	PRE-QUALIFICATION REQUIREMENT	PE-PQ-504-161-A001	
	PROJECT: 2X800 MW MEL SINGRAULI TPP	DATE	15-04-2024
	PACKAGE: COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	REV NO	00

1.0	Bidder should have experience in supply of Air Blasters, used for coal deblocking in Coal Bunkers/ Silos.
2.0	The bidder shall submit following supporting documents meeting the above mentioned pre-qualification requirement: Copy of performance certificate/commissioning certificate/installation certificate/work completion certificate etc (in English) from the End user/s along with copy of related Purchase Order/s (PO) or Letter of intent (LOI/s) or Letter of Award (LOA/s) or Work Order (WO/s) in support of credential above.
3.0	Bidder shall submit design documents to substantiate technical parameters specified in PQR, if the same is not mentioned in performance certificate/purchase order.
4.0	Minimum one (1) no. Purchase order shall be submitted which should not be more than seven (7) years old as on date of bid submission, for establishing continuity in business. This is over and above the requirement of PO mentioned of PQR clause at S. No. 2.0 above.
5.0	Bidder to submit all supporting documents in English. If documents submitted by bidder are in language other than English, a self-attested English translated document should also be submitted.
6.0	Notwithstanding anything stated above, BHEL/CUSTOMER reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of BHEL/CUSTOMER.
7.0	Consideration of offer shall be subject to customer's approval of bidders, if applicable.
8.0	After satisfactory fulfilment of all the above criteria/ requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.

228356/2024/PS-PEM-MAX

Mahan Energy Limited
(Subsidiary of M/s Adani Power Ltd)

2x800 MW MEL SINGRAULI TPP

TECHNICAL SPECIFICATION
FOR
COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)

SPECIFICATION NO.: PE-TS-504-161-A001

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR- PROJECT ENGINEERING MANAGEMENT
NOIDA
INDIA

228356/2024/PS-PEM-MAX

CONTENT

SUB SECTION-IA

SPECIFIC TECHNICAL REQUIREMENT (MECHANICAL)

SCOPE OF ENQUIRY / INTENT OF SPECIFICATION

1.1 This specification includes, but not limited to SUPPLY PART, SERVICE PART & MANDATORY SPARES comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants & consumables along with all accessories and spares for erection, start up and commissioning, forwarding, proper packing, shipment and delivery & warranty as per requirement given in NIT SUPERVISION SERVICES for erection and commissioning, trial run at site, Performance guarantee/Demonstration tests at site, training of Customer's O&M staff covering all aspects of Operation & Maintenance at site complete with all accessories of **Coal bunker Deblocking Device (Air Blasters)** for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil 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. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the Supply & Services.

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.

1.5 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Section-III of the specification within 10 days of receipt of tender documents. In

absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed deviation schedule along with cost of withdrawal; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, more stringent requirement as per the interpretation of the owner shall apply.

1.10 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or Customer including their consultant as interpreted by BHEL in the relevant context. For details refer the relevant clause in GCC.

1.11 Quality plan for reference is included in this specification to enable the bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the quality plan's minimum requirement during manufacturing and testing.

1.12 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.0 SCOPE OF WORK

The specification covers Supply part, Services part and Mandatory spares comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, first fill and top-up of lubricants & consumables, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site AND services part covers supervision services for erection & commissioning, trial run at site and Performance guarantee/Demonstration tests at site, training of Customer's O&M staff covering all aspects of Operation & Maintenance at site & handover in flawless condition of the package to the customer complete with all accessories.

Design: Broadly includes basic engineering, detail engineering, preparation and submission of engineering drawings/ calculations/ datasheets/ quality assurance documents/ field quality plans, storage instructions, commissioning procedures, Erection & assembly Drawings, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from customer.

Supply: Broadly includes manufacturing/fabrication, shop floor testing, stage inspections, final inspections, painting, packing & forwarding.

Services: Broadly includes supervision services for erection & commissioning, trial run at site and Performance Guarantee / Demonstration tests at site, training of Customer's staff covering all aspects of Operation & Maintenance at Site.

1.1 SCOPE OF SUPPLY

Scope of supply shall comprise of but not necessarily limited to the following:

a) Coal Bunker Deblocking device consisting of Pneumatic Air Blasters with all accessories like solenoid valves, mounting bracket, safety chain, nozzles, control unit, panel, sequential timer etc. as detailed at Annexure 1.

b) One (1) set of Mandatory Spares as per the list attached in specification.

c) One (1) set of Erection & Commissioning spares as required for the complete system.

d) One (1) set of Maintenance tools and tackles.

e) All counter-flanges with nuts, bolts and gaskets at all the terminal points.

f) Charge of all lubricants and fluids.

g) Any other instrument, item required for making the installation complete in all respect within battery limits and for satisfactory operation of the system, unless specifically EXCLUDED from scope under Clause No. 2.0 below.

1.2 SCOPE OF SERVICES

Scope of services shall include but not necessarily limited to

a) Detailed procedure for Erection and commissioning shall be submitted by successful bidder for carrying out the erection and commissioning at site by BHEL.

b) Supervision for Erection & Commissioning, trial run at site.

c) Supervision for Performance guarantee/Demonstration tests at site.

d) Training of Customer's O&M staff covering all aspects of Operation & Maintenance at site.

e) For supervision services, visits shall be planned by BHEL site team and prior intimation shall

be sent to supplier for visit to site. Bidder shall be informed around 10 days in advance for the requirement of visit at site. Visiting team shall consist of one or two experts of bidder as deemed necessary.

2.0 EXCLUSION

a) Civil work.

b) Compressors for service air.

c) Supply of Cables, cable trays, power supply etc.

d) Relevant exclusions as per GTR, GCC, SCC & ECC.

3.0 SERVICES PROVIDED BY THE CUSTOMER

a) 1 no. tapping of service air with pressure 5-7 Kg/cm2 at feeder floor (EL +22.75m) with 25NB isolation valve shall be provided.

b) 1 no. 230V AC power supply for each bay shall be provided. Distribution board shall be in vendor's scope.

c) DCS control for remote On/ Off commands to start/ stop auto sequence operation.

4.0 TERMINAL POINT

Service Air tapping (1 no. in each bay) with 25NB isolation valve at feeder floor (EL + 22.75 mtr)	Refer "FLOW SCHEME FOR COAL BUNKER DEBLOCKING DEVICES"

5.0 INSPECTION AND TESTING

Shall be carried out as per enclosed BHEL standard quality plan. Prime inspection agency shall be BHEL/End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/ CHP (Customer Hold Point) at any stage of inspection deemed necessary by Customer/BHEL during detailed engineering shall be carried out without any commercial or technical implication.

6.0 **PROCEDURE FOR ERECTION, PRE-OPERATIONAL TESTING/STARTUP & COMMISSIONING**

This shall be furnished by the successful bidder during detail engineering for review and acceptance.

7.0 PAINTING/CORROSION PROTECTION REQUIREMENT

Successful bidder shall furnish detailed Painting Schedule (based on painting specification attached with specification) for Customer's approval during detail engineering.

8.0 LAYOUT REQUIREMENTS

Piping and equipment installation (applicable as per scope of work) shall be according to the regulations and recommendations of recognized Indian / International Standards, Codes and Statutes, as and where applicable, practice in vogue (to be supported with back up document to the satisfaction of Customer). Input drawings shall be furnished by BHEL.

9.0 EQUIPMENT DESIGN CRITERIA

The minimum design criteria to be followed for various equipment shall be as per requirements indicated under specific and standard technical specifications.

In case of *any contradictory requirement* in specification of particular equipment, the requirement given in Section I shall prevail over those indicated in Section-II. Further, in case of any contradictory requirement within the same section and clarifications not having been sought by the bidders w.r.t. the same within the stipulated period, the most stringent requirement as per interpretation of the Customer will prevail. Successful bidder will furnish detailed data sheets/ specifications/design calculations for various equipment for customer/consultant's approval during detail engineering. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

10.0 DRAWINGS/DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

The tentative list of drawings and documents required during detail engineering shall be as per the list. The drawing list, however, will be finalized with the successful bidder prior to start of detail engineering.

11.0 DRAWING/DOCUMENT DISTRIBUTION SCHEDULE

Drawing/document distribution schedule shall be as per Annexures enclosed elsewhere in the specification.

12.0 DOCUMENT MANAGEMENT SYSTEM (DMS)

Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web-based Document Management System (DMS). Bidder would be provided access to DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end:

BHEL reserves the right for drawing/document submission through web based Document Management System. Bidder would be provided access to the DMS for drawing/document approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.

- Internet explorer version – Minimum Internet Explorer 7.
- Internet speed – 2 Mbps (Minimum preferred).
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked.
- Vendor's internal proxy setting should not block DMS application's link (https://www.bhelpem.com/wrenchweb).

DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor section. For quick access bidder may refer the link http://bhelpem.com/DMSManuals/DMSManuals.html

13.0 DRAWINGS ENCLOSED WITH THE SPECIFICATION

Bidder to note that the flow scheme shows the minimum requirement including accessories for the system. Any additional equipment/instruments required for safe, efficient & reliable operation of the system within the battery limit shall also be considered

as included in bidder's scope without any commercial/ cost implication to BHEL.

