) Manufacturer		
	b) Model		

Sl. No.	Description	Unit of measure-ments	
	c) Dimensions (WxLxH)	mxmxm	
	a) Cloth Width	m	
	b) No. Working / Stand-by		
	c) Capacity (Guaranteed)		
	- Gypsum (Dry)	kg/hr	
	- Gypsum (Slurry)	m3/hr	
	d) Inlet Flow Volume	m3/hr	
	Solid Concentration	% w/w	
	e) Gypsum Flow (Dry)	kg/hr	
	f) Moisture Removed	%	
	g) No. of stages of cake washing / water flow	m3/hr	
	h) No. of stages of cloth washing / water flow	m3/hr	
	i) Design Pressure of Vacuum Chamber	kgf/cm2/a	
	j) Operating Pressure of Vacuum Chamber	kgf/cm2/a	
	k) Material / Thickness	mm	
	- Casing		
	- Cloth		
	- Gypsum discharge Hopper		
	- Vacuum Box		
	l) Life of cloth	Hrs.	
	m) Type /Material of Carrying Belt		
	n) Type / Material of Sealing Belt		
	o) Life of Carrying Belt	Hrs.	
	p) Life of Sealing Belt	Hrs.	
	q) Automatic Cloth Tensioning Mechanism Provided	Yes/No	
	v) Vacuum Receiver Tank		
	a) No. of Tank		

Sl. No.	Description	Unit of measure-ments	
	b) Capacity	m^3	
	c) Dimensions (Dia x Height)	mm x mm	
	d) Material / Thickness	mm	
	e) Lining Material / Thickness	mm	
	vi) Vacuum Pumps		
	a) Make / Model		
	b) Type		
	c) No. of Pumps for each Vacuum Belt Filter		
	d) Rated Capacity Flow/ Head/ Power	m3/hr/mW CI/KW	
	e) Power Consumption	kW	
	f) Pump Speed	rpm	
	g) Motor Rating	kW	
	h) Motor Speed	rpm	
	i) Margins (Flow / Head)	% / %	
	j) Operating Pressure	kgf/cm2/a	
	k) Design Pressure	kgf/cm2/a	
	l) Material / Thickness of Base/Lining	mm	
	- Casing		
	- Shaft		
	- Impeller		
	m) Type of Seal		
	n) Sealing Water Flow	m3/hrs	
	o) Bearing		
	- No. of Bearings		
	- Type of Bearings		
	p) Type of coupling		
	q) Whether Silencer Provided at Outlet	Yes/No	
	vii) Filtrate Tank		
	a) No. of Tank		

Sl. No.	Description	Unit of measure-ments			
	b) Capacity	m^3			
	c) Dimensions	WxDXH			
	d) Material / Thickness	mm			
	e) Lining Material/Thickness				
2.11	**Slurry Pipes**		**Recirculation Slurry**	**Limestone slurry**	**Gypsum slurry**
	i) Pipe size	mm			
	ii) Type of Joints				
	a) Pipe to Pipe/Pipe to Fittings				
	b) Fittings				
	iii) Material / Thickness of Pipe	Mm			
	iv) Material Thickness of lining				
	v) Estimated Life of liners	Hrs.			
	vi) Slurry Solid concentration	w/w %			
	vii) Slurry Settling Velocity	m/s			
	viii) Pipe Velocity	m/s			
2.12	**Secondary Waste Water Hydro-cyclone Feed Tank**				
	a) No. of Tank				
	b) Capacity	m^3			
	c) Dimensions (WxDXH)	(mxmxm)			
	d) Material / Thickness	mm			
	e) Lining Material / Thickness	mm			
2.12.1	Secondary Waste Water Hydro-cyclone Feed Pump				
	a) Number				
	b) No. of stand-by pumps				
	c) Make/Model				
	d) Impeller Type				
	e) Material / Thickness of Impeller and lining	mm			
	f) Casing Type				

Sl. No.	Description	Unit of measure-ments	
	g) Material/Thickness of Casing/Lining		
	h) Rated Flow/Head	m3/hr./mW CI	
	i) Slurry Solid concentration	w/w %	
2.12.2	Secondary Waste Water Hydro-cyclone		
	a) Make / Model		
	b) Number (working + standby)		
	c) Flow Capacity	m3/hr	
	d) Inlet Solid Concentration	% w/w	
	e) No. of Hydro-cyclone in each set		
	f) No. of spare hydro-cyclone in each set		
	g) Under flow Volume	m3/hr	
	Solid Concentration	% w/w	
	h) Overflow Volume	m3/hr	
	Solid Concentration	% w/w	
	i) Size (mm)/ Material / Thickness of base / Lining	mm	
	a) Feed Chamber		
	b) Apex Stopper		
	c) Cone Casing		
	d) Under flow pipe		
	e) Overflow pipe		
	f) Pressure Drop at rated capacity	mmwc	
	g) Design Pressure	kgf/cm2	
2.13	**Waste Water Tank**		
	i) No. of Tank		
	ii) Capacity	m^3	
	iii) Dimensions (WxDXH)	m x m x m	
	iv) Material / Thickness	mm	
	v) Lining Material / Thickness	mm	

Sl. No.	Description	Unit of measure-ments	
2.13.1	Waste Water Pump		
	i) Number		
	ii) No. of stand-by pumps		
	iii) Make / Model		
	iv) Impeller Type		
	v) Material / Thickness of Impeller and lining	mm	
	vi) Casing Type		
	vii) Material / Thickness of Casing / Lining	mm	
	viii) Rated Flow Head	m^3/hrs/mWCI	
	ix) Slurry Solid concentration	w/w %	
2.14	**Sump Pump (for absorber area, limestone grinding area and gypsum dewatering area sumps)**		
	i) Number		
	ii) No. of stand-by pumps		
	iii) Make / Model		
	iv) Impeller Type		
	v) Material / Thickness of Impeller and lining	mmWCI	
	vi) Casing Type		
	vii) Material / Thickness of Casing / Lining		
	viii) Rated Flow Head		
	ix) Slurry Solid concentration	w/w %	
2.15	**Absorbent Auxiliary Slurry Sump**		
	i) Capacity Recommended	m3	
	ii) Slurry Solid concentration	w/w %	
	iii) No. of Agitators		
	iv) No. of Redundant Agitators		
2.16	**Absorbent Auxiliary Slurry Sump Agitators**		
	i) No. of Agitators in Sump		

Sl. No.	Description	Unit of measure-ments	
	ii) No. of redundant agitators		
	iii) Make / Model		
	iv) Type		
	v) Speed	rpm	
	vi) Drive Mechanism		
	vii) Shaft Material		
	viii) Material / Thickness of Impeller / Lining	Mm	
	ix) Power Consumption		
	x) Motor Rating	KW	
	xi) Motor Speed	Rpm	
2.17	**Absorbent Auxiliary Slurry Pumps**		
	i) No. of pumps		
	ii) No. of stand-by pumps		
	iii) Manufacturer		
	iv) Model		
	v) Type		
	vi) Rated Capacity		
	a) Flow	m3/hr	
	b) Head	mWCI	
	c) Power	kW	
	d) Efficiency	%	
	e) Slurry Concentration	% w/w	
	vii) Max. Slurry Concentration	% w/w	
	viii) Margin		
	a) Flow	%	
	b) Head	%	
	ix) Motor Rating	kW	
	x) Motor details	volts/Hz	
	xi) Speed	rpm	
	xii) Synchronous Motor speed	rpm	
	xiii) Critical Speeds	rpm	
	xiv) Impeller		

Sl. No.	Description	Unit of measure-ments	
	a) Impeller type		
	b) Diameters	mm	
	c) Shaft Material /Diameter	mm	
	d) Material / Thickness of Impeller	mm	
	e) Lining Material / Thickness	mm	
	xv) Casing Type		
	xvi) Casing Material / Thickness	mm	
	xvii) Casing Liner Materials / / Casing Liners	Hrs.	
	xviii) Weight of Rotating Parts	Kgs	
	xix) Weight of Static Parts	Kgs	
	xx) Type of Seal		
	xxi) Seal Water Flow	m3/hr	
	xxii) Cooling Water Flow	m3/hr	
	xxiii) Bearings		
	a) Number		
	b) Type		
	xxiv) Type of Coupling		
	xxv) Reference Drg. Nos		
3.0	**Storage Silo**		
i.	Total number of Silos provided		
ii.	Effective capacity of silo		
iii.	Whether bag filter and fans as specified provided on each Silo		
iv.	Whether aeration system as specified has been provided on each silo		
v.	Type of unloading arrangement provided		
vi.	Material of Construction and Thickness		
	a) Body		

Sl. No.	**Description**	**Unit of measure-ments**	
	b) Liners (indicate hardness also)		
vii.	All accessories, supporting structure steel included as per specification requirements?	Yes/No	

Sr. No	Conv. No.						
7.0	**A.0 Belt Conveyor (LIMESTONE/ GYPSUM)**						
1	Qty	1	1	1	1	1	1
2	Do Belt Conveyors conform to the requirements of spec. [Yes/ No]						
A	**Conveyor Data**						
A.1	Capacity, tph						
A.2	Operating Speed, m/s						
A.3	Belt Width, mm						
A.4	No of roll x troughing Angle (deg) carrying side						
A.5	No of roll x troughing Angle (deg) return side						
A.6	Conveyor Inclination max						
A.7	Horizontal Length, c/c pulley (m)						
A.8	Lift, (m)						
A.9	Installed Power, kw						
A.10	Angle of wrap (deg) for single snub drive						
A.11	Skirt Plate as per spec. / drgs. Provided [yes/no]						
A.12	Skirt board length & height to suit effective dust suppression by specified D.S nozzles considered [yes/no]						
A.13	Deck Plate as per spec provided [yes/no]						
A.14	Seal Plate as per spec provided [yes/no]						
A.15	Gallery/ tunnel section as per enclosed drgs. Provided [yes/no]						
B	**Take-up**						
B.1	Type						
B.2	Access platform provided complete with stair [yes/no]						
B.3	Counter weight material						
B.4	Safety guard provided [yes/no]						

C	**Drive Unit**						
C.1	Motor Type (LT/ HT)						
C.2	Motor RPM						
C.3	Weight of Motor, kgf						
C.4	Type of Gearbox						
C.5	Make of Gearbox						
C.6	Service factor on belt kw for selection of Gearbox						
C.7	Type of cooling arrgmt						
C.8	Weight of Gearbox, kgf						
C.9	Type of lubrication for gear box						
C.10	Type & Make of HS Coupling						
C.11	Service factor for selection of HS Coupling						
C.12	Weight of HS Coupling, kgf						
C.13	Type & Make of LS Coupling						
C.14	Service factor on belt kw for selection of LS Coupling						
C.15	Weight of LS Coupling, kgf						
C.16	Whether Coupling guards Provided [yes/no]						
C.17	Type & Make of holdback						
C.18	Rating of holdback, kN-m						
C.19	Location of holdback						
C.20	Brakes as per spec considered [yes/no].						
D	**Belting**						
D.1	Type						
D.2	Moulded or cut edge construction						
D.3	Make						
D.4	Standard followed						
D.5	Maximum operating tension [T1] as %age of RMBT {max allowable work tension of belt} …N/N belt						
D.6	Safety factor for NN belt						
D.7	Heavy duty belt considered, [yes/no].						

D.8	Belt rating/ no of ply [for N/N belt]						
D.9	Top cover thickness, (mm)						
D.10	Bottom cover thickness, (mm)						
D.11	Grade of cover						
D.12	Type of Joint						
E	**Idlers (Carrying/ Return/Impact)**						
E.1	**General**						
E.2	Make						
E.3	Roller Tube Material/ its IS						
E.4	Roller tube OD,(mm) x thk(mm) [Carrying/Return/Impact]						
E.5	Standard followed for Idler set construction						
E.6	Type, Make & Size of Bearing						
E.7	Idler Shaft Material						
E.8	Bearing Life, L_{10}, Hrs.						
E.9	Type of Lubrication						
E.10	Furnish type & detail of seal provided						
E.11	Friction factor at work (Max.)						
E.12	Normal tr. Idler spacing						
E.13	SAC idler spacing, mm						
E.14	Normal return Idler spacing						
E.15	SAR idler spacing, mm						
E.16	**Impact Idler**						
E.17	No of impact idler set x spacing, (mm) at each loading point						
E.18	OD/ ID rubber disc						
E.19	Material of rubber disc & its Hardness						
E.20	Wt of one impact idler set [kgf] x wt of its rotating parts, [kgf/set]						
E.21	Reference to arrangement drg. enclosed						
E.22	Wt of one carrying idler set [kgf] x wt of its rotating parts, [kgf/set]						
E.23	Reference to arrangement drg. Enclosed [Carrying Idler set ...all types]						
E.24	No of roller per idler set [Return Idler]						

E.25	Spacing, (mm) [Return Idler]						
E.26	Wt of one Return idler set [kgf] x Wt, of its rotating parts, [kgf/set]						
E.27	Reference to arrangement drg. Enclosed [Return Idler set ...all types]						
F	**Pulleys (Drive/ Head/ Tail/ Take up/ Snub/ Bend)**						
F.0	**General [pulleys]**						
F.1	Type of Pulley construction						
F.2	Standard followed for pulleys						
F.3	Make						
F.4	Face width of Pulley						
F.5	Bearing Center, (mm)						
F.6	Type of bearings and minimum bearing life {drive pulley}						
F.7	Type of bearings and minimum bearing life {non-drive pulley}						
F.8	Material of shell						
F.9	Material of end disc						
F.10	Material of hub						
F.11	Material of shaft						
F.12	Type, Material & thk of lagging on drive pulley						
F.13	Type, Material & thk of lagging on non drive pulley						
F.14	Type of shaft fixing arrangement with hub						
F.15	Max Shaft deflection at end disc - Drive Pulley, minute						
F.16	Max Shaft deflection at end disc - Non Drive Pulley, minute						
F.17	Whether safety guard included where required.						
F.18	Head/ drive Pulley [Drum dia. OD steel]						
F.19	Tail/ TU/ bend Pulley [Drum dia. OD steel]						
F.20	Snub Pulley [Drum dia. OD steel]						
F.21	Reference to arrangement drg. enclosed						

G	**Belt Cleaning Arrangement**						
G.1	Manufacturer						
G.2	Are blade replaceable type						
G.3	Type & Make of primary cleaner						
G.4	Qty. of Primary Cleaner provided per discharge pulley						
G.5	MOC of blade for primary cleaner						
G.6	Type & Make of Sec. Cleaner						
G.7	Qty. of Sec. cleaner provided for discharge pulley						
G.8	MOC of blade for Sec. cleaner						
G.9	Type & Make of plow cleaner						
G.10	Qty. of plow cleaner provided per conv. & its location						
G.11	MOC of blade for plow cleaner						
H	**Conveyor Safety Switches**						
H.1	**Pull Cord Switches (in Pair)**						
H.2	Type & Make						
H.3	Amp Rating, A						
H.4	Spacing of Switch, m						
H.5	**Belt Sway Switches (in Pair)**						
H.6	Type & Make						
H.7	Amp Rating, A						
H.8	Spacing of Switch, m						
H.9	**Zero Speed Switch (in Pair)**						
H.10	Type & make						
H.11	Amp Rating, A						

S-2	**Chutes**			
S. No.	**Description**	**Hood [above discharge pulley]**	**Main Chute**	**Floor cleaning/ tramp metal chute**
1	Do Chutes conform to the requirements of specifications as per Tech Spec. M-2 [Yes/ No]			
2	Material & thk, mm of parent plate			
3	Minimum Sloping angle (degree) of chute inclined part			
4	Rubber curtain at entrance to hood (above discharge pulley) provided, [Yes/ No]		NA	NA
5	Gasket material & thk, mm			
6	Inspection door/ poking door/ removable covers provided [Yes/ No]			

S-3	**Gates**	
S. No	**Description**	
A.0	**Flap Gate**	**FG**
1	Does Flap Gate conform to the requirements of specifications as per Tech Spec. M-3 [Yes/ No]	
2	Type & make	
3	Alternate manual operation provided [Yes/ No]/effort reqd,kgf	
4	MOC of flap	
5	MOC of gate shaft	
6	Type of bearing, its life,L_{10} ,hr	
7	Type of lubrication arrangement	
8	No of consecutive starts/ stops per hr	
9	No of switching per hr	
10	Max thrust (kgf)	
11	Motor kw rating & type	
12	Limit Switches Provided[Yes/ No]	

13	Estimated weight of one gate, (kgf)	

S-4	**Monorail & Hoists**	
A.0	**Electric Hoist with Monorail**	
S.No.	**Description**	
1.	Does Electric Hoist with monorail conform to the requirements of specifications as per Tech Spec. M-4 [Yes/No]	
2.	Make of Hoist	
3.	Construction to Indian Standard (I.S.)	
4.	Max Safe Working Load, tonne	
5.	Trolley speed (m/min)	
6.	Hoisting speed (m/min)	
7.	Construction of rope and No. of falls of Rope	
8.	Breaking strength of rope, kgf/mm^2	
9.	Type and material of load hook, Furnish I.S. No.	
10.	Pendant push button control detail	
11.	Type and arrangement of lubrication	
12.	Is Hoist tested to 125% of SWL before dispatch (Yes/No)	
B.0	**Chain Pulley Block with Geared Trolley[manual hoist]**	
S.No.	**Designation No.**	
1.	Does Chain Pulley Block with Geared Trolley conform to the requirements of specifications as per Tech Spec. M-4 [Yes/No]	
2.	Make	
3.	Construction to I.S. standard	
4.	Wt. of Manual Hoist with Trolley, kgf	
5.	Is Hoist tested to minimum 125%times SWL before dispatch (Yes/No)	
S-5	**Belt Vulcanizing Machine**	
S.No.	**Designation No.**	**BVM-1**
1	Does Belt Vulcanizing Machine conform to the requirements of specifications as per Tech Spec. M-5 [Yes/No]	
2	Type	

3	Qty offered, no.	
4	Make	
5	Minimum / Maximum Belt width that can be vulcanized by above machine, mm/mm	
6	Type of Temperature Controller provided	
7	Size of Platen ,mm x mm and its thickness ,mm	
8	MOC of Platen	
9	Temperature range, °C	
10	Operating Pressure range, bar	
11	Detail of Mechanism for application of pressures & heat etc.	
12	Method of heating	
13	Connected load, kW	
14	Whether Power receiving plug, Switch & Cable provided (Yes / No)	
15	Cable length, m	
a)	Socket to temperature control box	
b)	Between Control Box & Platen	
16	Operating Voltage	
17	Furnish Detail of Tool Kit / Vulcanizing accessories	
18	Weight of Machine, kgf	
19	Qty & Capacity (tonne) of Portable Winch	
20	Make of Winch / Wt, kgf	

S-6	**In-Line Magnetic Separator (ILMS)**	
S.No	**Designation No.**	**ILMS-1A/1B**
1	Does magnetic separator conform to the requirements of specifications as per Tech Spec.M-6 [Yes/No]	
2	Type	
3	Manufacturer	
4	Qty/ Location	
5	Operating height, mm	

6	Minimum wt. & size of tramp iron that can be picked from belt at specified operating height	
7	Maximum wt. & size of tramp iron that can be picked from belt at specified operating height	
8	Size of magnet, mm x mm x mm [W x L x H].	
9	Force Index	
10	Gauss strength at specified operating height	
11	Required voltage (DC/AC)	
12	Material of Coil	
13	Type of cooling arrangement.	
14	Rectifier	
a.	Type & make	
b.	Input Power supply to Rectifier	
15	Material of magnet /IS standard	
16	Tramp Iron Chute provided at operating floor (Yes / No)	
17	Tramp Metal Trolley provided, (Yes / No)	
18	Tramp Metal chute near main chute provided, (Yes / No)	
19	DC Power consumption in hot condition, kw	
	a) After 24 hours of continuous operation b) After 8 hours of continuous operation	
20	a) Type, Rating & Cover Grade of belt	
	b) Top Cover x Bottom cover thk,(mm x mm)	
	c) Built in ribs provided in the belt (Yes / No)	
21	Drive motor rating, kw	
22	Non-Magnetic Pulley as per Spec. provided (Yes / No)	
23	Total wt. of Magnetic Separator, tonne.	
24	Reference arrangement drawing/catalog enclosed (Yes / No)	
S-7	**Suspended Electro Magnet (SEM)**	
S.No	**Designation No.**	**SEM-1A/1B**
1	Does Suspended Electro Magnet conform to the requirements of specifications as per Tech Spec. M-7 [Yes/No]	

2	Type	
3	Manufacturer	
4	Qty/ Location	
5	Operating height, mm	
6	Minimum wt. & size of tramp iron that can be picked from belt at specified operating height	
7	Maximum wt. & size of tramp iron that can be picked from belt at specified operating height	
8	Size of magnet, mm x mm x mm [W x L x H]	
9	Force Index	
10	Gauss strength at specified operating height	
11	Required voltage (DC/AC)	
12	Material of Coil	
13	Type of cooling arrangement.	
14	Rectifier	
	a. Type & make	
	b. Input Power supply to Rectifier	
15	Material of magnet/ IS standard	
16	Tramp Iron Chute provided at operating floor (Yes / No)	
17	DC Power consumption in hot condition, kw	
	a) After 24 hours of continuous operation b) After 8 hours of continuous operation	
18	Tramp Metal Trolley provided, (Yes / No)	
19	Non-Magnetic Idlers as per Spec. provided (Yes / No)	
20	Total wt. of Suspended Electromagnet, tonne.	
21	Reference arrangement drawing/ catalog enclosed (Yes / No)	

S-8	**Metal Detector**	
S.No	**Description**	**MD-1A/1B**
1	Does Metal Detector conform to the requirements of specifications as per Tech Spec. M-8 [Yes/ No]	
2	Qty	

3	Location	
4	Operation Details	
5	Material to be examined	
6	Belt Width, mm x Troughing angle	
7	Belt Speed, m/s	
8	Type of Detector	
9	Capacity for detection [size of Aluminium ball it can detect] for specified type of belt	
10	Capacity for detection [size of MS bolt it can detect] for the specified belt	
11	Type of Annunication/ Hooter provided	
12	Furnish details of hooter	
13	Audible range of hooter	
14	Indication type	
15	Power Supply	
16	Max Power Consumption (kw)	
17	Installed Power, kw	
18	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]	

S-9	**Belt Weigher**	
S.No	**Description**	**BW-1A/1B**
1	Does Belt Weigher conform to the requirements of specifications as per Tech Spec. M-9? [Yes/ No]	
2	Location/ Qty	
3	Type	
4	Make	
5	No. of Weigh Idlers Provided	
6	Weigh Idler Machined [Yes/ No]	
7	Belt Width mm x Tr. Angle (Deg)	
8	Weigh Range (tph)	
9	Belt Speed, m/s	
10	Furnish detail of weighbridge/ weigh frame	

11	Furnish detail of sensor	
12	Accuracy (%) at full load	
13	Accuracy (%) at minimum load	
14	Type of feed rate indicator	
15	Location of feed rate indicator	
16	Whether microprocessor based/ Totaliser unit provided	
17	Type of load cell & its detail	
18	Power consumption, kw	
19	Calibrating instruments related items included in supply [Yes/ No]	
20	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]	

S-10	**Fixed Tripper**			
S. No.	**Description**	**FT-1A/1B**	**FT-2A/2B**	**FT-3A/3B**
1	Does Fixed Tripper conform to the requirements of specifications as per Tech Spec. M-10? [Yes/ No]			
2	Location/ Qty			
3	Type of belt cleaner provided			
4	Flap gate/ Skirt board/ other items as per spec. provided [Yes/ No]			
5	Belt width			
6	Discharge chute as per spec. provided [Yes/ No]			
7	Access platform with ladders hand rail provided? [Yes/ No]			
8	Belt Guard provided [Yes/ No]			

S-11	**Crane and hoist**	
S. No.	**Description**	**EOT**
1	Does Hoist conform to the requirements of specifications as per Tech Spec. [Yes/ No]	
2	Type & Make	
3	Code followed	

S-11	Crane and hoist	
S. No.	**Description**	**EOT**
4	Qty, no	
5	Location	
6	Safe working load (Main Hoist), tonne x lift, m [approx]	
7	Safe working load (Auxiliary Hoist), tonne x lift, m [approx]	
8	Approx. Span (m)	
9	Duty Class	
10	Speed m/min	
i.	Main hoist (normal/ creep)	
ii.	Aux. Hoist (normal/ creep)	
iii.	Cross travel	
iv.	Long travel	
11	Max wheel load (t)	
12	Type & Material of hook	
i.	Main hook	
ii.	Aux. hook	
13	Main Hoist rope	
i.	No. of rope falls	
ii.	Size & Construction	
iii.	Breaking strength, UTS, kgf/mm^2	
iv.	Rope grade/ IS	
14	Aux. hoist	
i.	No. of rope falls	
ii.	Size & Construction	
iii.	Breaking strength, UTS, kgf/mm^2	
iv.	Rope grade/ IS	
15	Test Load, tone [for main hoist]	
16	Test Load, tone [for aux. hoist]	
17	Gantry rail size	

S-11	Crane and hoist	
S. No.	Description	EOT
18	Crab rail size	
i.	Installed kw [Main hoist]	
ii.	Installed kw [Aux. hoist]	
iii.	Installed kw [Cross travel]	
iv.	Installed kw [Long travel]	
19	Type & arrangement of lubrication	
20	Type of brakes & limit switches provided	
21	Details of DSL	
22	Wt of crane [excluding rails]	
23	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-12	Surface Feeder	
S. No.	Description	AF-1A/1B
1	Does Surface Feeder conform to the requirements of specifications as per Tech Spec. M-12 [Yes/ No]	
2	Qty, no/location	
3	Make	
4	Material handled	
5	Max lump size, mm	
6	Variable capacity feeder provided? [Yes/ No]	
7	Type of arrgmt provided for variable capacity	
8	Max Capacity, (tph) and its corresponding speed ,m/s	
9	Minimum Capacity, (tph) and its corresponding speed , m/s	
10	Method of speed variation	
11	Material(MOC) & thk of skirt board	
12	Furnish location & type of control gate [if provided]	

13	Clear Width, mm	
14	Length C/C, m(approx),	
15	Installed Power, kw	
16	Type of drive motor	
17	Type & make of HS coupling	
18	Type & make of gear box[water cooled gear box not acceptable]	
19	Type & make of LS coupling	
20	Material(MOC) & thk of pan	
21	Type of chain x no of strand	
22	Safety factor considered for chain selection	
23	Chain roller pitch, mm	
24	Material(MOC) & thk of link x hardness[BHN]	
25	Roller of Chain	
i.	Type of roller & its lubrication arrgmt.	
ii.	MOC of roller x BHN	
iii.	Roller dia, mm	
26	Roller [for pan supports]	
i.	Type of roller & its lubrication arrgmt.	
ii.	MOC of roller x BHN	
iii.	Roller dia., mm	
27	Roller on return side for chain support	
i.	Type of roller & its lubrication arrgmt.	
ii.	MOC of roller x BHN	
iii.	Roller dia, mm	
28	Type of take up device	
29	Drive sprocket assly.	
i.	PCD x no of teeth x MOC of sprocket	
ii.	Hardness of teeth, BHN	
30	Tail sprocket assly	
i.	PCD x no of teeth x MOC of sprocket	
ii.	Hardness of teeth, BHN	

31	Type of lubrication arrgmt.	
32	Weight of heaviest part, kgf	
33	Weight of machine (total),kgf excluding drive unit	
34	Matching dribble conveyor provided, Yes/ No	
35	Arrangement Drawing/ Catalogue enclosed	

S-13	Crusher (Hammer Mill Type)		
S. No.	**Description**	**CR-1A**	**CR-1B**
1	Do Crusher conform to the requirements of Tech Spec. M-13 [Yes/ No]		
2	Number		
3	Type		
4	Manufacturer & Model no		
5	Guaranteed Crushing Capacity, (tph) for specified limestone		
6	Guaranteed limestone output size, mm (at above Guaranteed capacity)		
7	Feed opening size, mm x mm		
8	Rotor speed, rpm		
9	Are required Interlocks provided?		
10	Nature of interlocks & safety measures		
11	Hydraulic power pack for door opening/closing provided.		
12	Drive Motor		
a)	Type		
b)	Make & Model no.		
c)	Power Supply		
d)	Maximum starting current		
e)	Maximum starting torque		
f)	Insulation Type		
g)	Rated Power, Kw		
h)	Type of cooling arrangement provided		
i)	Maximum KVA demand		
13	Type/ Size of Bearing		
14	Bearing Life,L_{10} (hours)		
15	Normal life of:		
a)	Suspension disc		
b)	Breaker plate		
c)	Crushing rings		
d)	Frame liners		
16	Material of Construction (MOC)		

a)	Frame (MOC) & thk, mm		
b)	Frame liners (MOC) & thk, mm		
c)	Cage Frame (MOC)		
d)	Screen bars or plates (MOC) & thk, mm		
e)	Rotor Shaft(MOC)		
f)	Suspension disc(MOC)		
g)	Crushing rings(MOC)		
h)	Suspension bars(MOC)		
17	Is product size adjustment device provided?		
18	Is tramp iron trap provided?		
19	Type of dust seal provided		
20	Type of coupling provided		
21	Coupling Make & Model no		
22	Weight of heaviest part, kgf		
23	Weight of machine (total),kgf including drive unit & motor		
24	Break up of above machine wt,kgf		
25	Vibration Isolation System as called for provided [Yes/ No]		
26	Details of Gerb spring system		
27	Furnish details of Vibration Monitoring System		
28	Furnish details of Temperature Monitoring Device for Crusher & Motor Bearings		
29	Guaranteed Vibration Levels after using GERB Spring		
a)	For Crusher		
b)	For Supporting Structure		
30	Arrangement Drawing/ Catalogue enclosed [Yes/ No]		

S-14	**Plain water type DS System for Gypsum storage area**	
S. No.	**Description**	**PWDS-1**
1	Do Plain Water DS System for Gypsum storage conform to the requirements of specifications as per Tech Spec. M-14 [Yes/ No]	
2	Water Tanks	
i.	Location/ Qty/ all the needed / inlet/ outlet/ drain etc as per requirements provided... for water tank [Yes/ No]	
ii.	Water holding Capacity of each tank,cum	

iii.	Type of water tank construction	
3	**Pump**	
i.	Designation no	
ii.	Location & Qty	
iii.	Duty	
iv.	Type & Make	
v.	Total Discharge Head, m(water column)	
vi.	Discharge capacity (m^3/hr)	
vii.	Pump (RPM)	
viii.	Motor rating (kw) x RPM	
ix.	MOC of pump... Casing	
x.	MOC of pump... Impeller	
xi.	MOC of pump... Shaft	
xii.	ID inlet/ ID outlet size, mm	
4	**Duplex Filter**	
i.	Type & Make of filter	
ii.	Qty & Location	
iii.	Size of Particle removed by filter	
5	**Sprinkler**	
i.	Type & Make	
ii.	Spacing (along length)	
iii.	Max. throw radius, m	
iv.	Capacity range, lpm	
v.	Range (Water Pressure) at nozzle tip, kgf/cm^2	
vi.	MOC of sprinkler items	
a)	Body & Flag	
b)	Spring	
c)	Base	
d)	Washer	
e)	Nozzle Tip	
6	Pipe work/ Valves/ Fittings/ Solenoid Valve/ Main Water Header/ sprinklers etc per requirements provided [Yes/ No]	

7	Indian Standard followed for piping work etc	
8	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-15	**Void**

S-16	**Dust Extraction System**	**DE-1A/ 1B**
S.No.	**Description**	
1	Does Dust Extraction System conform to the requirements of specifications as per Tech Spec. M-16 [Yes/ No]	
2	Type	
3	Qty & Number	
4	Location for DE Unit	
5	Dust emission level in clean air exhaust from fan outlet (mg/Nm^3)	
6	Fan	
i.	Capacity, m3/hr x Fan Speed, rpm	
ii.	Type of impeller	
iii.	Type & make of Fan	
iv.	Casing material & thk.	
v.	Impeller material & thk.	
vi.	Are the following accessories provided?	
	a. V-belt drive	
	b. Belt guard	
	c. Pair of slide rails	
	d. Common base frame	
	e. Vibration isolators (spring type)	
	f. Foundation bolts	
	g. Drain plug	
	h. Canvas connection	
	i. Motor, starter and other electricals	
	j. Any other accessories	
vii	a. Motor kW x RPM	
	b. Static/total pressure(mmwg)	

	c. Power consumption (kw)	
	d. Weight of fan unit , tonne	
7	Ducting & Suction Hood	
	a. Ducting Material / construction / thickness	
	b. Max. spacing of support for Ducting, m	
	c. Velocity through duct, m/sec	
	d. Material & thickness of Exhaust Ducting	
8	Damper as per requirement provided, Yes/No	
9	Bag filter Unit	
	a. Collecting efficiency (%)	
	b. Dust collecting hopper material & thk.	
	c. Effective Dust Holding Capacity,m^3	
	d. Type & Make	
	e. Air to cloth ratio, cum/ (m^2 x hr)	
	f. Bag material and its life in working hours	
	g. Overall size of filter unit (W x L x M) ,m x m x m	
	h. Weight of Unit, tonne	
10	Air compressor	
	a. Type & Make	
	b. Motor kW x RPM	
	c. Free air delivery (Nm^3/hr) & Delivery pressure ,bar	
	d. Power consumption (kw)	
	e. Weight of air compressor unit including motor , tonne	
	f. Reference to the arrangement drawing / catalogue enclosed	
11	Rotary feeder	
	a. Type & Make	
	b. Type of Drive Unit	
	c. Capacity, tph (limestone Dust)	
	d. Motor kW x RPM	
	e. Reference to the arrangement drawing / catalogue enclosed	
12	Screw Conveyor	
	a. Type & Make	
	b. Type of Drive Unit	
	c. Capacity, tph (limestone Dust)	

	d. Motor kW x RPM	
	e. Reference to the arrangement drawing / catalogue enclosed	
13	Cowl and bird screen provided, Yes/No	
14	Reference to the flow scheme of DE system enclosed, Yes/No	
15	Arrangement Drawing/ Catalogue enclosed, Yes / No	
16	Do the Vent Filter conform to the Technical Spec. Yes/No	
a.	Total Qty provided, No.	
b.	Location	
c.	Type & Make	
d.	Air to cloth ratio	
e.	Capacity, cum/hr.	
f.	Construction Details	
g.	MOC of Filter bag	
h.	MOC of Housing & its thk, mm	
17	Arrangement Drawing/ Catalogue enclosed, Yes / No	
18	Type and make of compressor	
19	Free Air Delivery cum/hr & Delivery pressure, bar	
20	Motor kw X RPM	
21	Wt. of air compressor unit including motor ,tonne	
22	Power consumption ,kw	
23	Reference to the arrangement drawing/catalogue enclosed	

S-17	**Weigh Bridge for Truck**		
S.No	**Description**	**WB-1A**	**WB-1B**
1	Does Truck Weigh Bridge conform to the requirements of specifications as per Tech Spec. M-17 [Yes/ No]		
2	Qty		
3	Gross Weighing Capacity, tonne		
4	Type & Make		
5	Range of Weighing speed (of rake), kmph		
6	Range of Non Weighing speed (of rake), kmph		
7	Suitable for type of wagons		
8	Type of Load Cells		

9	Weigh Bridge detail		
10	Rolling load that can pass over it (tonnes) with speed		
11	Type of Over speed indication		
12	Track Switches details		
13	Weighing Accuracy % (for each wagon)		
14	Weighing Accuracy % (for full rake)		
15	Resolution		
16	Details of Calibration System		
17	Detail of electronic console/ indicator		
18	Bi-directional weighing facility provided (Yes/No)		
19	Details of computer		
20	Detail of software/ report type		
21	Arrangement Drawing/ Catalogue enclosed? [Yes/ No]		

S-18	**Bulldozer**	
S. No.	**Description**	**Bulldozer**
1	Does Bulldozer conform to the requirements of specifications as per Tech Spec. M- 18 [Yes/ No]	
2	Type offered [tyre or crawler mounted]	
3	Make & Model no	
4	Qty, no	
5	Limestone blade size, mm [L] x mm [H] and capacity, cum	
6	Earth blade size, mm[L]X mm[H] & Capacity, cum	
7	Technical features of machine as per spec provided [Yes/ No]	
8	Minimum net Power as per ISO: 9249, kw	
9	Spares as per spec included under supply	
10	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-19	**Front End Loader**	
S. No.	**Description**	**Front End Loader**

1	Does Front End Loader conform to the requirements of specifications as per Tech Spec. M- 19 [Yes/ No]	
2	Type offered	
3	Make & Model no	
4	Qty, no	
5	Limestone bucket size, mm [L] x mm [H] & water filled volume , cum	
6	Bucket capacity, cum (heaped), for limestone @1.4 t/m3	
7	Technical features of machine as per spec provided [Yes/ No]	
8	Minimum net Power as per ISO, kw	
9	Spares as per spec included under supply	
10	Arrangement Drawing/ Catalogue enclosed [Yes/ No]	