14.0 OTHER REQUIREMENTS

i) Technical Requirements

- Operation philosophy and control philosophy shall be submitted by the vendor during detail engineering stage for BHEL / CUSTOMER /CONSULTANT approval and approved document shall be adhered and the system shall be provided accordingly for which no commercial implication shall be entertained by BHEL.

- All possible efforts shall be made by the bidder to get the approval of drawings and documents from BHEL / customer / consultant at the earliest and the documents prepared / generated by them or their sub-vendors shall be checked by their competent authority before submission to BHEL.

- Revision made by the bidder in any drawings and documents shall be highlighted by indicating the no. of revisions in a triangle without fail so that the minimum time is required by BHEL to review the drawings and documents.

- All the drawings which are required to be furnished to BHEL during detailed engineering stage shall include technical parameters, details of paints, BOQ / BOM etc in tabular form indicating all components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

- All drawings and documents including general arrangement drawing, data sheet, calculation etc. shall be furnished to BHEL during detailed engineering stage and shall include / indicate the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.:-

  a) All drawings and documents shall bear BHEL's title block and drawing / document number.

  b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view, all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.

- List of drawings and documents including data sheet, manual calculation, quality plan, field quality plan, performance test procedure, list of sub – vendors, technical specification and material of construction, painting specification / schedule, dispatch schedule etc. of various items as required by BHEL / customer / consultant shall be submitted to BHEL / customer / consultant during detail engineering stage for approval and the approved drawings / documents shall be adhered by the bidder without any commercial implication.

ANNEXURE 1 : EQUIPMENT DESIGN/SELECTION CRITERIA FOR COAL BUNKER DEBLOCKING DEVICES:

	Function	The air blasters shall aid and assist the free flow of raw coal in coal bunkers to address the material build-up problems like arching, bridging, rat-holing & funneling which occur due to moisture, compaction, storage for long duration etc. They are operated to provide optimal flow pattern.
	No. of coal bunkers in plant	Eight (8) bunkers in Two (2) bays of four (4) bunkers each.
Raw Coal Bunker Data		
	Refer attached "BUNKER SIZING CALCULATION for RAW COAL-CYLINDRICAL WITH CONICAL HOPPER"	
Coal Analysis / Biomass Analysis		
	Refer attached "Coal Analysis" and "Biomass Analysis". The mix shall be 90% Coal and 10% Biomass in Coal Bunker.	
Equipment Data		
1	**Pneumatic Air Blasters with all accessories like solenoid valves, mounting bracket, safety chain etc.**	
	No. of Air blasters per bunker	The bunkers shall be provided with air blasters at strategic locations and the system shall be complete with pipework, valves, blasters, panel etc. As per vendor's design based on hopper profile, bulk density of material etc. (Minimum 6 nos. per bunker) shall be strategically located/ mapped on coal bunker as per vendor's proven practice.
	Capacity	As per vendor's proven practice.
	Material of Construction	As per relevant codes and standards.
3	**Nozzles** for air blasters (used for connection between air blasters to bunkers)	Along with mounting accessories such as Flange, Gasket, Connecting Pipe, Mounting Plate etc.
4	**Control panel** for air regulation alongwith sequential timer	One no. for each bunker, located at feeder floor (El. 22.75 mtr). Panels shall include Ball Valve, Solenoid Valve (230 VAC), Non-Return Valve, Quick Exhaust Valve etc.
5	**Piping**	
	Material of construction	Refer Customer's specification, "1.4 PIPING, VALVES AND SPECIALITIES"
	SS pipes for piping from terminal point to panels at feeder floor	Including pipe supports, Air Filter, Pressure Regulator, Lubricator, Ball Valve, Collar/Socket, Union, Nipple, Reducer Collar etc for.
	SS Tubing & fittings:	for connection of individual air blasters from control panels.
6	**Control System**	The "No COAL" flow detector of ultrasonic type provided (in BHEL's scope) in the raw coal discharge line from bunker to the coal feeder shall start the air blasters in the bunker. Control of deblocking devices shall be through DCS. In addition to control from DCS, control from local panel shall also be provided.

		The firing sequence of blasters shall be through sequential timer card/s (air blasters suppliers scope).

ANNEXURE 2 - DRAWINGS/DOCUMENTS TO BE SUBMITTED AFTER AWARD OF CONTRACT: The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

S.No.	BHEL DRG NO	DRG TITLE	CATEGORY	SCHEDULED SUBMISSION (NO. OF DAYS FROM LOA DATE)	REMARKS
COAL BUNKER DEBLOCKING DEVICES					
1	PE-V0-504-161-A110	OPERATION AND MAINTENANCE MANUAL --COAL BUNKER DEBLOCKING DEVICE	I	90	
2	PE-V0-504-161-A104	SCHEMATIC (P&ID) DRAWING FOR COAL BUNKER DEBLOCKING SYSTEM	A	30	PRIMARY DRG.
3	PE-V0-504-161-A109	GENERAL ARRANGEMENT & DATASHEET FOR COAL DEBLOCKING DEVICES	A	30	PRIMARY DRG.
4	PE-V0-504-161-A101	MQP FOR COAL DEBLOCKING DEVICES	A	30	PRIMARY DRG.
5	PE-V0-504-161-A110	ERECTION AND COMMISSIONING PROCEDURE	I	90	

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work. Drawings /documents indicated at Electrical and C&I specification are also to be submitted as per applicability.
2. Drawings shall be prepared in Auto-Cad latest edition and to the scale. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-

a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.

b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.

c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.

d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 ….etc.

f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.

g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.

h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing No.

i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

j) Bidder to follow the following the drawing submission schedule:

k) 1st submission of drawings from date of LOI as per the submission schedule.

l) Every revised submission incorporating comments – within 10 days.

m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

n) BHEL drawing numbers shall be informed after award of contract and essentially to be incorporated in drawings. The pdf files of all drawings and documents shall be named and submitted with BHEL drawing numbers.

o) Drawings documents above have been identified as basic drawings in remarks column. During contract engineering stage, approval of these drawings from BHEL/Customer shall be treated as clearance to milestone payment for completion of design & engineering.

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- 1 : Approved
CATEGORY- 1* : Approved with comments.
Resubmit revised drawing incorporating the comments.
CATEGORY –2 : Approved except as noted, forward final drawing.
CATEGORY - 3 : Approved except as noted, resubmission required.
CATEGORY – 4 : Disapproved.
CATEGORY – 5* : For information and record with comments.
CATEGORY – 5 : For information and record.

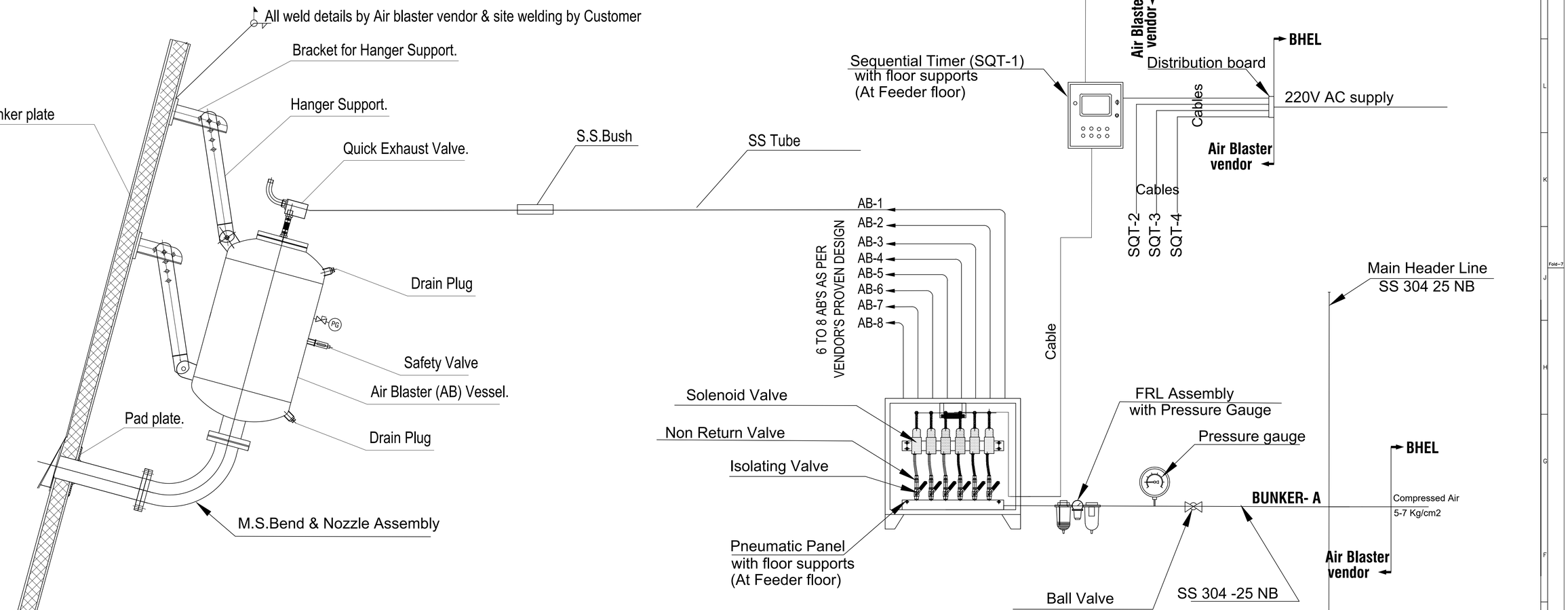
Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.