S-20	**Sump Pump**	
S. No.	**Description**	**SP-1A/1B**
1	Do Sump Pump conform to the requirements of specifications as per Tech Spec. M-20 [Yes/ No]	
2	Type & Model No	
3	Manufacturer	
4	Location	
5	Number	
6	Discharge Capacity (m^3/hr)	
7	Head (m)	
8	Type of mechanism for automatic starting/ stopping	
9	Type of strainer at impeller inlet provided?	
10	Sump level for starting/ stopping	
11	Type of lubrication	
12	Type of drive	
13	Piping, valve & accessories as specified provided, [Yes/ No]	
14	Grating over sump pit provided, [Yes/ No]	
15	Material of construction	
16	Casing	
17	Impeller	

18	Shaft	
19	Strainer	
20	Motor kw rating of each sump pump	
21	Arrangement Drawing / Catalogue enclosed? [Yes/ No]	

S-21	**Screen (Vibrating Grizzly feeder)**		
S. No.	**Description**	**VGF-1A**	**VGF-1B**
1	Do screen conform to the requirements of Tech Spec. [Yes/ No]		
2	Number		
3	Type		
4	Manufacturer & Model no		
5	Size of Screen mm		
6	Screen length mm		
7	Screen width mm		
8	Material of Construction		
	a) Grizzly Bars		
	b) Screen decks / discs		
	c) Screen decks liner mm		
	d) Shaft		
9	Type of Drive provided		
10	Motor Rating KW		
11	Speed Rpm		
12	Efficiency of screening %		
13	Weight T		

WEIGH BRIDGE

(Bidder shall fill separate sheet for each WEIGH BRIDGE)

S. No.	Item	Units	Description
1.0	**DESIGN DATA**		
a.	Type		
b.	Capacity		
c.	Size of Platform		
d.	Minimum Gradutaion		
e.	Accuracy		
f.	Method of Weighing		
g.	Load Cell Capacity		
2.0	**MATERIAL OF CONSTRUCTION**		
a	Platform supporting structure		
b.	Platform		
c.	Knife Edge		
d.	Levers		
e.	Load Cell		
3.0	**DISPLAY UNIT**		
a.	Mechnical		
b.	Electronic		
	Digital Indicator		
	Digital Indicator+ Recorder+Printer + Keyboard		
	PC with Keyboard		
c.	Provision for RS 232 C/ 485 for MMI		
d.	Display Unit/ Local/ Remote		
e.	Does Weighing software shall have the facility to print the following details on continuous basis :		
	Date & Time	Y/N	
	Material to be weighed	Y/N	
	Truck/ Wagon/ Vehicle Number	Y/N	
	Batch Number	Y/N	
	Gross weight	Y/N	
	Tare Weight	Y/N	

	Net weight	Y/N	
f.	PC Configuration	Y/N	
	22" TFT Monitor	Y/N	
	4 GB Ram	Y/N	
	Intel Core I7 Processor	Y/N	
	1 TB HDD	Y/N	
	DVD R/W Combo	Y/N	
	4 USB Ports	Y/N	
	2 Serial & 1 Parellel Port	Y/N	
	Windows 7 OS	Y/N	
	Standard Weighing Software	Y/N	
	MS Office	Y/N	
g.	Laser Printer	Yes	
4.0	**CALIBRATION & STAMPING**		
a.	Test Weight for Calibration		
b.	Stamping at site as per weights & measures act		
5.0	**ACCESSORIES**		
a.	Auto Zero Tracking	Yes	
b.	Provision of Tare Facility	Yes	
c.	Arrestors	Yes	
d.	Furniture in control room	Yes	
e	UPS	Yes	
6.0	**TESTS & INSPECTION**	Yes	
a.	Overload test with 150% of specified load	Yes	
b.	Performance test at site	Yes	

MISC PUMPS

S. No.	em	Units	Parameters							
			AHP Pumps	DM Feed pumps	Raw water pumps	Cartridge Filter Feed Pumps	UF Back Wash Pumps	RO Permeate Pumps	Service water Pumps	Potable Water Pumps
1.	Total no. of pumps	Nos.								
2.	Pump capacity	M^3/ hr								
3.	Pump total head excluding losses in the pump	MWC								
4.	Pump speed (max.)	RPM								
5.	Type of pump									
6.	Location									
7.	Type of internal element									
8.	Liquid handled									
9.	Type of line bearing lubrication									
10.	Liquid for lubrication									
11.	Type of pump motor coupling									
12.	Thrust bearing location									
13.	Pump operating range									
14.	Power supply									
15.	Materials of construction									
a.	Pump column pipe									

S. No.	em	Units	Parameters							
			AHP Pumps	DM Feed pumps	Raw water pumps	Cartridge Filter Feed Pumps	UF Back Wash Pumps	RO Permeate Pumps	Service water Pumps	Potable Water Pumps
b.	Pump bowl and discharge elbow									
c.	Impeller									
d.	Shaft									
e.	Line shaft coupling									
f.	Line shaft bearing									
g.	All hardware under water									
h.	Base plate									
i.	Shaft sleeve									
j.	Thrust bearing cooling system pipes and valves									

ELECTRICAL

1.00.00 GENERATOR AND ACCESSORIES

S. No.	Description		UNIT
1.00.00	Maximum continuous output at rated Hydrogen pr.		MVA/MW
1.02.00	Rated terminal voltage		KV
1.03.00	Rated stator current		Amps
1.04.00	Rated frequency		Hertz
1.05.00	Rated power factor		
1.06.00	Rotor current at MCR		Amps
1.07.00	Rotor voltage at MCR		Volts
1.08.00	Maximum continuous permissible variation range in :		
	a) Rated terminal voltage	%	
	b) Rated frequency	%	
	c) Combined permissible variation of frequency and voltage	%	
1.09.00	Number of :		
	a) Phases		
	b) Number of parallel paths/phase		
	c) Line terminals brought out		
	d) Neutral terminals brought out		
1.10.00	Generator efficiency at:		
	a) 100% load	%	
	b) 80% load	%	
	c) 60% load	%	

1.11.00	Performance data for short circuit ratio corresponding to maximum capability		
1.12.00	Regulation at:		
	a) Unity power factor		
	b) 0.85 lag power factor		
1.13.00	Rated Hydrogen pressure: (Gauge)		Kg/cm^2
1.14.00	Cooling water flow at normal load	m^3/hr	
1.15.00	Symmetrical run short circuit current with generator isolated initial saturated value and sustained value		
	a) 3 phase		kA
	b) Single phase to neutral		kA
1.16.00	3 phase short circuit withstand time for:		Secs
1.17.00	Permissible unbalanced loading subject to rate current not being exceeded in any phase.		
	a) Maximum continuous negative phase sequence current I2		amps
	b) Minimum value of I_2^2t for transient operation under system fault conditions (where 't' in seconds)		
1.18.00	Generator reactance, per unit at rated kV and MVA		Unsaturated Saturated
1.18.01	Direct axis synchronous reactance		Xd
1.18.02	Quadrature axis synchronous reactance		Xq

1.18.03	Direct axis transient reactance	X'd
1.18.04	Quadrature axis transient reactance	X'q
1.18.05	Direct axis sub-transient reactance	X"d
1.18.06	Quadrature axis sub-transient reactance,	X"q
1.18.07	Negative phase sequence reactance	X_2
1.18.08	Zero phase sequence reactance	Xo
1.18.09	Potier reactance	Xp
1.18.10	Leakage reactance	XL
	a) Combined	
	b) Stator	
	c) Rotor	
	d) Damper	
1.18.11	Permissible tolerance in all guaranteed reactance values	%(+)
1.18.12	Synchronous impedance	ohms
1.18.13	a) X/R ratio from fundamental to 20th harmonic	
	b) Harmonic impedance at each harmonic upto 20th harmonic	
	c) Permissible current at each harmonic other than fundamental	
1.19.00	Armature resistance per phase at :	
	a) 25 deg. C	ohms
	b) 75 deg. C	ohms
1.20.00	Field resistance per phase at :	
	a) 25 deg. C	ohms

	b) 75 deg. C	ohms
1.21.00	Effective negative sequence resistance	
1.22.00	Time constants	
1.22.01	Direct axis open circuit time constant T'do	Sec.
1.22.02	Direct axis 3 phase transient short circuit time constant T'd3	Sec.
1.22.03	Direct axis 2 phase transient short circuit time constant T'd2	Sec.
1.22.04	Direct axis 1 phase transient short circuit time constant T'd1	Sec.
1.22.05	Direct axis sub-transient short circuit time constant T"d	Sec.
1.22.06	A-periodic 3 phase short circuit time constant Ta3	Sec.
1.22.07	A-periodic 2 phase short circuit time constant Ta2	Sec.
1.22.08	A-periodic 1 phase short circuit time constant Ta1	Sec.
1.22.09	Armature winding short circuit time constant Ta	Sec.
1.22.10	Quadrature axis transient open circuit time constant T'qo	Sec.
1.22.11	Direct axis transient short circuit time constant T'd	Sec.
1.22.12	Direct axis sub-transient open circuit time constant T"do	Sec.
1.22.13	Quadrature axis sub-transient open circuit time constant T"q0	Sec.
1.22.14	Quardrature axis sub-transient short circuit time constant T"q	Sec.

1.22.15	Direct axis open circuit excitation winding time constant Tfdo		Sec.
1.22.16	Direct axis open circuit equivalent damper circuit time constant Tkdo		Sec.
1.22.17	Direct axis short circuit excitation winding time constant Tfd		Sec.
1.22.18	Direct axis short circuit equivalent damper winding time constant Tkd		Sec.
1.22.19	Acceleration time Tj		Sec.
1.22.20	Stored energy constant H		KW sec /KVA
1.23.00	Maximum temperature with the secondary cooling water inlet temperature as 34 deg C		
1.23.01	Maximum absolute temperatures when generator delivers 800 MW at 0.8 p.f. at its terminals.		
	a) Stator windings		deg. C
	b) Stator core		
	i) In contact with insulated winding		deg. C
	ii) Not in contact with insulated winding		deg. C
	c) Stator teeth temperature		deg. C
	d) Rotor windings		deg. C
	e) Mechanical parts in contact with or adjacent to insulation		deg. C

f)	Damper winding	deg. C	
g)	Rotor surface	deg. C	
h)	Other miscellaneous parts	deg. C	
i)	Cooled gas	deg. C	
j)	Hot gas in the stator and rotor	deg. C	
k)	Water to inlet of gas/air cooler	deg. C	
l)	Water at outlet of gas/air cooler	deg. C	

1.23.02 Maximum absolute temperatures when generator delivers maximum capability of the turbine (with Vwo, HP heaters out, over-pressure conditions etc.) at 0.8 p.f. at its terminals and items (a) to (l) covered under Cl.1.23.01

1.24.00 Generator losses,'also indicate where one loss components is included in the another one. Give curves for various losses Vs. load as above at different hydrogen pressure

i)	No load loss		
	a) Iron loss	kW	
	b) Rotor copper loss		kW
ii)	Full load loss		
	a) Iron loss		kW
	b) Stator copper loss		kW
	c) Stray load loss		kW
	d) Rotor copper loss		kW

e) Friction and windage loss kW

f) Mechanical losses including bearing losses kW

g) Exciter and exciter rheostat losses kW

h) Collector brush contact losses kW

i) Rotary rectifier losses kW

j) Fan loss kW

k) Shaft seal loss kW

l) Eddy current loss kW

m) Total loss at full load kW

n) Any other loss (indicate) kW

1.25.00 Dissipation losses in

a) Hydrogen/air cooler

b) Seal oil cooler

c) Exciter air cooler

d) Excitation system panels

1.26.00 Generator efficiency at 50% loading.

1.27.00 Type of stator winding connections.

1.28.00 Synchronous speed

1.29.00 Degree of protection.

1.30.00 Type of cooling of stator core, stator winding, rotor.

1.31.00 Symmetrical run short circuit current with generator isolated initial saturated value and sustained value for:

a) Max. initial short ckt current (peak).
b) Steady state 3 phase short ckt. Current.

1.32.00 Saturation factor.

1.33.00 Waveform factor.

1.34.00 Permissible unbalanced loading subject to rated current not being exceeded in any phase.

1.35.00 Maximum permissible capacitive loading at rated load & voltage.

1.36.00 Maximum permissible capacitive loading (zero lead)

1.37.00 Maximum permissible inductive loading (zero lag)

1.38.00 Regulation at: 0.85 PF lead.

1.39.00 Generator short time overload capability

1.40.00 Over speed capability.

1.41.00 Details of fire protection provided for generator with wrire-up.

1.42.00 Stored Energy Constant (H)

- Generator + Exciter - kW.sec / kVA
- Complete TG - kW.sec/ kVA

2.00.00 ADDITIONAL DATA:

2.01.00 Permissible overload and duration

2.02.00 "Rapid defluxing" time and the technique used.

2.03.00 Surge capacitor requirement for the generator must be stated with reasons.

2.04.00 What provisions are made for automatic generator runback (turbine control point set back) and loss of cooling?

2.05.00 To what power level is runback required and what time is allowed for runback

2.06.00 Furnish permissible volts/ HZ vs time characteristic of the generator

2.07.00 Furnish the no-load saturation and zero Power-factor saturation curve for AC exciter used for brushless excitation system, if proposed. Details of Generator rotor winding temperature monitoring system and rotor winding earth fault detection system

2.08.00
a) Performance (transient and steady state) characteristics.
b) Initial high response characteristics
c) Excitation control system
d) Exciter ratings (where applicable)
e) Performance record as per relevant clause of specs.
f) List of instruments provided

2.09.00 Describe the performance characteristics of voltage regulator, proposed for this generator.

2.10.00 Provide dimensioned general arrangement drawings for the following equipment :

a) Seal oil tank
b) Hydrogen Coolers

2.11.00 Details of generator neutral grounding system

2.12.00 Furnish the schematic diagram of excitation system, giving its controls & interface with automatic voltage regulation.

2.13.00 Type of Cooling:

a) Stator winding
b) Stator Core
c) Rotor

2.14.00 Rated Output MW

2.15.00 Transient rise of voltage on sudden rejection of full load at rated power factor

	a) with AVR	P.U.
	b) without AVR	P.U.
2.16.00	Zero sequence Resistance	
2.17.00	Inertia constant H	(KW-Sec/KVA)
	a) Generator & Exciter	
	b) Complete turbine generator unit	
2.18.00	Short circuit Current (P.U)	
2.18.01	Subtransient current	
	a) on 3 phase short circuit	
	b) on 2 phase short circuit	
	c) on 1 phase short circuit	
2.18.02	Transient Current	
	a) on 3 phase short circuit	
	b) on 2 phase short circuit	
	c) on 1 phase short circuit	
2.18.03	Steady state current	
	a) on 3 phase short circuit	
	b) on 2 phase short circuit	
	c) on 1 phase short circuit	
2.19.01	Whether specified earth fault current and duration as per specification	Yes/No
2.19.02	Indicate values of earth current and duration	
2.20.00	Voltage regulation under conditions of rated speed voltage & output (%)	
	a) at 0.8 power factor lag	
	b) at unity power factor	
	c) at 0.90 power factor lead	
2.21.00	Maximum continuous KVA capacity of generator	

- with one cooler out of operation

2.22.00 Maximum inductive capacity (KVAR)

2.23.00 Excitation requirements at

a) Rated load
b) No load
c) At maximum capacitive load (at Zero Active power)
d) Under field forcing condition

2.24.00 Short circuit torque as a ratio of full load torque

2.25.00 Fly wheel moment (GD^2) of generator + exciter (Kg m2)

2.26.00 Capacity of space heaters at 415 V where applicable (KW)

2.27.00 Number, type and rating of CT's and PT's used exclusively for EHG and generator excitation system

Design and construction features

2.28.01 Stator Core

a) Type of spring mounting

b) Grade of sheet steel (Thickness & loss figure)
c) Stator core outer diameter
d) Stator core length
e) Air gap
f) Flux density
g) Stator teeth
h) Rotor core
i) Rotor teeth

2.28.02 Stator Windings

a) Type and Class of insulation

b) Resistance per phase at 20 deg.C ohm
c) Capacitance per phase
d) Dielectric Test Voltage
Value kV
e) Impulse voltage strength kV
peak (for wave shape of
1.2/50 micro sec)
f) Is the winding transposed in
the ends ?

2.28.03 Terminals

a) No. of terminals brought out
b) Type of cooling of terminals and
connectors
c) Type of terminal bushings

d) Number of distributed multi-
ratio bushing CT's & relaying
accuracy class that is
accommodated in the bushing
furnished

e) Dielectric Test Voltage - kV

f) Impulse Voltage strength- kV
(for a wave shape of 1.2/50 micro sec.)

2.28.04 Rotor

a) Material of rotor forging
b) Material of retaining ring forging
c) Material of rotor wedge
d) Type of retaining ring mounting
e) Material of Damper winding
f) Overspeed Test Value and duration

2.28.05 Rotor Winding

a) Class & Type of insulation
b) Turns per pole
c) Resistance at 20 deg.C (ohms)
d) Dielectric Test Voltage kV
value

2.28.06 Bearing

a) Type of bearing (Pedestal/End Shield)
b) Oil quantity per bearing — m3/hr
c) Oil pressure — kg/cm2
d) Grade of Oil

2.28.07 Shaft Seal

a) Type of seal
b) Pressure of Seal oil — kg/cm2
c) Grade of oil
d) Quantity of oil per seal — m3/hr

2.28.08 Gas/Air Coolers

a) Number of Coolers
b) Material of
   i) Tubes
   ii) Fins
c) Material of tube plate
d) Quantity of Cooling water required/cooler — m3/hr
e) Material of water boxes
f) Pressure drop across cooler on water side — MWC

2.29.00 AUTOMATIC VOLTAGE REGULATORS

a) Manufacturer
b) Type
c) Power supply to the regulator — Volts
d) Range of generator voltage adjustment — %
   i) in auto position
   ii) in manual position
e) Frequency range of operation — Hz
f) Temperature range of operation — deg.C
g) Accuracy — %
h) Dead band
i) Excitation system response time with AVR
j) Time required for generator terminal voltage to get restored to within 2% of the nominal preset value when

subject to sudden loss of rated output.

k) Number of auto and manual channel

l) Whether following features/monitors provided.

- Auto synchronizer
- Field earth fault monitoring
- On-line shaft leakage current/ voltage Monitoring Device

2.30.00	EXCITATION SYSTEM		
2.30.01	Type of excitation system offered		
2.30.02	Nominal field voltage	Volts	
2.30.03	Maximum field voltage	Volts	
2.30.04	Ceiling /Field forcing voltage	Volts	
2.30.05	Minimum and maximum filed current With generator at no load and with With generator on 100 % load	Amp	
2.30.06	Range of voltage control in auto		
2.30.07	Frequency range of operation		
2.30.08	Range of excitation control in manual		
2.30.09	Accuracy of voltage control		
2.30.10	Response ratio		
2.30.11	Excitation System Cooling		
	1) Type of cooling		
	2) If air, forced or natural i) AVR Panels ii) Other Panels		
	3) If force, No. of fans each 100% duty.	Nos.	
	4) Whether automatic changeover of fans provided or not?		
	d) Whether standby fan provided to achieve 100% duty.	Yes/No	Required
2.31.00	GENERATOR FIELD CHARACTERISTICS		
2.31.01	With generator at no load and rated voltage	VA	
2.31.02	With generator at 125 % of MCR	VA	
2.31.03	With generator at rated load and rated voltage		
2.31.04	Rated P.F		
2.31.05	Unity P.F.		

2.32.00 BRUSHLESS EXCITATION SYSTEM (If applicable)

2.32.01 Pilot Excitor

a)	Manufacturer		
b)	Type		
c)	Type of drive		
d)	Normal Speed	rpm	
e)	Rated Voltage	Volts	
f)	Rated frequency	amp	
g)	Rated current	amp	
h)	Type of insulation		

2.32.02 Rectifier for pilot excitor

a)	Manufacturer		
b)	Type		
c)	Rated rectifier voltage	Volts	
d)	Rated rectifier current	amp	
e)	Ceiling rectifier current	amp	
f)	Ceiling rectified current	amp	
g)	Total number of rectifier cells per parallel path of a bridge		
h)	Number of parallel paths per bridge arm		
i)	No. of bridge arms		
j)	Maximum peak inverse voltage rating of a cell	Volts	

k) Method of over voltage protection

l) Maximum number of bridges/rectifier cells without which the rectifier can give output corresponding to generator MCR

2.32.03 Main Excitor

a)	Manufacturer	
b)	Type	
c)	Type of drive	
d)	Normal speed	rpm
e)	Rated rectified voltage	Volts
f)	Rated rectified current	amp
g)	Ceiling rectified voltage	Volts
h)	Ceiling rectified current	amp
i)	Excitor field voltage with manual control (rectified)	
	i) Maximum	Volts
	ii) Minimum	Volts
j)	Field current at generator MCR and rated power factor lagging	amp
k)	Nominal excitor response ratio	
l)	Class of insulation	
m)	Insulation material on	

rotor winding

n) Insulation material on field winding

o) Type of end winding support

p) Maximum temperature with secondary cooling water temperature of 31 deg.C

i) Excitor stator winding in contact with insulation

ii) Excitor stator winding not in contact with insulation

iii) Rotor winding

2.32.04 Excitor rectifier assembly

a) Manufacturer

b) Type of rectifier

c) Total number of rectifier cells per ring

d) Number of parallel paths per bridge arm

e) Number of bridge arms

f) Maximum number of rectifier cells/bridge without which the rectifier can give output corresponding to generator MCR

g) Maximum peak inverse voltage rating of cell Volts

h) Number of rectifier cells

in series in each bridge arms

i) Method of overvoltage protection

j) Overload rating of the rectifier cell

k) Ceiling output voltage of rectifier assembly — Volts

l) Ceiling output current of rectifier assembly — amp

m) Maximum junction temperature of rectifier cells

n) Method of mounting cells to cooling fins

o) Make and type of cooling fins

p) Type of visual indication provided for faulty rectifier cells

2.32.05 Air/Water Coolers (For Excitor)

a) Number of Coolers

b) Material of

i) Tubes

ii) Fins

c) Material of tube plates

d) Material of water boxes

e) Quantity of circulating water required per cooler — m3/hr

f) Maximum allowable water temperature — deg.C

	g)	Pressure drop across the cooler on water side	mwc
2.33.00		STATIC EXCITATION SYSTEM (if applicable)	
2.33.01		No. and type of static excitation transformers provided	
2.33.02		Rating of Excitation transformers	
	i.	Power	MVA
	ii.	Voltage Ratio	kV/V
	iii.	Current rating on primary and secondary	Amps
2.33.03		Insulation class of excitation transformer	
2.33.04		Type of cooling for transformer cubicle/ Thyristors /Rectifier cubicles	
2.33.05		Transformer drop/ Drop compensation	
2.33.06		Degree of protection	
2.33.07		Partial Discharge	
2.33.08		Vector group of excitation transformer	
2.34.00		GAS SYSTEM	
	a)	Volume of Hydrogen space in generator	m3
	b)	Cooling gas flow	m3/min
	c)	Volume of CO2 at NTP required for displacing air	m3
	d)	Volume of CO2 at NTP required for displacing hydrogen	m3
	e)	Volume of H2 at NTP required for displacing carbon-di-oxide and to bring the casing to the rated pressure	m3
	f)	Purity of H2 required	%
	i)	Normal	
	ii)	Minimum allowable	
	g)	Leakage of H2 by volume at NTP per day at rated H2 pressure in the generator	
	h)	Is Nitrogen required to displace CO2 in the generator	
	i)	Volume of air at NTP required to displace CO2	m3
	j)	Requirement of	

compressed air for
gas tightness test
k) No. of cylinders
proposed to be furnished

i) Hydrogen
ii) Carbon dioxide
iii) Nitrogen (if required)

l) Standards to which the
cylinders conform
i) Hydrogen
ii) Carbon dioxide
iii) Nitrogen (if required)

m) Internal volume of the cylinder
i) Hydrogen
ii) Carbon dioxide
iii) Nitrogen (if system require)

2.35.00 SEAL OIL SYSTEM

2.35.01 Seal Oil Pump Motor Set

a)	Type	
b)	Numbers	
c)	Capacity	m3/hr
d)	Discharge pressure (gauge)	kg/cm2
e)	Shut-off Head	mwc
f)	Size of motor	kW

2.35.02 Vapour extraction unit
(in seal oil drain)
on air side stream

a)	Type	
b)	Capacity	m3/hr
c)	Size of motor	kW

2.35.03 Vapour extractor motor set

a) Type
b) Numbers
c) Capacity
d) Discharge pressure
e) Shut-off head
f) Seal oil flow and pressure

	required for normal operation	
2.36.00	MAIN WEIGHTS :	
	a) Heaviest lift of generator stator with trunnions etc.	
	b) Weight of complete generator stator	Tonnes
	c) Weight of complete rotor	Tonnes
	d) Weight of complete generator	Tonnes
	e) Weight of lifting beam assembly	Tonnes
2.37.00	Critical speeds for Generator + excitor (if any)	rpm
	a) First	
	b) Second	
	c) Third	
2.38.00	MOTORS (rated above 50 kW) (attach separate data sheet for separate motors)	
2.38.01	Equipment driven by motor	
2.38.02	Rated output for 50 deg.C ambient air/31 deg.C cooling water temperature	kw
2.38.03	Temperature rise at rated output conditions as in item 2.40.02 above	deg.C
2.38.04	Class and type of insulation	
2.38.05	Rated voltage	Volts
2.38.06	Efficiency at rated output	%
2.38.07	Power factor at rated output	

2.38.08	Rated current	amp.
2.38.09	Locked_Rotor_kVA (Indicate the Rated output kW upper limit)	
2.38.10	Upper limit of locked rotor current	amp.
2.38.11	Whether motor is capable of two successive hot starts with the driven equipment coupled	
2.38.12	Rated speed	rpm
2.38.13	Rated torque	
2.38.14	Starting torque	
2.38.15	Pull out torque	
2.38.16	Type of enclosure, degree of protection and method of cooling	
2.38.17	Type of terminal box for stator leads	
2.38.18	Bearing type	
2.39.00	Rotor Earth fault protection	
2.39.01	Whether for single earth fault or for both single and double earth fault	
2.39.02	Make	
2.39.03	Type	
2.39.04	Range	
2.39.05	Requirement of auxiliary supply a. Voltage b. AC/DC c. Frequency d. VA	

2.40.00 Shaft current relay with CT

2.40.01 CT Dia

2.40.02 CT Ratio

2.40.03 CT VA and Accuracy

2.40.04 Core weight

2.40.05 Core dimension

2.40.06 Core material

2.40.07 Relay make and type

2.40.08 Relay range

2.41.00 Exciter Field Breaker

a) Manufacturer
b) Type
c) Rated DC voltage
d) Rated continuous current at 50 deg C design ambient
e) Short time rating
f) No. of main poles
g) Material of main poles
h) No. of arcing contacts
i) Material of arcing contacts
j) Type & material of arcing chutes
k) Closing coil voltage with operating voltage range
l) Tripping coil voltage with operating voltage range

m) Making current
n) Rupturing capacity

2.42.00 Exciter Field discharge resistance

a) Manufacture
b) Type
c) Material
d) Current rating
e) Power rating

2.43.00 Enclosure

	a) Type of enclosure b) Degree of protection c) Type & thickness of sheet steel d) Overall dimensions e) Weight	
3.00.00	CONTROL PANEL/DESK (furnish data separately for each control panel/desk)	
3.01.00	Control panel/Desk (Service)	
3.02.00	Tentative dimensions control panel/desk	mm
3.03.00	Details of components	Make & Type
3.04.00	Contactors (Furnish details for AC & DC separately)	
3.05.00	Timers (Furnish details for AC & DC separately)	
3.06.00	Relay (Furnish details for AC & DC Relays separately)	
3.07.00	Control switch	
3.08.00	Push button	
3.09.00	Ammeter/voltmeter selector switches	
3.10.00	Indicating lamps	
3.11.00	Space heater	
3.12.00	Terminal blocks	
3.13.00	Indicating Instruments	
3.14.00	Wires	

3.15.00 Panel

3.16.00 Annunciator

3.17.00 Whether detail write-up of the scheme furnished

2.00.00 220kV & 400kV SWITCHYARD

(Separate sheets to be filled up for 220kV & 400 kV)

1.0	Switchyard Design & layout		
1.1	Rated voltage (Nominal/Highest)	KV	
1.2	1.2/50 Micro sec impulse withstand voltage.	KVp	
1.3	One minute power frequency withstand voltage	KV	
1.4	Current rating		
	a) continuous for Main buses	Amp	
	b) Phase to Phase	Amp	
	c)Short time withstand current and duration	KA & sec	
1.5	Minimum air clearance		
	a) Phase to phase	mm	
	b) Phase to ground	mm	
	c) Live point to ground	mm	
	d) Section clearance	Mm	
1.6	Bay width	M	
1.7	Phase to Phase spacing	M	
1.8	Size of the I) switchyard	L x B	
	ii) Switchyard building	LxBxHT	
1.9	Design tensions		
	a) Main bus	Kg	
	b) Bay bus	Kg	
	c) Overhead conductors for GT, ICT & ST connection	Kg	
1.10	Total creepage distance for all	mm	

	equipment – Indoor -- Outdoor		
1.11	Protected creepage distance	Mm	
1.12	Factor of safety adopted for the structural design		
	a) Normal condition		
	b) Short circuit condition		
	c)Seismic condition		
1.13	Type of design for Main & Bay buses		
	a) Strung bus or tubular bus		
	b) Material		
1.14	System Frequency & variation		
1.15	Radio Interference Voltage		
2.0	**400 KV Circuit Breakers**		
2.1	Make, type country of manufacture		
2.2	Applicable standard		
2.3	Rated voltage	KV	
2.4	Type of circuit breaker (SF6)		
2.5	Reference ambient temperature	50°C	
2.6	Rated continuous current	Amp	
2.7	Rated short circuit breaking current and rated making current.	KA	
2.8	Temperature rise of contacts over an ambient of 45°C while carrying rated current.	°C	
2.9	Rated operating duty		
2.10	Total break time	Msec	
2.11	Total make time	Msec	

2.12	Rated transient recovery voltage for terminal fault	KV	
2.13	Rated transient recovery voltage for short line faults	KV	
2.14	No. of breaks in series		
2.15	Insulation level		
	a)One minute P.F withstand voltage	KV	
	b) impulse withstand voltage.	KVp	
	c)Switching surge withstand voltage.	KVp	
2.16	Minimum clearance in air:		
	a) Between live parts	Mm	
	b) Between live part & earth	Mm	
	c) Centre to centre distance between phases.	mm	
2.17	Fixed trip or trip free		
2.18	Type of operating mechanism		
2.19	Normal method of tripping		
2.20	Emergency method of tripping		
2.21	No. of trip coils per phase		
2.22	Range of voltage for		
	a) Trip coils		
	b) Closing coils		
2.23	Rated line charging current		
2.24	Rated cable charging current		
2.25	Maximum over voltage when		

	switching off		
	a) Unloaded transformer		
	b) Unloaded lines		
	c) Cable charging		
	d) Capacitor banks		
2.26	When switching off a synchronous system.		
	a) Maximum current		
	b) Maximum recovery voltage between contacts		
2.27	No. of operating circuit breaker can perform without inspection, replacement of contacts		
	a) At rated breaking current		
	b) At rated continuous current		
2.28	Creepage distance for the interrupter insulator	mm	
2.29	Cantilever distance for the interrupter insulator		
2.30	Whether pressure switches for SF6		
2.31	Compressed air system details		
	a) Type(unit/centralised)		
	b) Rated pressure		
	c) Time for the compressor to charge to reservoir from atmospheric pressure.		
	d) Time for the compressor to charge to reservoir from starting pressure to rated.		
	e) Number of stored close open operated before lockout pressure is reached.		
	f) Whether pressure, switches for		

	start, stop of compressor, high, low alarm, close lockout, open lockout, auto reclose lockout provided.		
3.0	**400KV Isolators**		
3.1	Make, type and country of manufacture		
3.2	Reference standard		
3.3	Rated voltage & frequency	Volts, Hz	
3.4	Rated current	Amps	
3.5	Reference ambient temperature	°C	
3.6	Short time withstand current & duration	KA.sec	
3.7	Dynamic withstand current	kAp	
3.8	Maximum temperature rise of current carrying parts.		
3.9	**Insulation test values**		
	One minute PF wet withstand voltage		
	i) Between poles & earth	kV	
	ii) Across isolating distance	kV	
	b) Impulse withstand voltage		
	i) Between poles & earth	kVp	
	ii) Across isolating distance	kVp	
3.10	**Material**		
	a) Main contact		
	b) Arcing contact		
	c) current carrying parts		
3.11	Whether contacts are silver faced		
3.12	**Clearance**		
	a) Between poles	mm	
	b) Between live parts and earth	mm	
	c) Between live parts when switch is open		
	i) Between same pole	mm	

	ii) Between adjacent poles	mm	
3.13	Phase spacing	mm	
3.14	**Type of interlock**		
	a) External		
	b) Earth switch		
3.15	**Insulators**		
	a) Type of insulator (solid core)		
	b) Cantilever strength		
	c) Total creepage distance		
	d) Applicable standards		
3.16	**Operating mechanism (motor / manual)**		
	a) Main blade		
	b) Earth blade		
4.0	400KV & 220 KV current transformer		
4.1	Make & country of manufacture		
4.2	Applicable standards		
4.3	Rated voltage class		
4.4	**Insulation withstand level**		
	a) Impulse withstand voltage 1.2/50 microsecond wave	KV peak	
	b) One minute power frequencies withstand voltage.	KV rms	
4.5	Number of cores per CT		
4.6	Rated secondary current for each withstand voltage		
	Core 1	A	
	Core 2	A	
	Core 3	A	
	Core 4	A	
	Core 5	A	
	Core 6	A	
4.7	**Ratio taps for each core**		
	Core 1		
	Core 2		
	Core 3		

	Core 4		
	Core 5		
	Core 6		
4.8	Whether it is possible to adjust tap setting of any core independent of other cores	Yes/No	
4.9	**Relaying cores**		
	a) Accuracy class (for 5P20)		
	b) Rated burden (for 5P20)	VA	
	c) Accuracy limit factor (5P20)		
	d) Minimum knee point voltage VK, VK/2 volts (for PS class)		
	e) Max. excitation current at Vk,Vk/2(for PS class)	V	
	f) Max. secondary resistance for PS class)		
4.10	**For metering cores:**		
	a) Accuracy class		
	b) Rated burden		
	c) Rated power factor	VA	
	d) Instrument security factor		
4.11	**Short time thermal current rating**		
	a) Current	kA	
	b) Rated time	Sec	
4.12	Dynamic current rating	kA peak	
4.13	Maximum temperature rise of windings at rated burden, when referred to specified ambient temperature	°C	
4.14	Class of insulation of windings		
4.15	Radio influence voltage (for CTs rated at 400KV and above)	V	
4.16	Cantilever strength at terminal	Kg	
4.17	Creepage distance of insulator	M	

	housing		
5.0	**Capacitive voltage transformer**		
5.1	Manufacturer and country of manufacture		
5.2	Applicable standards		
5.3	Type of VT		
5.4	**Insulation withstand level**		
5.4.1	Impulse withstand voltage 1.20/50 micro sec.	kV peak	
5.4.2	One minute power frequency withstand voltage	kV rms	
5.5	Number of secondary windings for each VT		
5.6	Rated primary voltage	kV	
5.7	Rated secondary voltage	V	
5.8	Rated VA burden for each secondary windings	VA	
5.9	Rated power factor		
5.10	Accuracy class for each secondary winding		
5.10.1	Winding-1		
5.10.2	Winding -2		
5.10.3	Winding-3		
5.11	**Method of connection**		
5.11.1	Primary winding		
5.11.2	Each secondary winding		
	a) Winding-1		
	b) Winding -2		
	c) Winding-3		
5.12	Rated voltage factor		
5.13	Maximum temperature rise of windings at 110% excitation and	°C	

	rated burden, when referred to specified ambient temperature.		
5.14	Class of insulation of windings		
5.15	***Capacitor data***		
5.15.1	High voltage capacitance	pF	
5.15.2	Intermediate voltage capacitance	pF	
5.15.3	Nominal intermediate voltage	kV	
5.15.4	Equivalent capacitance for carrier coupling	pF	
5.15.5	Maximum permissible impedance at power frequency	Ohms	
5.16	Total creepage distance	mm	
5.17	Radio influence voltage	Volts	
5.18	Details of high speed switch on secondary winding (alternative to fuses)		
5.18.1	Make, type, rating, coil rating, other technical details.	Amp	
5.19	Cantilever strength	Kg	
6.0	**Lightning arresters**		
6.1	Maker's Name and Type and country of manufacture		
6.2	Arrester type		
6.3	Applicable standards		
6.4	Arrester class		
6.5	Rated arrester voltage	kV	
6.6	Rated frequency	Hz	
6.7	Nominal discharge current (8/20 micro seconds wave)	kA	
6.8	Minimum discharge capability	kJ/kV	

6.9	**Residual voltage corresponding to**	kV(peak)	
6.9.1	Steep current impulse		
6.9.2	Lightning impulse		
6.9.3	Switching impulse		
6.10	Reference current	A	
6.11	Reference voltage	kV (rms)	
6.12	Over voltage withstand capability for:		
	a) 10 cycles	kV (rms)	
	b) 1second	kV(rms)	
	c) continuous	kV(rms)	
6.13	Energy discharge capacity	kJ/kV	
6.14	Maximum residual voltage at nominal discharge current	kV(rms)	
6.15	Discharge voltage at 5KA discharge current	kV(peak)	
6.16	Discharge voltage at 10KA discharge current	kV(peak)	
6.17	Discharge voltage at 20KA discharge current	kV(peak)	
6.18	**Impulse current withstand**		
	a) High current short duration (4/10 micro second wave)	kV (peak)	
	b) low current long duration	A (peak)	
	c) Virtual duration of rectangular wave	Micro-second	
6.19	One minute power frequency (dry) withstand voltage of arrester housing	kV(rms)	
6.20	Impulses withstand test voltage	kV	

	of arrester housing with 1.2/50 microsecond wave.	(peak)	
6.21	Total creepage distance of whole arrester housing	mm	
6.22	Cantilever strength of complete arrester	Kg	
6.23	Pressure relief class (as per IEC 60099)		
6.24	**Routine tests**		
	a) Measurement of reference voltage test	Yes/No	
	b) Residual voltage test	Yes/No	
	c) Leakage check for arrester units with sealed housing.	Yes/No	
	d) Current distribution test for multi-column arrester	Yes/No	
6.25	**Acceptance tests**		
	a) Measurement of power frequency voltage on the complete arrester at the reference current measured at the bottom of the arrester	Yes/No	
	b) Lightning impulse residual voltage on the complete arrester or arrester unit at nominal discharge current	Yes/No	
	c) Partial discharge test at 1.05 times continuous operating voltage	Yes/No	
7.0	**Insulator and hardware (Fill in for bus post Insulator as well as Insulator string)**		
7.1	**Insulator / Insulator string**		
	Manufacturer and country of manufacture		
	b) Applicable standard		
	c) Type of insulator (Antifog / normal)		
	d) Insulating material		

	e) No. of units per string		
	f) Creepage distance i) disc unit ii) string assembly	 mm mm	
	g) One minute power frequency withstand dry i) Single desk ii) String assembly / bus post	 kV kV	
	h) One minute power frequency withstand (wet) i) Disk unit ii) String assembly / bus post	 kV kV	
	i) Impulse withstand voltage (dry) i) Disk unit ii) String assembly / bus post	 kVp kVp	
	j) Impulse withstand voltage (wet) i) Disk unit ii) String assembly / bus post	 kVp kVp	
	k) Electro mechanical strength of each disk	Kg	
	l) Live parts to earth clearance (spark over distance)	mm	
	m) Cantilever strength (for bus post insulator only)	Kg	
	n) Tensile strength (for bus post insulator only)	Kg	
	o) Compression strength (for bus post insulator only)	Kg	
	p) Visual discharge voltage for falling power frequency voltage (string and bus post insulator)	Kg	
7.2	**Insulator Hardware**		

	a) Manufacturer		
	b) Applicable standard		
	c) All ferrous parts are hot dip galvanised.	Yes / No	
8.0	**Bus Conductors, clamps and Connectors**		
8.1	**Flexible Conductor**		
	a) Size of conductor for main bus		
	c) Purity of Aluminium		
8.2	**Tubular Conductor**	Aluminium tube	
	a)Size of the Tubular conductor for main bus bay		
	b) The temperature rise of the tabular conductor while carrying the rated current		
	c) Purity of Aluminium / copper		
8.3	**Shield Wire**		
	a) Material of the shield wire		
	b) Size of the shield wire		
8.4	**Clamps and connectors**		
	a) Whether material specification of the clamps and connectors are as per specification	Yes / No	
	b) Temperature rise of the clamp while carrying the rated current	°C	
	c) Minimum thickness at any part of the clamps	mm	
	d) Corona extinction voltage for falling power frequency voltage	V	
9.0	**400kV Control panel**		
9.1	Desk make country of manufacture		
9.2	Degree of protection for enclosure of desk		

9.3	Applicable standards		
9.4	**Indicating Meters**		
9.4.1	Meter size		
9.4.2	Accuracy		
9.4.3	Type		
9.5	**MWHr / MVARHr meters**		
9.5.1	Accuracy (Required 0.2)		
9.5.2	Whether retransmission contact provided (Required)		
9.6	**Transducers**		
9.6.1	Accuracy		
9.6.2	Output current		
9.6.3	No. of channels		
9.6.4	Type No. & Make		
9.7	Whether annunciator scheme, features, sequence and size are same as the one offered for plant control system.		
9.8	Mimic material and width in mm		
10.0	**400kV Switchyard relay panel**		
10.1	Panel make and country of manufacture		
10.2	Degree of protection for enclosure of panel		
10.3	Mounting of relays		
10.3.1	On conventional panels		
10.3.2	On pre-engineered panel		
10.4	**Relay particulars**		
10.4.1	Control voltage		
10.4.2	Current rating		
10.4.3	Voltage rating		

10.4.4	Operating temperature range		
10.4.5	Applicable standards		
10.4.6	Aux. Supply operating range		
10.4.7	On line automatic testing facility provided		
10.4.8	On line manual testing facility provided		
10.5	Relay types offered (list each relay and furnish the data)		
10.6	All the relays offered are type tested	Yes /No	
10.7	If no which are all not type tested		

3.00.00 INTERCONNECTING TRANSFORMERS

1.0	Type & make	
2.0	Applicable standard	
3.0	Quantity	
4.0	Full load rating	MVA
5.0	System voltage (Nominal/Highest)	kV
5.1	HV	KV
5,2	LV	KV
6.0	Rating of different cooling methods ONAN/ONAF/OFAF	
7.0	Impedance value	%
8.0	Rated frequency	Hz
9.0	Winding connection of different windings and vector group	
10.0	System earthing HV LV Neutral	
11.0	Type of tap changer off circuit / on load	
12.0	Tapping range and number of steps	
13.0	Full power tapping provided	Yes/No
14.0	Type of voltage variation (CFVV/VFVV/CBVV)	
15.0	Over fluxing capability	
16.0	Winding insulation type uniformly or non-uniformly insulated.	
16.1	HV	
16.2	LV	
17.0	Impulse withstand voltage of winding HV/LV	kVp

18.0	Power frequency withstand voltage of winding HV/LV/neutral	kV / rms
19.0	Maximum temperature rise at full load with 100% coolers:	
	Oil	°C
	Winding	°C
20.0	Bushing particulars.	
20.1	Applicable standard for bushing	
20.2	Clearance in air HV/LV/neutral (between phases and phase to earth)	mm
20.3	Quantity of oil filled bushing	litre
20.4	Creepage distance	mm /kV
21.0	No load loss	kW
22.0	Load loss	kW
23.0	Cooler loss	kW
24.0	Efficiency	
	a) At full load	%
	b) At 75% load	%
25.0	No load current	A
26.0	Total estimated weight	Kgs
27.0	OLTC	
27.1	Make	
27.2	Rated voltage	Volts
27.3	Rated current	Amps
27.4	No. of steps	
27.5	Step voltage	Volts
27.6	Time of operation from one step	Sec.

	to other for Auto / manual mode	
28.0	Type of axial and radial coil supports for HV/LV	
29.0	No. of cooler banks and capacity of each cooler bank	
30.0	Guaranteed no load current When excited from LV side at 100% and 110% rated voltage.	Amps
31.0	Max. flux density when rated and 110% rated voltage.	Wb / Sq.m
32.0	Vacuum withstand capability main tank, radiators and accessories	mm of Hg
33.0	Weight	
33.1	Core	Kg
33.2	Net copper Wt. HV/LV	Kg
33.3	Oil	Kg
33.4	Tank, coolers & fittings	Kg
33.5	Total	Kg
33.6	Un-tanking weight	Kg
34.0	Cooling fans rating	kW
35.0	Capability of transformer to remain in operation from hot conditions after failure of forced cooling with full load.	Min.

4.00.00 GENERATOR TRANSFORMER

S. No.	**Description**		
1.00.00	**General**		
1.01.00	Service		
1.02.00	Make		
1.03.00	Type		
1.04.00	Number of windings per phase		
1.05.00	Number of phases		
1.06.00	Reference Standard		
2.00.00	**Rating**		
	- Full load rating - Rating of each winding - Rating no load voltage		HV/LV
2.01.00	Type of cooling		
2.02.00	Rated output	MVA	
	i) With ONAN cooling		
	ii) With ONAF cooling		
	iii) With OFAF cooling		
2.03.00	Rated Voltage	kV	
	L.V. H.V.		
2.04.00	Rated Current		Amps.
	L.V. H.V.		
2.05.00	Rated Frequency		Hz
2.06.00	Voltage Withstand Time		Sec.

a) 110% of rated voltage

b) 120% of rated voltage

c) 125% of rated voltage

d) 130% of rated voltage

e) 140% of rated voltage

f) 150% of rated voltage

2.07.00 Over fluxing Capability Sec.

a) For Over fluxing Factor 1.10

b) For Over fluxing Factor 1.20

c) For Over fluxing Factor 1.25

d) For Over fluxing Factor 1.30

e) For Over fluxing Factor 1.40

f) For Over fluxing Factor 1.50

3.00.00 Temperature

3.01.00 Reference

a) Ambient Temperature (max./max daily/min.)

3.02.00 Temperature rise over reference ambient Deg. C.

a) Of top oil by thermometer

b) Of winding by resistance at OFAF rating

3.03.00 Maximum continuous over loading capacity of transformer without exceeding the specified winding temperature

4.00.00 Tap Changer

4.01.00 Type and make

4.02.00 Capacity

a) Rated voltage
b) Rated current

c) Step voltage

d) No. of steps

4.03.00 Range- Steps X % Variation

4.04.00 Taps provided on HV winding

4.05.00 Number of taps
Auxiliary Power (kW)

4.06.00 Time required for one step change (sec.)

4.07.00 Tap Change motor.

4.08.00 Control circuit

4.09.00 Local manual operation feasible from standing height from ground

4.10.00 a) Local tap position indicator furnished

b) Local operation counter furnished

4.11.00 Provision for padlocking provided

4.12.00 Auxiliary switch for interlock provided as specified

4.13.00 Safety limit switch provided

4.14.00 Are all contacts silver plated

5.00.00 Insulation Level **kVp / kV**
H.V.
L.V.
H.V. Neutral

5.01.00 HV/LV imepedance voltage at rated current

	for the normal tapping HV/LV winding	
5.02.00	HV/LV reactance at rated current and rated frequency	
5.03.00	Separate source power frequency voltage withstand HV/LV winding	
5.04.00	Inducted over voltage withstand HV/LV winding	
5.05.00	Full wave lightening impulse withstand voltage	
6.00.00	**Impedances at Principal Tap at Rated Frequency and 75° C winding temperature**	
6.01.00	Base MVA	
6.02.00	Impedance	
6.03.00	Reactance	
6.04.00	Resistance at 75° C	
6.05.00	Zero sequence Impedance at 75°C	
6.06.00	Capacitance of windings micro farad / phase	
	H.V. - Earth	
	L.V. - Earth	
	H.V - L.V	
7.00.00	**Guaranteed Losses at Principal Tap, Full Load and 75°C.**	**kW**
7.01.00	No Load Losses	
7.02.00	Load Losses	
7.03.00	Cooler Losses	
7.04.00	Tolerance on Losses	

8.00.00	**Efficiency at 75°C and 0.8 power factor lag**	**%**
8.01.00	At full load	
8.02.00	At 3/4 full load	
8.03.00	At 1/2 load	
8.04.00	Maximum Efficiency	
8.05.00	Load and power factor at which the max. efficiency occurs	
9.00.00	**Regulation at full load at 75°C**	
9.01.00	At unity power factor	
9.02 00	At 0.8 power factor lagging	
10.00.00	**No load current referred to HV**	
10.01.00	At 90% rated voltage	
10.02.00	At 100% rated voltage	
10.03.00	At 110% rated voltage	
10.04.00	At 125% rated voltage	
10.05.00	At 140% rated voltage	
11.00.00	**Approximate Maximum Flux Density**	**Web / Sq.m**
11.01.00	At 90% rated voltage	
11.02.00	At 100% rated voltage	
11.03.00	At 110% rated voltage	
11.04.00	At 125% rated voltage	
11.05.00	At 140% rated voltage	
12.00.00	**Maximum Current Density**	**A/Sq.cm**
	H.V.	

L.V.

13.00.00 Cooling System

13.01.00 a)Type of cooling
Input to cooling plant (kW)

b)Number X capacity of
Cooler units furnished

c)No. of cooler units required
for full load operation

13.02.00 Each cooler unit is provided with

a) No. X kW of oil pump motor (running)

b) No of standby pump

c) No. X kW of fan motor(running)

d) No. of standby fan

13.03.00 Motors rated for voltage, phase, frequency

a) Automatic operation of cooler fans provided

b) Automatic operation of cooler pumps provided

13.05.00 Transformer is capable of delivering rated output under following conditions

a) Failure of all pumps and fans of one cooler unit

1) Continuous in % rated MVA

2) Rated output for ---min.

b) Failure of one complete cooler unit including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

c) Failure of all pumps and fans of both cooler units

1) Continuous in % rated MVA

2) Rated output for ---min.

d) Failure of complete cooler system including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

14.00.00 Details of Tank

14.01.00 Material

14.02.00 Thickness of sides mm.

14.03.00 Thickness of bottom mm.

14.04.00 Thickness of cover mm.

14.05.00 Tank Designed for

Vacuum mm of Hg

Pressure kN / Sq.m

15.00.00 Insulating Material

a) H.V Turn

b) L.V Turn

c) H.V - L.V

d) H.V Earth

b) L.V Earth

16.00.00 H.V Winding provided with graded insulation

17.00.00 Insulating Oil (EHV Grade)

17.01.00 Approximate volume Litre

17.02.00 10% excess oil furnished

17.03.00 Oil conforms to

17.04.00 Details of oil furnished

17.05.00 a) Oil preservation system provided

b) Type

c) Quantity of oil in main tank Litre.

d) Quantity of oil for topping of main tank Litres.

e) Quantity of oil for conservator, radiator, pipe work etc. Litres.

f) Total Oil Litres.

g) 10% extra oil Litres

h) Total oil to be dispatched

1) Oil to be dispatched in main tank Litres
2) Dispatched in barrels Litres.

3) Each barrel contains Litres.
4) Total No. of barrels to be dispatched

18.00.00 Bushings

18.01.00 Make

18.02.00 Type

18.03.00 Reference Standard

18.04.00 Voltage Class kV

18.05.00 Type of atmosphere

18.06.00 Creepage Distance mm.

18.07.00 Weight

18.08.00	Free space required for bushing removal	
18.09.00	Test terminals for HV bushings provided	Yes/No
19.00.00	**Minimum Clearance**	
19.01.00	Between Phases	
	a) In air	mm.
	b) In oil	mm.
19.02.00	Between Phase and earth	
	a) In air	mm.
	b) In oil	mm.
20.00.00	**Terminal Connections**	
20.01.00	H V	
20.02.00	L V	
20.03.00	H.V Neutral	
21.00.00	**Marshalling Box**	
21.01.00	Weather proof, suitable for outdoor duty	Yes/No
21.02.00	Degree of protection	
22.00.00	**Terminal Blocks**	
22.01.00	Make	
22.02.00	Type	
22.03.00	20% spare terminals furnished	
23.00.00	**Wiring**	
23.01.00	Cable Type	
23.02.00	Voltage grade	

23.03.00	Conductor		
	a) Size	Sq. mm	
	b) Material		
	c) Stranded		
23.04.00	All wires as per specification provided		
24.00.00	**Ratings of Trip and Alarm contacts**		
24.01.00	Voltage		V
24.02.00	Rated making current		A
24.03.00	Rated breaking current		A
25.00.00	**Accessories**		
25.01.00	Transformer furnished with fittings and accessories as per specification		
26.00.00	**Details of Conservator**		
26.01.00	Volume of conservator		
26.02.00	Volume of oil between the highest and lowest levels		
27.00.00	**Pressure Release Device**		
	a) Minimum pressure the device is set to operate/rupture		kN/Sq.m
	b) Trip contacts provided		
28.00.00	**Approximate Overall Dimensions**		
28.01.00	Length	mm.	
28.02.00	Breadth	mm.	
28.03.00	Height	mm.	
28.04.00	Crane lift for		

	a) Untanking core and coil assembly (including sling)	
	b) Tank cover for bell type tank	mm.
29.00.00	**Approximate Weights**	
29.01.00	Core and coil	Kg.
29.02.00	Tank cover for bell type tank	Kg.
29.03.00	Tank and fittings	Kg.
29.04.00	Oil	Kg
29.05.00	Total Weight	Kg.
30.00.00	**Shipping Data**	
30.01.00	Weight of the heaviest package	Kg.
30.02.00	Dimension of the largest package (LXBXH)	mm.
31.00.00	**Bushing Current Transformer**	
31.01.00	**General**	
31.00.01	Make	
31.00.02	Type	
31.00.03	Reference Standard	
31.00.04	Use	
31.02.00	**Rating**	
31.02.01	CT Ratio	
31.02.02	Class	
31.02.03	Insulation Level	
31.02.04	Burden	

31.03.00	**Insulation Class**	
31.03.01	Temperature Rise at rated overburden over top oil temperature	Deg.C
31.04.00	**Characteristics**	
31.04.01	Secondary Resistance R_{CT} at 75Deg.C	Ohm
31.04.02	Knee Point Voltage Vk	Volt
31.04.03	Excitation Current at Vk/2	Amps
31.05.00	**Dimensions and Weights**	
31.05.01	Dimension (LxBxH)	mm
31.05.02	Weight	Kg
31.06.00	**Tests**	**As Per Standard**

5.00.00 **GENERATOR BUSDUCT AND NEUTRAL GROUNDING EQUIPMENTS**

S. No.	**Description**		
1.00.00	**General**		
1.01.00	Service		
1.02.00	Manufacturer		
1.03.00	Installation		
1.04.00	Specifications and Standards		
1.05.00	Degree of Protection		
1.06.00	Design ambient temperature	(°C)	
1.07.00	System particulars		
2.00.00	**Busducts**		
2.01.00	Type		
2.02.00	Installation		
2.03.00	Rated voltage:		
2.03.01	Nominal		(kV)
2.03.02	Maximum Insulation level		(kV)
2.04.00	Number of phases		
2.05.00	Frequency		(Hz)
2.06.00	Rated Current		
2.06.01	Continuous		(A)
2.06.02	Short time thermal		
	1. One (1) second		(kA)
	2. Three (3) second		(kA)
2.06.03	Dynamic		(kA peak)

2.07.00	Type of cooling		
2.08.00	Maximum temperature rise over design ambient temperature		
2.08.01	Busbars :		
	1. With silver plated joints	(°C)	
	2. With plain joints	(°C)	
2.08.02	Enclosure		(°C)
2.08.03	Supporting Structure	(°C)	
2.09.00	Guaranteed calculated losses per set of bus duct three phase at rated current and frequency without any positive tolerance for		
	a) Conductor		
	b) Enclosure		
	c) Total		
2.09.01	Total Losses at rated current & frequency in watt /meter/phase		
	1. Main run		
	2. Tap off run		
2.10.00	One (1) minute power frequency withstand voltage		
2.10.01	Dry	(kV)	
2.10.02	Wet	(kV)	
2.11.00	Impulse withstand voltage (1.2x50 microsecond wave)		
2.11.01	Positive	(kV peak)	
2.11.02	Negative	(kV peak)	

2.12.00	DC Resistance per phase (Ohms) per metre of busbar length at twenty (20) degrees Centigrade ambient temperature a. Main Run b. Tap off Run	
2.12.01	Skin effect ratio	
2.13.00	Inductance per phase per metre at twenty (20) degrees Centigrade ambient temperature	(henry)
2.14.00	Capacitance to ground per phase per metre at twenty (20) degrees Centigrade ambient temperature	(micro-farads
2.15.00	Material :	
2.15.01	Busbar	
2.15.02	Joints	

1. Whether all joints silver plated
2. How are bimetallic joints prevented from galvanic action ?

2.15.03	Flexible termination	
2.15.04	Bolts, nuts and washers for	

1. Copper to copper joint
2. Aluminium to aluminium joint
3. Aluminium to copper joint

2.15.05	Busduct enclosure	
2.15.06	Phase Barriers	
2.16.00	Busbar :	
2.16.01	Cross/sectional area and shape of Busbar	(mm^2)

2.16.02	Current density	(A/mm^2)
2.16.03	Conductivity	(mhos/cm)
2.16.04	Tensile strength	(Kg/cm2)
2.16.05	Silver coating at joints	
	1. Thickness	(microns)
	2. Length	(mm)
2.17.00	Shape and size of busducts	
2.18.00	1. Phase to phase spacing 2. Phase to ground (mm) (Enclosure) spacing	(mm)
2.19.00	Standard section length	(mm)
2.20.00	Minimum recommended clearances between periphery of the busduct enclosure and	
2.20.01	Structural steel work :	
	1. Parallel to busduct	(mm)
	2. Perpendicular to busduct	(mm)
2.20.02	Reinforced concrete	(mm)
2.20.03	Weight per meter run of busduct i. Main run	(Kg)
	ii. Tap off run	
2.21.00	Details of arrangement offered to prevent insulation of busduct going down when generating unit is under shut down for some period	
2.22.00	It is guaranteed that insu-lation of busduct shall not go down when generating unit is under shut down ?	
2.23.00	Isolating links and copper clamps	

2.23.01	Cross sectional area	(mm2)
2.23.02	Current density	(A/mm2)
2.23.03	Conductivity	(mhos/cm)
2.23.04	Tensile strength	(Kg/cm2)
2.23.05	Shape and size	
2.24.00	Enclosure finish	
	a. Outside b. Inside	
2.25.00	Supporting steel structure hot dip galvanized as required	
2.26.00	Grounding	
	a. Material & size of ground bus if provided separately b. No. of ground pads provided for 50/6 mm galvanized steel flats	
2.27.00	Generator terminal	
	a) Material of enclosure in mm	
	b) Thickness of enclosure in mm	
	c) Material of inter phase barrier	
	d) Thickness of inter phase barrier in mm	
3.00.00	**Bus Insulators, Seal-Off Bushing And Through-Off Bushings**	
3.01.00	Make	
3.02.00	Type	
3.03.00	Rated voltage	(kV)
3.04.00	One (1) minute power frequency test voltage	
3.04.01	Dry	(kV)

3.04.02	Wet	(kV)
3.05.00	Impulse withstand test voltage (1.2x50 micro second wave)	(kV)
3.06.00	Creepage distance	
3.06.01	Total	(mm)
3.06.02	Protected	(mm)
3.07.00	Flash over voltage	(kV)
3.08.00	Cantilever strength	(Kg)
3.08.01	Upright	(Kg)
3.08.02	Under hung	(Kg)
4.00.00	**Current transformer**	
4.00.01	Make	
4.00.02	Type	
4.00.03	Reference standard	
4.00.04	Voltage class	
4.00.05	Rated frequency	
4.00.06	Type of Insulation	
4.00.07	Temp. rise at rated current Over 105^0 C ambient	
4.01.00	Short time rating	
	a. Main run CTs	
	b. Tap off run CTs	
4.02.00	CT ratings	
4.02.01	Main run CTs neutral side	
4.02.02	Main run CTs Line side	

CT Type	Description	Current Ratio	Output VA	Class	ISF / ALF	Knee point voltage*	Excitation current in mA**
D2	Generator differential						
E	Generator relaying						
F	Generator meterting & EHG system						
G	AVR & EHT system						
H	EHG system & load sheding relay tap off CTs						
I	Overall differential						
J	UT Differential						
K	**UT Differential**						
L	**UT Differential**						
M	**UT Differential**						
O	**UT Differential**						
N	**UT Differential**						

5.00.00 Voltage Transformer

5.01.00 Make

5.02.00 Type

5.03.00 Reference standard

5.04.00 Voltage class kV

5.05.00 Basic Impulse Level

5.06.00 Type of Insulation

5.07.00 Max. Temp. rise over 50^0 C ambient

5.08.00 Rated Frequency Hz

5.09.00 Over Voltage Factor

a. continuous

b. 30 – seconds

5.10.00 No. of secondary windings per voltage transformer

5.11.00	Winding connections	
	a. Primary	
	b. Secondary	
5.12.00	V.T. Ratings	
5.12.01	a. primary Voltage	kV
	b. Secondary Voltage	V/V
	c. Rated Output	VA
	d. Accuracy Class	
5.13.00	V.T.Fuses	
	a. Continuous current	Amp.
	H.V.	
	L.V.	
	b. Short circuit rating	kA sym
	H.V.	
	L.V.	
	c. Rated voltage	Volt
	H.V.	
	L.V.	
6.00.00	Lightning Arrester	
	i. Make	
	ii. Type	
	iii. Reference standard	
6.01.00	L.A. Rating	
	a. Rated voltage	(kV)

b. Nominal discharge current KA

c. Discharge class

6.02.00 Insulation level

a. One (1) minute power frequency test voltage

Dry (kV)
Wet (kV)

b. Impulse withstand test voltage (1.2x50 micro second wave) (kV)

6.03.00 Spark Over Voltage

a. Minimum 50 Hz kV peak

b. Maximum 1.2 / 50 micro sec. kV peak

c. Maximum front-of wave kV peak

d. Maximum switching kV peak

6.04.00 Maximum Residual Voltage at 8 /20 micro-sec. current wave

a. 10 KA kV peak

b. 20 KA kV peak

c. 40 KA kV peak

d. 100 KA kV peak

6.05.00 Impulse current withstand

a. High current 4/10 Micro sec. kV peak

b. Long duration current for

i) 1000 Micro sec kA peak
ii) 2000 Micro sec kA peak

6.06.00 Porcelain creepage distance kV/mm

6.07.00	No. of section per pole No.	
6.08.00	Approx. dimension (LxBxH) mm	
6.09.00	Approx. weight	Kg
6.10.00	Catalogue furnished	Yes/No
6.11.00	Characteristic curve furnished	
7.00.00	SURGE CAPACITOR	
7.01.00	Make	
7.02.00	Service	
7.03.00	Type & Catalogue No.	
7.04.00	Reference Standard	
7.05.00	Rated Voltage	kV
7.06.00	Rated frequency	Hz
7.07.00	Rating	
	a. Capacity in micro farad/pole	
	b. Guarantee tolerance	
7.08.00	Insulation class	kV
7.09.00	Test voltage between terminals	
	a. A.C. for 1 minute	
	b. D.C. for 10 seconds	
7.10.00	Dimensions	mm
7.11.00	Weight	Kg
7.12.00	Bushings	Kg
	a. 1 minutes dry withsand KV test	
	b. 10 secs. wet withstand Kv test	
	c. Basic impulse withstand KVP	
7.13.00	Discharge resistor furnished?	
8.00.00	**Neutral Disconnecting Link**	
8.01.00	Current	

9.00.00	**Cubicles**		
9.01.00	Type		A
9.02.00	Thickness of sheet steel used		mm
9.03.00	Dimension	mm	
9.04.00	Weight	Kg.	
9.05.00	Finish		
	a. Inside		
	b. Outside		
9.06.00	Degree of protection		
9.07.00	Space Heater		
	a. KW		
	b. Volt		
10.00.00	**Pressurization Unit**		
10.01.00	Compressors		
	a. Make		
	b. Type		
	c. Capacity		sq.mm.
	d. Heat at rated speed		
	Static		mm of W.C.
	Total		mm of W.C.
	e. Nos. furnished per sec.		
10.02.00	Motor		
	a. Make		
	b. Type		
	c. Ratings Output		
	d. Voltage, Phase, Frequency		
	e. Insulation class		
	f. Enclosure		
	g. Nos. furnished per set		
10.03.00	Filter Set		
	a. Make		
	b. Type		
	c. Size		

d. No. furnished per set

10.04.00 Heater

a. Make
b. Rated / KW
c. Voltage, Phase, Frequency
d. Nos. furnished per set

10.05.00 Thermostat

a. Make
b. Type
c. Model No.
d. Nos. furnished per set

10.06.00 Dryer

a. Make
b. Type
c. Model No.
d. Nos. furnished per set

10.07.00 Duct work furnished with all connection, accessories pressure monitoring device with alarm

10.08.00 Operating pressure inside enclosure

10.09.00 Safety valve set pressure — mm of wc

10.10.00 Guaranteed Qty. of air leakage — % of encl. Volume/4 Hr.

10.11.00 Write-up of system furnished

11.00.00 NEUTRAL_GROUNDING CUBICLE

11.01.00 GENERAL

11.01.01 Service

11.01.02 Make

11.01.03 Type

11.01.04 Location

11.01.05	Specifications & Standards	
11.01.06	Fittings and accessories Included	
11.01.07	Design ambient temperature	(°C)
11.01.08	System particulars	
11.02.00	Grounding Transformers	
11.02.01	Rated output at Design ambient on ONAN cooling	(KVA)
11.02.02	Rated Voltage of HV	(KV)
11.02.03	Rated voltage of LV	(KV)
11.02.04	Rated frequency	(Hz)
11.02.05	Maximum temperature rise in oil by thermometer above design ambient	(°C)
11.02.06	Maximum temperature rise above design ambient of winding by resistance method on ONAN cooling	(°C)
11.02.07	Overload capacity for specified time	
11.02.08	Short circuit rating for time	(Sec)
11.03.00	Winding	
11.03.01	Insulation material	
11.03.02	Connections	
	a) HV winding	
	b) LV winding	
11.03.03	Tappings on HV winding	
	a) Number	

	b) Range	
	c) Value of each step	
11.03.04	Current density	
	a) HV winding	(A/mm2)
	b) LV winding	(A/mm2)
11.03.05	Conductor area	
	a) HV winding	(mm2)
	b) LV winding	(mm2)
11.04.00	Losses	
11.04.01	No load losses at rated frequency and	
	a) Hundred (100) percent rated volts	(KW)
	b) Tolerance on (± Percent) above	
	c) Hundred ten (110) percent rated volts	(KW)
11.04.02	Copper losses at rated current, frequency and seventy five (75) degrees Centigrade temperature	(KW)
	a) Tolerance on (± Percent) above	
11.04.03	Tolerance on total of no load and load losses (± Percent)	
11.05.00	Efficiency	
11.05.01	Efficiency at seventy five (75) degrees Centigrade and	

	a) Hundred (100) percent full load	(%)
	b) Seventy five (75) percent full load	(%)
	c) Fifty (50) percent full load	(%)
11.05.02	Maximum efficiency	(percent)
11.05.03	Load at which maximum efficiency occurs	(MVA)
11.06.00	Constructional Details	
11.06.01	Type of construction	
11.06.02	Type of winding	
	a) HV winding	
	b) LV winding	
11.06.03	Type of joints in winding	
11.06.04	Minimum clearances	
	a) HV TOLV	
	b) HV to earth	
11.06.05	Terminal arrangement	
	a) High voltage	
	b) Low voltage	
11.07.00	Weights And Dimensions	
11.07.01	Net weight of core	(Kg)
11.07.02	Net weight of copper	
	a) HV winding	(Kg)
	b) LV winding	(Kg)
11.07.03	Total weight of transformer	

11.07.04	Overall dimensions of the transformer	
11.08.00	Grounding Resistor	
11.08.01	Ohmic valve	(ohm)
11.08.02	Rated Voltage	(V)
11.08.03	Rated Current	(A)
11.08.04	KW rating	(KW)
11.08.05	Rated time	(sec)
11.08.06	Taps, if any	
11.08.07	Insulation class	
11.08.08	Material	
11.08.09	Type of construction	
11.08.10	Dimension	

6.00.00 STATION TRANSFORMER

S. No.	**Description**		
1.00.00	**General**		
1.01.00	Service		
1.02.00	Make		
1.03.00	Type		
1.04.00	Number of windings per phase		
1.05.00	Number of phases		
1.06.00	Reference Standard		
2.00.00	**Rating**		
	- Full load rating - Rating of each winding - Rating no load voltage		HV/LV
2.01.00	Type of cooling		
2.02.00	Rated output	MVA	
	i) With ONAN cooling		
	ii) With ONAF cooling		
	iii) With OFAF cooling		
2.03.00	Rated Voltage	kV	
	L.V. H.V.		
2.04.00	Rated Current	Amps.	
	L.V. H.V.		
2.05.00	Rated Frequency	Hz	
2.06.00	Voltage Withstand Time	Sec.	

a) 110% of rated voltage

b) 120% of rated voltage

c) 125% of rated voltage

d) 130% of rated voltage

e) 140% of rated voltage

f) 150% of rated voltage

2.07.00 Overfluxing Capability Sec.

a) For Overfluxing Factor 1.10

b) For Overfluxng Factor 1.20

c) For Overfluxing Factor 1.25

d) For Overfluxing Factor 1.30

e) For Overfluxing Factor 1.40

f) For Overfluxing Factor 1.50

3.00.00 Temperature

3.01.00 Reference

a) Ambient Temperature (max./max daily/min.)

3.02.00 Temperature rise over reference ambient Deg. C.

a) Of top oil by thermometer

b) Of winding by resistance at OFAF rating

3.03.00 Maximum continuous over loading capacity of transformer without exceeding the specified winding temperature

4.00.00 Tap Changer

4.01.00 Type and make

4.02.00 Capacity

a) Rated voltage
b) Rated current

c) Step voltage

d) No. of steps

4.03.00 Range- Steps X % Variation

4.04.00 Taps provided on HV winding

4.05.00 Number of taps
Auxiliary Power (kw)

4.06.00 Time required for one step change (sec.)

4.07.00 Tap Change motor.

4.08.00 Control circuit

4.09.00 Local manual operation feasible from standing height from ground

4.10.00 a) Local tap position indicator furnished

b) Local operation counter furnished

4.11.00 Provision for padlocking provided

4.12.00 Auxiliary switch for interlock provided as specified

4.13.00 Safety limit switch provided

4.14.00 Are all contacts silver plated

5.00.00 Insulation Level **kVp / kV**

H.V.

L.V.

	H.V. Neutral	
5.01.00	HV/LV imepedance voltage at rated current for the normal tapping HV/LV winding	
5.02.00	HV/LV reactance at rated current and rated frequency	
5.03.00	Separate source power frequency voltage withstand HV/LV winding	
5.04.00	Inducted over voltage withstand HV/LV winding	
5.05.00	Full wave lightening impulse withstand voltage	
6.00.00	**Impedances at Principal Tap at Rated Frequency and 75° C winding temperature**	
6.01.00	Base MVA	
6.02.00	Impedance	
6.03.00	Reactance	
6.04.00	Resistance at 75° C	
6.05.00	Zero sequence Impedance at 75°C	
6.06.00	Capacitance of windings micro farad / phase	
	H.V. - Earth	
	L.V. - Earth	
	H.V - L.V	
7.00.00	**Guaranteed Losses at Principal Tap, Full Load and 75°C.**	**kW**
7.01.00	No Load Losses	
7.02.00	Load Losses	

7.03.00	Cooler Losses		
7.04.00	Tolerance on Losses		
8.00.00	**Efficiency at 75°C and 0.8 power factor lag**	**%**	
8.01.00	At full load		
8.02.00	At 3/4 full load		
8.03.00	At 1/2 load		
8.04.00	Maximum Efficiency		
8.05.00	Load and power factor at which the max. efficiency occurs		
9.00.00	**Regulation at full load at 75°C**		
9.01.00	At unity power factor		
9.02 00	At 0.8 power factor lagging		
10.00.00	**No load current referred to HV**	**A**	
10.01.00	At 90% rated voltage		
10.02.00	At 100% rated voltage		
10.03.00	At 110% rated voltage		
10.04.00	At 125% rated voltage		
10.05.00	At 140% rated voltage		
11.00.00	**Approximate Maximum Flux Density**		**Web / Sq.m**
11.01.00	At 90% rated voltage		
11.02.00	At 100% rated voltage		
11.03.00	At 110% rated voltage		
11.04.00	At 125% rated voltage		
11.05.00	At 140% rated voltage		

12.00.00 Maximum Current Density **A/Sq.cm**

H.V.

L.V.