B.0 NO.OF DRAWINGS/DOCUMENTS FOR SUBMISSION

A.	Drawing for Approval	No. of prints/copies (hard prints)
i.	For approval	8
ii.	For final distribution (after the vendor obtains final approval from the customer).	12
B.	Certificate, reports etc. (Material test, inspection report and all other type of tests etc.)	6
C.	O&M Manual	
I.	Draft for approval	2
ii.	For final distribution	12

ANNEXURES

Annexure 3	Flow Scheme for Coal Bunker Deblocking Devices (Drg no PE-DG-504-161-A100)
Annexure 4	BUNKER SIZING CALCULATION for RAW COAL-CYLINDRICAL WITH CONICAL HOPPER
Annexure 5	MILL & BUNKER BUILDING – G.A. OF BUNKERS AND SUPPORTING DETAILS (Drg no PE-DG-504-616-C014)
Annexure 6	Typical layout drawing of Feeder floor
Annexure 7	General Arrangement of Boiler - Front Elevation (For Feeder floor)
Annexure 8	Coal Analysis
Annexure 9	Biomass Analysis
Annexure 10	PIPING, VALVES AND SPECIALITIES
Annexure 11	Standard Quality Plan
Annexure 12	Technical Specification for Painting & Coating of Equipment & Structures
Annexure 13	Site Condition
Annexure 14	Special Tools and Tackles
Annexure 15	General Plant and Technical Requirements
Annexure 16	C&I Specification
Annexure 17	Mandatory spares list



FIRST ANGLE PROJECTION

Annexure 3

ALL DIMENSIONS ARE IN MM

DRAWING NO.
PE-DG-504-161-A100

FLOW DIAGRAM FOR COAL BUNKER DEBLOCKING SYSTEM
(TYPICAL ARRANGMENT FOR A BUNKER)

Note :

1. Nozzle cut out and welding details to be provided during detail engineering.
2. Air Blaster position and Nozzle orientation can be adjusted as per
   site condition at the time of erection.

ELECTRONIC FILE NAME: STD

JOB NO. 504
STATUS CONTRACT
DISTRIBUTION

TO				
NO.				
REV.	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

Maharatna Company

DEPT CODE		NAME	SIGN	DATE
A	DESN			
	CHD			
	APPD			

TITLE
FLOW SCHEME FOR COAL BUNKER DEBLOCKING DEVICES

DEPT.
SCALE NTS
SIGN
DATE
DRAWING NO. PE-DG-504-161-A100
SHEET 1 OF 1
REV. 00
SIZE-A0

MAHAN ENERGEN LIMITED,2x800MW ULTRA SUPER CRITICAL THERMAL POWER PROJECT,MAHAN (PH-II) SINGRAULI, MP										
BHEL drawing no PE-DC-504-161-A001 **MEL drawing no 552H-E-BTG-BOA-BM-C-V-0002** △2			**BUNKER SIZING CALCULATION FOR RAW COAL-CYLINDRICAL WITH CONICAL HOPPER**				**REV**	**2**	**13-10-2023**	
Description of Item	**Data**	**Unit**	**Remarks**	**Description of Item**	**Data**	**Unit**	**Storage volume of coal (in m3)**		**Unit**	**Remarks**
Basis of calculation	Max mill capacity for entire range of coal firing of the unit. △1		*(As per MAH1-E-BTG-BOA-TM-S-I-001, Page 30 of 124 ,Vol II_Section 2_Mechnical.)*	H1 +H2 Where H1=Slab thickness of Bunker Floor. △1 H2 = Depth for dust extraction, sealing arrangement and operation of level indicator (excluding slab thickness). △2	1726	mm	V1 + V2	0.00	m3	H1= 250 mm Refer Note 2. H2= 1476 mm. Refer Note 3. △2
Type of coal	Worst									
Coal consumption per unit at above mentioned condition	517.00 △2	TPH	*"Mill sizing calculation & Performance Curves" doc no HY-BM-Adani-MS-00* △1	H3 (Height of coal heap in vertical cylindrical portion)	4642	mm	V3	143.46	m3	
Number of active bunkers per unit at above mentioned condition	7 △2	nos.		H4 = (Height of vertical cylindrical portion) △2	10584	mm	V4	713.91 △2	m3	
Number of standby bunkers per unit at above mentioned condition	0	no.		H5 = (Height of conical hopper portion)	11478	mm	V5	286.22	m3	
Storage capacity provided in terms of hours per bunker for above mentioned condition	12.00	hours	*(As per MAH1-E-BTG-BOA-TM-S-I-001, Page 30 of 124 ,Vol II_Section 2_Mechnical.))*	H6 (Flange thickness)	20	mm	V6	0.00	m3	
Bulk density of coal & biomass considered for storage calculation in T/m3	0.775	T/m3	*(Coal density 0.8T/m3 & BIOMASS density 0.55T/m3)*	Total height of bunker, HBO (=H1+H2+H3+H4+H5+H6) △2	**28450**	**mm**	Volume of coal per bunker in m3, V	1144 △2	m3	
Amount of coal per bunker in tonnes	886.29 △2	T		Elevation of bunker outlet flange, LOF as per BHEL- Trichy's Boiler input	29050	mm				
Volume of coal per bunker in m3, V (=Amount of coal per bunker in tonnes / Bulk Density)	1144 △2	m3		Elevation of bunker floor, LTF (=HBO+LOF) △2	**57500**	**mm**				
L1 (Center line of bunker from centre line of mill bay)	384	mm	*BHEL- Trichy's Boiler input. Refer Note 4.*	No. of outlets per bunker	1	no.				
Thickness of parent material in hopper portion (PH)	10	mm	Refer Note 1.	F (Inside Diameter of Bunker Outlet)	914.4	mm				
Thickness of parent material in vertical portion (PV)	12	mm		Angle of repose in degrees, Y1	37.00	degrees				

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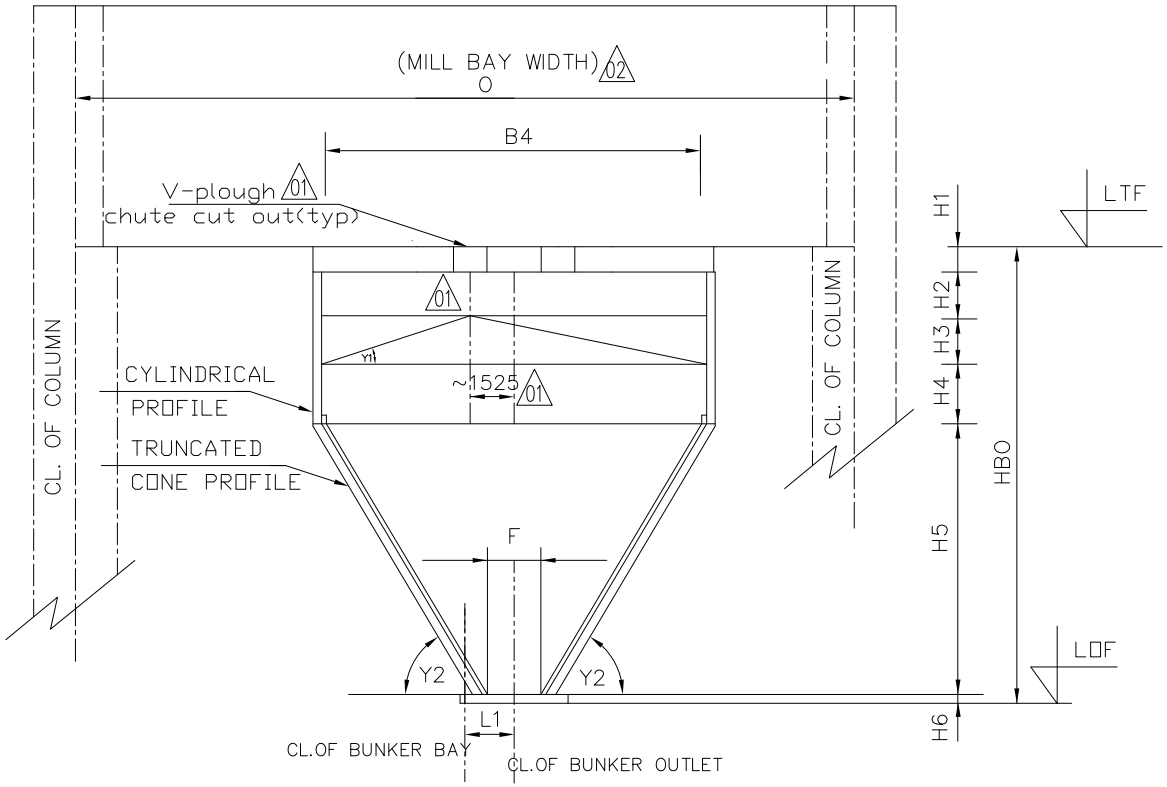
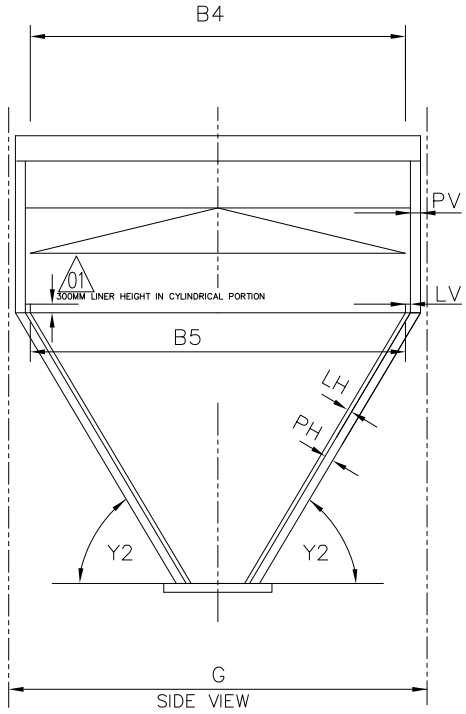
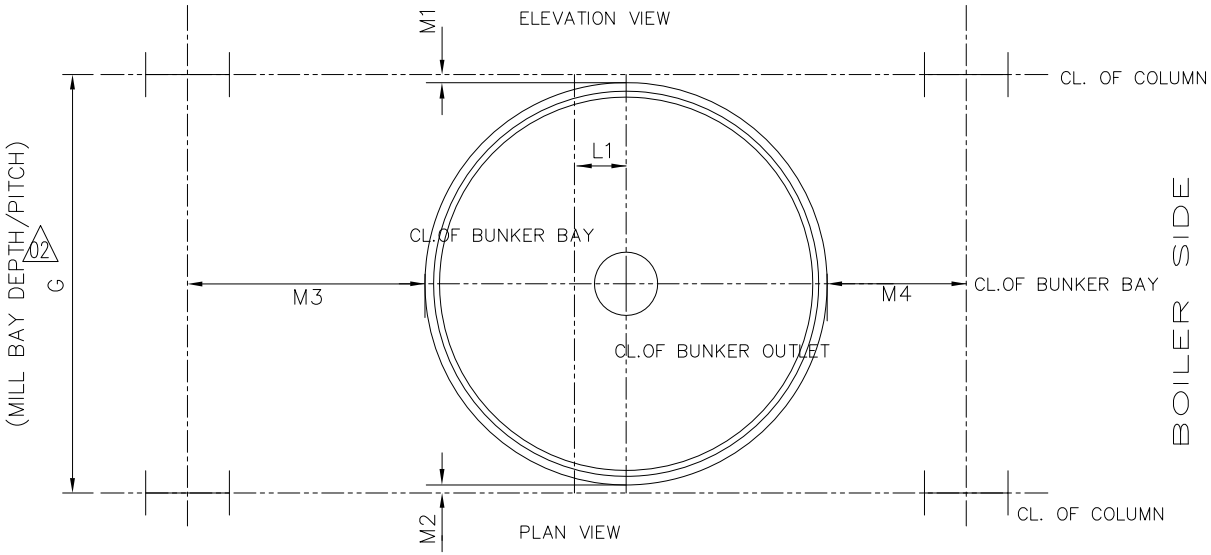
BHEL drawing no PE-DC-504-161-A001 MEL drawing no 552H-E-BTG-BOA-BM-C-V-0002 △2			BUNKER SIZING CALCULATION FOR RAW COAL-CYLINDRICAL WITH CONICAL HOPPER					REV	2	13-10-2023
Description of Item	**Data**	**Unit**	**Remarks**	**Description of Item**	**Data**	**Unit**	**Storage volume of coal (in m3)**		**Unit**	**Remarks**
Type of liner material in hopper portion	SS 304		*(As per MAH1-E-BTG-BOA-TM-S-I-001, Page 30 of 124 ,Vol II_Section 2_Mechnical.)*	Inclination of wall angle considered for bunker in degrees, Y2	70	degrees				
Thickness of liner material in hopper portion (LH) & 300 mm of vertical portion (LV).	5	mm		M1 (Clearance between edge of parent material of bunker and centre line of column)	600	mm				
				M2 (Clearance between edge of parent material of bunker and centre line of column)	600	mm				
O (Mill Bay Width)	13500	mm	*BHEL- Trichy's Boiler drgs "" GA of Boiler Plan A-A drg no 0-00-022-77733"*	M3 (Clearance between edge of parent material of bunker and centre line of column)	2484	mm				
G (Mill Bay Depth/Pitch)	10500	mm	*Lowest of Mill bay depths (10500/11800/11500) considered.* △2	M4 (Clearance between edge of parent material of bunker and centre line of column)	1716	mm				
B4 (=G-[2*(PV)+M1+M2]) (Inside diameter of bunker in vertical cylindrical portion)	9276	mm	Refer Note 4.	**NOTES** **1) Thickness of parent material (PH & PV) shall be as per Civil drawing "BUNKER BAY - G.A. OF BUNKERS & SUPPORTING DETAILS".** **2) Slab thickness of bunker Floor shall be as per Civil drawing "BUNKER BAY - FRAMING PLAN OF bunker FLOOR".** **3) Maximum depth for Dust Extraction System including slab thickness from bunker floor elevation as per drawing " Typical Load Data of Bunker Feeding Floor" .** △2 **4) M/s MEL to note the bunker inside diameter & centreline of bunker for arrangement of V plough.**						
B5 (=G-[2*(PH+LH)+M1+M2]) (Inside diameter of bunker in conical hopper portion)	9270	mm								







02
NOTE: REFER "BUNKER BAY – G.A. OF BUNKERS & SUPPORTING DETAILS" DRG NO PE-DG-504-616-C014 AND "BUNKER BAY – DETAILS OF BUNKERS & SUPPORTING DETAILS" DRG NO PE-DG-504-616-C015 FOR DETAILS OF NUMBER OF PREFABRICATED SEGMENTS OF SUPPLIED ITEMS OF SHELL AND HOPPER & PREFABRICATED SS LINER FOR EACH BUNKER.

PROJECT:	MAHAN ENERGEN LIMITED 2x800MW ULTRA SUPER CRITICAL THERMAL POWER PROJECT MAHAN (PH-II) SINGRAULI, MP
CUSTOMER:	ADANI POWER LIMITED
CONSULTANT:	TATA CONSULTING ENGINEERS LIMITED MUMBAI INDIA
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 504
STATUS CONTRACT
DISTRIBUTION