13.00.00 Cooling System

13.01.00 a) Type of cooling
Input to cooling plant (kW)

b) Number X capacity of
Cooler units furnished

c) No. of cooler units required
for full load operation

13.02.00 Each cooler unit is provided with

a) No. X kW of oil pump motor
(running)

b) No of standby pump

c) No. X kW of fan motor(running)

d) No. of standby fan

13.03.00 Motors rated for voltage,
phase, frequency

13.04.00 a) Automatic operation of cooler
fans provided

b) Automatic operation of cooler
pumps provided

13.05.00 Transformer is capable of delivering
rated output under following conditions

a) Failure of all pumps and fans of
one cooler unit

1) Continuous in % rated MVA

2) Rated output for ---min.

b) Failure of one complete cooler unit

including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

c) Failure of all pumps and fans of both cooler units

1) Continuous in % rated MVA

2) Rated output for ---min.

d) Failure of complete cooler system including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

14.00.00 Details of Tank

14.01.00	Material	
14.02.00	Thickness of sides	mm.
14.03.00	Thickness of bottom	mm.
14.04.00	Thickness of cover	mm.
14.05.00	Tank Designed for	
	Vacuum	mm of Hg
	Pressure	kN / Sq.m

15.00.00 Insulating Material

a) H.V Turn

b) L.V Turn

c) H.V - L.V

d) H.V Earth

e)L.V Earth

16.00.00 H.V Winding provided with graded insulation

17.00.00 Insulating Oil (EHV Grade)

17.01.00	Approximate volume	Litre
17.02.00	10% excess oil furnished	
17.03.00	Oil conforms to	
17.04.00	Details of oil furnished	
17.05.00	a) Oil preservation system provided	
	b) Type	
	c) Quantity of oil in main tank	Litre.
	d) Quantity of oil for topping of main tank	Litres.
	e) Quantity of oil for conservator, radiator, pipe work etc.	Litres.
	f) Total Oil	Litres.
	g) 10% extra oil	Litres
	Total oil to be dispatched	
	1) Oil to be dispatched in main tank	Litres
	2) Dispatched in barrels	Litres.
	3) Each barrel contains	Litres.
	4) Total No. of barrels to be dispatched	

18.00.00 Bushings

18.01.00	Make	
18.02.00	Type	
18.03.00	Reference Standard	
18.04.00	Voltage Class	kV
18.05.00	Type of atmosphere	
18.06.00	Creepage Distance	mm.

18.07.00	Weight	
18.08.00	Free space required for bushing removal	
18.09.00	Test terminals for HV bushings provided	Yes/No
19.00.00	**Minimum Clearance**	
19.01.00	Between Phases	
	c) In air	mm.
	d) In oil	mm.
19.02.00	Between Phase and earth	
	c) In air	mm.
	d) In oil	mm.
20.00.00	**Terminal Connections**	
20.01.00	H V	
20.02.00	L V	
20.03.00	H.V Neutral	
21.00.00	**Marshalling Box**	
21.01.00	Weather proof, suitable for outdoor duty	Yes/No
21.02.00	Degree of protection	
22.00.00	**Terminal Blocks**	
22.01.00	Make	
22.02.00	Type	
22.03.00	20% spare terminals furnished	
23.00.00	**Wiring**	
23.01.00	Cable Type	

23.02.00	Voltage grade	
23.03.00	Conductor	
	a) Size	Sq. mm
	b) Material	
	c) Stranded	
23.04.00	All wires as per specification provided	

24.00.00 Ratings of Trip and Alarm contacts

24.01.00	Voltage	V
24.02.00	Rated making current	A
24.03.00	Rated breaking current	A

25.00.00 Accessories

25.01.00	Transformer furnished with fittings and accessories as per specification	

26.00.00 Details of Conservator

26.01.00	Volume of conservator	
26.02.00	Volume of oil between the highest and lowest levels	

27.00.00 Pressure Release Device

	a) Minimum pressure the device is set to operate/rupture	kN/Sq.m
	b) Trip contacts provided	

28.00.00 Approximate Overall Dimensions

28.01.00	Length	mm.
28.02.00	Breadth	mm.
28.03.00	Height	mm.
28.04.00	Crane lift for	

	a) Untanking core and coil assembly (including sling)	
	b) Tank cover for bell type tank	mm.
29.00.00	**Approximate Weights**	
29.01.00	Core and coil	Kg.
29.02.00	Tank cover for bell type tank	Kg.
29.03.00	Tank and fittings	Kg.
29.04.00	Oil	Kg
29.05.00	Total Weight	Kg.
30.00.00	**Shipping Data**	
30.01.00	Weight of the heaviest package	Kg.
30.02.00	Dimension of the largest package (LXBXH)	mm.
31.00.00	**Bushing Current Transformer**	
31.01.00	**General**	
31.00.01	Make	
31.00.02	Type	
31.00.03	Reference Standard	
31.00.04	Use	
31.02.00	**Rating**	
31.02.01	CT Ratio	
31.02.02	Class	
31.02.03	Insulation Level	
31.02.04	Burden	

31.03.00	**Insulation Class**	
31.03.01	Temperature Rise at rated overburden over top oil temperature	Deg.C
31.04.00	**Characteristics**	
31.04.01	Secondary Resistance R_{CT} at 75Deg.C	Ohm
31.04.02	Knee Point Voltage Vk	Volt
31.04.03	Excitation Current at Vk/2	Amps
31.05.00	**Dimensions and Weights**	
31.05.01	Dimension (LxBxH)	mm
31.05.02	Weight	Kg
31.06.00	**Tests**	**As Per Standard**

7.00.00 UNIT TRANSFORMERS & AUXILIARY TRANSFORMERS

(to be filled separately for each type)

S. No.	Description		
1.00.00	**General**		
1.01.00	Service		
1.01.00	Make		
1.02.00	Type		
1.03.00	Number of windings per phase		
1.04.00	Number of phases		
1.05.00	Reference Standard		
2.00.00	**Rating**		
	- Full load rating - Rating of each winding - Rating no load voltage		HV/LV
2.01.00	Type of cooling		
2.02.00	Rated output	MVA	
	i) With ONAN cooling		
	ii) With ONAF cooling		
	iii) With OFAF cooling		
2.03.00	Rated Voltage	kV	
	L.V. H.V.		
2.04.00	Rated Current	Amps.	
	L.V. H.V.		
2.05.00	Rated Frequency	Hz	

2.06.00	Voltage Withstand Time	Sec.
	a) 110% of rated voltage	
	b) 120% of rated voltage	
	c) 125% of rated voltage	
	d) 130% of rated voltage	
	e) 140% of rated voltage	
	f) 150% of rated voltage	
2.07.00	Overfluxing Capability	Sec.
	a) For Overfluxing Factor 1.10	
	b) For Overfluxng Factor 1.20	
	c) For Overfluxing Factor 1.25	
	d) For Overfluxing Factor 1.30	
	e) For Overfluxing Factor 1.40	
	f) For Overfluxing Factor 1.50	
2.08.00	Rated no load voltage HV/LV	kV
2.09.00	Full power tapping provided	Yes/No
2.10.00	Power frequency withstand voltage of winding neutral of HV/ LV/HV(Dry &Wet)	kV /rms
2.11.00	Type of voltage variation (CFVV/VFVV/C BVV)	
3.00.00	**Temperature**	
3.01.00	Reference	
	a) Ambient Temperature (max./max daily/min.)	
3.02.00	Temperature rise over reference ambient Deg. C.	

a) Of top oil by thermometer

b) Of winding by resistance at OFAF rating

3.03.00 Maximum continuous over loading capacity of transformer without exceeding the specified winding temperature

4.00.00 Insulation Level **kVp / kV**

H.V.

L.V.

H.V. Neutral

4.01.00 HV/LV imepedance voltage at rated current for the normal tapping HV/LV winding

4.02.00 HV/LV reactance at rated current and rated frequency

4.03.00 Separate source power frequency voltage withstand HV/LV winding

4.04.00 Inducted over voltage withstand HV/LV winding

4.05.00 Full wave lightening impulse withstand voltage

5.00.00 Impedances at Principal Tap at Rated Frequency and 75° C winding temperature

5.01.00 Base MVA

5.02.00 Impedance

5.03.00 Reactance

5.04.00 Resistance at 75° C

5.05.00	Zero sequence Impedance at 75°C		
5.06.00	Capacitance of windings micro farad / phase		
	H.V. - Earth		
	L.V. - Earth		
	H.V - L.V		
6.00.00	**Guaranteed Losses at Principal Tap, Full Load and 75°C.**		**kW**
6.01.00	No Load Losses		
6.02.00	Load Losses		
6.03.00	Cooler Losses		
6.04.00	Tolerance on Losses		
7.00.00	**Efficiency at 75°C and 0.8 power factor lag**	**%**	
7.01.00	At full load		
7.02.00	At 3/4 full load		
7.03.00	At 1/2 load		
7.04.00	Maximum Efficiency		
7.05.00	Load and power factor at which the max. efficiency occurs		
8.00.00	**Regulation at full load at 75°C**		
8.01.00	At unity power factor		
8.02.00	At 0.8 power factor lagging		
9.00.00	**No load current referred to HV**		**A**
9.01.00	At 90% rated voltage		
9.02.00	At 100% rated voltage		

9.03.00	At 110% rated voltage		
9.04.00	At 125% rated voltage		
9.05.00	At 140% rated voltage		
10.00.00	**Approximate Maximum Flux Density**		**Web / Sq.m**
10.01.00	At 90% rated voltage		
10.02.00	At 100% rated voltage		
10.03.00	At 110% rated voltage		
10.04.00	At 125% rated voltage		
10.05.00	At 140% rated voltage		
11.00.00	**Maximum Current Density A/Sq.cm**		
	H.V.		
	L.V.		
12.00.00	**Cooling System**		
12.01.00	a)	Type of cooling Input to cooling plant	(KW)
	b)	Number X capacity of Cooler units furnished	
	c)	No. of cooler units required for full load operation	
12.02.00		Each cooler unit is provided with	
	a)	No. X kW of oil pump motor (running)	
	b)	No of standby pump	
	c)	No. X kW of fan motor(running)	

d) No. of standby fan

12.03.00 Motors rated for voltage, phase, frequency

12.04.00 a) Automatic operation of cooler fans provided

b) Automatic operation of cooler pumps provided

12.05.00 Transformer is capable of delivering rated output under following conditions

a) Failure of all pumps and fans of one cooler unit

1) Continuous in % rated MVA

2) Rated output for ---min.

b) Failure of one complete cooler unit including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

c) Failure of all pumps and fans of both cooler units

1) Continuous in % rated MVA

2) Rated output for ---min.

d) Failure of complete cooler system including radiator, fans pumps etc.

1) Continuous in % rated MVA

2) Rated output for ---min.

13.00.00 Details of Tank

13.01.00 Material

13.02.00 Thickness of sides mm.

13.03.00 Thickness of bottom mm.

13.04.00	Thickness of cover	mm.
13.05.00	Tank Designed for	
	Vacuum	mm of Hg
	Pressure	kN / Sq.m
14.00.00	Insulating Material	
	a) H.V Turn	
	b) L.V Turn	
	c) H.V - L.V	
	d) H.V Earth	
	e) L.V Earth	
14.01.00	H.V Winding provided with graded insulation	
15.00.00	**Tap Changer**	
15.01.00	Type and make	
	a) Rated voltage	
	b) Rated current	
	c) Step voltage	
	d) No. of steps	
15.02.00	Range- Steps X % Variation	
15.03.00	Taps provided on HV winding	
15.04.00	Number of taps	
15.05.00	Auxiliary Power	(kw)
15.06.00	Time required for one step change	(sec.)

15.07.00	Tap Change motor.			
15.08.00	Control circuit			
15.09.00	Local manual operation feasible from standing height from ground			
15.10.00	a)	Local tap position indicator furnished		
	b)	Local operation counter furnished		
15.11.00	Provision for padlocking provided			
15.12.00	Auxiliary switch for interlock provided as specified			
15.13.00	Safety limit switch provided			
15.14.00	Are all contacts silver plated			
16.00.00	**Insulating Oil (EHV Grade)**			
16.01.00	Approximate volume			Litre
16.02.00	10% excess oil furnished			
16.03.00	Oil conforms to			
16.04.00	Details of oil furnished			
16.05.00	a)	Oil preservation system provided		
	c)	Type		
	d)	Quantity of oil in main tank	Litre.	
	e)	Quantity of oil for topping of main tank	Litres.	
	f)	Quantity of oil for conservator, radiator, pipe work etc.		Litres.
	g)	Total Oil		Litres.

	h) 10% extra oil	Litres
	i)Total oil to be dispatched	
	k) Oil to be dispatched in main tank	Litres
	l) Dispatched in barrels	Litres.
	m) Each barrel contains	Litres.
	n) Total No. of barrels to be dispatched	

17.00.00 Bushings

17.01.00	Make	
17.02.00	Type	
17.03.00	Reference Standard	
17.04.00	Voltage Class	kV
17.05.00	Type of atmosphere	
17.06.00	Creepage Distance	mm.
17.07.00	Weight	
17.08.00	Free space required for bushing removal	
17.09.00	Test terminals for HV bushings provided	Yes/No
17.10.00	One minute power Frequency withstand dry and wet	

18.00.00 Minimum Clearance

18.01.00	Between Phases	
	a) In air	mm.
	b) In oil	mm.
18.02.00	Between Phase and earth	

	a)	In air	mm.
	b)	In oil	mm.

19.00.00	**Terminal Connections**	
19.01.00	H V	
19.02.00	L V	
19.03.00	H.V Neutral	
20.00.00	**Marshalling Box**	
20.01.00	Weather proof, suitable for outdoor duty	Yes/No
20.02.00	Degree of protection	
21.00.00	**Terminal Blocks**	
21.01.00	Make	
21.02.00	Type	
21.03.00	20% spare terminals furnished	
22.00.00	**Wiring**	
22.01.00	Cable Type	
22.02.00	Voltage grade	
22.03.00	Conductor	
	a) Size	Sq. mm
	b) Material	
	c) Stranded	
22.04.00	All wires as per specification provided	
23.00.00	**Ratings of Trip and Alarm contacts**	
23.01.00	Voltage	V

23.02.00	Rated making current	A
23.03.00	Rated breaking current	A
24.00.00	**Accessories**	
	Transformer furnished with fittings and accessories as per specification	
25.00.00	**Details of Conservator**	
25.01.00	Volume of conservator	
25.02.00	Volume of oil between the highest and lowest levels	
26.00.00	**Pressure Release Device**	
	a) Minimum pressure the device is set to operate/rupture	KN/Sq.m
	b) Trip contacts provided	
27.00.00	**Approximate Overall Dimensions**	
27.01.00	Length	mm.
27.02.00	Breadth	mm.
27.03.00	Height	mm.
27.04.00	Crane lift for	
	a) Untanking core and coil assembly (including sling)	
	b) Tank cover for bell type tank	mm.
28.00.00	**Approximate Weights**	
28.01.00	Core and coil	Kg.
28.02.00	Tank cover for bell type tank	Kg.

28.03.00	Tank and fittings	Kg.
28.04.00	Oil	Kg
28.05.00	Total Weight	Kg.
29.00.00	**Shipping Data**	
29.01.00	Weight of the heaviest package	Kg.
29.02.00	Dimension of the largest package (LXBXH)	mm.
30.00.00	**BUSHING CURRENT TRANSFORMER**	
30.01.00	**General**	
30.01.01	Make	
30.01.02	Type	
30.01.03	Reference Standard	
30.01.04	Use	
30.02.00	**Rating**	
30.02.01	CT Ratio	
30.02.02	Class	
30.02.03	Insulation Level	
30.02.04	Burden	
30.03.00	**Insulation Class**	
30.03.01	Temperature Rise at rated overburden over top oil temperature	Deg.C
30.04.00	**Characteristics**	

30.04.01	Secondary Resistance R_{CT} at 75Deg.C	Ohm
30.04.02	Knee Point Voltage Vk	Volt
30.04.03	Excitation Current at Vk/2	Amps
30.05.00	**Dimensions and Weights**	
30.05.01	Dimension (LxBxH)	mm
30.05.02	Weight	Kg
30.06.00	**Tests**	**As Per Standard**
30.07.00	Rated no load voltage HV/LV	in kV
30.08.00	One minute power Frequency withstand dry and wet	kV (rms)KV/rms

8.00.00 HV SWITCHGEAR

S. No.	Description		
1.00.00	SWITCHGEAR ASSEMBLY		11/6.6 kV
1.01.00	Make		
1.02.00	Type		
1.03.00	Reference Standard		
1.04.00	Voltage (Nom./Max.)		kV
1.05.00	Phase, Frequency		No. Hz
1.06.00	Short Circuit Rating		
	a. Interrupting Symmetrical		MVA
	b. Short-time for 3 sec.	kA rms	
1.07.00	Insulation Level		
	a. Impulse Withstand	kVp	
	b. 1 min. 50 Hz. Voltage Withstand	kV rms	
1.08.00	Metal-clad construction		
1.09.00	Degree of Protection		
1.10.00	Minimum thickness of sheet metal used	mm	
1.11.00	Switchgear completely assembled, wired and tested at factory.		
2.00.00	CONSTRUCTION		
2.01.00	Draw-out features provided for		
	a. Circuit breaker with SERVICE, TEST and ISOLATED position.		
	b. Voltage Transformer		
	c. Protective relays		

2.02.00	Breaker cubicle – a. Cubicle door can be closed with breaker in TEST position			
	b. Working zone limits from floor level	mm		
2.03.00	All meters, switch & relays flush mounted type			
2.04.00	Minimum clear space required at			
	a. Front for breaker withdrawal		mm	
	b. Rear		mm	
2.05.00	Typical vertical section			
	a. Overall dimension and weight ii) Buscoupler iii) Transformer/Motor fdr.		mm	i) Incomer/Tie
	b. Dynamic load per panel	Kg.		
3.00.00	BUS BAR			
3.01.00	Make			
3.02.00	Material & Grade			
3.03.00	Reference, Standard			
3.04.00	Cross sectional Area Size	 mm	sq.mm	
3.05.00	Continuous Current (at site condition, 50 deg. C ambient) within cubicle			
3.06.00	Maximum temperature rise over 50 deg. C		deg. C	
3.07.00	Short-time current for 3 sec.		KA rms	
3.08.00	DC resistance at 85 deg. C		ohm/m/ph	
3.09.00	Skin-effect ratio			
3.10.00	Reactance		ohm/m/ph	

3.11.00	Losses-middle phase		w/m/ph
3.12.00	Minimum clearance of bare bus bar and connection (air clearance)		
	a. Phase to phase	mm	
	b. Phase to ground	mm	
3.13.00	Bus bar provided with		
	a. Insulating sleeve		
	b. Phase barriers		
	c. Cast resin shrouds for joint		
3.14.00	Bus Connections		
	a. Silver plated		
	b. Made with antioxide grease		
3.15.00	Bus bar support spacing		mm
3.16.00	a. Make		
	b. Reference standard		
	c. Voltage class		kV
	d. Minimum creepage distance		mm
	e. Cantilever strength		kg/sq.cm
	f. Net weight		kg.
4.00.00	CIRCUIT BREAKER		
4.01.00	Make		
4.02.00	Type		
4.03.00	Reference standard		
4.04.00	Rated voltage		kV
4.05.00	Rated frequency		Hz.
4.06.00	No. of poles		No.
4.07.00	Rated Currents		
	a. Continuous (at site condition, 50 deg C ambient & within cubicle).		Amp.
	b. Short-time current for 3 sec. KA rms.		

	c. % DC component	
4.08.00	Max. temperature rise over 50 deg. C ambient	deg. C
4.09.00	Rated operating duty	
4.10.00	Interrupting capacity at rated voltage and operating duty	
	a. Symmetrical	kA rms.
	b. Assymmetrical	kA rms.
4.11.00	Rated Making Current	kA peak
4.12.00	Transient Recovery voltage	
	a. Rate of rise	kV/rms
	b. Peak voltage	kV
4.13.00	Maximum over voltage factor when switching off	
	a. Unloaded transformer	
	b. Loaded transformer	
	c. Unloaded lines	
	d. Induction Motor	
4.14.00	Insulation Level	
	a. Impulse voltage withstand with 1.2 x 5.0 micro sec. wave	kV peak
	b. 1-minute 50 Hz. Voltage withstand	kV
4.15.00	At 100% interrupting capacity	
	a. Opening time – max.	ms
	b. Arcing time max.	ms
	c. Total tripping time (max.)	ms
4.16.00	Total closing time (max.)	ms
4.17.00	Number of break per pole	
4.18.00	Total length of breaks per pole	mm
4.19.00	Total length of contact travel	mm
4.20.00	Rate of contact travel	
a.	At tripping	mm/sec.
b.	At closing	mm/sec.

4.21.00 No. of breaker operations permissible, without requiring inspection, replacement of contacts and other main parts.

a. At 100% rated current
b. At 100% rated interrupting current

4.22.00 Circuit breaker provided with gas pressure monitoring device

a. Operating pressure of breaker
b. Alarm & trip setting pressure

4.23.00 Type of contacts -

a. Main
b. Arcing

4.24.00 Material of contacts

a. Main
b. Arcing
c. Whether contacts silver plated
d. Thickness of silver plating

4.25.00 Contact pressure at no load Kg.

4.26.00 Minimum clearance in air mm

a. Between poles
b. Between live parts and ground

4.27.00 Type of arc control device provided

4.28.00 Operating Mechanism

a. Type
b. No. of breaker operations
c. Trip free or fixed trip?
d. Anti-pumping features provided?

4.29.00 Spring charging motor

a. Rating kW
b. Voltage (A.C. or D.C.) V
c. Permissible voltage variation %

4.30.00 Closing coil :

a. Voltage V
b. Permissible voltage variation %
c. Closing current at rated voltage A
d. Rating Watts

4.31.00 Tripping coil :

a. Voltage V
b. Permissible voltage variation %
c. Trip current at rated voltage A
d. Rating Watts

4.32.00 For trip circuit supervision can the tripping coil be connected in series with

a. Auxiliary relay '79' as shown in the drawing.
b. RED LED when breaker is closed:

4.33.00 Breaker/Cubicle Accessories
Accessories such as control switch, indication lamps, relays furnished as specified

Breaker/Breaker Cubicle provided with the following

a. Mechanical safety interlock

b. Automatic safety shutter

c. Emergency manual trip

d. Mechanical ON-OFF indicator

e. Operation counter

f. Charge/Discharge indication

g. Manual spring charging facility?

h. Auxiliary switch with 6 NO + 6 NC contacts mounted on drawout portion

i. 2 Cell switch with 4 NO + 2 NC contacts.
Auxiliary switch with 4 NO +4 NC contacts mounted as stationary parts

j Feeders covered under bus transfer schemes provided with adequate

contact multiplication and auxiliary relays for interface with bus transfer schemes.

k. One(1) additional contact multiplication relay latch type(6 NO + 6NC) multiplied with aux. contacts(1 NO+1NC) mounted on the moving portion.

4.34.00 Cell/Auxiliary Switch

a. Are switch contacts convertible type?

b. Contact rating at

i) make & continuous Amp.

ii) Break (Inductive) Amp.
P.F. for A.C. & L/R for D.C.

4.35.00 Impact load for foundation design
(to include dead load plus impact values
on opening at maximum interrupting rating). Kg.

4.36.00 Overall dimension (LXBXH) mm

4.37.00 Type test report on identical breaker furnished.

4.38.00 On leakage of SF6 to atmospheric pressure/loss of vacuum.
i) Possible load current breaking Amps.
ii) Possible fault current breaking Amps

5.00.00 CONTROL & INDICATIONS

5.01.00 Push Buttons

Contact rating at :

i) Make & continuous Amps

ii) Break (Inductive) Amps PF for A.C & L/R for D.C

5.02.00 LEDS

Watts/Voltage
Series resistance Ohm.
LEDS & Lens replaceable from front.

5.03.00	Selector Switch Contact rating at : i) Make & continuous Amps ii) Break (Inductive) Amps iii)Key interlock furnished?	
6.00.00	CURRENT TRANSFORMER	
6.01.00	Make	
6.02.00	Type	
6.03.00	Reference standard	
6.04.00	CT rations as per drawings?	
6.05.00	Rated frequency	
6.06.00	Short Circuit Withstand Short-time current for 1 sec. Dynamic current KA peak	kA rms
6.07.00	Class of Insulation	
6.08.00	Temp. rise over 50 deg. C ambient	deg. C.
6.09.00	Basic Insulation level	kV peak
6.10.00	CT magnetization curve furnished	
6.11.00	CT for Differential protectionClass Secondary resistance at 75 deg.C Knee point voltage Excitation current at VK/4	
6.12.00	Metering C.T. a. Incomer/Tie b. Motor feeder c. Transformer feeder	VA Burden
6.13.00	Relaying C.T. a. Incomer/Tie b. Motor feeder c.Transformer feeder	
6.14.00	Core balance C.T.	

7.00.00	VOLTAGE TRANSFORMER	
7.01.00	Make	
7.02.00	Type	
7.03.00	Reference Standard	
7.04.00	Voltage ratio	
7.05.00	Rated frequency	
7.06.00	Accuracy class	
7.07.00	VA burden	
7.08.00	Over voltage factor a. Continuous b. 8 Hours	
7.09.00	Class of Insulation	
7.10.00	Temp. rise over 50 deg.c ambient	deg.C
7.11.00	Basic Impulse level	KVP peak
7.12.00	Winding Connection a. Primary b. Secondary	
7.13.00	Fuses	
	a. Continuous ratings - H.V./L/V.	Amps
	b. Symmetrical fault rating - HV/LV	KA rms
8.00.00	RELAYS	
8.01.00	Draw-out type with built in test facilities	
8.02.00	Type of mounting?	
8.03.00	Relay details :	
8.03.01	Incomer/tie/feeder (Numerical) a. 3-I . D.M.T. o/c relay for phase fault	

with high set instantaneous unit.
b. I-Definitie o/c relay for earth fault
c. 1-Restricted E/F
relay for incomer
fed from transformer only.
d. 1-definite time delay relay

8.03.02 Transformer feeder

a. 3-IDMT o/c relay with high-set instantaneous unit 50/51/50T

b. 1-Definit o/c relay for earth fault with timer 50N

c. Auxiliary relays for contact multiplication of buchholz alram and trip, winding temperature alarm & trip.

8.03.03 Motor feeder
a. 1-Numerical Relay-99

b. 1-Differential protection
3-pole relay for motors
1000 KW & above rating

8.03.04 Changeover
Scheme furnished for manual/automatic changeover:

8.03.05 Miscellaneous relay
a. Antipumping relay 94
b. Trip supervision relay 79/95
c. Lockout relay 220V D.C.
hand reset with 86
4 pairs of contact
8 pairs of contact
d. Time delay relay
Delay on drop out 62
Delay on pick up 2
e. Frequency compensated u/v relay 27
3-pole
1-pole
f. Auxiliary relay 220V D.C.
hand reset with
4 pair of contact
8 pair of contact

g. Lock out relay 220V D.C. with electrical reset :
6 No + 2 NC contact
8 No + 8 NC Contact

9.00.00 METERS

9.01.00 Make

9.02.00 Type

9.03.00 Size

9.04.00 Scale

9.05.00 Accuracy class

9.06.00 Meter switch

a. Make

b. Type

10.00.00 SECONDARY WIRING

10.01.00 Type and Insulation

10.02.00 Voltage grade

10.03.00 Conductor material

10.04.00 Conductor size (Minimum)
Potential circuit
Control & current circuit

10.05.00 Wires identified at both ends with markers.

11.00.00 TERMINAL BLOCK

11.01.00 Make

11.02.00 Type

12.00.00 CABLE TERMINATION

12.01.00 Cable termination & connection arrangement furnished as specified

12.02.00 Cable Lugs
Type
Material

12.03.00 Removable Gland Plate
a. Material for multi-core cable
b. Material for single-core cable

13.00.00 BUSDUCT CONNECTION

13.01.00 Busduct connection for :
a. Top entry
b. Side entry
c. Bottom entry

14.00.00 SPACE HEATER/PLUG SOCKET

14.01.00 Cubicle Heater
a. Thermostat controlled
b. Wattage
c. Voltage

14.02.00 Plug Socket
a. Type
b. Rating

14.03.00 Motor Heater
a. Provision made for motor heater supply
b. Separate contactor furnished
c. Contactor rating

14.04.00 Cubicle heater, motor heater & plug socket circuit provided with individual switch fuse unit?

15.00.00 A.C/D.C SUPPLY

15.01.00 Isolating switches fuse unit for incoming supply:-
a. A.C. – Type & rating
b. D.C. – Type and rating

15.02.00 Isolating switch fuse unit at each cubicle :

a. A.C. supply - type & rating
b. D.C. supply - type & rating

16.00.00 PAINTING

16.01.00 Finish of switchgear-
Inside
Outside

17.00.00 NO. OF ACCESSORIES FURNISHED

a.Earthing equipment
b.Slow closing device
c.Test cabinet

9.00.00 HV BUS DUCTS

S. No.	Description	
1.00.00	SEGREATED PHASE BUSDUCT	
1.01.00	Manufacturer's Name & Address	
1.02.00	Type of Busduct	
1.03.00	Shape & Cross Section of Busbars	
1.04.00	Rated Voltage	(kv)
1.05.00	Max. voltage at which busduct can operate continuously	(kV)
1.06.00	Space & size of busduct	
1.07.00	Continuous current rating of busbars	(Amps)
1.08.00	Short circuit current rating and duration	(kA Peak)
1.09.00	Momentary current rating	(kA Peak)
1.10.00	Temp. rise over on ambient of 50 deg.C	(deg.C)
1.10.01	Busbars	
1.10.02	Enclosure	
1.11.00	Number and arrangement of support insulators	
1.12.00	One minute power frequency withstand voltage	(KV)
1.13.00	Minimum creepage distance over insulator	(mm)
1.14.00	Conductor Treatment	
1.15.00	Clearance	(mm)

1.15.01	Phase to phase	
1.15.02	Phase to earth	
1.16.00	Average weight per metre of busduct	(Kg)

10.00.00 LV SWITCHGEAR & BUS DUCTS

S. No.	**Description**	
1.01.00	Application	
1.02.00	Make	
1.03.00	Installation (Indoor/Outdoor)	
1.04.00	Specification and standards	
1.05.00	Degree of protection as per IS:13947	
1.05.01	Breaker/MCC cubicles	
1.05.02	Busbar chamber	
1.06.00	Design ambient temperature	(deg.C)
1.07.00	System particulars	
1.08.01	Supply for motors winding/ space heating	
1.08.01	Motors upto 30 KW	(V)
1.08.02	Motors above 30 KW	(V)
1.09.00	Painting shade as per IS:5	
1.09.01	External surfaces	
1.09.02	Internal surfaces	
2.00.00	SWITCHGEAR	
2.01.00	Type	
2.02.00	Installation	
2.03 00	Rated voltage:	
2.03.01	Nominal	(KV)

2.03.02	Maximum	(KV)
2.04.00	Control supply voltage	
2.04.01	Breakers	
2.04.02	DOL starters	
2.05.00	Supply for cubicles space heating and illumination	
2.06.00	Number of phase	
2.07.00	Frequency	
2.08.00	Symmetrical short circuit withstand capacity	(KA)
2.09.00	Rated one (1) second short time current	(KA)
2.10.00	Rated dynamic current	(KA peak)
2.11.00	One (1) minute power frequency dry and wet withstand voltage	
2.11.01	Complete Switchgear	(KV)
2.11.02	Power circuit and its components	(KV)
2.11.03	Control, instrumentation and protection circuits	(KV)
2.12.00	1.2x50 microsecond impulse withstandf voltage full wave of positive and negative polarities	
2.12.01	Complete Switchgear	(KV peak)
2.12.02	Power circuit and its components	(KV peak)
2.12.03	Control, instrumentation and protection circuits	(KV peak)
3.00.00	SWITCHGEAR OONSTOUCTIONAL FEATURES	
3.01.00	Type and designation	

3.02.00	Type of construction	
3.03.00	Cubicle sheet metal details	
3.03.01	Cold rolled/hot rolled	(mm)
1.03.02	Thickness, structural frames and load bearing members	(mm)
3.03.03	Thickness, Front and rear	(mm)
3.03.04	Thickness, sides and top	(mm)
3.03.05	Equipment mounting plate	(mm)
3.03.06	Door witn cut-out	(mm)
3.03.07	Door without cut-out	(mm)
3.03.08	Cover bolted/screwed cover	
3.03.09	With cut-out	(mm)
3.03.10	Without cut-out	(mm)
3.03.11	Insulating cover/partition plate/separator plate	(mm)
3.04.00	Dimensions of Complete Board	
3.04.01	Height	(mm)
3.04.02	Length	(mm)
3.04.03	Depth	(mm)
3.05.00	Standard height, width and depth of typical panel	
3.05.01	MCC Panel	(mm)
3.05.02	PCC Panel	(mm)
3.05.03	Distribution Board Panel	(mm)
3.06.00	Weight	
3.06.01	Each MCC vertical panel	(Kg)

3.06.02	Each DB Vertical Panel	(Kg)
3.06.03	Each PCC (Breaker Panel) Vertical Panel	
3.06.04	Each transformer (for LDB/ELDB/PDB)	
3.07.00	Size of separate mounting channel	(mm)
3.08.00	Width of cable alley	(mm)
3.09.00	Recommended dynamic loading for foundation design	
3.10.00	Following acdessories provided	
3.10.01	Each vertical panel provided with space heater, thermostat & SPN MCB	
3.10.02	Each vertical panel provided with space heater, thermostat & SPN MCB	
3.10.03	Name plates front and rear	
3.10.04	Danger plate (wherever it is required)	
3.11.00	Type of Swgr./MCC/DB (i.e.) whether Double/Single Front)	
3.12.00	Execution (i.e. whether fully drawout/semi-drawout/fixed)	
4.00.00	POWER BUS BARS AND INSULATORS	
4.01.00	Material and applicable standard	
4.02.00	Cross-sectional area per phase for different current rating alongwith calculations (attach sheet if required)	
4.02.01	Horizontal Busbar	
4.02.02	Vertical Busbar	

4.03.00	Type of Busbar (HBS & VBB) insulation [bare/Painted/Epoxy Insulated/PVC Sleeved]	
4.04.00	Minimum clearance in air	
4.04.01	Between phases	(mm)
4.04.02	Between phases to earth	(mm)
4.05.00	Continuous current rating (for various HBB & VBB sizes)	
4.05.01	At 40 Deg.C ambient	(Deg.C)
4.05.02	At 50 Deg.C ambient	(Amp)
4.06.00	One (1) second short time current rating	(KA)
4.07.00	Dynamic current rating	(KA peak)
4.08.00	Maximum temperature rise over design ambient temperature of fifty (50) degree centigrade for continuous rating	(°C)
4.09.00	One (1) minute power freq- uency dry and wet withstand voltage	(KV)
4.10.00	Is horizontal and vertical busbar provided with heat shrunkable PVC sleeve ?	
4.11.00	All busbars joints have been shrouded properly	
4.12.00	Calculation justifying adequacy of Horizontal as well as vertical bus bar size selected furnished for following :	
4.12.01	Continuous current carrying capacity	
4.12.02	Short time current carrying capacity	
4.12.03	Short circuit dynamic force withstand capacity	

4.13.00	Calculation justifying adequacy of each size of fish plate selected for continuous as well as short time current rating furnished		
4.14.00	Busbar joints silver faced		
4.15.00	Material of the support insulators		
4.16.00	Tracking index in insulators		
4.17.00	Material of interface barriers and its characteristics		
5.00.00	AUXILIARY BUSBARS		
5.01.0	24V AC (motor winding heating)		
5.01.01	Material		
5.01.02	Size		
5.01.03	continuous current rating		
5.01.04	Is busbar provided with heat shrinkable PVC sleeve ?		
5.02.00	240V AC (for motor space heater control circuit, panels space heating panel illumination and sockets)		
5.02.01	Material		
5.02.02	Size		
5.02.03	Continuous current rating		(A)
6.00.00	415 VOLT NON-SEGREATED PHASE BUSDUCT		
6.01.00	Manufacturer's Name & Address		
6.02.00	Type of Busduct		
6.03.00	Shape & Cross Section of Busbars		
6.04.00	Rated Voltage	(volts)	
6.05.00	Max. voltage at which busduct can operate continuously		(V)

6.06.00	Space & size of busduct	
6.07.00	Continuous current rating of busbars	(Amps)
6.08.00	Short circuit current rating and duration	(kA Peak)
6.09.00	Momentary current rating	(kA Peak)
6.10.00	Temp. rise over on ambient of 50 deg.C	(deg.C)
6.10.01	Busbars	
6.10.02	Enclosure	
6.11.00	Number and arrangement of support insulators	
6.12.00	One minute power frequency withstand voltage	(kV)
6.13.00	Minimum creepage distance over insulator	(mm)
6.14.00	Conductor Treatment	
6.15.00	Clearance	(mm)
6.15.01	Phase to phase	
6.15.02	Phase to earth	
6.16.00	Average weight per metre of busduct	(kg)

11.00.00 **LV TRANSFORMER**

S. No.	Description	
1.00.00	**General**	
1.01.00	Make	
1.02.00	Type	
1.03.00	Reference Standard	
2.00.00	**Rating**	
2.01.00	Rated output	kVA
2.02.00	Type of cooling	
2.03.00	Rated voltage	Volt
	H.V	
	L.V	
2.04.00	Rated Current	Amps
	H.V	
	L.V	
2.05.00	No. of phases	
2.06.00	Rated Frequency Hz	
2.07.00	Vector group reference	
3.00.00	**Temperature**	
3.01.00	Reference ambient temp. 50 deg C	
3.02.00	Temp. rise over reference ambient	
	a. On enclosure by thermometer	Deg. C

	b. In winding by	Resistance	Deg. C
4.00.00	**Tappings**		
4.01.00	Type		
4.02.00	Capacity		
4.03.00	Taps provided on HV winding		
5.00.00	**Insulation level**		kV/kVp
5.01.00	H.V		
5.02.00	L.V		
5.03.00	L.V Neutral		
6.00.00	**Impedance at principal tap rated current & frequency**		**%**
6.01.00	Impedance		
6.02.00	Reactance		
6.03.00	Resistance at 75 Deg. C		
	a) H.V Winding		
	b) L.V Winding		
6.04.00	Zero sequence impedance :		
6.05.00	Zero sequence capacitance of H.V winding		uf/ph
7.00.00	**Guaranteed losses at Principal tap, full load and 75 deg.**		
7.01.00	No load losses		
7.02.00	Load losses		
8.00.00	**Efficiency at 75 deg. C and 0.8 power factor lag**		**%**
8.01.00	At full load		

8.02.00	At ¾ full load		
8.03.00	At ½ full load		
8.04.00	Maximum efficiency		
8.05.00	Load and power factor at which it occurs		
9.00.00	**Regulation at full load and 75 deg.C**	**%**	
9.01.00	At unity power factor		
9.02.00	At 0.8 power factor lagging :		
10.00.00	**No load current referred to HV**	**Amps**	
10.01.00	At 90% rated voltage		
10.02.00	At 100% rated voltage		
10.03.00	At 110% rated voltage		
11.00.00	**Maximum current density**	**Amps/sq.m**	
11.01.00	At 90% rated voltage		
11.02.00	At 100% rated voltage		
11.03.00	At 110% rated voltage		
12.00.00	**Maximum current density**	**Amps/sq.m**	
12.01.00	H.V Winding		
12.02.00	L.V Winding		
13.00.00	**Withstand time without injury for**	**Sec.**	
13.01.00	Three phase dead short-circuit at Terminal with rated voltage maintained on other side		
13.02.00	Single phase short circuit at terminal with rated voltage maintained on other side		

14.00.00	**Details of Enclosure**	
14.01.00	Material	
14.02.00	Thickness	mm
14.03.00	Degree of protection	
14.04.00	Padlocking provisions	
15.00.00	**Core**	
15.01.00	Type-core or shell	
15.02.00	Core material	
15.03.00	Thickness of lamination mm	
15.04.00	Insulation of lamination	
16.00.00	**Coils**	
16.01.00	Type of coil	
	b. H.V	
	c. L.V	
16.02.00	Conductor material	
16.03.00	Insulation material	
17.00.00	**Bushings**	
17.01.00	Make	
17.02.00	Type	
17.03.00	Reference standard	
17.04.00	Voltage class	kV
17.05.00	Creepage distance	mm/KV
17.06.00	Dry flashover voltage at 50 c/s	
17.07.00	Wet flashover voltage at 50 c/s	

17.08.00 Weight

17.09.00 Free space required for bushing removal

18.00.00 Minimum clearance

18.01.00 Between phase mm

18.02.00 Between phase & earth mm

19.00.00 Terminal connections

19.01.00 H.V

19.02.00 L.V

19.03.00 L.V Neutral

19.04.00 H.V Neutral

20.00.00 Marshalling box

20.01.00 Provided with removable gland Plate/conduit knock out'

20.02.00 Degree of protection

21.00.00 Terminal Blocks

21.01.00 Make

21.02.00 Type

21.03.00 10% spare terminals furnished:

22.00.00 Tests

22.01.00 Routine test as per IS and other tests as per specification

22.02.00 Core bolt withstand voltage for 1 min.

22.03.00 Type test quoted?

12.00.00 HV CABLES

1.00.00 General

1.01.00	Name of the Contractor		
1.02.00	Name of subcontractors, if any		
1.03.00	Specifications and Standards		
1.04.00	Design ambient temperature		(Deg. C)
1.05.00	System particulars		

2.00.00 Cables

(Fill separate columns for the following particulars for each type and size of cable)

2.01.00	Name of the Manufacturer		
2.02.00	Place of manufacturer		
2.02.01	ISI registration and validity date		
2.03.00	Cable type		
2.04.00	Applicable specifications and standards		
2.04.01	Whether cable will carry ISI mark		
2.05.00	Voltage grade		
2.06.00	No. of cores and size (in sq.mm)		
2.07.00	Suitable for earthed/unearthed system		
2.08.00	Permissible voltage and frequency variation for satisfactory operation		
	a. Voltage		
	b. Frequency		
	c. Voltage and Frequency combined		
2.09.00	Continuous current carrying capacity		
2.09.01	For standard conditions as per IS		
	a. In air	(A)	
	b. In ground		(A)
	c. In duct	(A)	
	d. In trench	(A)	
2.09.02	For site conditions:		
	a. In air	(A)	
	b. In ground		(A)
	c. In duct	(A)	
	d. In trench	(A)	
2.09.03	Derating factors for various conditions of laying are not worse than the ones specified in applicable IS		Yes/No
2.09.04	Derating factor for fire resistance treatment		
2.10.00	Conductor		
2.10.01	Material reference standard for conductor		
2.10.02	Grad and shape of conductor		
2.10.03	Nominal cross section area	mm^2	
2.10.04	Number of wires		
2.10.05	Diameter of wire	mm	

2.10.06	Diameter/size of conductor	mm	
2.10.07	Screening/Sheilding/heat barrier tape (as applicable) a. Material b. Type / applicable Std c. Thickness		
2.11.00	Insulation		
2.11.01	Material composition and conforming standard and type		
2.11.02	Thickness of insulation a. Between cores b. Between cores and inner sheath	mm	mm
2.11.03	Tolerance on thickness of insulation		%
2.11.04	Diameter of core over insulation		mm
2.11.05	Specific insulation resistance at ninety (85)/(20) degrees centrigrade		Ohm-cm
2.11.06	Screening/Sheilding/heat barrier tape (as applicable) a. Material b. Type / applicable Std c. Thickness		
2.11.07	Whether triple extrusion technique for HV adopted?		Yes/No
2.12.00	Inner sheath		
2.12.01	Material, conforming standard/type		
2.12.02	Extruded	Yes/No	
2.12.03	Calculated diameter over laid up cores		
2.12.04	Thickness (min)		mm
2.12.05	Diameter of cable over inner sheath		mm
2.12.06	Whether inner sheath will be of FRLS/FS Material and meet special tests as per specification For FRLS/FS cables		
2.13.00	Filler material details		
2.14.00	Armouring		
2.14.01	Material		
2.14.02	Type of armouring		
2.14.03	No. and size of strip/wire		
2.14.04	Whether galvanized	Yes/No	
2.14.05	Diameter of cable over armouring	mm	
2.15.00	Outer sheath		
2.16.01	a. Material conforming standard/type b. Extruded	Yes/No	
2.16.02	Min. thickness of sheath	mm	
2.16.03	Tolerance on thickness of sheath	mm	
2.16.04	Min. tensile strength	N/sq.mm	
2.16.05	Min. elongation percentage at rupture		
2.16.06	Colour of outer sheath		
2.16.07	Whether outer sheath will be of FRLS/FS Material and meet special tests as per specification		Yes/No

2.16.08	a. Overall diameter of cable b. Tolerance on O.D	mm	
2.17.00	Scheme for identification of cores		
2.22.00	Short circuit withstand capacity		
2.22.01	Short circuit current	kA	
2.22.02	Duration of short circuit	sec	
2.22.03	Formula relating short circuit and duration		rms, sec respectively
2.23.00	Allowable/attainable maximum conductor temperature when carrying continuously currents as per item 2.14.00 above	°C	
2.24.00	Allowable/attainable maximum conductor temperature at the termination of short circuit current as per item 2.22.00 above	°C	
2.25.00	Cable constants		
2.25.01	Max. DC resistance of conductor at twenty (20) Degrees centigrade	ohm/km	
2.25.02	AC resistance of conductor at twenty (20) Degrees centigrade	ohm/km	
2.25.03	Reactance per core at 50 Hz	ohm/km	
2.25.04	Capacitance per core at 50 Hz	micro farad/km	
2.25.05	Insulation a. Insulation resistance constant mega ohm-km at 27 °C and at max. rated temperature b. Volume resistivity ohm-cm at 27 °C and at max. rated temperature c. Min. tensile strength d. Min. elongation percentage at rupture	N/sq.mm	
2.25.06	Loss tangent		
2.25.07	Dielectric constant		
2.26.00	Maximum cable charging current at normal operating voltage	A/km	
2.27.00	Factory tests (Enumerate in detail for each type of cable) a. Type tests b. Acceptance tests c. Routine tests d. Special tests to prove FRLS/FS properties		
2.28.00	Is the offered cable guaranteed to safely withstand continuous conductor temperature of 20 °C for XLPE, FS /85°C for HRPVC		Yes/No
2.22.00	Cable weight	kg/km	
2.30.00	Recommended minimum bending radius	mm	
2.31.00	safe pulling force	kg	
2.32.00	Maximum allowable spacing for angle iron supports		mm
2.33.00	Length of cable per drum	m	
2.34.00	Cable drum		
2.34.01	Material		
2.34.02	Dimensions of drum		
2.34.03	IS reference		

2.34.04	Standard drum length for each size of cable (single length)	
2.34.05	Cable weight	kg
2.34.06	Shipping weight	kg
2.34.07	Drum weight	kg

13.00.00 LV POWER CABLES

1.00.00	**General**		
1.01.00	Name of the Contractor		
1.02.00	Name of subcontractors, if any		
1.03.00	Specifications and Standards		
1.04.00	Design ambient temperature (Deg. C)		
1.05.00	System particulars		
2.00.00	**Cables**		
	(Fill separate columns for the following particulars for each type and size of cables)		
2.01.00	Name of the Manufacturer		
2.02.00	Place of manufacturer		
2.02.01	ISI registration and validity date		
2.03.00	Cable type		
2.04.00	Applicable specifications and standards		
2.04.01	Whether cable will carry ISI mark		
2.05.00	Voltage grade		
2.06.00	No. of cores and size (in sq.mm)		
2.07.00	Suitable for earthed/unearthed system		
2.08.00	Permissible voltage and frequency variation for satisfactory operation		
	a. Voltage		
	b. Frequency		
	c. Voltage and Frequency combined		
2.09.00	Continuous current carrying capacity for cables laid		
2.09.01	For standard conditions as per IS		
	a. In air	(A)	
	b. In ground		(A)
	c. In duct	(A)	
	d. In trench	(A)	
2.09.02	For site conditions:		
	a. In air	(A)	
	b. In ground		(A)
	c. In duct	(A)	
	d. In trench	(A)	
2.09.03	Derating factors for various conditions of laying are not worse than the ones specified in applicable IS		Yes/No
2.09.04	Derating factor for fire resistance treatment		
2.10.00	Conductor		
2.10.01	Material reference standard for conductor		
2.10.02	Grad and shape of conductor		
2.10.03	Nominal cross section area	mm^2	
2.10.04	Number of wires		
2.10.05	Diameter of wire		mm
2.10.06	Diameter/size of conductor		mm

2.10.07	Screening/Sheilding/heat barrier tape (as applicable) a. Material b. Type / applicable Std c. Thickness			
2.11.00	Insulation			
2.11.01	Material composition and conforming standard and type			
2.11.02	Thickness of insulation a. Between cores	mm		
	b. Between cores and inner sheath		mm	
2.11.03	Tolerance on thickness of insulation			%
2.11.04	Diameter of core over insulation		mm	
2.11.05	Specific insulation resistance at ninety (85)/ (20) degrees centigrade		Ohm-cm	
2.11.06	Screening/Shielding/heat barrier tape (as applicable) a. Material b. Type / applicable Std c. Thickness			
2.11.07	Whether triple extrusion technique for HV adopted?			Yes/No
2.12.00	Inner sheath			
2.12.01	Material, conforming standard/type			
2.12.02	Extruded	Yes/No		
2.12.03	Calculated diameter over laid up cores			
2.12.04	Thickness (min)		mm	
2.12.05	Diameter of cable over inner sheath			mm
2.12.06	Whether inner sheath will be of FRLS/FS Material and meet special tests as per specification For FRLS/FS cables			
2.13.00	Filler material details			
2.14.00	Armouring			
2.14.01	Material			
2.14.02	Type of armouring			
2.14.03	No. and size of strip/wire			
2.14.04	Whether galvanized	Yes/No		
2.14.05	Diameter of cable over armouring		mm	
2.15.00	Outer sheath			
2.15.01	a. Material conforming standard/type b. Extruded	Yes/No		
2.15.02	Min. thickness of sheath		mm	
2.15.03	Tolerance on thickness of sheath		mm	
2.15.04	Min. tensile strength	N/sq.mm		
2.15.05	Min. elongation percentage at rupture			
2.15.06	Colour of outer sheath			
2.15.07	Whether outer sheath will be of FRLS/FS Material and meet special tests as per specification			Yes/No
2.15.08	a. Overall diameter of cable b. Tolerance on O.D	mm		

2.16.00	Scheme for identification of cores		
2.17.00	Short circuit withstand capacity		
2.17.01	Short circuit current	kA	
2.17.02	Duration of short circuit	sec	
2.17.03	Formula relating short circuit and duration		rms, sec
2.18.00	Allowable/attainable maximum conductor temperature when carrying continuously currents as per item 2.14.00 above	°C	
2.19.00	Allowable/attainable maximum conductor temperature at the termination of short circuit current as per item 2.22.00 above	°C	
2.20.00	Cable constants		
2.20.01	Max. DC resistance of conductor at twenty (20) Degrees centigrade	ohm/km	
2.20.02	AC resistance of conductor at twenty (20) Degrees centigrade	ohm/km	
2.20.03	Reactance per core at 50 Hz	ohm/km	
2.20.04	Capacitance per core at 50 Hz		micro farad/km
2.20.05	Insulation		
	a. Insulation resistance constant mega ohm-km at 27 °C and at max. rated temperature		
	b. Volume resistivity ohm-cm at 27 °C and at max. rated temperature		
	c. Min. tensile strength	N/sq.mm	
	d. Min. elongation percentage at rupture		
2.20.06	Loss tangent		
2.20.07	Dielectric constant		
2.21.00	Maximum cable charging current at normal operating voltage	A/km	
2.22.00	Factory tests (Enumerate in detail for each type of cable)		
	a. Type tests		
	b. Acceptance tests		
	c. Routine tests		
	d. Special tests to prove FRLS/FS properties		
2.23.00	Is the offered cable guaranteed to safely withstand continuous conductor temperature of 20 °C for XLPE, FS /85°C for HRPVC	Yes/No	
2.24.00	Cable weight	kg/km	
2.25.00	Recommended minimum bending radius	mm	
2.26.00	safe pulling force	kg	
2.27.00	Maximum allowable spacing for angle iron supports		mm
2.29.00	Cable drum		
2.29.01	Material		
2.29.02	Dimensions of drum		
2.29.03	IS reference		
2.29.04	Standard drum length for each size of cable (single length)		
2.29.05	Cable weight	kg	

2.29.06	Shipping weight	kg	
2.29.07	Drum weight	kg	

14.00.00 CONTROL CABLES

1.00.00	**General**		
1.01.00	Name of the Contractor		
1.02.00	Place & Country of manufacturer		
1.03.00	a. Applicable specifications and standards		
	b. Whether cable will carry ISI mark		
1.04.00	a. Cable type		
	b. Voltage grade of cable		
	c. Voltage designation of cable	(U_0/U)	
	d. No. of cores x cross sectional area of conductor	sq.mm	
1.05.00	Suitable for earthed/unearthed system		
1.06.00	Permissible voltage and frequency variation for satisfactory operation		
	a. Voltage		
	b. Frequency		
	c. Voltage and Frequency combined		
1.07.00	Continuous current rating with single cable laid in air in an ambient temperature of 50 °C and for maximum conductor temperature of 85 °C for HRPVC/20 for FS (For single core cables, the continuous current rating shall be furnished both for armour earthed at one end and for armour earthed at both ends)		
1.08.00	Permissible conductor temp. corresponding to maximum continuous current	(°C)	
1.09.00	Maximum permissible conductor temp. for emergency Overloading	(°C)	

2.00.00 Derating factors for the following shall be furnished

2.01.00	a. Variation in ambient air temp. (for cables laid in air from 30 °C to 55 °C in steps of 5 °C)		
	b. Variation in ambient air temp. (for cables laid direct in ground from 25 °C to 50 °C in steps of 5 °C)		
	c. Grouping		

3.00.00 Derating factors

Furnish chart showing derating factors for different spacing of cables in horizontal formation in single row and in trefoil formation (for single core cables) as well as in different tiers under the following methods of laying:

a. Cable laid in concrete cable trenches with removable covers
b. Cables laid in ground
c. Cables laid in air
d. Cables laid in pipes or ducts
e. Variation in depth of laying for cables laid directly in ground
f. Variation in thermal resistivity of soil of cables laid directly in ground in range 600 mm to 1500 mm.

4.00.00 Short circuit capacity

a. Short circuit Amp. (rms) kA
b. Duration of short circuit sec
c. Conductor temp. allowed for the short circuit duty (DC) (°C)
d. Formula relating short circuit and duration rms, sec respectively

5.00.00 Conductor

5.01.00 Material of conductor (if copper state whether tinned/untinned)
5.02.00 Material of conductor conforms to (state standard)
5.03.00 Grade
5.04.00 Nominal cross sectional area
5.05.00 Number and diameter of wires
5.06.00 Shape of conductor
5.07.00 Maximum conductor resistance (DC) at 20 (°C) Ohms/km
5.08.00 Shielding on conductor / heat barrier type (whichever is applicable)
a. Material
b. Type / applicable standard
c. Thickness

6.00.00 Insulation
6.00.01 Composition of insulation
6.00.02 Material of insulation conforms to (State std & type & grade)
6.00.03 Nominal thickness of insulation mm
6.00.04 Tolerance on thickness
6.00.05 Minimum insulation resistance at 20 (°C) megaohms/km
6.00.06 Minimum volume resistivity for HRPVC insulation at
a. 27 (°C)
b. 85 (°C)
6.00.07 Minimum tensile strength N/sq.mm
6.00.08 Minimum elongation percentage at rapture
6.01.00 Shielding on insulation/ binder tape (as applicable)
a. Material
b. Type/Applicable standard
c. Thickness mm

6.02.00	Colour scheme for identification of cores		
6.02.01	Furnish details		
6.03.00	Details and type of filters used in interstices should be specified		
6.04.00	Inner sheath		
6.04.01	Material		
6.04.02	Extruded/wrapped	Yes/No	
6.04.03	Calculated diameter over laid up cores		
6.04.04	Material of inner sheath conforms to standard/type		
6.04.05	Calculated diameter over laid up cores		mm
6.04.06	Thickness (min)		mm
6.04.07	Diameter of cable over inner sheath		mm
6.04.08	Colour of inner sheath		
6.04.09	Whether inner sheath will be of FRLS/FS Material and meet special tests as per specification For FRLS/FS cables		
6.05.00	Armour		
6.05.01	Type and material of armour		
6.05.02	Material of armouring conforms to standard		
6.05.03	Calculated diameter of cable over inner sheath (or even insulation for single core cables)	mm	
6.05.04	Size of armour wire/strip		mm
6.05.05	Number of armour wires/strips		
6.06.00	Outer sheath		
6.06.01	a. Material b. Material conforming standard/type c. Method of application		
6.06.02	Calculated diameter under the sheath (over armour)	mm	
6.06.03	Min. thickness of sheath		mm
6.06.04	Tolerance on thickness of sheath	mm	
6.06.05	Min. tensile strength	N/sq.mm	
6.06.06	Min. elongation percentage at rupture		
6.06.07	Colour of outer sheath		
6.06.08	Whether outer sheath will be of FRLS/FS Material and meet special tests as per specification	Yes/No	
6.07.00	a. Overall diameter of cable b. Tolerance on O.D	mm	
6.08.00	a. Weight of cable for 1000 metres (without drum) b. Bending radius		kg
7.00.00	Cable constants		
7.01.00	DC resistance of conductor at twenty (20) per 1000 m Degrees centigrade	ohm ohm/km	
7.02.00	Approx.AC resistance of conductor at 85 Degrees centigrade	ohm/km	

7.03.00	Calculated Reactance per phase at 50 Hz	ohm/km
7.04.00	Calculated electrostatic Capacitance per core at 50 Hz	micro farad/km
8.00.00	Maximum charging current for cable at nominal voltage	Amps/km
9.00.00	Test voltage & voltage duration	
	a. High voltage tests	kV
	b. Water immersion test	kV
	c. Test procedures conform to (state std.)	
10.00.00	Loss tangent at normal frequency	
11.00.00	Dielectric constant at normal frequency	
12.00.00	Recommended minimum bending radius in terms of O.D. of cable	
13.00.00	Recommended spacing of angle iron supports	
14.00.00	Safe pulling force when pulled by pulling eye	kg
14.01.00	a. Full details of tests proposed to be carried out and special tests for FRLS cables/FS cables b. Whether all type test certificates enclosed	
15.00.00	Whether progressive sequential marking on outer sheath of cables can be provided?	Yes/No
16.00.00	Derating factor for following ambient temperature in air/ground	
	a. At 30 °C	
	b. At 35 °C	
	c. At 45 °C	
	d. At 50 °C	
17.00.00	Cable drums	
17.01.00	Dimensions	
	a. Flange diameter	mm
	b. Barrel diameter	mm
	c. Traverse	mm
17.02.00	Shipping weight of drum for standard drum length	kg
17.03.00	Standard cable length for drum for each size of cable (single length)	
17.04.00	Tolerance on packing length	

15.00.00 EARTHING & LIGHTING PROTECTION SYSTEM

S. NO.	DESCRIPTION
1	**GROUNDING SYSTEM**
	a) Main ground grid conductor material & size
	b) Ground electrode material & size
	c) Riser material & size
	d) Grounding installation work carried out as per specification
2	**LIGHTNING PROTECTION SYSTEM**
	a) Vertical air termination conductor material & size
	b) Horizontal air termination conductor material & size
	c) Down Conductor material & size
	d) Electrode material & size
	e) Riser conductor material & size
	f) Lightning Protection work carried out as per specification.

16.00.00 EMERGENCY DIESEL GENERATING SET

1.00.00 Diesel Engine

1.01.00	General	
1.01.01	Manufacture and model no.	
1.01.02	No. of Engines offered	
1.01.03	Continuous duty reacting (BHP)	
	i. At design condition	
	ii. At site condition	
1.01.04	Operating speed	RPM
1.01.05	Trip speed	RPM
1.01.06	Engine overhaul required after	___ Hours
1.01.07	Continuous hours of operation in full load of the engine at site elevation and design ambient temperature	
1.01.08	Total dimension of the set	__mm Lx __mm W x __mm H
1.02.00	Fuel Consumption	
1.02.01	Fuel oil grade	
1.02.02	Consumption at continuous duty rating	g/kwh
1.02.03	Consumption at generator rating output	g/kwh
1.02.04	Consumption at 25%, 50%, 75% generator output	g/kwh
1.02.05	Consumption at most economic load (mention also the load in BHP)	g/kwh
1.02.06	Engine fuel oil day tank	
	i. Nos. offered	
	ii. Capacity	
	a. M^3	
	b. Hours of engine operation	
	iii. Overall dimension	
	a. Diameter	mm
	b. Height	mm
1.03.00	Engine Lubrication	
1.03.01	Oil grade & Indian brand names	
1.03.02	Oil consumption at rated output	kg/hr
1.04.00	Main Lube Oil Pump details	
1.04.01	Type	
1.04.02	Number/Engine	
1.04.03	Location	
1.04.04	Drive rating	kW
1.04.05	Capacity	L/Min
1.04.06	Discharge pressure	kg/sq.cm(g)
1.05.00	Engine cooling system	
1.05.01	Method of cooling provided	Radiator/Secondary
1.06.00	Engine starting system	
1.06.01	No. of electrical starter motors provided and total kW rating	

1.06.02	Max. No. of consecutive starting possible	
1.06.03	Is the system complete with auto starter, indicating lamps, cables,etc	Yes/No
1.06.04	Is hand cranking provided	Yes/No
1.06.05	Batteries, voltage and AH capacity	
1.07.00	Exhaust line	
1.07.01	Nominal size and material	
1.07.02	Is insulation over exhaust line provided	
1.07.03	Is vibration isolator provided	
1.07.04	Aluminium wrapping over the insulation provided	
1.07.05	Silencer	
	a. Manufacturer	
	b. Dimension	
	c. Material of construction	
1.07.06	Sound level (dB) at exhaust outlet	
1.07.07	Type and no. of ventilation fans provided	
1.07.08	Manufacturer	
1.07.09	Material of construction	
1.07.10	Recommended size of the DG skid mount plinth	
	a. Length	m
	b. Width	m
	c. Height	m
1.07.11	Weight schedule	
1.07.12	Shipping weight of DG set	
1.07.13	Shipping weight of engine	
1.07.14	Shipping weight of generator	
1.07.15	Weight of battery set	
1.07.16	Heaviest part to be handled at a time	
1.07.17	Load on foundation during running of DG set	
	i. Vertical Load	
	ii. Horizontal Load	
1.08.00	Piping, Valves, Fittings	
1.08.01	Pipes	
	a. Manufacturer, standard and schedule/Thickness/Grade of	
	i. Fuel oil lines	
	ii. Lub oil lines	
	iii. Water line	
	iv. Exhaust gas line	
1.08.02	Valves	
	a. Manufacturer type standard and pressure rating (ANSI/Equipment) of valves	
	i. Fuel oil lines	
	ii. Lub oil lines	
	iii. Water line	
1.09.00	Please furnish below list of all annunciation control and interlock features provided	

1.10.00	List of all instruments used in diesel engine	
1.11.00	Whether all pipe terminals are supplied with counter flange bolts, nuts, etc	
1.12.00	Whether insulation on exhaust pipe provided	
1.13.00	Safety system	
1.13.01	Digital display of lub oil pressure	
1.13.02	Digital display of lub oil temperature	
1.14.00	Governing System	
1.14.01	Type of governor and details	
1.15.00	Other accessories	
1.15.01	Flywheel	
1.15.02	Flywhel housing	
1.16.00	Acoustic Enclosure	
1.16.01	Details of enclosure	
1.16.02	Material	
1.16.03	Performance of enclosure	
1.16.04	Constructional feature	
1.16.05	Details of mounting	

2.00.00 Generator Set

2.01.00	General	
2.01.01	Make	
2.01.02	Type	
2.01.03	Cooling medium for winding and core	
2.01.04	Method of cooling	
2.01.05	Maximum continuous rating under site Condition and at 0.8 p.f	kW
2.01.06	Electrical power consumption of the running auxiliaries of DG set	kW
2.01.07	Net maximum continuous output under site conditions at 0.8 p.f (excluding auxiliaries)	
2.01.08	Full load current	A
2.01.09	Excitation at MCR	
	a. Voltage	Volts
	b. Current	Amps
2.01.10	Rise of voltage and frequency when rated load is thrown off	
	a. With AVR	Volts,Hz
	b. Without AVR	Volts, Hz
2.01.11	Terminal voltage at rated load	kV
2.01.12	Frequency	Hz
2.01.13	Variation of terminal voltage	%
2.01.14	Variation of frequency	%
2.01.15	Speed	RPM
2.01.16	Direction of rotation	
2.01.17	Class of insulation	
2.01.18	Bearings	

2.02.00	Temperature rise over ambient at rated operating condition	
2.02.01	Temperature rise of armature windings above cooling medium temperature (Measured by embedded detectors)	°C
2.02.02	Temperature rise of field winding above cooling medium temperature	°C
2.02.03	Temperature of exit cooling air from windings (detected by thermocouple)	°C
2.02.04	Generator bearing temperature rise	°C
2.03.00	Losses	
2.03.01	Copper loss	
2.03.02	Iron loss	
2.03.03	Windage and friction loss	
2.03.04	Stray loss	
2.04.00	Efficiencies	
2.04.01	At MCR and rated p.f	%
2.04.02	At 75% MCR and rated p.f	%
2.04.03	At 50% MCR and rated p.f	%
2.04.04	At 40% MCR and rated p.f	%
2.04.05	At 20% MCR and rated p.f	%
2.04.06	Regulation under condition of rated speed, voltage and output a. At 0.80 p.f lag b. At 1.0 p.f c. At 0.80 p.f lead	
2.05.00	Type and degree of enclosure	
2.06.00	Type of mounting	
2.07.00	Type of bearing and its lubrication	
2.08.00	Space heater provide: if yes,	
2.08.01	Quantity	
2.08.02	Voltage	
2.08.03	Wattage	
2.09.00	Exciter	
2.09.01	Make	
2.09.02	Type of excitation	
2.10.00	Automatic voltage regulator (AVR)	
2.10.01	Make	
2.10.02	Type	
2.10.03	Dead band	
2.10.04	Range of droop setting	
2.10.05	Response time	
2.10.06	Voltage of operation	Volts
2.10.07	Range of voltage adjustments	
2.10.08	Catalogues and characteristic curves attached	Yes/no
2.10.09	CT/PT burden	
2.11.00	Make, quantity and location of the following	
2.11.01	Current transformers	

2.11.02	Temperature detectors
2.11.03	Space heaters
2.12.00	Annunciation system
2.12.01	Make
2.12.02	Model no.
2.12.03	Catalogue No.
2.12.04	Type
2.12.05	Architecture
2.13.00	Auto mains failure panel (AMF) panel
2.13.01	Make
2.13.02	Type
2.13.03	Construction
2.13.04	Material
2.13.05	Sheet metal thickness
2.13.06	Degree of protection
2.13.07	Floor channel sills and kick plate furnished?
2.13.08	Nameplate
2.13.09	Material
2.13.10	Thickness
2.13.11	Size for a. Equipment b. Panel
2.13.12	Internal illumination
2.13.13	Volt
2.13.14	Watt
2.13.15	Space heater
2.13.16	Volt
2.13.17	Watt
2.13.18	Thermostat controlled
2.13.19	Plug socket
2.13.20	Rating
2.13.21	panel illumination, space heater and plug socket circuit provided with individual switch fuse unit?
2.13.22	AC/DC supply Type and rating of isolating switch fuse units for: a. Incoming AC supply b. Incoming DC supply
2.13.23	Internal wiring
2.13.24	Wire type
2.13.25	Voltage grade
2.13.26	Conductor material
2.13.27	Conductor size for a. Current/control circuit
2.13.28	Wires identified at both ends with ferrules?
2.13.29	Terminal block
2.13.30	Make
2.13.31	Type/catalogue no.
2.13.32	20 % spare terminals furnished

2.13.33 Ground bus
2.13.34 Material
2.13.35 Day tank capacity & material

17.00.00 BATTERY

S. NO.	DESCRIPTION	
1.00.00	***BATTERY***	
1.01.00	***General***	
	a. Make	
	b. Type	
1.02.00	***Rating***	
	a. Rated Voltage	Volt
	b. 10-hour rating at 27 Deg.C to end cell voltage	AH
	c. 2-hour discharge rate to end cell voltage	Amp
	d. 1 –hour discharge rate to end cell voltage	Amp
	e. 1 -minute discharge rate to end cell voltage	Amp
1.03.00	***Performance***	
	a. Battery duty cycle curve furnished	Yes/No
	b. Cell voltage characteristics during duty cycle furnished	Yes/No
	c. Minimum cell voltage during duty cycle	Volt
	d. AH efficiency at 10-hour discharge rate	%
	e. Expected life of Battery	Yr
1.04.00	***Battery Characteristics***	
	a. Recommended charging rate for	
	i) Float charging	Amp

ii) Equalising Charge	Amp
iii) Boost charging in 10 hrs.	Amp
Start	Amp
Finish	Amp
b. Recommend specific gravity at 27 Deg C	
i) For first filling	
ii) At full charge	
iii) At end of 10-hour discharge	
c. Short-circuit current for a dead-short across battery terminals, when	
i) Float charge at 2.15 V/Cell	kA
ii) Boost charge at 2.75 V/Cell	kA
d. Battery internal resistance	Ohm
e. Cell voltage characteristics during charging furnished	Yes/No

18.00.00 BATTERY CHARGER

S. NO.	DESCRIPTION	UNIT
1.00.00	General	
	a. Make	
	b. Catalogue No.	
	c. Type	
	d. Reference Standard	
2.00.00	A.C. Input	
	a. Voltage ± % variation	Volt, %
	b. Phase	No.
	c. Frequency ± % variation	Hz., %
	d. Input current	Amp

3.00.00	D.C. Output	
	a. Voltage	Volt/Cell
	b. Current	Amp.
	/ Type of Cooling	
4.00.00	Max. Temp rise within cubicle above site ambient	
	a. Rectifier transformer	Deg.C
	b. SCR	Deg.C
5.00.00	Performance	
	a. Regulation for 0-100% rated load with ±10% Input voltage and ±5% input frequency variation	%
	b. Ripple content in O.C. output	
	i) With battery	%
	ii) Without battery	%
	c. Guaranteed efficiency at rated load	%
	d. Power factor at rated load	%
6.00.00	Miscellaneous	
	a. Charger provided with following features	
	i) Automatic voltage regulation	Yes/No
	ii) Current limiting circuitry	Yes/No
	iii) Smoothing filter circuit	Yes/No
	iv) Soft-start feature	Yes/No
	v) Automatic load shahng during parallel operation	Yes/No
	b. SCR elements provided with	
	i) Surge protection	Yes/No
	ii) Fast acting HRC fuse	Yes/No
7.00.00	A. C. Switch / MCCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current rating	

	i) Continuous	Amp
	ii) Interrupting	kA
8.00.00	A. C. Fuse / MCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current rating	
	i) Continuous	Amp
	ii) Interrupting	kA
9.00.00	A.C. Contactor	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Rated Current	Amp
	e. Utilization category	
	f. Thermal overload with In-built single-phase preventer provided	Yes/No
10.00.00	Rectifier Transformer	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Rating	
	i) KVA	KVA
	ii) Voltage	V
	iii) % reactance	%
	e. Class of insulation	
	f. Method of cooling	
11.00.00	Controlled Rectifier (SCR)	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. RMS Current rating	Amp

	e. Surge Current	
	i) One-cycle	Amp
	ii) Repetitive Cycle	Amp
	f. Peak inverse voltage	
	i) Continuous	Volt
	ii) Surge	Volt
12.00.00	D.C. Fuse/MCB	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	
	i) Continuous	Amp
	ii) Interrupting	KA
13.00.00	D.C. Contactor	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	Amp
	e. Utilization category	
14.00.00	Blocking Diodes	
	a. Make	
	b. Type/Cat. No.	
	c. Reference Standard	
	d. Current Rating	
	i) One – minute	Amp
	ii) One-hour	Amp
	e. Peak inverse voltage	Volt

19.00.00 MOTORS

1.00.00 H.V. & L.V. MOTORS

S No.	Description
1.01.00	Manufacturer
1.02.00.	Type and frame size &
1.03.00	design code no.
1.04.00.	Nos. required
1.05.00.	Application
1.06.00	Specification & Codes
1.07.00	Capacity for i) for specified climatic conditions (50^0C) ii) At 40^0C ambient
1.08.00.	Location for installation
1.09.00.	Type of enclosure & ventilation
1.10.00.	Degree of protection
1.11.00	Type of duty
1.12.00.	No. of phases, frequency & voltage
1.13.00.	Permissible variations in a) Voltage b) Frequency c) Combined
1.14.00.	At rated voltage & frequency a) Full load current b) Full load speed c) No load current
1.15.00.	Minimum permissible voltage during starting
1.16.00.	Maximum permissible time at minimum permissible voltage during running at full load.
1.17.00.	Maximum permissible time at 75% of rated voltage during running at full load.
1.18.00.	Whether motor stalls at 70% of rated voltage.
1.19.00	Efficiency & power factor Load (% of full load) 100 50 25

0
At start
Duty Point

1.20.00 Stator winding
i) Connection
ii) Type & nos. of terminals Brought out
iii) Resistance between terminals at 20°C
iv) Resistance per phase at 20°C
v) Inductance per phase
vi) Capacitance per phase

1.21.00. Starting current as % of full load current
i) With IS tolerance
ii) Without IS tolerance

1.22.00 Torque at full load in Kgm.

1.23.00 Break away torque in % of full load torque

1.24.0. Pull up torque in % of full load torque

1.25.00. Pull out torque in % of full load torque

1.26.00 Starting time in sec.
Without mechanism coupled or Mechanism coupled through hydraulic coupling when it may be presumed that load is transferred to motor shaft only after attaining almost full speed.
i) with rated voltage
ii) with 80% of rated voltage
iii) with 110% of rated voltage

1.27.00 Starting time in sec.
With mechanism coupled through Flexible coupling.
i) with rated voltage
ii) with 80% of rated voltage
iii) with 110% of rated voltage

1.28.00 Safe stall time (hot motor)
i) At rated voltage
ii) At 80% of rated voltage
iii) At 110% of rated voltage

1.29.00 Safe stall time (Cold motor)
i) At rated voltage
ii) At 80% of rated voltage
iii) At 110% of rated voltage

1.30.00 Limiting motor temperature to determine safe stall time

1.31.00 Permissible maximum accelerating time (hot motor)
- i) At rated voltage
- ii) At 80% of rated voltage
- iii) At 110% of rated voltage

1.32.00. Permissible maximum accelerating time (cold motor)
- i) At rated voltage
- ii) At 80% of rated voltage
- iii) At 110% of rated voltage

1.33.00 Insulation
- i) Class of insulation
- ii) Material & treatment of insulation

1.34.00 Whether insulation is suitable for 415 V, 6.6KV, ungrounded system

1.35.00 Temperature rise under normal conditions over 50^0C ambient temperature
- i) By resistance method
  - --- Degree centigrade over cooling water temp. for CACW motors.
  - --- Degree centigrade over cooling air temp. for CACA motor.
- ii) By Thermometer method
  - ---- Degree centigrade over cooling water temp. for CACW motor.
  - ---- Degree centigrade over cooling air temp. for CACA motor.