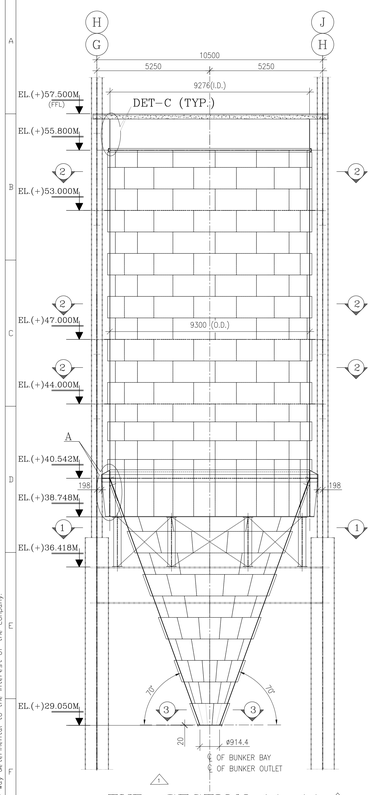
REV.	DATE	ALTD	CHD	APPD

DEPT	NAME	SIGN	DATE
CODE	BRN	VVK	
	DESN	VVK	
M	CHD	RK	
	APPD	RK	

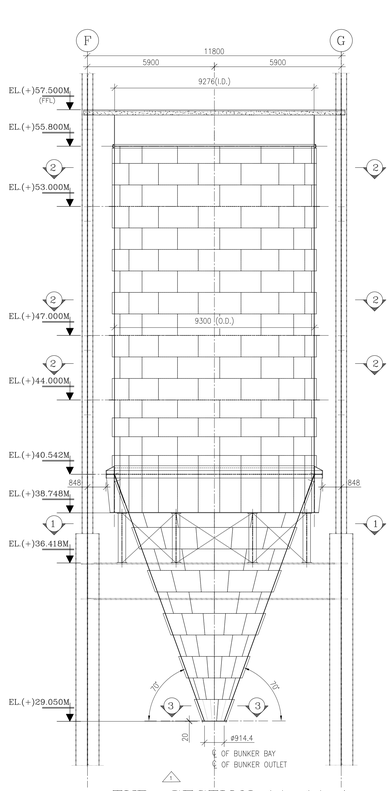
TITLE RAW COAL BUNKER PROFILE

DEPT. SCALE : NTS
SIGN
DRAWING NO. PE-DG-504-161-A001
SHEET 1 1 OF REV 02.
SIZE-A4

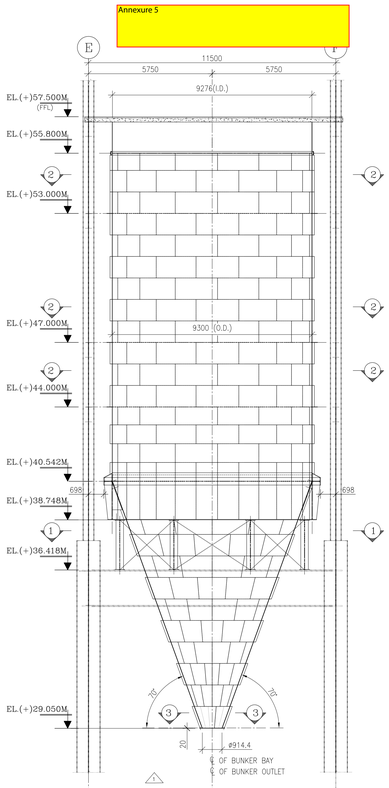
Annexure 5



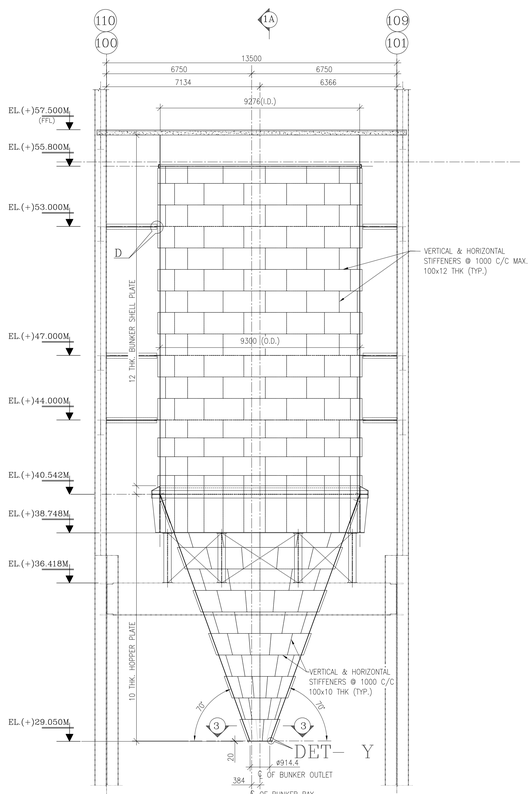
TYP. SECTION 1A–1A (FOR SILO C, D, E, & F)



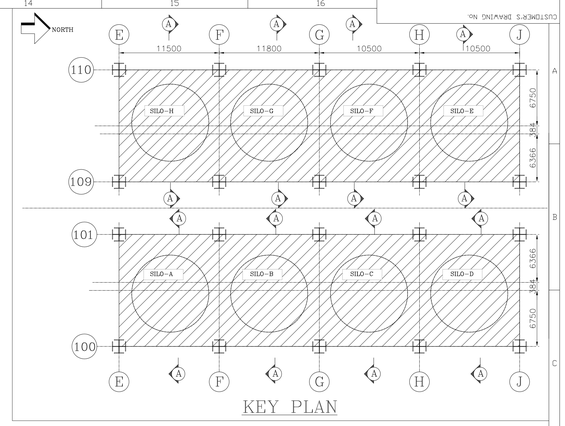
TYP. SECTION 1A–1A (FOR SILO B & G)



TYP. SECTION 1A–1A (FOR SILO A & H)



TYP. SECTION A–A



KEY PLAN

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWING- PE-DG-504-616-C015

TOTAL APPROX. QTY. OF STR. STEEL = 2000.00 MT (APROX.)

PLATE ABOVE 12 THK. SHALL BE OF GR. E350

NOTES:–

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITIONS, SPECIFICATIONS AND SCHEDULE OF ITEMS.
2. ALL ELEVATION LEVELS ARE REFERRED TO THE FINISHED GROUND FLOOR LEVEL OF POWER HOUSE BUILDING AS 0.0M .
3. ALL DIMENSIONS ARE IN MILLIMETRE AND ALL LEVELS ARE IN METRE.
4. PROPER CARE SHALL BE TAKEN IN WELDING OF BUNKER PLATES. HORIZONTAL & VERTICAL JOINTS IN BUNKER & HOPPER SHALL BE SUBJECT TO NDT AS PER FQP.
5. VERTICAL JOINTS IN BUNKER PL SHALL BE STAGGERED.
6. PLATE SHALL BE CUT TO MAX WIDTH TO REDUCE NUMBER OF JOINTS.
7. BEFORE COMMENCING REGULAR FABRICATION OF THE BUNKER TRIAL ASSEMBLY AT SITE OF THE BUNKER INCLUDING HOPPER SHALL BE MADE ATLEAST FOR ONE BUNKER.
8. ALL END CONNECTIONS FOR BRCG SHALL BE DESIGNED FOR FULL TENSILE STRENGTH OF MEMBERS.
9. STAINLESS STEEL LINER IN THE COAL HOPPER & SILO SHALL BE OF 5.0MM THICKNESS OF GRADE AISI 304L FINISH 2B, COLD ROLLED, ANNEALED AND DESCALED (PICKELED) & SKIN PASSED MATERIAL & SHALL BE PROVIDED ON THE INNER FACE OF INCLINED PORTION OF HOPPERS UP TO BOTTOM 300 MM OF VERTICAL PORTION OF SILO, WITHOUT ALLOWING ANY PROJECTIONS IN COAL FLOW PATH.
10. PLUG WELD IN SST LINER PLATE SHALL BE GROUND SMOOTH TO MATCH WITH PLATE PROFILE.
11. ALL BUTT WELD OF BUNKER SUPPORTING STRUCTURE SHALL BE 100% RADIOGRAPHED. ELECTRODE E308L FOR WELD JOINTS BET SST PLATES & E309L FOR WELD JOINTS BETWEEN SST PL & MS PLATE.
12. SPOT RADIOGRAPHY FOR BUTT WELDS SHALL BE CARRIED OUT IN TENSION ZONE AND IN COMPRESSION ZONE AS PER FQP.
13. ALL SITE FILLET WELDS OF BUNKER AND BUNKER SUPPORTING GIRDERS/BEAMS AS PER FQP.
14. ADEQUATE TEMPORARY STIFFENER TO BE PRORATED TO AVOID BUCKLING DISTORTION OF BUNKER STRUCTURE DURING FABRICATION, HANDLING AND ERECTION STAGE.
15. VERTICAL JOINT IN SIDE PLATE SHALL BE STAGGERED.
16. BEAMS MARKED '*' ARE IN BHEL TRICHY SCOPE.

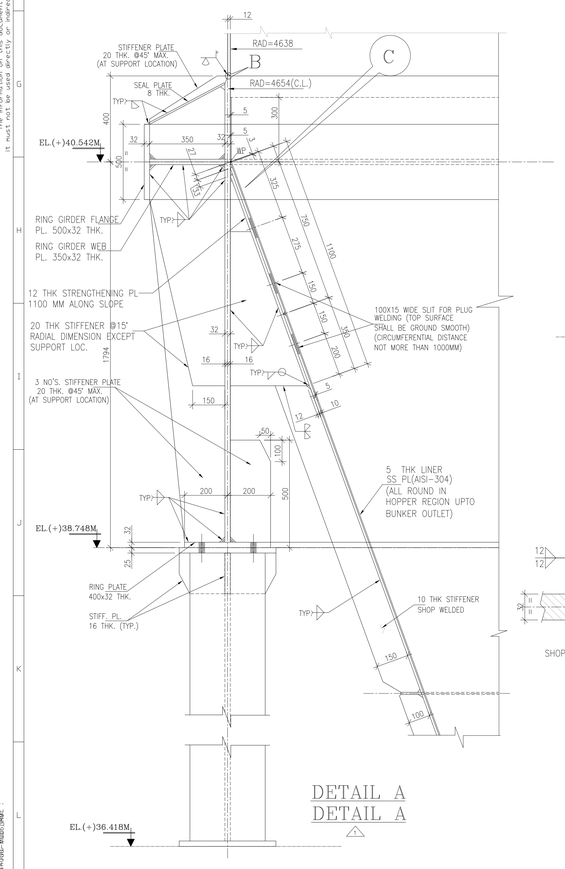
ENGG. REF. DRAWING :–

1. MAIN EQUIPMENT LAYOUT PLAN ----------PE-DG-504-100-M002
2. GA & LOAD DATA OF BUNKER CONVR TRIPPER FLOOR ----------IS-1-GA-699-101-M019/M022
3. G.A. OF BOILER PLAN A-A---------- 0-00-022-77733
4. GENERAL NOTES AND STANDARD DETAILS FOR STRUCTURAL STEEL WORKS ----PE-DG-504-600-C002
5. BUNKER PROFILE---------- CB-2S-R0.