1.36.00 Method of starting

1.37.00. Permissible starting duty cycles

1.38.00. Stator thermal time constant

1.39.00 Maximum permissible voltage During high speed bus transfer & special design feature.

1.40.00 Time required for voltage to decay down to when driving voltage is removed.
- i) At 50% of rated voltage
- ii) At 40% of rated voltage

iii) At 25% of rated voltage
iv) At 0% of rated voltage

1.41.00 Method of cooling

1.41.01 Details of water cooling system

i) No. of cooler
ii) Water requirement per cooler
iii) Losses removed by cooler
iv) Max. permissible temperature Of cooling water at inlet
v) Max. permissible temperature Of cooling water at outlet
vi) Maximum permissible pressure At water outlet
vii) Water pressure drop through The cooler
viii) Temp. of cold air coming Out & entering the machine For permissible cooling Water temperature of 31^0C
ix) Temp. rise of air passing through machine at full load.
x) Air pressure drop through The cooler
xi) Temp. rise of water through cooler
xii) Protection against leakage of water
xiii) Arrangement to ensure the water flow

1.42.00 Bearings

i) Number
ii) Type
iii) Lubrication system
iv) Quantity of lubrican reqd. For both the bearings.
v) Life in hours at rated speed
vi) Recommended lubricant
vii) Bearing end play
viii) Inlet oil pressure
ix) Temp. rise of oil
x) Max. permissible temp. ofBearing
Xi Max. permissible temp. of Oil
Xii Permissible running time without forced oil at full load & full speed
xiii) Whether bearings are provided with 4 wire, platinum RTD having 100-ohm resistance at 0^0C

for remote temp. indication.

xiv) Whether bearings are provided with local temperature indicator having two adjustable contacts rated for 2A at 240V AC or 0.2A at 220V DC.

xv) If forced lub oil system provided :

i) Qty of lubricant required for initial filling.
ii) Recommended period after which lubricant should be replaced
iii) Bearing cooling water requirement
iv) Max. permissible bearing cooling water inlet temp. (permissible)
v) Max. permissible bearing cooling water outlet temp.

1.43.00. Terminal designation correspond to direction of rotation (Facing driving end).

1.44.00 Terminal boxes with accessories separate terminal boxes provided.

i) Main
ii) Space heaters
iii) Winding temp. detectors
iv) Bearing temp. detectors
v) Moisture detectors
vi) Neutral terminals

1.45.00 Main terminal box details

i) Type & Nos.
ii) Fault level permissible for 0.25 sec.
iii) Location
iv) Cable gland size & no.
v) Direction of cable entry.

1.46.00. Space Heater

i) Number
ii) Location
iii) Capacity of each
iv) Total power requirement
v) Voltage.

1.47.00. Details of 4 wire platinum RTD having 100 ohm resistance at 0°C for winding temp. detector.

i) Nos. provided
ii) Location

1.48.00 Whether CTs for differential protection are provided

i) If Yes, no. of CTs supplied alongwith motors.C.T. details
a) C.T. ratio
b) Knee point voltage

ii) S.C. withstand capacity

1.49.00 Type of mounting
1.50.00 Shaft orientation
1.51.00 Shaft extension
1.52.00 Grounding pads size nos. & location
1.53.00 Method of coupling to driven mechanism
1.54.00 Motor GD^2
1.55.00 Lifting device
1.56.00 Weight

i) Weight of stator (wound)

ii) Weight of rotor (wound)

iii) Weight of base plate

iv) Weight of cooler

v) Net weight of motor

1.57.00 Shipping dimensions & weight

1.58.00 Thermometer provided

i) In cold air path

ii) In hot air path

iii) For measurement of oil temp.

1.59.00 Characteristic curves furnished

i) Speed vs. current at rated voltage

ii) Speed vs. torque at 110%, 100%, 90% and 80% of rated voltage

iii) Thermal withstand curve for hot & cold conditions.

iv) Efficiency vs. load: Yes / No

v) P.F. Vs. load: Yes / No

vi) Current vs. time: Yes / No

vii) Negative phase sequence curve: Yes / No

1.60.00 Drawings furnished

i) General arrangement of motor

ii) Main terminal box showing the method of terminating the incoming cables

iii) Instruction manuals

1.61.00 Rotor design as per specification clause 5.04.00

2.00.00 MOTOR (DC)

2.01.00 General

i) Manufacturer
ii) Equipment driven by Motor
iii) Motor type
iv) Country of origin

2.02.00 Design & Performance

i) Frame Size
ii) Type of duty
iii) Type of enclosure & type of cooling
iv) Applicable standard to which motor generally confirms
v) Type of mounting :
vi) Direction of rotation
vii) KW rating at amb. Temp. 50 deg C
viii) Rated power supply voltage
a) Armature circuit (v)
b) Field (v)
ix) Permissible voltage variation
x) Minimum permissible starting voltage
xi) Rated speed at rated voltage (RPM)
xii) At rated voltage
a) Full load current (A)
b) NO load current (A)
xiii) Starting current (A)
a) 100% voltage
b) 85% voltage
xiv) Starting time (with pump coupled)
a) 100% voltage (Sec)
b) 85 % voltage
c) 80 % voltage
xv) Efficiency at rated voltage at
a) 100% load
b) 75% load
c) 50% load
xvi) Safe stall time (sec) at 110%
a) Hot condition
b) Cold condition
xvii) Torque (Kg-m)

a) Starting at min. permissible voltage
b) Rated

xviii) Fly wheel moment (GD2) motor (Kg-m)

2.03.00 Constructional Features

i) Winding insulation
   a) Class & type
   b) Tropicalised (Yes/No)
   c) Temp. rise over specified ambientof 50 deg.
   d) Method of temp. measurement

ii) Degree of protection of terminal box for
   a) Main terminal box
   b) Space heaters (AUX. TB)

iii) For main terminal box
   a) No. and type of cable gland
   b) Recommended cable size (Armature/field)
   c) Fault level (KA, sec)

iv) Bearings
   a) Type (at DE/NDE)
   b) Make
   c) Recommended lubricant
   d) Life

v) Weight of motor (Kg.)

vi) Field current at rated speed (A)

vii) Field resistance (Ohm) at rated speed at 30 deg

viii) Field trimmer rating (Ohm) for getting basic speed at 30 deg C.

ix) Resistance (Ohm) between terminals at 30 deg C.
   a) Armature
   b) Series winding
   c) Inter pole winding
   d) Shunt winding resistance

x) 1st and 2nd critical speed

xi) Overload that can be carried by motor without changing overall performance and period for which it is applicable

xii) Grounding device

xiii) Space heater
   a) No. & location
   b) Volt & KW rating

2.04.00 Resistors

i) Starting (external) resistance
   a) Type of resistor

b) Ohmic, current & power rating of resistor elements

c) Max. permissible temp. of resistor elements

d) Connection diag. Of resistor elements

e) No. of startup stages/steps

f) Resistance values of stages

-at 30 deg. C (Ohm)

- at running condition (Ohm)

20.00.00 ELECTRICAL MOTOR ACTUATORS

1.00.00 General

1.01.00	Application	
1.02.00	Make	
1.03.00	Model	
2.00.00	Enclosure	
2.01.00	Type	
2.02.00	Degree of protection	
2.03.00	Reference standard	
3.00.00	Actuator	
3.01.00	Torque range	Nm
3.02.00	Maximum thrust	kN
3.03.00	speed of output shaft	rpm
3.04.00	Set torque open/ close	Nm
3.05.00	Max. stem diameter	mm
3.06.00	Starting torque	kN
3.07.00	Operating time	sec
3.08.00	Travel stroke/Angular	mm/rotation degree
4.00.00	Motor	
4.01.00	Type	
4.02.00	Duty cycle/designation	
4.03.00	Motor rating	
4.03.01	Output	kW
4.03.02	Voltage/phase/frequency	V/No./Hz
4.03.03	Speed	rpm
4.04.00	Admissible voltage fluctuation	±%
4.05.00	Admissible frequency fluctuation	±%
4.06.00	Admissible combined voltage and frequency Fluctuation (absolute sum)	%
4.07.00	Full load torque	Nm
4.08.00	Starting torque	Nm
4.09.00	Power factor at full load	
4.10.00	Full load efficiency	
4.11.00	Motor current	
4.11.01	Starting	
4.11.02	Running	
4.11.03	Stalling	
4.12.00	Insulation class	
4.13.00	Temperature rise allowed over 50°C Ambient temperature	°C
4.14.00	Whether suitable for inching operation?	
4.14.01	Method of starting	
4.14.02	Type of starter	
4.15.00	Type of mounting	

4.16.00	Sizes of glands provided	
4.17.00	Type and nos. of terminals brought out	
4.18.00	Type and nos. of bearings	
4.19.00	Lubrication (motor)	
4.20.00	Terminal wiring diagram furnished?	Yes/No
5.00.00	Limit switches	
5.01.00	No. of limit switches furnished	
5.01.01	Torque limit switch	
5.01.02	End of travel limit switch	
5.01.03	Position limit switch	
5.02.00	No. of N.O and N.C contacts provided for each limit switch	
6.00.00	Position indicator/ Transmitter	
6.01.00	Position indicator	
6.01.01	Provided locally	
6.01.02	Type	
6.02.00	Position Transmitter	
6.02.01	Type	
6.02.02	Output signal	
7.00.00	Space Heater	
7.01.00	No. x Watt	
7.02.00	Voltage	
8.00.00	Accessories	
	Specify accessories if furnished	

19.00.00 COMMUNICATION SYSTEM

S. NO.	Description		
1.00.00	General		
1.01.00	Make		
1.02.00	Type		
1.03.00	Location		
1.04.00	Specifications and standards		
1.05.00	Degree of protection		
1.06.00	Design ambient temperature		°C
1.07.00	System particulars	As per specification	
1.08.00	Input supply to		
1.08.01	Power supply unit		
1.08.02	Amplifier		
1.09.00	Power consumption		
1.09.01	Page channel only	VA	
1.09.02	Party channel only	VA	
1.09.03	Both page and party channels		VA
1.09.04	None of the channels working		VA
1.09.05	Maximum at any time		VA
1.10.00	Maximum allowable cable between Handset station and amplifier rack.		Km
2.00.00	Amplifier/Pre-Amplifier		
2.01.00	Make		
2.02.00	Type		
2.03.00	Applicable standards		
2.04.00	Mains voltage	V	
2.04.01	Voltage variation (+ percent)		
2.05.00	Average current consumption		
2.05.01	Without signal		A
2.05.02	At full output	A	
2.05.03	Temperature rise above ambient temperature		°C
2.06.00	Number of amplifiers		
2.07.00	Output power		
2.07.01	Rated	W	
2.07.02	Maximum	W	
2.08.00	Distortion		
2.08.01	At rated output		%
2.08.02	At 1 kHz		%
2.09.00	Output impedance	ohms	
2.10.00	Output voltage		V
2.11.00	Frequency response		
2.12.00	Noise level	dB	
2.13.00	Input impedance		ohms
2.14.00	Input sensitivity		MV
2.15.00	Fuse ratings	A	
2.16.00	Protection (self restoring type)		

2.16.01	Short circuit	
2.16.02	Open circuit	
2.16.03	Overload	
2.16.04	Against oscillations	
2.17.00	Whether amplifier system supplemented with pre amplifier	Yes/No
2.18.00	Whether bass and treble control provided	Yes/No
2.19.00	Transistors/ICs used	Yes/No
3.00.00	Handset/Pilfer proof stn	Desk mounted/ Wall/Column mounted outdoor
3.01.00	Make	
3.02.00	Type	
3.03.00	Applicable standards	
3.04.00	Type of construction	
3.05.00	Material	
3.06.00	Dimensions	___mm Lx ___mm H x ___mm D
3.07.00	Total weight	kg
3.08.00	Weather-proof enclosure/Degree of protection	
3.08.01	Type	
3.08.02	Material	
3.08.03	Dimensions	mm
3.08.04	Locking arrangement provided	Yes/No
3.09.00	Mounting arrangement	
3.10.00	Paint and finish	
3.11.00	Cable entry	
3.12.00	Equipment mounted/housed (Furnish list of equipmentsand their numbers)	
3.13.00	Arrangement made to make it pilfer proof	Yes/No
4.00.00	Handset	
4.01.00	Make	
4.02.00	Type	
4.03.00	Degree of protection	
4.04.00	Applicable Standards	
4.05.00	Controls provided	
4.06.00	Type of noise cancelling device	
4.07.00	Type, number of cores size and length of coiled cord	
4.08.00	Materials used	
4.09.00	Dimensions	
4.10.00	Weight	kg
4.11.00	Paint and finish	
4.12.00	Cable entry details	
4.13.00	Reciever	
4.13.01	Make	
4.13.02	Type	
4.13.03	Impedance at 1 kHz	ohms
4.13.04	Resistance	ohms
4.13.05	Frequency response	kHz
4.13.06	Allowable input voltage	V

4.14.00	Transmitter	
4.14.01	Make	
4.14.02	Type	
4.14.03	Impedance at 1 kHz	ohms
4.14.04	Resistance	ohms
4.14.05	Frequency response	kHz
4.14.06	Output voltage	V
4.14.07	Overall sensitivity	
4.14.08	Directional characteristics	

5.00.00	**Cable**	Signal cable for handset stn AC 1Ø Power supply
5.01.00	Make	
5.02.00	Type	
5.03.00	Applicable standards	
5.04.00	Conductor	
5.04.01	Material	
5.04.02	Nominal cross-sectional area	mm^2
5.04.03	Number and diameter of wires	
5.05.00	Voltage rating	V
5.06.00	Insulation	
5.06.01	Composition of insulation	
5.06.02	Thickness of insulation	mm
5.06.03	Insulation resistance at 20 deg. C	ohms-cm

21.00.00 VARIABLE FREQUENCY DRIVE

S.No.	Description	
1.0	**Mains connection**	
1.1	Voltage and power range	:
1.2	Frequency	:
1.3	Power factor	:
2.0	**Motor connection**	
2.1	Voltage	:
2.2	Frequency	:
2.3	Continuous loading capability(constant torque at a maxambient temperature of50°C)	:
2.4	Overload capacity (at a max. ambienttemperature of	:

S.No.	Description		
	50 °C)		
2.5	Switching frequency Selectable	KHZ	:
2.6	Acceleration time	Sec	:
2.7	Deceleration time	Sec	:
2.8	Speed control		:
2.8.1	Open loop	%	:
2.8.2	Closed loop	%	:
2.9	Torque control		:
2.9.1	Open loop	%	:
2.9.2	Closed loop	%	:
3.0	**Programmable control connections**		
3.1	Two analog inputs		:
3.1.1	Voltage signal		:
3.1.2	Current signal		:
3.1.3	Potentiometer		:
3.1.4	Reference value		:
3.1.5	Maximum delay	ms	:
3.1.6	Resolution	%	:
3.1.7	Accuracy	%	:
3.2	Two analog outputs Accuracy		:
3.3	Auxiliary voltage		:
3.4	Six digital inputs		:
3.4.1	Input impedanceMaximum delay		:
3.4.2	Three relay outputs		:
3.4.3	Maximum switching voltage		:

S.No.	Description	
3.4.4	Maximum switching current	:
3.4.5	Maximum continuous current	:

22.00.00 CABLING SYSTEM / FIRE SEALING SYSTEM

1.0 Pre-fabricated Cable Trays

1.1 Type / Material :

1.2 Load Bearing capacity between two supported points **. . . .** Kg :

1.3 Load bearing capacity under cantilever condition **. . . .** Kg :

1.4 Cable trays are furnished complete with all accessories? :

1.5 Cable trays & accessories properly galvanised? State minimum/average thickness of galvanising :

1.6 Standard width of cable trays furnished **. . . .** mm :

1.7 Reference Standard :

2.00 Conduits

2.1 Type/Material :

2.2 Reference Standard :

2.3 Gauge - upto 25 mm dia. :
- above 25 mm dia. :

2.4 Catalogue furnished :

3.0 Junction Box

3.1 Type / Material :

3.2 Reference Standard :

3.3 Degree of protection outdoor/indoor:

3.4 Catalogue furnished? :

4.0 Terminal Block

4.1 Type :

4.2	Reference Standard	:		
4.3	Current rating	:		
4.4	Catalogue furnished?	:		
4.5	20% spare terminals provided	:		

5.0 Cable Termination Kit

			XLPE Cable	PVC Cable
5.1	Type	:		
5.2	Suitable for voltage grade	:		
5.3	Cable termination kit furnished for XLPE & PVC cable	:		
5.4	Complete with all accessories?	:		

6.0 Cable Straight-Through jointing Kit

			XLPE Cable	PVC Cable
6.1	Type	:		
6.2	Suitable for Voltage Grade	:		
6.3	Cable Jointing Kit furnished for both XLPE and PVC cables	:		
6.4	Complete with all necessary accessories?	:		

7.0 Cable Gland

7.1	Type / Material	:
7.2	Double Compression Type	:
7.3	Complete with armour clamp	:
7.4	Catalogue furnished?	:

8.0 Cable Lug

8.1	Type / Material	:
8.2	Sizes furnished as specified?	:

8.3	Reference Standard	:

9.0 Ferrules

9.1	Type / Material	:
9.2	Colour	:
9.3	Interlocked type?	:
9.4	Reference Standard	:

10.0 Clamps

10.1	Type / Material	:

11.0 Fire Protection Sealing Compound

11.1	Type / Material	:

12.0 Cable Marker

12.1	Type / Material	:

13.0 **Outer Sheath**

23.00.00 Illumination System

1.0 LIGHTING FIXTURES

1.1 Catalogue No. :

1.2 Catalogue furnished Yes/No :

1.3 Applicable standards :

1.4 Weight of fixtures Kg :

1.5 Characteristics of fixtures

a)	Nominal working voltage	V	:
b)	Starting current	A	:
c)	Starting time	Sec	:
d)	Input operating curren	A	:
e)	Running power factor		:
f)	Total power consumed	W	:
g)	Power loss per ballast	W	:
h)	Maximum permissible supply	%	:
	i) voltage variation for satisfactory		
	ii) operation of Fixture/Accessories		

1.6 Lamps (To be filled for each type of lamp in separate sheets)

a)	Rating		:
b)	Type		:
c)	Lumen Output	Lumen	:
d)	Average life	Hour	:

2.0 LIGHTING PANEL

a. Type :
b. Reference Standard
c. Enclosure
   i) Sheet metal thicknessmm. :
   ii) Degree of protection for :
   Indoor Panel
   Outdoor Panel

d. Bus-Bars
   i) Material :
   ii) Size :

e. Bus Rating A KArms

i) Continuous at 40°C :
ii) 1 Sec. Current :

f. Finish
i) Colour :
ii) Shade :

g. Dimension mm

h. VOID

i. Weight Kg :

j. MCCB/SWITCH
i) Type :
ii) Reference Standard :
iii) Voltage rating V :
iv) Current rating A :
v) No. of Poles :
vi) MCCB provided with S.C. release & Thermal 0/L element Yes/no :

vii) Breaking Current (400V AC/125V DC) kA :

viii) Catalogue furnished Yes/No :

k. Miniature Circuit Breaker (MCB) / A. C. Fuse

i) Type :
ii) Reference Standard :
iii) Voltage rating V :
iv) Current rating A :
v) No. of Poles ms :
vi) Interrupting time Yes/no :
vii) Breaking Current kA :
viii) Catalogue furnished Yes/No :
ix) Type of blowout device :
x) Type of overload :

l. Timer Switch
i) Type :
ii) Reference Standard :
iii) Rating/Range :
iv) Catalogue furnished Yes/No :

m. A.C./D.C. Magnetic Contactor

i)	Type		:
ii)	Reference Standard		:
iii)	Rating at site ambient A		:
iv)	Duty class		:
v)	Utilization category		:
vi)	Operating Coil		:
vii)	Rated Voltage	V	:
viii)	Drop-out Voltage	V	:
ix)	Catalogue furnished	Yes/No	:

n. Push Buttonand type

i)	Contact rating	A	:

o. Indicating Lamp

i)	Type		:
ii)	Watt/Voltage		:

p. Meters

i)	Type		:
ii)	Reference Standard		:
iii)	Size	mm	:
iv)	Scale	°C	:
v)	Accuracy class		:

q. Selector Switch

i)	Type		:
ii)	Rating	A	:
iii)	Key interlock furnished	Yes/No	:

3.0 **RECEPTACLES**

a)	Type		:
b)	Reference Standard		:
c)	Voltage grade	V	:
d)	Catalogue furnished	Yes/No	:

4.0 **CEILING FAN**

a)	Type		:
b)	Reference Standard		:
c)	Sweep of the Fan	mm	:
d)	Regulator control smooth or step		:
e)	Catalogue furnished		:

5.0 **LIGHTING POLE/TOWER**

a) Type :
b) Reference Standard :
c) Heigh
i. Overall Meter :
ii. Fixture mounting Meter :
d) Catalogue furnished :

6.0 **PORTABLE EMERGENCY LIGHTING SET**

a) Type :
b) Weight kg :
c) Catalogue furnished Yes/ No :

d) Overall dimension mm :

e) Wattage Kg :

f) Battery type :

g) Battery voltage V :

h) Flexible cord with 3 pin plug furnished Yes/ No:

7.0 **MISCELLANEOUS ITEMS**

a) Wires (1 core)
i) Type :
ii) Reference Standard :
iii) Voltage grade V :
iv) Wire Sizes mm2 :

b) Conductor
i) Material :
ii) No. & dia. of wires Nos.mm :

c) Insulation
i) Material :
ii) Thickness mm :

8.0 Continuous current rating when laid in Conduit at site ambient temperature for wire size A :

a) Maintenance Ladder

i) Material :

ii) Reference Standard :
iii) Height m :
iv) Catalogue furnished
Yes/ No :

9.0 **24V Supply Module**

a) Type :
b) Reference Standard :
c) Transformer rating and type :
d) Enclosure material and thickness :
e) Degree of protection :
f) Catalogue furnished Yes/ No :

24.00.00 SUBSTATION AUTOMATION SYSTEM

SL NO.	DESCRIPTION		
1.	**BAY CONTROL UNIT**		
1.1	Make		
1.2	Model		
1.3	Communication Protocols supported		
1.4	Protocol for time synchronization		
1.5	Power Supply Board		
1.5.1	Model		
1.5.2	Input supply voltage	V DC	
1.5.3	Input Power	W	
1.5.4	Watchdog	No	
1.5.5	Communication	Hz±dB	
	Port 1		
	Port 2		
1.5.6	Quantity	Nos.	
1.6	Processor		
1.6.1	Model		
1.6.2	Microprocessor		
1.6.3	Watchdog		
1.6.4	Clock	Hz	
1.6.5	DRAM	Mbytes	
1.6.6	Flash	Mbytes	
1.6.7	SRAM	Kbytes	
1.7	**Communication**		
1.7.1	Serial		
1.7.2	IRIG-B		
1.7.3	Ethernet		
1.7.4	Quantity		
1.7.5	Burden		
1.8	**Digital Input Board**		
1.8.1	Model		
1.8.2	Input voltage	V DC	

SL NO.	DESCRIPTION		
1.8.3	No. of channels		
1.8.4	Scanning period		
1.8.5	Quantity		
1.8.6	Burden		
1.9	**Digital Output Board**		
1.9.1	Model		
1.9.2	Burden		
1.9.3	No. of Channels		
1.9.4	Quantity		
1.10	**Analog Input Board**		
1.10.1	Model		
1.10.2	Burden		
1.10.3	No. of Channels		
1.10.4	Sampling period	ms	
1.10.5	Quantity		
1.11	**Transducer less Measurement Unit**		
1.11.1	Model		
1.11.2	Burden		
1.11.3	No. of channels		
1.11.4	Frequency Range		
1.11.5	Quantity		
1.12	**Front Panel**		
1.12.1	Model		
1.12.2	Burden		
1.12.3	LEDs (configurable/Non configurable)		
1.12.4	Pushbuttons (Quantity & Type)		
1.12.5	LCD (Size, Resolution etc.)		
1.12.6	Quantity		
2.	**ETHERNET FIBER SWITCH**		
2.1	Make		
2.2	Model		
2.3	Type		
2.4	Connector Type		
2.5	Forwarding Mode		

SL NO.	DESCRIPTION		
2.6	Auxiliary Voltage	V DC	
2.7	Operating Temperature	^{0}C	
2.8	Relative Humidity	%	
2.9	Standards		
2.10	Protocol		
2.11	Latency time		
2.12	VLAN (Virtual LAN capability)		
2.13	Priority Processing		
2.14	Size		
2.15	Quantity		
3.	**SERVER MAIN & REDUNDANT**		
3.1	Make		
3.2	Mounting		
3.3	Dimensions (W X D)		
3.4	Power Supply		
3.5	Single Board Computer		
3.6	Processor		
3.7	RAM		
3.8	HDD		
3.9	CD Drive		
3.10	I/O		
3.11	Keyboard & Mouse		
3.12	Temperature		
3.13	Relative Humidity		
3.14	Ethernet Port		
3.15	Operating System		
3.16	Software Installed		
3.17	Quantity		
4.	**ENGINEERING WORKSTATION**		
4.1	Make		
4.2	Mounting		
4.3	Dimensions (W X D)		
4.4	Power Supply		
4.5 5	Single Board Computer		

SL NO.	DESCRIPTION		
4.6	Processor		
4.7	RAM		
4.8	HDD		
4.9	CD Drive		
4.10	I/O		
4.11	Keyboard & Mouse		
4.12	Temperature		
4.13	Relative Humidity		
4.14	Ethernet Port		
4.15	Operating System		
4.16	Software Installed		
4.17	Quantity		
5.	**OPERATOR WORKSTATION**		
5.1	Make		
5.2	Mounting		
5.3	Dimensions (W X D)		
5.4	Power Supply		
5.5	Single Board Computer		
5.6	Processor		
5.7	RAM		
5.8	HDD		
5.9	CD Drive		
5.10	I/O		
5.11	Keyboard & Mouse		
5.12	Temperature		
5.13	Relative Humidity		
5.14	Ethernet Port		
5.15	Operating System		
5.16	Software Installed		
5.17	Quantity		
6.	**GATEWAY**		
6.1	Make		
6.2	Mounting		
6.3	Dimensions (W X D)		

SL NO.	DESCRIPTION		
6.4	Power Supply		
6.5	Single Board Computer		
6.6	Processor		
6.7	RAM		
6.8	HDD		
6.9	CD Drive		
6.10	I/O		
6.11	Keyboard & Mouse		
6.12	Temperature		
6.13	Relative Humidity		
6.14	Ethernet Port		
6.15	Operating System		
6.16	Software Installed		
6.17	Quantity		
7.	**LASERJET PRINTER**		
7.1	Make		
7.2	Model		
7.3	Print Speed (Black)		
7.4	Print Speed (Colour)		
7.5	Processor speed	MHz	
7.6	Duty Cyclev (Monthly A4)		
7.7	Resolution		
7.8	Interface		
7.9	Memory		
7.10	Standard Input Capacity		
7.11	Power supply		
7.12	Power consumption		
7.13	Quantity	Nos.	
8.	**MONITOR**		
8.1	Make		
8.2	Viewable Size		
8.3	Resolution		
8.4	Interface		
8.5	Connectivity		

SL NO.	DESCRIPTION		
8.6	Input Video Signal		
8.7	Input Connectors		
8.8	Stand		
8.9	Power consumption		
8.10	Viewing Angle		
8.11	Contrast Ratio		
8.12	Operating Temperature		
8.13	Operating humidity range		
8.14	Quantity	Nos	

25.00.00 Wave Trap

1	Installation		
i.	Type of earthing		
ii.	Rated current	A	
iii.	Minimum resistive component of impedance within carrier frequency blocking range	Ohm	
iv.	Inductance of main coil	mH	
v.	Maximum tapping loss (Insertion loss with a line impedance of 220 Ohms)	dB	
vi.	Blocking range		
vii.	Type of mounting		
viii.	Line trap arrester discharge current	kA	
ix.	Band width	kHz	

x.	Tuning device required		
xi.	Type of tuning		
xii.	Variation in 50 Hz impedance per degree centigrade variation in ambient temperature		
xiii.	Variation in resonant frequency band per degree centigrade variation in ambient temperature		
xiv.	Winding material		
xv.	Radio interference voltage at 155kV (rms)	Micro volts	
2	**Coupling Devices**		
I.	Composite loss within passband	dB	
II.	Return loss within passband	dB	
III.	Nominal Peak power P.E.P. at 50/100 Hz.	W	
IV.	Inductance of the drain coil at 50Hz		
V.	Continuous / Short time current of Drain coil		
VI.	Rated / Short time current of Earth switch		
VII.	Rated voltage of surge arrestor	V	

VIII.	Max. 100% impulse spark voltage (1.2/50 micro sec) of surge arrestor	V	
IX.	Rated discharge current (8/20 micro sec) of surge arrestor	kA	
X.	Type of construction of surge arrestor		
XI.	No. of H.F. terminals provided for carrier equipment connection		
XII.	Type of mounting / Degree of protection		
3	**HIGH FREQUENCY CABLE**		
I.	Type of cable		
II.	Withstand test voltage (RMS) between conductor and sheath		
III.	Earthing details of H.F. cable		
4	**POWER LINE CARRIER TERMINAL**		
I.	Operating Mode		
II.	Type of modulation		
III.	Carrier frequency range	kHz	
IV.	Band width per channel	kHz	

V.	Frequency separation between transmission(Tx) and reception (Rx)	kHz	
VI.	Frequency separation between adjacent channels	kHz	
VII.	HF power output	Watts	
VIII.	Mode of transmission of guard signal	Hz	
IX.	Maximum number of noise impulses pps in presence of which the equipment shall satisfactorily perform its duty		

26.00.00 SOLAR PLANT

A) PV Modules

Type	
Origin	
Efficiency	
Fill factor	
warranty	
Module frame	
Termination box	
Blocking diodes	
Module minimum rated power	
Power output rating	
Compliance with standards and codes	
Salt Mist Corrosion Testing	

B) Module Mounting Structure (MMS)

Wind velocity withstanding capacity	
Structure material	
Mounting arrangement formetal sheet roofs	
Mounting arrangement forelevated structures	
Mounting arrangement forground installations	
Mounting arrangement forRCC-flat roofs Installation	
Minimum distance between roof edge and mounting structure	
Access for panel cleaningand maintenance	
Panel tilt angle	

(C) Solar Grid Inverter

1	Total output power	
2	Input DC voltage range	
3	Maximum power point (MPPT)	
4	Number of independent MPPT inputs	
5	Operation AC voltage	
6	Operating Frequency range	
7	Nominal frequency	
8	Power factor of the inverter	
9	Total harmonic distortion	
10	Built-in Protection	
11	Anti-islanding protection	
12	Operating ambient temperature range	
13	Humidity	
14	Inverter efficiency	
15	Inverter weighted efficiency	
16	Protection degree	
17	Communication interface	
18	Safety compliance	
19	Environmental Testing	
20	Efficiency Measurement Procedure	
21	Cooling	
22	Display type	
23	Display parameters to include	

SCHEDULE: CONTROL & INSTRUMENTATION

1.00.00 TECHNICAL INFORMATION AND DATA TO BE FILLED BY BIDDER:

WORK COMPLETION SCHEDULE

Sr. No	Activity	Control & Instrumentation
1.	Submission of drawing	
2.	Approval of drawing	
3.	Inspection & factory testing	
4.	Supply of equipment • Commencement • Completion	
5.	Erection • Commencement • Completion	
6.	Testing and Commissioning	

Signature

Name:

Designation:

Seal of the company

Note: For all field instruments, C&I major equipment etc., catalogues, detailed literature and drawing shall be submitted along with the offer.

1.00.0 GENERAL REQUIREMENTS

1.01.00 INSTRUCTIONS TO BIDDERS

1.01.01 This section describes the technical information and data to be submitted by the Bidder along with the Proposal for the equipments and services covered in the Vol. V. For Technical Information and Data to be submitted after the Award of Contract, refer Vol.V, Appendix-II to Part-A of Technical Specifications.

1.01.02 The Bidder shall ensure that all information, data, performance curves, technical literature (catalogues/instruction manuals) and drawings furnished with the proposal fully describe all equipment/systems covered under this proposal and fully meet the requirements of this specification.

1.01.03 Bids not containing full description/data/technical literature/details regarding past experience for similar application for the proposed equipment may be treated as non responsive and this will be considered as an adequate reason for rejection of the concerned Bid.

1.01.04 The owner reserves the right to ask for further details regarding technical features, application particulars, performance, past experience for similar applications or any other information as may be required to fully satisfy himself regarding suitability, quality, reliability and full compliance with this specification for all equipment and systems offered by the Bidder.

1.01.05 Bidder shall furnish with his proposal the original Technical Data Sheets completely filled in and five Photostat Copies of the data sheets (photocopies of the original). In no case, the Bidder shall retype/redraft these data sheets.

1.01.06 It may be noted that this technical data sheet is for Bidding purpose only. During detailed engineering, the Bidder shall be required to furnish all additional data about the equipment/System being supplied, even if such details are not asked for in this part.

1.01.07

a) Bidder should legibly fill in all the data asked for in these sheets either by hand in black ink or preferably by typing the matter. All the filled in data sheets should be duly returned with the bid.

b) Continuation sheets may be suitably attached whenever the need arises. These pages may be suitably numbered accordingly.

c) Corrections should be avoided. However, whenever it is imperative to carry out correction, this should be done neatly and should be initialled by the authorised signatory.

d) Each page of the technical data sheet should be initialled by the authorised signatory & should bear the legal stamp of the company.

e) Bidder should indicate his name on each sheet.

2.00.00 DDCMIS

2.01.00 System Details

Whether the system configuration Diagram for DDCMIS is enclosed	Yes/No
DDCMIS Manufacturer's Name	……..
DDCMIS Make/Model No.	……..
DDCMIS's Place of manufacture	…….
Number of controller and I/O cabinets (List separately)	.....
Dimensions (H x W x D)	.....
Weight	.....
Location of cabinets (furnish details) Enclosure class	.....
Number of Peripheral Cabinets	.....
Dimensions (HxWxD)	
Weight	.....
Number of process I/O Cabinets	……..
Dimensions (HxWxD)	.....
Weight	.....
Number of any other type of cabinets	(To be furnished separately for each type)
Dimensions (HxWxD)	.....
Weight	.....
Make and Model Number of CPUS (give details of each type along with application)	.....
Bulk Memory	.....
Floppy disc drive	.....
LEDs Monitors	.....
Magnetic Tape Capacity	.....
Keyboard	.....
DVD/CD ROM Drive	----------

Dot Matrix Printer .....