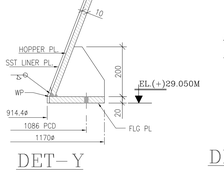
LEGEND :

BOS – BOTTOM OF STEEL
C/C – CENTRE TO CENTRE
℄ – CENTER LINE
EL – ELEVATION
N/S – NEAR SIDE
F/S – FAR SIDE
LVL – LEVEL
TOS – TOP OF STEEL
TYP – TYPICAL
UNO – UNLESS NOTED OTHERWISE

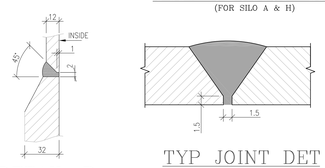
BHEL- PROJECT ENGINEERING MANAGEMENT(CIVIL)			
THIS DRAWING MARKED(✓) IS RELEASED FOR			
✓	COMMENTS/APPROVAL	☐	FABRICATION
☐	PLANNING	☐	INFORMATION
☐	CONSTRUCTION	☐	AS BUILT DRAWING
STAMP ALL PREVIOUS REVISION AS SUPERSEDED			
ISSUED BY			
NAME	PRADEEP PAUL		
SIGNATURE	–sd–		
DATE	22.03.2024		



DETAIL A
DETAIL A

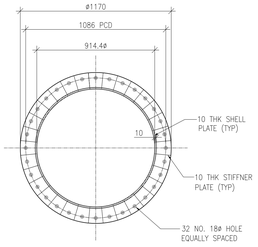


DET-Y

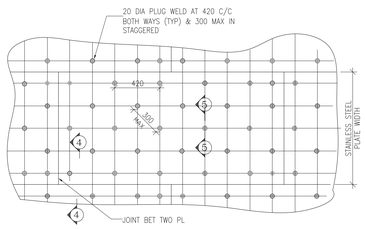


DETAIL-B

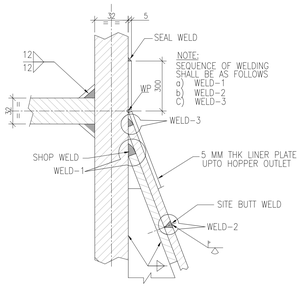
TYP JOINT DET FOR BUNKER PL



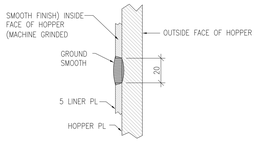
SECTION 3–3



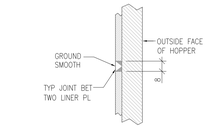
TYP DET FOR FIXING SST LINER PL TO HOPPER PL



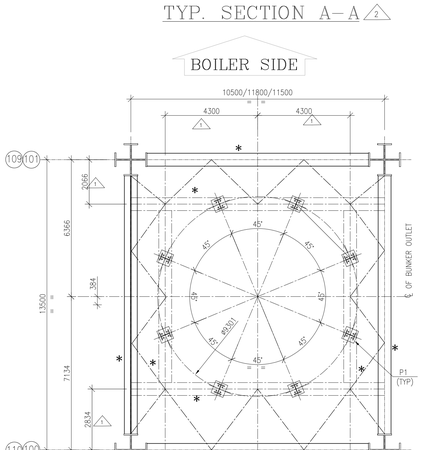
DETAIL-C



SECTION 5–5



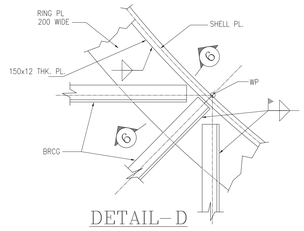
SECTION 4–4



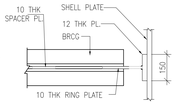
SECTION 1–1

TYP DET FOR BRACING AND BEAM ARRANGEMENT AT BUNKER SUPPORTING LEVEL

'*' BEAM-TRICHY SCOPE



DETAIL-D



SECTION 6–6

REV.	DATE	ALTD	CHD	APPD
2	22.03.24	RP	PP	LALAN

REVISED AS PER LATEST CUSTOMER CHP INPUT AND MARKED AS 1

REV.	DATE	ALTD	CHD	APPD
1	17.01.24	RP	PP	LALAN

REVISED AS PER CUSTOMER COMMENTS,REVISION MARKED AS 1

JOB NO. 504
STATUS CONTRACT
DISTRIBUTION

DEPT CODE		NAME	SIGN	DATE
C	DRN	RPC	–SD–	14.11.2023
	DES'N	P. PAUL	–SD–	14.11.2023
	CHD	LALAN	–SD–	14.11.2023
	APPD	TNSR	–SD–	14.11.2023

OWNER DRAWING NO.–552H–E–BTG–CIV–DC–G–V–0001

PROJECT: MAHAN ENERGEN LIMITED
2x800MW ULTRA SUPER CRITICAL THERMAL POWER PROJECT
MAHAN (PH–II) SINGRAULI, MP

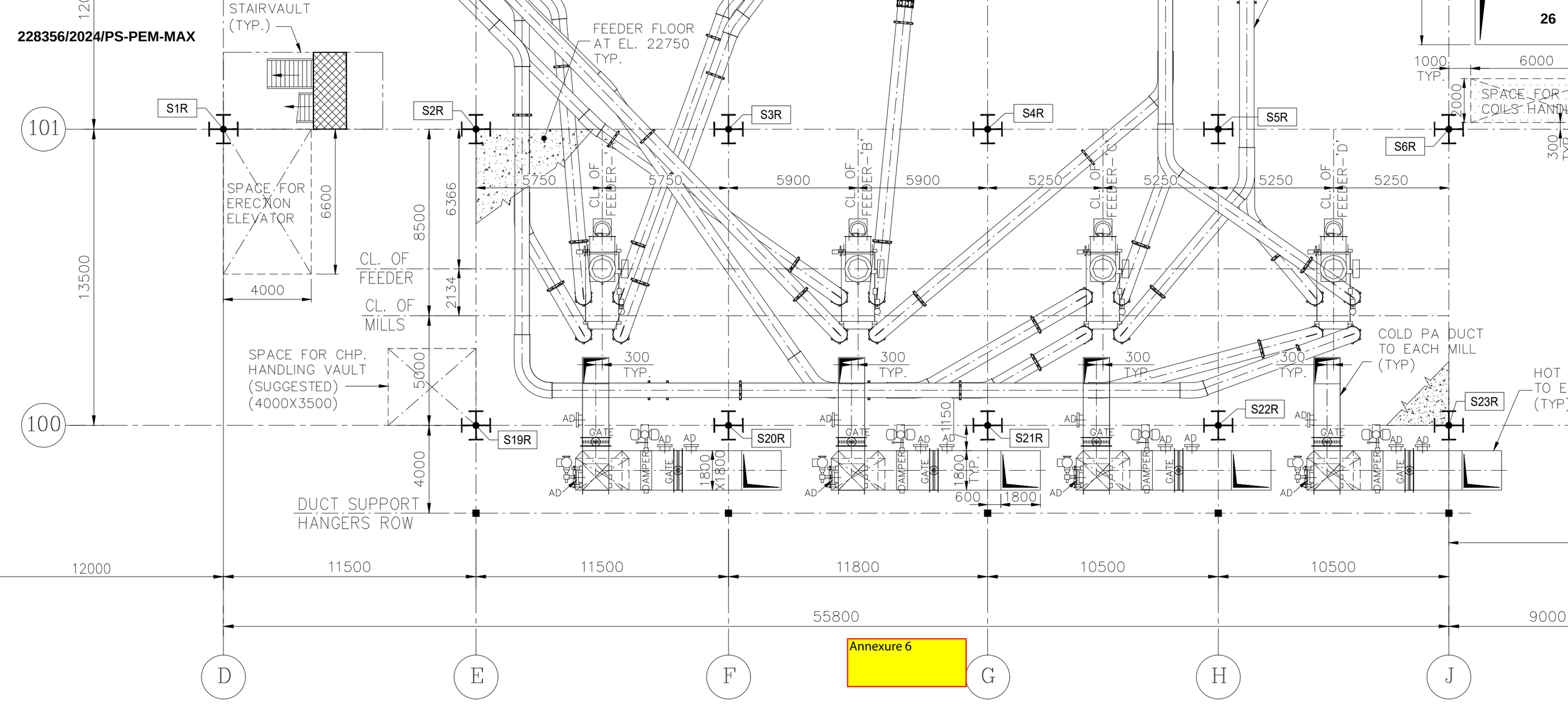
CUSTOMER: adani — ADANI POWER LIMITED

CONSULTANT: TATA — TATA CONSULTING ENGINEERS LIMITED
MUMBAI INDIA

BHARAT HEAVY ELECTRICALS LTD

TITLE: MILL & BUNKER BUILDING
G.A. OF BUNKERS & SUPPORTING DETAILS

DEPT. | SCALE 1:250 | DRAWING NO. PE-DG-504-616-C014
SIGN
SHEET 1 1 OF REV. 2
SIZE-A0



Annexure 6

Typical layout drawing of Feeder floor

General Arrangement of Boiler - Front Elevation (For Feeder floor)

Annexure 7

EL.95144
BOT. OF GIRDER

PLATFORM EL.89900

PLATFORM EL.86650

PLATFORM EL.83300
(MBL-6)

PLATFORM EL.79600

PLATFORM EL.74800

PLATFORM EL.70900

PLATFORM EL.67900
(MBL-5)

64450

PLATFORM EL.60500

PLATFORM EL.57500
(MBL-4)

PLATFORM EL.53000

PLATFORM EL.50000

PLATFORM EL.47000

PLATFORM EL.44000
(MBL-3)

PLATFORM EL.40150

PLATFORM EL.36450

PLATFORM EL.32750

PLATFORM EL.29100
(MBL-2)

PLATFORM EL.22550

EL.17000
LANDING

VENTURIMETER(TYP.)

PLATFORM EL.12000
(MBL-1)

PLATFORM EL.5700

LIFT COLUMN LC1 & LC2 FROM GROUND

ELEVATOR

LIFT COLUMN LC3 & LC4 FROM GROUND

DUST EXTRACTION SYS.

5000

SPACE FOR
COAL TRIPPER

CL. OF BUNKER

9300

7134

6366

HANGER SUPPORT

2134

SUGGESTED
MRS PIPE
SLOT

CL. OF MILLS

EL.4110
MILL MAINT. FLOOR

743

PASSAGE
WAY

MILL BAY FFL.0.0 M

5000

8500

13500

110

109

GENERAL NOTES:-

1. ALL ELEVATIONS ARE WI
CORRESPONDS TO RL(+)
FINISHED GROUND FLOOR
(-)0.150m, WHICH CORR
FINISHED GROUND FLOOR
2. FOR NOTES & LEGENDS

DUST EXTRACTION SYS.

EL.64450
BUNKER BAY ROOF

TRIPPER FLOOR
CLADDING

5000

SPACE FOR
COAL TRIPPER

EL.57500
TOP OF BUNKER FLOOR

CL. OF BUNKER

9300

6366

7134

1150 2600

HOT AIR DUCT
TO MILLS
EL.39600

5000

650

850

1850

COLD AIR DUCT
TO MILLS
2400 1900

EL.30600

3000

EL.29050
BOF.

EL.27200

HANGER SUPPORT

COAL FEEDER

EL.24050

EL.22750
FEEDER FLOOR

2134

MIXED
AIR DUCT
TO MILLS

EL.15000
HANDLG. LEVEL

SUGGESTED
MRS PIPE
SLOT

MILLS
HP-1103
(TYP.)

MILL
HANDLING
ARRGT.

1500 1450X
2438

743X
2438

CL. OF MILLS

2115

EL.2400
MRS

EL.4100
MILL MAINT. PLATFORM

EL.3384
MILL AIR INLET

PASSAGE
WAY

8500

5000

13500

101

100

Annexure 8

Addendum 228

COAL & ASH SPECIFICATIONS FOR 2X800 MW MAHAN ENERGEN LTD. (MEL) - EXPANSION					
Proximate Analysis (ARB)	**UOM**	**Design**	**Best**	**Worst**	**Remarks**
Total Moisture	%	15.00	12.00	17.00	
Ash	%	34.00	29.00	42.00	
VM	%	22.86	24.04	19.00	
FC	%	28.14	34.96	22.00	
Total	**%**	**100.00**	**100.00**	**100.00**	
GCV	**kCal/kg**	**3700**	**4300**	**3200**	
Fuel Ratio (FC/VM)		**1.23**	**1.45**	**1.16**	
Ultimate Analysis (ARB)					
Carbon	%	40.02	45.91	31.31	
Hydrogen	%	2.14	2.69	2.50	
Nitrogen	%	1.64	1.62	1.72	
Oxygen	%	6.75	8.38	4.97	
Sulphur	%	0.45	0.40	0.50	
Total Moisture	%	15.00	12.00	17.00	
Ash	%	34.00	29.00	42.00	
Total	**%**	**100.00**	**100.00**	**100.00**	
Grind ability Index (HGI)		45	50	47	
Other trace elements in coal					
Chlorine	%	0.03	ND	0.003	
Mercury (Hg)	ppm	0.001	0.039	0.20	
As	ppm	0.001	1.02	4.11	
CdO (Cd)	ppm	ND	0.091	34.20	
Cr2O3 (Cr)	ppm	100	27	73.90	
NiO (Ni)	ppm	60	19.35	95.40	
Pb (Lead)	ppm	0.01	ND	115	
Phosphorous (P)	ppm	2982	1229	1717	
Pottasium (K)	ppm	2762	ND	3425	
Flouride as F	%	ND	ND	0.36	
Ash Elemental Analysis - Dry Basis					
SiO2	%	69.36	66.38	57.30	
Al2O3	%	25.09	24.73	31.25	
Fe2O3	%	3.02	4.77	6.36	
CaO	%	0.06	0.98	2.57	
MgO	%	0.36	0.81	0.29	
Na2O	%	0.08	0.04	0.63	
K2O	%	0.08	0.06	0.94	
P2O5	%	0.28	0.07	0.20	
SO3	%	0.20	0.46	0.07	
TiO2	%	1.36	1.62	0.37	
MnO	%	0.04	0.08	0.02	
Others (BaO, SrO, V2O5, ZnO)	%	0.07	ND	ND	
Total	**%**	**100.00**	**100.00**	**100.00**	
Ash Fusion Temperature (Reducing Atmosphere)					
Initial Deformation Temp.	deg. C	1250	1250	1200	
Sphere Temperature	deg. C	-	-	-	
Hemispherical Temp.	deg. C	1300	1350	1250	
Flow Temp.	deg. C	1400	1400	1400	

Noted: Ash Resistivity in the order of 10^13 Ohm-cm and YGP Index - 80 mg/kg

Mahan Energen Limited

BHARAT HEAVY ELECTRICALS LIMITED NEW DELHI PSTG-I

BIOMASS ANALYSIS FOR CO-FIRING IN 2x800 MEL (PHASE-II)

S.N	Description	Values	Remarks
A			
1	% Moist (IM)	4.65	
2	% Ash	17.84	
3	% VM	61.85	
4	% FC	15.66	
	Total	**100.00**	
5	GCV Kcal/Kg	3671	
B			
1	% Moist (TM)	10.15	
2	% Ash	16.81	
3	% VM	58.28	
4	% FC	14.76	
	Total	**100.00**	
5	GCV Kcal/Kg	3459	
6	HGI	60	

Note:

i) Type - Non-Torrefied Agro-Waste Biomass Pellets
ii) Diameter - <=20 mm & Length - 10 to 150 mm
iii) Bulk Density - >= 550 kg / Cu. M
iv) Finess - <= 5%
v) Biomass shall transfered along with Coal through Coal Conveyor.
vi) Biomass Handling Systems shall be excluded from Bidder Scope.
vii) In additional latest CEA guideline issued in October 2021 for co-firing of biomass with coal in the boiler shall be refered

Mahan Energen Limited

BHARAT HEAVY ELECTRICALS LIMITED * NEW DELHI * PSTG-I

- All sumps and sump level controls and instrumentation shall be designed and sized to prevent frequent cycling of sump pumps.

1.4 PIPING, VALVES AND SPECIALITIES

The Contractor is responsible for the design, supply and construction of all piping equipment and accessories which must be in accordance with the latest editions of the specified standards. The requirement of Indian Boiler Regulation (IBR) shall be complied with as far as applicable.

The basic and detailed design of all pipework and related components must be carried out by the Contractor in such a way that there is good coordination and cooperation between the Contractor, the sub-contractors and the Owner.

The Contractor is responsible for ensuring that no mistake is made with regard to the materials used either in the workshop or during erection on site. This applies especially to pipes from which the material marking put on at the pipe mill and / or workshop is removed by such processing as bending, forging etc. In case of doubt the Contractor is responsible for suitable quality checks.

All pipe components manufactured by the Contractor and parts on which he has worked, are to be marked clearly with an item number and material marking, this marking shall be permanent.

For reasons of easy availability in India for future replacement, ANSI / ASTM materials and dimensional standards are preferred.

Secondary steel (Channel, Angle, etc) for pipe supports, Anchor fasteners, Anchor Plates, MS Plates for Saddles, U-Clamps, Bolts, Nuts & Gasket, Companion Flanges, etc shall be considered in the piping system and at all terminal points in the scope of EPC Contractor.

1.4.1 Design Criteria

The pipework shall be designed and erected in accordance with the American National code for Pressure Piping ANSI B31.1 'Power Piping' or an expressively approved equivalent standard and Indian Boiler Regulations wherever applicable.

The present specification will prevail against that of the code whenever the former is more restrictive.

The following approximate flow velocities should not be exceeded:

Type of Pipework	**Max. Flow Velocity**
Condensate Lines	
Pump suction lines (without feed water suction line)	1.5 m/s
Water discharge lines	2.5 m/s
Water Lines	

Water suction and discharge lines	2 m/s
Air Lines	
Delivery line for reciprocating compressors	20 m/s
Suction and delivery lines for rotary compressors	15 m/s
Suction line for reciprocating compressors	20 m/s
Oil Lines	
Lubricating oil lines and fuel oil suction lines	1.0 m/s
Fuel oil supply lines (preheated)	1.5 m/s
Diesel fuel lines	1.5 m/s

All rules of the art considering technical and economic parameters shall be carefully followed, namely:

- For lines conveying liquids the design pressure must be equal to maximum operating pressure which the system can be subjected to during its lifetime including the pressure reached during transients (water hammer.)