Colour Laser Printer ----------

2.02.00 SG CONTROL SYSTEM

2.02.01 General

a) Control System functional grouping diagram furnished at Page No. ..... Vol. No.....

b) No. of functional groups (FGs) offered .....

c) Confirm that for each of the FGs, separate sets of controllers, I/O modules, communication controllers, power supply packs/modules are provided Yes/No

d) Confirm that Control System shall function under environmental environment Yes/No

e) On-line simulation, testing, configuration & tuning of controllrs is possible Yes/No .....

f) Programs in controllers is stored in (e.g. EEPROM/EPROM etc.) .....

2.02.02 Please indicate make/model no. of each of the control system indicated below

i) SG C&I system (BMS-Part) .....

ii) SG C&I system (Non BMS-Part) .....

2.02.03 Burner Management System (BMS)

1. a) Confirm that all modules used in BMS are of fail safe design Yes/No .....

b) Confirm that BMS ensures total fuel cut off on AC/DC power supply failure Yes/No .....

2. Confirm that any signal fault in either primary sensor, I/O modules, multi-function controllers etc. will not result in loss of Safety function. Yes/No .....

3. Confirm that BMS meets safety requirements including those stipulated in NFPA 85 Yes/No .....

4. Confirm that all protection functions are implemented in fault tolerant 2 out of 3, triple redundant configuration — Yes/No .....

5. Confirm that all safety related process inputs are fed to each of the 3 channels — Yes/No .....

6. Confirm that all the primary sensors for unit/boiler protec-tion are triple redundant — Yes/No .....

7. Make/model no. of each type

Of module used in BMS

a) Input module .....
b) Output module .....
c) Controller module .....
d) Communication controller module .....
e) (Any other module) .....

2.03.00 TG CONTROL SYSTEM

2.03.01 General

a) Control System functional grouping diagram furnished at — Page No ..... Vol.No .....

b) No. of functional groups (FGs) offered .....

c) Confirm that for each of the FGs, separate sets of controllers, I/O modules, communication controllers, power supply packs/modules are provided — Yes/No .....

d) Confirm that Control System shall function under environmental conditions — Yes/No .....

e) On-line simulation, testing, configura-tion & tuning of controllrs is possible — Yes/No .....

f) Programs in controllers is stored in (e.g. EEPROM/EPROM etc.) .....

2.03.02 Please indicate make/model no. of each of the control system indicated below

i)	TG Governing System	.....
ii)	ATRS	
iii)	TG C&I system (Turbine Protection)	.....
iv)	TG C&I system (Non Turbine Protection part)	.....
v)	HP/LP Bypass	.....
vi)	BFP TDBFP governing & protection	
vii)	COLCTS	.
viii)	SCS	.....
ix)	CPU	.....
x)	LOPS	.....

2.03.03 Turbine Protection System (TPS)

1. Confirm that all modules used in TPS are of fail safe design — Yes/No

2. Confirm that TPS meets all applicable safety requirements including those stipulated in VDE 0116, section 8.7, VDE 0160/ 8.83; DIN 57116 or IEC61508/IEC61511 — Yes/No

3. Confirm that any single fault in either primary sensor, input/output modules, controller module etc. will not result in loss of safety function — Yes/No

4. i) Electronic protection channel in 2-out-of-3/ Or 1 out of 2 — Yes/No .....
   ii) Hydraulic protection channel 2-out-of-3/ Or 1 out of 2 — Yes/No .....

5. Confirm that all trip signal inputs required for the safety of the turbine will be — Yes/No .....

based on 2 out 3 logic (indicate exceptions)

6. Confirm that redundant turbine trip Solenoids are provided — Yes/No .....

7. Make/Model no. of each type module used in TPS

a) Input module .....
b) Output module .....
c) Controller module .....
d) Communication controller module .....
e) Any other modules .....

2.04.00 List of proprietary control system's not offered as a part of offered DDCMIS. **No. .....**

2.04.01 Supporting documents furnished for above. Page No ..... Sec. No.....

3.00.0 MAIN EQUIPMENT RELATED CONTROL & INSTRUMENTATION

3.01.00 TG main equipment

3.01.01 Turbine Supervisory system (TSS)

1) All sensors, transmitters, conver- ters, LVMs, measuring & amplifier modules, power supplies etc. with required accessories, special cables (if any) etc. provided for all types of measurements as specified — Yes/No .....

2) Distribution of signals and interface with control system/ HMIPIS provided — Yes/No .....

3) Make & Model (for sensors/ transmitters, converter/monitor etc.)

i) Shaft Eccentricity .....
ii) Absolute & relative shaft vibration .....

	iii)	Diff expansion of HPT, IPT & LPT	
	iv)	Overall Expansion of HPT & IPT	.....
	v)	Absolute bearing vibration in each bearing	.....
	vi)	Stator winding vibration	
	vii)	Axial shift	.....
	viii)	Turbine speed	.....
	ix)	ESV/CV position	.....
	x)	All metal steam & oil temperature	.....
	xi)	MS/HRH steam inlet press	.....
	xii)	Any other (Please list)	.....
4)	For Vibration measurement Confirm That following has been provided		
	a)	Measurement provided in both X & Y Directions	Yes/No
	b)	On-line spectrum/ s/No harmonic analysis	Ye
	c)	Identification of exact No nature of failure & direct message on CRT	Yes/
	d)	Storage & comparative Analysis of vibration	Ye/No
	e)	Generation/Analysis of Bode plot /orbit plot & time wave form /Nyquest plot/shaft centre line plot/ coscade & water fall plot	Yes/No
	f)	Shaft mounted reference detectors and required supervisory circuitry provided	Yes/No
5)	All parameter fed to TCS through hardwiring		Yes/No

6) Test calibration jigs for site calibration provided — Y/es/No

7) Detailed Technical literatures for all TSS equipment furnished at — Page No. ..... Sec. No.....

8) Reference plant where the offered TSS system is in successful operation — .....

9) Bill of material for entire TSS system furnished at — Page No..... Sec. No.....

3.01.02 BFP Turbine Supervisory Instruments

1) All sensors, transmitters, converters, LVMs, measuring & amplifier modules, power supplies etc. with required accessories, special cables (if any) etc. provided for all types of measurements as specified — Yes/No

2) Distribution of signals and interface with control system / HMIPIS provided — (Yes/No)

3) Make & Model (for sensors/ transmitters, converters /monitors etc.)

a) Shaft Eccentricity .....
b) Axial Shift .....
c) Differential expansion .....
d) Overall Expansion .....
e) Speed .....
f) All steam & metal temp. .....
g) Bearing pedestal vibration .....

4) Test calibration jigs for site calibration provided — Yes/No

5) Detailed Technical literatures furnished at — Page No..... Sec. No.....

6) Reference plant where the offered system is in successful operation — .....

7) Bill of material for entire BFP Turbine Supervisory System furnished at Page No..... Sec. No. .....

3.02.0 SG MAIN EQUIPMENT RELATED CONTROL AND INSTRUMENTATION

3.02.01 Flame Monitoring System

1. Make & model No. .....

2. Reference plant of comparable size where similar make /model Is working satisfactorily .....

3. System totally fail safe Yes/No

4. System confirms to NFPA Ye s/No requirement (if `No' - then Indicate equivalent standard) .....

5. Location of detectors as per NEC std. Yes/No

6. Discrimination between oil & coal flame provided Yes/No

7. No. of flame detectors

   a. Oil .....

   b) Coal .....

   c) Discriminating .....

8. Burner arrangement drawing showing flame detector location and write up of justification for the location furnished at Page No ..... Sec. No. .....

9. 2 x 100 % scanner air fans (one AC & One DC) provided Yes/No

3.02.02 Coal Feeder Control and Instrumentation

1. Make & model no. .....%

2. Implemented in microprocessor s/No based hardware — Ye

3. Implemented in same family s/No of as that of CLCS — Ye

3.02.03 Electromatic safety valve

1. Make & model No. .....

2. Reference Plant where the the offered make / model is in service .....

3. Electrically actuated — Yes/No .....

4. Differential between opening & closing Pressure ....

5. Local control provided — Yes/No

6. Ows control as well as Remote control station s/No provided on UCP — Ye

7. Detailed write-up & Technical catalog provided at ..... — Page No. ..... Sec. No.

3.02.04 Furnace Temperature probes

1. Make & model No. .....

2. Type .....

3. OWS control provided .....Yes/No.....

4. Detailed write up with technical literature

urnished at ..... Page No. ..... Sec. No.

3.02.05 Acoustic Pyrometer

1. Make & model No. .....
2. Type .....
3. Reference Plant with similar type of boiler where the offered equipment is in successful operation for more than two year .....
4. Total quantity .....
5. System designed to eliminate high noise Yes/No
6. Max. measuring range .....deg C
7. Accuracy .....
8. PC based system with necessary hardware & software provided as specified Yes/No
9. Detailed technical literature furnished at ..... (Page No. ..... Sec. No. .....)

3.02.06 Furnace and Flame Viewing System

1. Make & model No. .....
2. Name of the Reference Plant with similar type of boiler where the offered equipment is in successful operation

		for more than two year	.....
	3.	Type of furnace flame camaras	
	4.	Number of cameras	
	5.	Length of fuel flow covered by each camera	.....
	6.	PC based system with necessary hardware & software provided as specified	Yes/No
	7.	Detailed technical literature furnished at	Page No. ..... Sec. No.
3.02.07		Separator Drain Level Control & Monitoring System (For Boilers Provided with Separator)	
3.02.07.01		Separator Drain Level Control & Monitoring System	Drum/Separator
	1.	Complete description & functional writeups with necessary diagrams & schemes furnished at No.....	Page No.....Sec.
	2.	Triple redundant measurement as per specification provided	Yes/No
	3.	Thermocouples for separator metal temperature measurement provided	.....
	4.	Type of Thermocouple	
	5.	All accessories like double isolation valves, drain and vent	

		valve provided as specified	Yes/No
	6.	Redundant power packs with redundant feeders provided as specified	Yes/No
	7.	Confirm that system is of fail s/No safe design & failure of any electrode/probe does not affect any other electrode/ probe and does not hamper system function	Ye
	8.	Alarm/Trip output provided s/No as specified	Ye
	9.	Fault detector features s/No provided as specified	Ye
	10.	Approval of statutory authority ..... (Factory Mutual, USA/IBR/Any other) Please indicate name	.....
	11.	Detailed Technical literature for probe/electrode, pressure vessel, electronic cubicle / system furnished at	Page No ..... Sec. No.
	12	Reference plant of comparable size where the offered system is operating successfully	.....
3.02.08	Conductivity type level switching system		Driplegs (For Boiler provided with Separator)
	1.	Make and model no	

2. Principle of working
.....

3. No. of pressure vessel
..... per unit

4. No. of electrodes/probes
..... per unit

5. Type of probes
.....

6. No. of Cabinets

a) Local
.....

b) In CER
.....

7. Confirm that system is of fail safe/No safe design & failure of any electrode/probe does not affect any other electrode/ probe and does not hamper system function
Yes

8. Approval of statutory authority (Factory Mutual, USA/IBR/Any other) Please indicate name
.....

9. Reference plant of comparable size where the offered system is operating successfully
.....

3.02.9 Mill and Air Heater Fire Detection System

a) No. of thermocouple

i) per mill
.....

ii) per air heater
.....

b) Controls implemented in respec- tive groups in SG-C&I system
Yes/No

c) Rate of rise algorithm Ye s/No implemented in control

d) Write-up of the system furnished at Page No ....Vol.No. .....

3.02.10 Acoustic Steam leak Detection System

1. Make and Model No. ……
2. Principle of Working ……
3. No, of Sensors per Unit ……
4. type of Sensors ……

4.00.00 MEASURING INSTRUMENTS

4.01.00 <u>TRANSMITTERS (PT, DPT, LT, FT) (DETAILS SHALL BE SUPPLIED FOR EACH TYPE OF TRANSMITTER MODEL NO. WISE)</u>

Quantity:

1. PT .....
2. DPT .....
3. LT .....
4. FT .....

Make, Model No. .....

Type .....

Range .....

Accuracy guaranteed for design ambient range .....

Output .....

Ambient temperature error in per cent of span per deg. C .....

Ambient temperature range for above listed performance in deg. C .....

Hysteresis percent .....

Repeatability percent .....

Operating temperature range

in deg. C Low limit/high limit	.....
Maximum over range pressure	.....
Integral LCD indicator	Yes / No
Power supply	.....
Nominal	.....
Variation limits	.....
Load impedance	.....
Positional effect	.....
Span/zero adjustment	.....
External/internal	.....
Span adjust limit	.....
Zero adjust limit	.....
Process connection	.....
Accessories included	.....
Enclosure class	.....
Detailed literature/ drawing reference	.....

4.02.00 LOCALLY MOUNTED INSTRUMENTS:

4.02.01 PRESSURE INDICATORS/DIFFERENTIAL PRESSURE GAUGES (PG/DPG):

Make/Model	.....
Type	.....
Range	.....
Accuracy/smallest division	.....
Dial size	.....
Connection - process/instrument	.....
Material of Bourdon tube/Bellows movement & casing	.....
Material of seperating Diaphragm (wherever applicable)	.....
Safety Device (List)	.....

Detailed literature/drawing Ref. .....

Accessories (Service wise) .....

Enclosures .....

4.02.02 TEMPERATURE GAUGES:(TG)

Make/Model .....

Type .....

Range .....

Accuracy .....

Material of Thermowell, Capillary, Bourdon tube, movement and casing .....

Dial size .....

Immersion Length .....

Extension Neck/Capillary Length .....

Response Time .....

Connection - process/instrument .....

Detailed literature/ Drawing Ref. .....

Enclosures .....

4.02.03 RESISTANCE THERMOMETERS (RTD) (SEPARATELY TO BE FURNISHED FOR EACH TYPE OF THERMOWELL AS PER APPLICATION):

Quantity .....
Make, Model No. .....

Type .....

Element:

Resistance (ohm)/Gauge .....

Sheathed material and OD mm .....

Insulation Material .....

Accuracy .....

Response time	.....
Well/Tube	.....
Construction	.....
Material	.....
Process connection	.....
Well dimensions	.....
Head:	
Material	.....
Conduit connection	.....
Terminal block	.....
Accessories included	.....
Detailed literature/ drawing reference	.....

4.02.04 THERMOCOUPLES: TE (TC) (SEPARATELY TO BE FURNISHED FOR EACH TYPEOF ELEMENT AND THERMOWELL AS PER APPLICATION):

Quantity	.....
Make, Model No.	.....
Type	.....
Extension wire type	.....
Grounded/ungrounded	.....
Sheathed material and OD mm	.....
Insulation material	.....
Accuracy	.....
Response time	.....
Well or Tube	
Construction	.....
Material	.....
Dimensions	.....

	Connections: Process	.....
	Head	
	Material	.....
	Conduit connection	.....
	Terminal block	.....
	Accessories included	.....
	Detailed literature/ drawing reference	.....

4.02.05 FLOW INTEGRATORS: (FYQ)

	Quantity	.....
	Make, Model No.	.....
	Type	.....
	Number of digits	.....
	Digit size	.....
	Accuracy	.....
	Input	.....
	Power supply requirement	.....
	Power and signal connections	.....
	Duty cycle	.....
	Resetting: Manual/Auto	.....
	Mounting	.....
	Dimensions	.....
	Detailed literature/ drawing reference	.....

4.03.00 Vibration Monitors

4.03.01	Make & Model No.	.....
4.03.02	Modules are Rack or Din Rail mounted	.....
4.03.03	No. of modules (monitors) in a rack	.....
4.03.04	Number of channels/points per monitor (considering horizontal & vertical	

	measurement as two channels)	Nos.
4.03.05	No of buffered raw signal output for use With vibration analysers provided.	Nos.
4.03.06	Power supply of Vibration monitoring System 240 V AC/ 24 V DC/ below	……..
4.03.07	Display indicators are on monitors or a PC based monitoring system is provided	…….
4.03.08	a) Power supply in built on the monitor Yes/No b) In case answer to 8'a' is `No' then no. of monitors fed by one power supply ……	
4.04.00	**Sensors/ Transducers**	
4.04.01	**Vibration transducer** a) Make & Model No. …….. b) Type of sensors (indicated for each application)	…….
	c)Low noise cable provided with sensors	Yes/No
4.04.02	**Keyphasor** a)Make & Model No b)Type of sensors (indicated for each application)	…….. …….
	c)Low noise cable provided with sensors	Yes/No
4.05.00	**Impact Head Type Elements**	
4.05.01	Make	……
4.05.02	Model Number	……
4.05.03	Accuracy	……
4.05.04	Provided with mounting hardware and all other Necessary accessories as per specification	Yes/No
4.05.05	On-line flushing facility provided	Yes/No
4.06.00	**Continuous Emission Monitoring System**	
4.06.01	Type of Flue gas analysers offered for Sox/NOx	……
4.06.02	Make and model no of the following instruments	

i) SOx/NOx analysers
ii) CO analysers
iii) Opacity analysers
iv) Low temp O2 analysers
v) High temp O2 analysers
vi) CO2 analysers
v) Stack flow meter

4.07.00 Ambient Air Quality Monitoring System (AAQMS) Make and model no of the following instruments

i) SO x analysers
ii) NO x analysers
iii) CO2 analysers
iv) Suspended particulate Monitors
v) Wind speed , Direction sensors
vi) Air Temperature sensor
vii) Relative Humidity (RH) sensor
viii) Solar radiation sensor
ix) Rain Gauge

4.08.00 **Local Switches**

4.08.01 Pressure Switches (PS)/ Diff. Pressure Switches(DPS)
(**To be furnished separately for PS and DPS):**

Make, Model	.....
Type	.....
Range	.....
Accuracy and Differential	.....
Repeatability	.....
Type of contacts	.....
Number of contacts	.....
Contact rating	.....
Operating temperature range low limit/high limit	.....
Set point	
i) Internal/External	.....
ii) Factory set/field	.....
Differential - Fixed/adjustable	.....
Enclosure class	.....

	Maximum over pressure	.....
	Dimensions	.....
	Connection - Process/conduit/ instrument	...../..../.....
	Detailed literature/ Drawing Ref.	.....
	Material of Bellows, Bourdon Tube, movement & Protective Diaphragm	.....
	Accessories	.....

4.08.02 <u>LEVEL SWITCHES</u> (LS) (Separately to be furnished for each type):

	Make, Model	.....
	Type	.....
	ASA rating	.....
	Accuracyanddifferential	.....
	Differential - Fixed/Adjustable	.....
	Repeatability	.....
	Material of Float/Displacer spring/ Tube/wire rope Material/wire rope	.....
	Body Material	.....
	Type of Contacts	.....
	Number of contacts	.....
	Contact Rating	.....
	Operating temperature range low limit/high limit	...../.....
	Dimensions	.....
	Connection	.....
	Enclosure class	.....
	Accessories	.....
	Detailed literature/ Drawing Ref.	.....

4.08.03 TEMPERATURE SWITCHES: (TS):

Make/Model	.....
Type	.....
Range	.....
Accuracy and differential	.....
Repeatability	.....
Type of Contacts	.....
Number of Contacts	.....
Contact rating	.....
Operating temperature range low limit/high limit	.....
Connection - Process/Instrument /Conduit	..../...../.....
Material of thermowell & Bulbs, capillary, Bourdon tube, movement and casing	.....
Immersion length	.....
Extension neck length/ Capillary length	.....
Setting/Differential	.....
Enclosure class	.....
Dimensions	.....
Detailed literature/ Drawing Ref.	.....

4.08.04 FLOW SWITCHES: (FS):

Make/Model	.....
Type	.....
Material of sensing element and case	.....
Flow range and surge ratio	.....
Accuracy	.....
Repeatability	.....

	Contacts - type rating and number	.....
	Enclosure class	.....
	Connection - Instrument/Conduit	...../.....
	Accessories	.....
	Detailed literature/ Drawing Ref.	.....

4.09.00 AMMETERS (AMM)

	Quantity	.....
	Make, Model	.....
	Type	.....
	Input	.....
	Range	.....
	Accuracy	.....
	Zero adjustment	.....
	Dimensions	.....
	Scale	.....
	Mounting	.....
	Over range protection	.....
	Detailed literature/ Drawings Reference	.....

4.10.00 DIGITAL INDICATOR (-YI)

	Quantity	.....
	Make	.....
	Model	.....
	Type	.....
	Dimensions	.....
	Input	.....
	Range	.....
	Number of digits	.....

	Display type	.....
	Display height	.....
	Accuracy	.....
	Power supply	.....
	Other features	.....
	Detailed literature/ drawing ref.	.....

4.11.00 VOLT METERS (AC + DC)

	Make	.....
	Model No.	.....
	Type	.....
	Range	.....
	Accuracy/Repeatability:	
	Input	.....
	Power Supply	.....
	Mounting	.....
	Dimensions	.....
	Zero adjustment capability limits	.....
	Detailed literature/ Drg. ref	.....
	Class of enclosure	.....

4.12.00 FLOW INDICATORS: (FI)

	Make, Model	.....
	Type	.....
	Range	.....
	Scale detail/Length	.....
	Material - Tube/Float/Packing/ Orifice Plate	.....

Accuracy	.....
Repeatability	.....
Overall dimensions	.....
Connection	.....
Accessories	.....
Detailed literature/ Drawing Ref.	.....
Enclosures	.....

4.13.00 <u>SOLENOID VALVES:</u> (SV) (To be indicated for each type of Solenoid Valve<u>):</u>

Make/Model	.....
Type	.....

Material

Body	.....
Seal	.....
Bonnet Gasket	.....
Internal Parts	.....
Coil rating/class of insulation	.....
Connection	.....
Enclosure Class	.....
Accessories included	.....
Detailed literature/ Drawing Ref.	.....

4.14.00 <u>AIR FILTER REGULATOR SET:</u>

Make/Model	.....
Type	.....
Filter - Size/Material	.....
Air supply pressure - kg/cm square	.....
- Minimum	.....

	- Maximum	.....
	Filter bowl - Transparent/opaque	.....
	Over pressure rating - kg/cm square	.....
	Material	
	Body	.....
	Spring	.....
	Trim	.....
	Packing	.....
	Diaphragm	.....
	Accuracy	.....
	Connection	.....
	Accessories included	.....
	Detailed literature/ Drawing Ref.	.....

4.15.00 <u>ELECTRO-PNEUMATIC CONVERTER:</u>

	Make	.....
	Type/Model No.	.....
	Input	.....
	Output	.....
	Calibration capability	.....
	Repeatability	.....
	Ambient temperature effect	.....
	Direct/reverse action facility	.....
	Enclosure class	.....
	Dimensions	.....
	Mounting	.....
	Accessories	.....
	Air filter regulator	.....

Output gauge .....

Connections

- Electrical .....

- Pneumatic .....

Detailed literature/drawing Reference .....

In addition to above field instruments, details/information for other type of field instruments as listed in chapter 2 envisaged for power plant shall also be furnished with offer.

4.16.00 PANEL MOUNTED INSTRUMENTS:

4.16.01 Illuminated Push Buttons: (ILPB)

Make/Model .....

Type .....

Contact configuration & ratings .....

Lamp supply voltage .....

Series resistor/transformer provided Yes / No

Rating of series resistor .....

Overall Dimensions .....

Wattage .....

Colour .....

Engraving : Type .....

Size .....

Accessories .....

Detailed literature/ Drawings Reference .....

4.16.02 Push Buttons (PB)

Make, Model .....

Type .....

Material .....

	Number of NO/NC Contacts	.....
	Contact configuration & ratings	.....
	Breaking Capacity	.....
	Overall Dimensions	.....
	Detailed literature/ Drawings Reference	.....
4.16.03	**Indicating Lamps (IL)**	
	Make, Model	.....
	Type	.....
	Supply voltage	.....
	Permissible voltage variation	.....
	Series resistor/transformer provided	Yes / No
	Rating of series resistor	.....
	Overall dimensions	.....
	Wattage	.....
	Life of lamp in burning hours	.....
	Engraving details	.....
	Detailed literature/ Drawing reference	.....
4.16.04	**Selector Switches (SS)**	
	Make, Model	.....
	Type/Number of inputs	.....
	Material	.....
	Contact configuration & ratings	.....
	Breaking capacity	.....
	Overall Dimensions	.....
	Detailed Literature/ Drawing Reference	.....
5.00.00	**Relay Modules**	

a.	**Quantity**	**……**
b.	**Type**	**……**
c.	**Model No.**	**……**
d.	**Coil Voltage Rating**	**……**
e.	**Contract rating**	**……**
f.	**Type of Enclosure**	**……**

5.01.00	**Power Requirements**	**Inrush**	**Normal**
	Controller cabinets	……	……
	I/O Cabinets	……	……
	Bulk Memory	…….	……
	Floppy disc drive		…….
……			
	OWS & LED MONITORs	…….	……
	DVD/CD ROM Drive	------	-------
	Keyboard	…….	……
	Dotmatrix Printer	…….	……
	Video copier/Ink Jet Printer	……	……
	Separate CPUs offered if any	……	……
	Any other device not covered above		……
……			
	Total system requirements	……	……
	Automatic soft start feature provided.	Yes/No	
	Communication Controller	-------	-------
	Any other device not covered above	-------	-------

5.02.00	**Reliability (for each type of following to be indicated separately)**	***MTBF***	***MTTR***
	CPUs	…….	……
	Bulk Memory	…….	……

	Floppy disc drive		.....
.....			
	LED MONITORs	.....	.....
	Keyboard	.....	.....
	DVD/CD ROM	------	-------
	Dotmatrix Printer	.....	.....
	Colour Laser Printer	------	-------
	Controller subsystem	.....	.....
	Analog I/O Sub-system	.....	.....
	Digital I/O Sub-system	.....	.....
	Drive Level Card	------	-------
	Analog input cards	.....	.....
	Analog output cards	.....	.....
	Digital input cards		.....
.....			
	Digital output cards		.....
.....			
	Power supplies	.....	.....
	Communication controllers	.....	.....
	Any other device used in DCS	.....	.....

5.03.00 Digital Controller/Process I/O
Controller (Details of each to be furnished separately)

Number of controllers offered for control system	.....
Number of controllers offered for monitoring system	.....
List for each controller	
Memory loading	.....
Assignment of loop	----------
CPU Type	.....
CPU clock Hz	.....
No. of I/O per controller	----------

Word length	.....bits
Working memory offered	.....K bytes
Expandable to	.....K bytes
In modules of	.....K bytes
Type of memory	
Memory cycle time	..... n sec.
Number of hours of battery back up	.....
Machine cycle time	.....
Number of general purpose registers	.....
Number of addressing modes	.....
DMA channel	Yes/No
Number of instructions (assembly)	.....
Filtering details order of filter	.....
Cut off frequency	..... HZ
Input/scan rate	
Output update rate	.....
Controller output	.....
In controllers for Interlock, Protection, Facility to configure output to be	.....
Momentary	Yes/No
Held	Yes/No
Held till feed back	Yes/No
Manual operation at drive level in case main as well as redundant processor fail	Yes/No
Analog-to-Digital Convertors	.....
Type of A/D Convertor	.....

Number of A/D Convertors offered	.....
Number of points per A/D convertor	.....
Number of bits	.....
Speed of conversion/sec.	.....
Operating capacity	.....
Resolution	.....
Each controller is equipped with the amount of functional capacity to perform its specified functions and still have an over all spare capacity of 30%	Yes/ No
Bidder to state list of control algorithm Offered with the controller	----------
Linearity	.....
Accuracy (% of FS)	.....
Repeatability (% of FS)	.....
Normal mode noise rejection	..... db
Common mode noise rejection	..... db
Digital-to-Analog Convertors	.....
Type of D/A Convertor	.....
Number of D/A Convertors offered	.....
Number of points per D/A convertor	.....
Number of inputs bits	.....
Speed of conversion/sec.	.....
Output voltage level	.....
Control loop response time (furnish separately for auto control as well as interlocks as per task assignment)	.....
Hysteresis	..... %
Repeatibility	..... %
Linearity	..... %

	Multiplexer	----------
	Proportional/integral & derivative band	.....
	Tuning, configuring and reconfiguring of the controller through LED MONITOR/KBD	.....
	Automatic updation of the Controller configuration residing in central device when configuration is changed by the engineer	..... Yes/No
	Any limit on the number of time an alogrithm to be used	.....
	Change over time to the back-up controller	.....
	On-line configuration via programmer console	.....
	On-line diagnostic minimum as per the specification	.....
	Details of the control algorithm furnished	.....
	Floating point hardware/firmware	.....
	Loop cycle time for each close loop and open loop system	.....
5.04.00	**Controller security**	**(Complete details to be furnished)**
	Power fail/auto restart feature	.....
	Watchdog timer clock rate	.....
	Real time clock	.....
	Memory protection	.....
	Cache memory	.....
	Interrupt handling time	..... K bytes
	Controller bus/I/O (Details of each to be furnished separately)	.....
	Type of bus	.....
	Maximum numbers of devices	.....

on the bus

Bus transfer rate .....

Details of protocol used .....

Operating temperature range (low/high limit) .....

Ambient temperature effect .....

5.05.00 Inputs_&_Outputs: (Details of each type for monitoring/control to be indicated separately as applicable)

5.05.01 Analog_Inputs (*each type*):

Numbers

Offered .....

Expandable to .....

In groups of .....

Scan Rate ..... Pts/Second

Scan classes .....

Number of T/C Inputs

Offered .....

Expendable to .....

In groups of .....

5.05.02 Number of RTD inputs

Offered .....

Expandable to .....

In groups of .....

5.05.03 Digital Inputs

Low Resolution Inputs

Offered .....

Expandable to .....

In groups of .....

Contact Interrogation
Voltage of LR inputs ….....V DC

Contact Bounce Filtering
Constant of LR inputs .....m sec.

Surge withstand capability (ANSI 37.90a) IEEE 472) LR Inputs .....

Scan rate for LR inputs
.....Pts/sec.

High Resolution inputs (Sequence of Events)

Offered .....

Expandable to .....

In groups of .....

Contact Interrogation
.....DC
Voltage for HR inputs

Contact Bounce Filtering Constant of HR inputs .....m Sec

Surge withstand Capability of HR inputs (ANSI 37.90a/IEEE 472) .....

Scan rate for HR inputs .....pts/millisec

5.05.04 Pulse inputs

Number of pulse inputs

Offered .....

Expandable to .....

In groups of .....

Register length
.....bits

5.05.05 Analog outputs

Control outputs offered .....

Expandable to .....

	In groups of	.....
	Updation/Scan rate	.....
5.05.06	**Digital outputs**	
	For Plant Automation	.....
	Offered	.....
	Expandable to	
	In groups of	.....
	Updation/Scan rate	.....
	For Protection & Interlock	----------
	Offered	.....
	Expandable to	
	In groups of	.....
	Updation/Scan rate	.....
	For all other applications	----------
	Offered	.....
	Expandable to	
	In groups of	.....
	Updation/Scan rate	.....
5.06.00	**LED MONITORs (Separately for each type of LED MONITOR offered)**	
	Screen Size	
	Diagonal	.....mm
	Display Area	..... H.... mm .....W...mm
	Resolution (in Dots)	Vertical ...Horizontal...
	Number of colours (excluding black)	.....
	Number of lines	.....

	Number of characters Per line	.....
	Number of graphic characters provided	.....
	Double height characters provided	Yes/No
	Refresh Rate	.....
	Transfer Rate	.....
	Local Memory Provided	Yes/No
	Number of controllers offered	.....
	Number of LED OWSs offered	
	Mounting dimensions (HxWxD)	.....

5.07.00 **<u>Keyboards</u> (Separately for each type of *ASCII* & *FUNCTIONAL* Keyboard offered)**

	Number of Keys	.....
	Number of functional keys	.....
	Number of graphic symbol keys	.....
	Keylock provided	Yes/No
	Alphabetic/Typewriter layout of keys	.....
	Mounting Dimensions (HxWxD)	.....
	Printers (Separately for each type of printer offered)	----------
Dot matrix/laser	Dot Matrix/ Laser	----------
	Characters per line	.....
	Lines per page	.....
	Modes of printing (expanded small case etc.)	.....
	Characters per second	.....per second

	Minimum number of Lines/minute	.....per minute
	Bi-directional	Yes/No
	Graphic capability provided	Yes/No
5.08.00	**Bulk Memory**	
	Make & model number	.....
	Capacity offered	.....Megabytes
	Number of controllers	.....
	Number of Units	
	Offered	.....
	Expandable to	.....
	Average Access time	.....
	Data Transfer time	.....
	Sealed Unit	Yes/No
	Phase locked loop provided	Yes/No
	Error detection and correction in hardware	Yes/No
5.09.00	**Floppy Disc Drive**	
	DC drive	Yes/No
	Capacity offered	.....M byte
	Data transfer rate	.....Bits/sec.
	Double side/double density media	Yes/No
	Read/write capability	Yes/No
	Error detection and correction in hardware	Yes/No
	DMA transfer capability	Yes/No
5.10.00	**Data Highway**	
	Type of highway	Fiber optic/co-axial cable
	Specifications of media	.....
	Number of highways	.....

	Total length of each highway	.....Km
	Maximum number of devices on each highway	.....Nos.
	Data transfer rate *in Mbps*	.....M baud
	Communication protocols employed (furnish details)	.....
	Message format details	.....
	Communication interface with digital controllers	.....
	Printers	.....
	Winchester disc sub-system	.....
	Supervisor's console	.....
	Operator's console	.....
	Method of error checking	.....
	Communication failure auto switching	.....
	On-line diagnostics (furnish details)	.....
5.11.00	**<u>Communication processors</u>**	
	Make and model number	.....
	Word length	.....
	Number of processors provided	.....
	Redundant highway provided	Yes/No
	Hot repair capability	Yes/No
	Nature of physical media	.....
	Protocol used	.....
5.12.00	**<u>Utility Displays</u>**	
	Group review displays (No)	.....
	Individual point display	----------

Give reference to document ..... enclosed for following

Trend display	----------
Format of group review	.....
Dynamic operator guide displays	.....
No. of OP-guide displays provided	.....
Characteristic point display	----------
No.of graphic displays provided	.....
No.of bar charts provided	.....
No.of X-Y plots provided	.....
Mimic display	----------

5.13.00 Alarm displays

Display format as specified	Yes/No
Double high characters	.....
Capacity per page	.....
Alarm suppression as per spec. provided	Yes/No
Facility to back up thro' utility	**Yes/No**
LED OWS provided	

5.14.00 Logs:

No. of pre and post trip logs	.....
No. of trend logs	.....
No. of alarm logs	.....
No. of logs of distributed & simulated values	.....
No. of logs of operator action	.....
No. of logs of scan period	.....
No. of point out of scan	.....
No. of maintenance logs	.....

No. of Hourly logs .....

No. of shift logs .....

No. of performance calculation logs .....

No. of daily logs .....

No. of special logs .....

5.15.00 **Performance Calculation and Optimisation**:

a) System supports all type of calculation required for performance calculation and optimi-sation function ... Yes/No .....

b) Performance calculation are run on nominal time of ten minutes or less period cycle ..... Yes/No ...

c) System shall support ..... Yes/No .....
on line real time performance calculation and optimisation function using high level language and plant model

d) For all Class II calcu- ..... Yes/No .....
lation 2 min. mean valve is used

e) Class I calculation are ..... Yes/No .....
are performed at 5 sec. or less periodic cyele

f) All Class I calculation ..... Yes/No .....
average of minimum 10 samples shall be used

g) Calculated results ..... Yes/No .....
are available for display, logs and historical storage

h) All performance calculation and opti- ..... Yes/No .....

misation functions indicated in specification are covered

i) A display of operator controlled losses along with fuel cost penalty which will be presented in bar graphs ..... Yes/No .....

j) It shall display current cost of producing electricity ..... Yes/No .....

k) Boiler optimisation program along with 'what if' compatibility is available ..... Yes/No .....

l) Controllable parameter calculation available for optimised operation of soot blowers, optimised combustion, burner tilt and spray water flows and optimum excess air flow in consideration of both combustion requirement and steam temperatures ..... Yes/No .....

m) Performance report and displays specified as per specification ..... Yes/No .....

5.15.00 **<u>System Redundancy</u>**:

a) Redundancy in data high-way is provided ...Yes/No....

b) Redundancy in communication controller is provided ...Yes/No....

c) 2x100% redundancy provided for all functional controllers ...Yes/No....

d) For open loop drives like motor operated valves, solenoid valves etc. individual drive control module or redundant multi-channel drive module/ redundant output module provided ...Yes/No....

e) Redundancy in I/O to controller Bus is provided *...Yes/No....*

5.16.00 **Sequence of Event Monitor**:

a) A 1024 pt. SOE is provided ...Yes/No....

b) SOE with 1 ms resolution is provided ...Yes/No....

c) SOE is also connected to main data bus through redundant communication links ...Yes/No....

d) Features like galvanic isolation; filtering for noise rejection, contact bounce protection etc. are provided for high resolution input card of SOE ...Yes/No....

e) Individual programmed time delay to compensate for response time characteri-stic sensing relay and other process device are provided ...Yes/No....

f) For initiating event the entry shall include time of initiation in hours, minutes, seconds, milli seconds. For subsequent event elapsed time in milli second from time of first event will be shown ...Yes/No....

g) Periodic time synchronization with master clock system shall be provided ...Yes/No....

h) After collecting the status changes, the collected events are printed out automatically on a dedicated SOE printer ...Yes/No....

i) *Printer, Monitors provided* *...Yes/No....*

5.17.00 **Master Clock System**:

a) Parabolic disc antenna of 8 ft. mesh provided ...Yes/No....

b) Required co-axial cable of 100 metre length (minimum) provided ...Yes/No....

c) Outdoor unit and indoor unit with demodulator provided ...Yes/No....

d) Interface for time synchronisation with DDCMIS and SOE & other control system provided ...Yes/No....

e) Secondary clocks provided as per NIT ...Yes/No....

5.18.00 **System Cabinets**:

a) No. of system cabinets .... Qty .....

b) Type of enclosure Bidder to state

c) Panel dimension Bidder to state

d) System cabinet shall have provision to mount 20% extra cards ...Yes/No....

e) System cabinet will be designed in such a way that when system is fully loaded the temperature rise at any part of the cabinet will not be above 10 deg.C with ambient temperature not exceeding 45 deg.C. ...Yes/No....

Hardware estimate of DDCMIS system is the sole responsibility of bidder. All the required hardware and software to meet the function specified will be met irrespective of B.O.M. and other details given in the bidder's offer ...Yes/No....

5.19.00 **Tests**:

a) Factory Test of DDCMIS system as per specification ...Yes/No....

b) Authorisation to ship test will be met as per specification ...Yes/No....

c) On-site test will be met as per specification ...Yes/No....

d) Performance and guarantee ...Yes/No....

test shall be met as per specification

e) Availability guarantee test will be as per specification ...Yes/No....

5.20.00 System response

I/O off normal detection time .....

Operator LED OWS response time .....

Printer response time .....

Operator command register time .....

Decisions/execute time in CPU .....

CPU to output port trans time .....

Message appear time on LED OWS .....

On line data retrieval time .....

Historic data retrieval time .....

Control loop response time for CLCS ----------

Control loop response time for OLCS ----------

I/O to controller bus speed in Mbps .....

6.00.00 Documents

Hardware, catalogues and software details of the bidder's System

Detailed write-up on quality control the Bidder proposes to follow

Description of tests and diagnostics

Installation and Site Preparation Manual

Previous experience of the Bidder on comparable installations

Description of the Bidder's service organisation

Service and Maintenance Contract

7.00.00 **Drawings**

System configuration drawings (block diagram)

Dimensional drawings of each system cabinet and peripheral cabinet

Cut-out drawings for panel mounted LED OWSs and keyboards

Interfacing requirement complied fully Yes/No

8.00.00 PLC *(each type)*

1.	Make & Model No.	:	_____
2.	Controller Redundancy	:	Provided/Not Provided
3.	No. of Inputs:		
	Analogue	:	_____
	Digital	:	_____
4.	No. of Outputs:		
	Analogue	:	_____
	Digital	:	_____
5.	Total No. of Points	:	
6.	I/O Expandability	:	Yes/No
7.	Maximum no. of channels	:	
8.	Input/Output Isolation	:	Provided/Not Provided
9.	Communication Line	:	_____
10.	Power Supply	:	_____
11.	LED MONITOR Size	:	_____
12.	Printer	:	Provided/Not Provided
13.	Type of back-up battery	:	_____
14.	Data Memory	:	_____

15. Program Memory : _____

16. Controller Memory : _____

17. Response Time/Scan Time *for Binary, Analog I/Os* : _____

18. Number of Instruction : _____

19. Programming from LED : Yes/No

20. CPU word length : _____

9.00.00 LOCAL CONROL PANEL/ DESK

1	Type	:	
2	Location of Cabinets	:	
3	Tentative Dimension	:	
4	Thickness of Sheet	:	
5	Details of Painting	:	
6	Degree of Protection	:	
7	Frame Angle Size	:	
8	Base Channel	:	
9	Anti Vibration Pad	:	(Yes/No)
10	Type of Cable Entry	:	
11	All the required control devices like control and selector switches, push buttons, indicating instruments, lamps, contactors, relays, timer, fuses, Mimic, HW Annunciation etc. are provided with the control panel/Desk fully installed & wired.	:	

10.00.00 Microprocessor Based Positioners

1. Make & Model No.
.....

2. E/P convertion & positioning

		functions	available
		Yes/No	
	3.	Detailed diagnostic functions provided	Yes/No
	4.	Diagnostic & Historical information available via HART interface	Yes/No
	5.	Position feed back (4-20mA) included	Yes/No
	6.	Characterisation via software	Yes/No
	7.	Possible to stayput the valve or open/close or signal failure	Yes/No
	8.	These are suitable for control dampers also	Yes/No
	9.	Detailed technical literature/ catalogue furnished at	Page No..... Sec No.....

11.00.00 PLANT PERFORMANCE ANALYSIS, DIAGNOSIS AND OPTIMISATION

11.01.00 (a) Hardware Configuration & BOM of PADO & its Sub-Systems enclosed at Page No. _____Sec.No._____

(b) Details of Interface with DDCMIS described at Page No. _____Sec.No._____

(c) Details of Dynamic analysis software (Simulator) described at Page No._____Sec.No._____

11.02.00 **PERFORMANCE ANALYSIS & MONITORING**

11.02.01 Heat Rate Calculation

(a) Unit heat rate (Gross & Net)
(b) TG heat rate (Gross & Net)

11.02.02 Plant & Equipment efficiencies Calculation Page No._____Sec.No._____

11.02.03 Controllable Losses Calculation Page No._____Sec.No._____

11.02.04 Analysis of impact of component performance on over all losses/ Gen. output Page No. _____Sec.No._____

11.03.00 SYSTEM & PERFORMANCE DIAGNOSIS Page No. _____Sec.No._____

11.04.00 **BPOS** Page No. _____Sec.No._____

11.04.01 (a) OWS Based BPOS

(b) Thermal Design model

(c) Forward calculation

(d) Backward calculation

(e) Model to be made site specific based on field trials

(f) On line calculations

(g) Performance prediction

(h) Zonal absorption

(i) Metal temperature calculation

(j) Fuel switching capability (to address varying coal properties)

(k) Pulveriser performance

11.05.00 Selective Soot Blowing Page No. _____Sec.No._____

12.00.00 SWAS and Flue Gas analyzer

12.01.00 STEAM AND WATER ANALYSIS SYSTEM (SWAS)

12.01.01 Detailed technical literature and data covering guaranteed performance of each category of proposed equipment for design specified herein Page No. ..... Sec. No. .....

12.01.02 **Proposal Data Sheets**

12.01.03	Steam & Water Analysis System Panels/Racks Analy- Construction	Field conditio-	Sample ser mounted ning panel racks
12.01.04	Size of each panel/racks (max.)	.....	.....
12.01.05	Sample Coolers	Primary	Secondary
12.01.06	Cooling water requirement (max.)	.....	.....
12.01.07	Conductivity cells for Hotwell		
12.01.08	Dimension of the cut out requirement (if any) for Hotwell cond. Measurement.	.....	

Sample Flow : _____
And Temperature

High Pressure Reducing Element:

Quantity : .....

Make & Model No. : .....

Type : .....

Other details as applicable : .....

Ion Exchange Column:

Quantity : .....

Make & Model No. : .....

Type : .....

Other details as applicable : .....

Internal Power Supply Module for **Alarm Annunciation System**:

Quantity : .....

Make & Model No. : .....

Type : .....

Other details : .....
as applicable

Annunciator Horns for Annunciator in Analyser System:

Quantity : .....

Make & Model No. : .....

Type : .....
Other details : .....
as applicable

Primary Cooler:

Quantity : .....

Make & Model No. : .....

Type : .....

Other details : .....
as applicable

Filter Elements for Steam and Water Analysis System:

Quantity : .....

Make & Model No. : .....

Type : .....

Size : .....

Other details : ..... as applicable

Temperature Gauges, Solenoid Valves, Pressure Gauges, Relief Valves, Back Pressure Regulating Valve, Blow down Valve, 3-way grab sampling valve:

Quantity : .....

Make & Model No. : .....

Type & size : .....

Other details : .....
as applicable

12.01.09 Conductivity Cells and Monitors :

- Quantity ……
- Make .....
- Type .....
- Range .....
- Material .....
- Monitor Output .....
- Power supply .....
- Accessories included .....
- Connections ----------
- Mounting ----------

12.01.10 **pH cells and monitors**

- Quantity .....
- Make .....
- Type .....
- Range .....
- Material .....
- Monitor Output .....
- Power supply .....
- Accessories included .....

12.01.11 Phosphate Analyser:

- Quantity .....
- Make .....
- Type .....
- Range .....
- Material .....

- Monitor Output .....
- Accuracy .....
- Power supply .....
- Accessories included .....

12.01.12 Chloride Analyser:

- Quantity .....
- Make .....
- Type .....
- Range .....
- Material .....
- Monitor Output .....
- Accuracy .....
- Power supply .....
- Accessories included .....

12.01.13 Chlorine Analyser:

- Quantity .....
- Make .....
- Type .....
- Range .....
- Material .....
- Monitor Output .....
- Accuracy .....
- Power supply .....
- Accessories included .....

12.01.14 Silica Analyser:

- Quantity .....
- Make, Model .....
- Type .....

- Range .....
- Accuracy .....
- Sample flow ml/min. .....
- Sensitivity ----------
- Sample temperature deg.C .....
- Output signal .....
- Power supply .....

12.01.15 Dissolved Oxygen Analyser :

- Quantity .....
- Make, Model .....
- Type .....
- Range .....
- Accuracy .....
- Sensitivity ----------
- Sample flow ml/min. .....
- Sample temperature deg.C .....
- Output signal .....
- Power supply .....
- Accessories ----------

12.01.16 Hydrazine Analyser:

- Quantity .....
- Make, Model .....
- Type .....
- Material .....
- Output signal .....
- Range .....
- Accuracy .....
- Power supply .....

- Sample pressure ----------
- Response Time ----------
- Mounting ----------

12.01.17 Sodium Analyser:

- Quantity .....
- Make, Model .....
- Type .....
- Material .....
- Output signal .....
- Range .....
- Accuracy .....
- Power supply .....
- Sample Pressure ----------
- Ambient temp. limit ----------
- Mounting ----------

12.02.00 Flue gas analysers

12.02.01 Oxygen Analyser

- Quantity .....
- Make & Mode Number .....
- Type .....
- Material - Case .....
- Power supply .....
- Output .....
- Accuracy .....
- Sensitivity ----------
- Range .....
- Ambient temp. limit ----------

- Mounting .....
- Standard Test gas cylinder ----Yes/ No---
- Accessories .....

12.02.02 CO Analyser

- Quantity .....
- Make, model .....
- Ambient temp. limit ----------
- Type .....
- Power supply .....
- Output .....
- Accuracy .....
- Range .....
- Facility to adjust range .....
- Self diagnosis and auto calibration provided .....Yes/No.....
- Enclosure class .....
- Mounting .....
- Accessories .....

12.02.03 Suspended Particulate Monitor (Dust Monitor):

- Quantity .....
- Make, Model .....
- Type .....
- Material .....
- Range .....
- Accuracy .....
- Output signal .....
- Power supply .....
- Enclosure class .....
- Pressure ----------

- Mounting .....
- Ambient temp. limit ----------

12.02.04 SO_2 and NO2 Analyser:

- Quantity .....
- Make, Model .....
- Type .....
- Material .....
- Output signal .....
- Range .....
- Accuracy .....
- Power supply .....
- Enclosure class .....
- Ambient temp. limit ----------
- Mounting ----------

13.00.00 UNINTERRUPTIBLE POWER SUPPLY SYSTEM

13.01.00 Performance and Design Data:

1. Detailed technical literature ..... and technical data covering the guaranteed performance of each category of the proposed equipment for design and operating conditions specified herein.

2. Detailed calculations for ..... capacity of inverter as specified herein

Detailed calculation for ..... capacity of battery as specified herein.

4. Detailed calculations for ..... capacity of battery chargers as specified herein.

13.02.00 UPS System Design Features

1. Bill of material for all tems ..... and accessories furnished and installed in the cabinets or panels furnished in this contract

2. Detailed write-up on the UPS..... system including special features (if any) for each alternative included in Bidder's proposal

3. Comperative evaluation of ..... alternative proposed by the bidder

4. Details regarding fuse co-ordination ..... and data/characteristics for all types of fuses/circuit breakers furnished by by Bidder.

13.03.00 Shop and Site Tests

1. Description of shop and site..... testing procedure to UPS system components, panels/enclosures circuit breakers furnished by and fully assembled system.

2. Description of facilities available ..... with the UPS system Manufacturer for conducting elevated temperature heat run test and SWC test as per 'ANSI-C-37. 90a/ICE standard 472-1974 Analog with results for recent tests Conducted for a comparable system.

Information pertaining to availability ..... of training course offered by the Bidder for Owner's personnel in System engineering and maintenance field.

13.04.00 Experience

1. Name and location of manufacturing ..... works where the proposed UPS system shall be manufactured and tested as per this specification.

2. List of installations comparable ..... in scope and complexity to the one specified referred at clause 5.02.06.1 above has supplied to other power generation owners. A CPM or milestone schedule for UPS

System showing activities from receipt of order through shipment. The schedule shall include cut-off dates for information from the Bidder.

13.05.00 Drawings

Schematic diagram of proposed UPS system. .....

2. Power distribution single line diagram showing all switches, fuses, circuit-breakers and other equipment covered under Bidder's proposal. .....

3. Typical drawings and photographs for UPS system equipment and enclosures to fully demonstrate to the owner, the Bidder's practice regarding. .....

a) Location of major UPS hardware .....

b) Location of monitoring devices .....

c) Location of bus chambers, cable Entry, type of internal wiring, Termination techniques etc. .....

Installation and/floor opening details for all UPS system equipment and panels/enclosures. .....

Proposed layout of batteries in battery room indicating minimum clearance requirement of ventilation etc. .....

Proposal Data Sheets

General

1. UPS system manufacturer's name .....

2. Number of cabinets furnished .....

Dimensions of inverter cabinet (W X H X D in mm) .....

4. Dimension of charger cabinet (W x H x D in mm) .....

5. Dimensions of any other UPS cabinet (if furnished) .....

6. Dimensions of DC distribution board (W x D x H in mm) .....

7. Dimensions of AC Distribution board (W x D x H in mm) .....

8. Weight of the following in Kg with all equipment installed .....

a) Invertor cabinets .....

b) Charger cabinets .....

c) Other UPS cabinets .....

d) DC distribution board .....

e) AC distribution board .....

f) Step down transformer .....

g) Voltage stabiliser .....

Heat load for air conditioning/ ventilation purpuses. .....

a) Invertor and static switch..... at 100% load

b) Inverter and static switch ..... at 50% load.

c) Inverter and static switch..... at 33% load

d) Charger and accessories ..... at 100 % load

e) Charger and accessories ..... at 50% load

f) UPS battery .....

g) (any other details considered essential by the bidder)

Inverter and Auxiliary Equipment

1. Manufacturer's name .....

2. Model, name and number .....

3. Rated full load capacity at 1.0 ..... power factor (at design ambient)

4. Rated full load capacity at 0.8 .....
   power factor (at design ambient)

5. Number of cells .....

6. DC input, ampers

7. DC input, volts

   a) No load .....

   b) Rated full load .....

8. Full load a.c. output, amperes .....

9. Steady state output voltage.... %.....
   resolution for 0 to 100 % load
   at all input voltages

10. Transient output voltage ..... %.....
    resolution on application and
    removal of 100 % load

11. Frequency variation for all .....%.....
    conditions of input supply, load
    and temperature occuring
    simultaneously or in any
    combination

12. Total harmonic content at rated load ....%...

13. Overload capacity at 100 percent voltage .... %....

    a) For 4 milliseconds (fuse clearing) .... %....

    b) For 100 milliseconds .... %...

    c) For 10 seconds ... %....

    d) For 60 seconds ... %...

    e) The proposed inverter ... %...
       has the capacity to clear ..Amp.
       fuse,Static maximum fuse rating) in milliseconds
       without entering into current limits mode

Overload capacity at 90 percent voltage:

a) For 4 milliseconds ... %.....

b) For 100 millisecond ..... %.....

c) For 10 seconds ..... %.....

d) For 60 seconds ..... %.....

No load current, amps .....

Maximum inrush current during .....
Inverter enersization amps.

Efficiency (watts output/wattsinput) at :

a) Rated load at 1.0 PF/0.8 PF .... %....

b) 50 % rated at 1.0 PF/0.8 PF..... %.....
c) 33% of rated load at 1.0 PF/0.8 PF..... %.....

18. Heat dissipation in KW while supplying

a) 100 percent of rated load ..... %.....

b) 50 percent of rated load ..... %.....

c) 33 percent of rated load .... %.....

d) No load

19. Cooling

a) Type (natural convection of fan ..... Cooled)

b) Number of fans .....

c) Make and model no.of fans .....

d) Technical literature furnished .....

e) Operating time at full load .....Minutes without forced air cooling.

20. Sound level at 1.5 metres for total .....dBA system.

21. Fuse-type size and characteristics .....

a) Inverter input .....…

b) Inverter output .....

22. Inverter auxiliary equipment provided as per specification .....Yes/No

23. Details of additional auxiliary equipment (if any) furnished .....

24. Technical literature for inverter And auxiliary equipment furnished ----------Yes/No

13.08.00 Static Transfer switch

1. Manufacturer's name .....
2. Model, name and number .....
3. Rated voltage .....
4. Rated capacity, amps .....
5. Transfer time, milliseconds .....
6. Overload capacity .....
   a) For 100 milliseconds.....%
   b) For 60 seconds .....%
   c) For indefinite period .....%
7. Oscillographic records for transfer ..... operation furnished.
8. Description of transfer on under voltage, no voltage and over current and transfer to 'Normal'source furnished .....
9. Static transfer switch auxiliary equipment furnished as per this spec. ----------Yes/No
10. Technical literature for static transfer switch and associated auxiliary equipment furnished .....

13.09.00 Manual Bypass Switch

1. Manufacturer's name .....
2. Model, name and number .....
3. Rated voltage .....
4. Rated capacity, amps .....
5. Contact configuration and switch type as per specifications. ...Yes/No
6. Technical literature furnished .....

13.10.00 UPS & 24 V DC Float-cum-Boost charges

1. Manufacturer's name .....
2. Model name and number .....

3. Rating amps .....

4. Current at 415 Volts AC input.....
and following loads
in addition to supply the battery
charging current.

a) 50% rated current amps .....

b) 100% rated current, amps .....

c) 110 % rated current, amps .....

5. Rated voltage .....

6. Charger maximum inrush
current amps .....

7. Charger input power factor at .....
240V DC output at

a) 50% rated current amps
.....

b) 100% rated current amps .....

8. Output voltage resolution at
following conditions:

a) No-load to full load at
Constant nominal input voltage (%) .....%.....

b) No-load to full load with input
Voltage variation of + 10% and
input frequency variation of
+5% in any combination(%) ....%.....

9. Maximum nipple voltage (rms) at any
Load and input voltage as per this
Specification:-

a) With battery having four times
AH capacity connected ....mv.....

b) For operation as battery
eliminator, mv .....

10. Charger efficiency at 240 V DC
Output voltage at

a) 50% rated current .....%.....

b) 100% rated current .....%.....

Maximum fault current for the .....
short circuit at the output

terminals

13.11.00 UPS Battery and Auxiliary Equipment

1. Manufacturer's name .....
2. Model, name and number .....
3. Battery type designation .....
4. Voltage per cell
   a) Nominal .....
   b) Maximum .....
   c) Floating .....
   d) Equalizing .....
   e) Final after discharge .....
5. Ampere – hour capacity .....
6. Duty cycle for which the ..... battery has been sized
7. Expected life of battery, years .....
8. Number of cells .....
9. Cell type .....
10. Construction of positive plates .....
11. Number of positive plates per cell .....
12. Describe method of supporting ..... positive and negative plates
13. Capacity (8 hour rate) discharged ..... to 1.75 volts per cell
14. Curve for discharge rate in ..... Amperes to 1.75 at 25 deg. C Vs Time (1 minute to 8 hours) furnished
15. Internal resistance of fully ..... Charged cell at 25 deg.C including intercell connector (ohms)
16. Recommended duration of equalizing ..... charges at 2.33 volts/cell to charge the battery from 1.75 volts/cell to fully charged condition (hours)

17. Temperature Vs battery capacity ..... capacity curve

18. Short circuit current /for a dead ..... short at the terminals (amps)

19. Heat loss from the battery (Watts) .....

20. Allowable voltage difference ..... between cells for proper matching of cells (volts)

21. Maximum hydrogen evolution from ..... the battery during a period of 15 minutes under any condition (cu.m/15 min)

22. Conditions required for achieving ..... battery life as per s.no.6 above

23. Period (in hour) the battery ..... can remain discharged to 1.75 volts per cell without reducing the battery life.

24. Weight per cell kg .....

25. Total weight of battery kg .....

26. Dimensions of each cell ..... (L x W x H mm)

27. Battery auxiliary equipment .....Yes/No furnished as per this spec.

28. Details regarding additional ..... auxiliary equpiment (if any) Furnished.

29. Technical literature for battery ..... and auxiliary equipment furnished.

13.12.00 UPS Battery Racks

Manufacturer's name .....

Type .....

Material .....

Insulation .....

Overall dimensions in mm .....
(Length x Width x Height)

13.13.00 Step-down -transformer

1. Manufacturer's name .....
2. Rating (KVA) .....
3. Rated voltage .....
4. a) HV winding (KV) .....
   b) LV winding (KV) .....
5. Number of phases .....
6. Frequency (HZ) .....
7. Type of cooling .....
8. Guaranteed losses at 100% ..... rated voltage at rated frequency
9. No load losses (KW) .....
10. Copper losses at full load at ..... 75 deg.C (KW)
11. Efficiency at 75 deg.C at unity power ..... factor (%)
    a) at full load .....
    b) at ¾ load .....
    c) at ½ load .....
12. Technical literature furnished .....

13.14.00 Voltage Stabilizer

1. Manufacturer's name .....
2. Rating (KVA) .....
3. Rated voltage .....
4. Number of phases .....
5. Frequency (Hz) .....
6. Type of cooling .....
7. Guaranteed losses at 100% rated ..... voltage at rated frequency
8. No load losses (KW) .....

9. Copper losses at full load at 75 Deg.C (KW) unit p.f.

a) at full load .....

b) at ¾ load .....

c) at ½ load .....

10. Technical literature furnished .....

13.15.00 DC distribution panel board

1. Make & type .....
2. Sheet steel thickness, mm .....
3. Fuse,make, type & characteristics ..... for branch circuits
4. Number of feeders (INCLUDING SPARE FEEDERS) .....
5. Type of mounting .....
6. Terminals .....
7. Spares terminals .....
8. Dimensions mm (Height x Width x depth) .....
9. Weight Kg .....
10. Technical literature for DC distribution panels furnished .....
11. Technical literature/curves for fuses, circuit breakers, switches furnished. .....

Similar data as applicable shall be furnished by bidder for other power supply systems included by bidder.

13.16.00 AC Distribution Panel Board

1. Make and Type .....
2. Sheet steel thickness, mm .....
3. Fure,make,type and characteristics ..... for branch circuits
4. Number of feeders (INCLUDING SPARE FEEDERS) .....

5. Terminals .....

6. Spare terminals .....

7. Dimensions, mm (HxDxW) ----------
   a) 1st section .....

   b) 2nd section .....

8. Weight Kg
a) 1st section .....

b) 2nd section .....

9. Technical literature for AC distribution panels furnished ----------

10. Technical literature/curves for fuses,circuits breakers ----------
switches furnished.

14.00.00 <u>CONTROL PANELS/CONSOLES</u> etc.

14.01.00 Control Consoles/Equipment panel/Marshalling/Relay Panel/Field enclosures/Racks

Tentative dimensions requirement control panel .....

Thickness of sheet .....

Total heat load predicted .....

Dimensional drawing Ref. .....

Details of painting .....

Cross-sectional details floor opening and installation details of control panels .....

Terminal Blocks .....

Numbers .....

Type .....

Make .....

Rating .....

No. of points .....

Body material .....

Connection strip material .....

Nameplates .....

Material .....

Size & thickness .....

Colour .....

Size of letters .....

Colour of letters .....

Method of fixing .....

Degree of protection .....

Details of components (make & type) .....

Control switch .....

Push button .....

Indicating lamps .....

Ammeter/volt meter selector switches .....

Space heater .....

Wires .....

Indicating instruments .....

Annunciator .....

Panel .....

Whether detailed write-up of the scheme furnished (Yes/No) .....

14.02.00 CONTROL CONSOLES

No.of control consoles .....

Weight of control console .....

Thickness of sheet .....

Dimensional drawings Ref. .....

	Details of painting	.....
	Cross sectional details, floor opening and installation details	
	Degree of protection	.....

14.03.00 General Design and Constructional Feature :

1.	**Whether fluorescent lamp is provided for internal illumination**	**:**	**.....Yes / No ....**
2.	**Protection against noise/disturbance due to fluorescent lamp is provided**	**:**	**.....Yes / No ....**
	Telephone jacks shall be provided As per owner requirements	**:**	**.....Yes / No ...**
	Convenient to power receptacles outlets provided as per specification	**:**	**.....Yes / No ....**
	Details of surface preparation & Painting furnishing with proposal	**:**	**Page No. Vol.No.**
	Provided fuse disconnect switches for various services & instruments Individually	**:**	**.....Yes / No ...**
	Air circuits fused separately	**:**	**.....Yes / No ....**
	Provided with all required transformers, converters and regulators etc. to adapt with power supplies specified by the Owner	**:**	**.....Yes / No ...**
	Type of cable glands	**:**	**.....**
10.	**Ground bus type and size**	**:**	**.....**
11.	**Whether each ground point is readily accessible**	**:**	**...Yes/No....**

14.04.00 Name Plates

1.	**Material**	**:**	**.....**
2.	**Colour**	**:**	**.....**
3.	**Size as per Owner's specification**	**:**	**.....Yes/No...**
4.	**Desk/Panel attachment**	**:**	**.....**

5.	**Shall be furnished as per specification and approved samples**	**:**	**…Yes/No…**

14.05.00 Control Valves (TO BE SUPPLIED FOR EACH CONTROL VALVES PROPOSED)

14.06.00 PNEUMATIC CONTROL VALVES, ACTUATORS, AND ACCESSORIES

14.06.01	Control valve characteristic Cv curves for all valves enclosed at	Page No. ..... Sec. No. .....
14.06.02	**control Valve Design Data**	
14.06.03	Control valve design data indicating valve design specification sheets for all valves, Technical literature for all categories of valves included in the proposal, Control valve sizing calculation methods used and calculation sheets for all valves including outlet velocity calculations and noise calculations and Details of special features of valve design for	
	a) Cavitation services, Flashing services and Low noise applications	Page No. ..... Sec. No. .....
14.06.04	**Control Valve Actuator Design Data**	
	Actuator design specification for all valves, Technical literature for each type of actuator included in the proposal and actuator sizing calculation methods used and calculation sheets for each type of actuator	Page No. ..... Sec. No. .....
14.06.05	**Experience**	
14.06.06	Name and location of manufacturing works	Name Location .....

14.06.07 Separate reference lists of installations comparable to one specified herein where the manufacturer at above has supplied the following equipment to power utilities Control valves for flashing services, Control valves with anticavitation trims and Other control valves for power station applications ..... Page No. ..... Sec. No.

14.06.08 **Bill of Material**
Complete bill of material including all the accessories for all the valves and actuators furnished as per this proposal furnished at No. ..... Page No. ..... Sec.

14.06.09 **Drawings**

14.06.10 Physical dimensions & connection drawing for each valve and Control valve accessory equipment drawings ..... Page No. ..... Sec. No.

14.06.11 **Proposal Data Sheets**

14.06.12 The Bidder shall enclose with proposal, valve specification sheets containing the following minimum information for each valve

1. Tag No. .....
2. Service description .....
3. Make & Model No. .....
4. Body material (ASTM No) .....
5. Body ANSI Pressure/temperature rating class .....

....

6. Body, port size .....

7. Type of seating and guiding .....

8. Anti-cavitation trim (type) .....

9. Trim material (ASTM No.)

a) Seat/Plug .....
b) Stem/Cage .....

10. Flow characteristics .....

11.

		Minimum Flow	Normal Flow	Max. Flow
	Valve Cv	.....	.....	
b)	Valve % open	.....	.....	
c)	Outlet velocity - m/sec	.....	.....	
d)	Noise level dBA	.....	.....	

12. Design pressure (Kg/sq.m) .....

13. Design temperature (oC) .....

Make, Model Number .....

Valve service .....

Valve type & size .....

Valve co-efficient .....

Connection size inlet /outlet .....

Guiding .....

Type of connection .....

Material

i) Valve body
ii) Stem
iii) Seat rings
iv) Plug
v) Bonnet
vi) Bonnet Gasket
vii) Spring
viii) Body size

Port size	.....
Plug type	.....
Plug characteristic	.....
Characteristic curves Ref. Drg.	.....
Differential pressure and CV	
At Maximum flow	.....
At normal flow	.....
Maximum flow capacity	.....
Valve stem packing	.....
Ref. drawing valve dimensions sheet showing detailed and connections	.....
Ref. valve cross section drawing	.....
Type of actuator	.....
Actuator make & model	.....
Signal range	.....
Action on Air Failure	.....
Torque/Force Rating	.....
Accessories included	.....
Air requirement & Consumption	.....
Noise Level	.....
Leakage Class	.....
Minimum clearance required for maintenance purpose	----------

15.00.00 **<u>Flow Elements</u>** (To be supplied for each flow element)

Make	.....
Type	.....
Numbers off pairs of tap off	.....
Type of tap off	.....

Max. d/D ratio	.....
Max. Differential pressure	.....
Max. permanent pressure loss	.....
Min. Straight length required	.....
- Up stream	.....
- Down stream	.....
Scale range	.....
Reference Drawings	.....
i) Assembly	.....
ii) Flow Nozzle/Orifice Plate	.....
iii) Flange	.....
Accessories	.....

16.00.00 Power Cylinders

Make, Model	.....
Bore	
Stroke	.....
Mounting	.....
Cylinder Material	.....
Trim Material	.....
Seal Material	.....
Air supply requirements	.....
Action on air failure	.....
Positioner	Yes/No
Transmitter	Yes/No
Limit Switches	Yes/No
Manual operation provided	Yes/No

Detailed literature/ drawings Reference .....

Accessories included .....

17.00.00 Instrumentation Cables (For Each Type)

1. Manufacturer's name : .....
2. Reference standard : .....
3. Conductor size : .....
4. Conductor material : .....
5. Number of pairs/cores : .....
6. Insulation :
   a) Individual conductor Insulation material : .....
   b) Inner sheath material : .....
   c) Outer sheath material : .....
   d) Individual conductor insulation thickness : .....
   e) Outer sheath insulation Thickness : .....
   f) Applicable design standard for outer sheath : .....
   g) Applicable design standard for conductor insulation : .....
7. Voltage grade : .....
8. Continuous operating temperature: ----------
9. Shield material and thickness : .....

Drain Wire:

a) Size : .....
b) Number of strands : .....
c) Material : .....

11. Individual pair shielded : .....

12. Cable accessories are flame retardant : ……

Capacitance imbalance/mutual capacitance : ……

14. Characteristic impedance : ……

15. Noise reject level : ……..

17.01.00 <u>Prefabricated Cable for Interconnection between Panels/Desk/Board Cabinets etc.</u>

1. Manufacturer's name : ----------

2. Reference : ……

3. Conductor size : ……

4. Conductor material : ……

5. Number of pairs/cores : ----------

6. Insulation :

a) Individual conductor insulation material : ……

b) Inner sheath material : ……

c) Outer sheath material : ……

d) Individual conductor insulation thickness : ……

e) Outer sheath insulation thickness : ……

f) Applicable design standard for conductor insulation : **……**

7. Voltage grade : ……..

8. Continuous operating temperature: ……..

9. Shield material & thickness : ……..

10. Drain Wire:

a) Size : …….

b) Number of strands : …….

c) Material : …….

11.	Individual pair shielded	:	……
12.	Cable accessories are flame	:	……
13.	Capacitance imbalance/ mutual capacitance	:	……
14.	Characteristics impedance	:	……
15.	Noise rejection level	:	……
16.	Make and model of each type of socket and connector	:	a) …….. b) …….. c) ……..
17.	End connection with plug/socket arrangement	:	……Yes/No……
18.	Confirm that prefabricated cables are included under bidder's scope on as required basis	:	……Yes/No……

17.02.00 Extension <u>Cables</u>

1.	Manufacturer's Name	:	----------
2.	Reference standard	:	----------
3.	Conductor size	:	----------
4.	Conductor material	:	----------
5.	Number of pairs	:	----------
6.	Number of strands	:	----------
7.	Size of each strand	:	----------
8.	Thickness of insulation	:	----------
9.	Diameter over insulation	:	----------
10.	Thickness of mylar tape	:	----------
11.	Percentage overlap of mylar tape	:	----------
12.	Size of drain valve	:	----------
13.	Thickness of inner sheath	:	----------
14.	Diameter over inner sheath	:	----------
15.	Thickness of outer sheath	:	----------

16. Diameter over outer sheath : ----------

17. Diameter over armour : ----------

18. Oxygen index of outer sheath as per ASTDM 2863 : ----Yes/ No ----

19. Flammability as per IEEE 383 : ----Yes/ No ----

20. Smoke density of outer sheath under fire as per ASTDM 2843 : ----Yes/ No ----

21. Mutual capacitance : ----------

22. Impedance at 0.8 KHz : ----------

23.Coupling capacitance : ----------

24. Cross talk attenuation at 0.8 KHz : ----------

18.00.00 <u>Impulse Piping/Tubing System</u>

The following data shall be supplied individually for all piping classes as specified above.

<u>Impulse Piping</u>

a) Manufacturer's name : ……

b) Type : ……

c) Material Specn. : ……

d) Size & Schedule No. : ……

2. <u>Impulse Tube</u>

a) Manufacturer's name : ……

b) Type : ……

c) Material Specn. : ……

d) Design rating : ……

e) Wall thickness : ……..

3. <u>Fittings</u>

a) Manufacturer's name : ……

b) Type : ……

c) Material Specn. : ……

	d)	Design rating	:	……
	e)	End connection	:	……

4. Valves Manifold

	a)	Manufacturer's name :	……	
	b)	Type	:	……
	c)	Material Specn.	:	……
	d)	Design rating	:	……
	e)	Connection size & type	:	……

5. Condensate Pot

	a)	Manufacturer's name	:	……
	b)	Type	:	……
	c)	Material Specn.	:	……
	d)	Design rating	:	……
	e)	Connection size & type	:	……

6. Catch Pot

	a)	Manufacturer's name	:	……
	b)	Type	:	……
	c)	Material Specn.	:	……
	d)	Design rating	:	……
	e)	Connection size & type	:	……

7. Confirm that impulse pipes/tubes and all required fittings, valves, valve manifold, condensate pots, catch pots and other accessories for impulse piping system cables, cable accessories, racks, JBs shall be furnished by the bidder as per NIT. : ……Yes/No……

19.00.00 PUBLIC ADDRESS SYSTEM (PAS)

19.01.00 Detailed technical literature and data covering proposed equipment for design specified herein ..... Page No.

Sec. No……..

20.00.00 PSSS/CCTV

	a) System offered complete in all respects (functional, design, operational require-ments, power supply, cables etc.)	Yes/No
	b) Reference of plant/industrial installation wherein bidder has designed, manufactured, tested & commissioned distributed type CCTV system	.....
	c) Technical literature of the system furnished at	.....
21.00.00	**MAINTENANCE AND CALIBRATION EQUIPMENT (MCE)**	
21.01.00	1) A complete technical literature of the M&C equipment including needed nos. and accessories enclosed No.....	Page No..... Sec.
	2) List of spare parts/components recommended No.....	Page No..... Sec.
21.02.00	**Bill of Material**	
	Complete Bill of Material for all maintenance and calibration equipment furnished in this proposal (including accessories required for satisfactory operation) No.....	Page No..... Sec.
21.03.00	**Drawings**	
21.04.00	**Electronic Test Bench**	

Outline drawing showing dimensional details and General arrangement drawing including position of different plugs, sockets, meters, switches, indicators etc. Page No..... Sec. No.....

21.05.00 **Pneumatic Test Bench**

Outline drawing showing dimensional details, and General arrangement drawing showing all devices Page No..... Sec. No.....

16.04.00 **Bidder Fill up for all the M & C items.**

Items	Make & Models	Confirm that meets spec.	Quantity	Vol. No.	Remarks
.....	.....	.....	.....	.....	.....
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