- The calculation of the pipe work shall consider also the highest possible temperature that can occur during any mode of operation together with the highest corresponding pressure.

- In addition to the required wall thickness in accordance with calculations a corrosion allowance of 3 mm must be added for unprotected water lines where corrosion is to be expected.

- Proper care shall be taken for thermal expansion of pipe systems.

- Expansion joints shall not be used in steam systems with operating pressures above
  500 kPa (g).

- For all systems subject to thermal expansion of pipe size larger than DN 100 the pipe manufacturer shall submit the necessary test certificates.

- All piping, fittings, valves, secondary steel supports and any special items etcshall be provided with painting conforming to C4 Environment Class as per Painting Specification attached with this tender.

- Piping shall be hydro-tested at 1.5 times of design pressure.

- Underground piping shall be provided with wrapping & coating and top of pipe shall be kept min 1.0M below finished ground level. Pipe shall be concrete encased below road.

- Mitre Fittings shall be provided as per AWWA C208.

- All piping systems shall be properly designed to take care of hydraulic shocks and pressure surges which may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolts, etc. for the safeguard of the piping systems under above mentioned conditions. External and internal attachments to piping shall be designed so as not to cause flattening of pipes, excessive localised bending stresses or harmful thermal gradients in pipe walls.

- All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting structural members, equipment etc. Adequate clearance shall be ensured with respect to the above to accommodate pipe movement.

- The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance.

- Piping shall generally be routed above ground but where specifically indicated/approved by the Engineer the pipes may be arranged in trenches or buried. Bidder shall provide either coal tar and Bitumen tapes on conventional coat and wrap system for corrosion protection of buried piping as per relevant codes and standards.

- All rubber lined pipes/fittings shall be seamless or bead removed ERW pipes. However, for ERW pipes the inside surface shall be completely debeaded and made suitable for lining.
-
- All rubber lined pipes shall have flanged joints for the applicable piping system.

1.4.2 Guidelines for the Design and Construction of Valves

For reasons of plant standardization the Contractor shall standardize the valves, to reduce number of types and manufacturers to a minimum.

Design, construction, fabrication and testing of the valves shall be in accordance with the applicable standards. The requirement of this clause will apply if they are more stringent than the approved standards. All valves shall be suitable for the media and for the service conditions and those performing similar duties shall be interchangeable. All valves shall conform at least with pressure class 150 according to ANSI B16.5 or equivalent. All Valves must meet the maximum design demands for pressure and temperature of the joint piping system. All valves must bear 1.5 times of the maximum design pressure. for hydro-test of body and 1.1 times of design pressure for seat.

Basically the following types of valves shall be used:

Type	Liquid			Special Applications
	(Water, Oil, etc)	Corrosive (Acid, Alkaline, etc)	Slurry Line	
Globe – Straight pattern	Yes	No	No	
Globe – Angle	Yes	No	No	

Type	Liquid			Special Applications
	(Water, Oil, etc)	Corrosive (Acid, Alkaline, etc)	Slurry Line	
pattern &Oblique pattern				
Globe – Multiport pattern	Yes	No	No	
Piston	Yes	No	No	
Parallel Gate - Conventional	Yes	No	No	Less pressure drop
Parallel Gate – Conduit gate	Yes	No	No	Water with sludge or debris
Parallel Gate – Knife gate	Yes	No	No	
Wedge gate – with bottom cavity	Yes	No	No	
Wedge gate – without bottom cavity (rubber seated)	Yes	Yes	No	
Plug – Lubricated & Non lubricated	Yes	Yes	No	
Plug – Eccentric/Lift plug	Yes	Yes	Yes	
Ball	Yes	Yes	No	
Butterfly	Yes	Yes	No	
Pinch	Yes	Yes	Yes	Powder as the nature of fluid
Diaphragm – weir type/ Straight through	Yes	Yes	Yes	No

If the media handled are polluted the shut off devices used in discharge lines (e.g. drains on vessels) and possibly also in vent lines should consist of gate valves.

The maximum permissible forces for actuation hand wheels are 300 N for wheels with diameter upto 400 mm and 600 N for larger diameters. Differential pressures requiring higher forces for actuation of hand wheels will entail fitting the valve with gears. For calculation of the gears or all other actuators the design pressures shall be taken as differential pressures. Large valves that are frequently operated or hard to operate manually shall be motorized.

Where required, valve spindles shall be lengthened so that the hand-wheel is at a minimum height of 1 metre above the level of the floor. Where necessary they shall

be provided with headstocks and pedestals of rigid construction. The actuation of valves by means of chain drives is not permissible.

All valves shall be closed by rotating the hand wheel in clockwise direction. The face of each hand wheel shall be clearly marked 'open and 'shut', with arrows indicating the direction of rotation to which each term refers.

Plastic or bakelite valve hand wheels will not be accepted. Valves with solid hand wheels are not acceptable since all valves must be capable of being locked by means of a chain and padlock in the open and closed position.

Outdoor valves must be suitable for outdoor installation with due consideration of the special climate and environmental conditions at the site.

Unless otherwise agreed, all valves shall be fitted with the spindle in the vertical position preferably. Eye bolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

Materials used must conform to the applicable standards and must comply with the pipe material and the requirements due to operating temperature. Materials for screws, bolts and nuts must have the operating temperature limits closely observed.

All valves of the relevant pipework systems must be suitable for pickling.
In no case will grey cast iron be allowed.
Unless otherwise required by virtue of the valve's function, bodies shall have an internal cross section corresponding to the nominal diameter of the connection.

Gate valves and swing check valves of the H.P. piping systems shall be equipped with self-sealing lid covers. Gate valves with self-sealing lid covers shall be equipped with a safety device at the body. If discs are used they must be capable of being dismantled and changed under operating conditions.

Connecting flanges shall be in accordance with the applicable standards with regard to both the connection dimensions and the minimum thickness of the material.

The transition from the flat rear surface of the flange (nut contact faces) to where the welding begins must have no sharp-edged machined grooves.

The stem must be made in one piece; the length of thread must be such that the threaded bush is fully engaged in any position of the moving part. The connection between the stem and the cone must be sufficiently flexible. For H.P. globe valves and globe valves for throttling purposes of DN 50 or less the spindle and cone must be made in one piece. Disc must have parabolic characteristic

In case of metallic sealing elements the difference in hardness between the body seat and the seat of the sealing element must be equal to or more than 30 HB (Brinel hardness), the seat element having the higher hardness values.

All globe valves shall be equipped with throttling cones with parabolic characteristics.

Each valve shall be marked on the body with the material diameter, the nominal pressure and an arrow showing the flow direction whenever only one is possible.

Drain lines shall be installed at each low point or condensate collecting point in each steam- installation shall include a permanent strainer, upstream and downstream isolation valves and a globe valve as free drain. Steam traps shall be of the bimetallic or thermodynamic type, selected to suit the service conditions.

No traps which incorporates internal screens or check valves shall be used unless specifically required by the specifications or approved by the Owner.

Condensate drainers shall be of the ball-float type.

For safety valves, pressure relief valves, bursting discs and other safety devices against excess pressure the directives of appendix II of the code ANSI B31. 1: 'New Mandatory Rules for the design of Safety Valve Installations' shall apply, as well as requirements of Indian Boiler Regulations (IBR) wherever applicable.

1.4.3 Materials requirements for Piping Components and Valves

The main materials and special requirements specified under this title shall be seen as the minimum requirement.

The following guideline represents minimum requirements. In case of intended deviations 'Deviation from Enquiry Documents' applies.

Fittings shall be provided as per piping material specification/ pressure rating. Elbows, Tees, Reducers shall be as per ASME B16.9 and Companion Flanges shall be as per ASME B16.5/ AWWA C207 CL.D or equivalent international standard.

Piping	**Main Materials acc to ASTM Standard**		**Special**
System	**Piping Components**	**Valves**	**Requirements**
Demineralized water	A 312 Grade TP 316L or equivalent	A 182 Grade F 316 L or A351 Grade CF 8M or equivalent. Sealing elements: (disc and seat) as body material.	Valves - kind of connection: flanged - stem: rising - bonnet connection: flanged
Plant Air Compressor	DN<12 copper DN>12 A53 Grade B galvanized/ IS 1239 (Heavy Grade)/ – Galvanized / IS 3589 Grade 410 (End connection: Flanged or Screwed Socketed)	A 182 Grade F 316 L or A351 Grade CF 8M or equivalent. Sealing elements: (Disc and seat) as body material.	Piping components and Valves -kind of connection: screwed upto max. DN 50 or flanged
Cooling water and Aux. cooling water	A 53 Gr. A or equivalent (End connection: Butt Welded or Socket Welded or flanged)	A 105, A 216 Grade WCB or equivalent Inside the minimum required suitable paint shall be considered to suit the system requirement.	Piping components and valves - kind of connection: flanged Valves: In the case of Butterfly valves the disc must be double eccentrically supported.

Piping	Main Materials acc to ASTM Standard		Special
System	Piping Components	Valves	Requirements
Fuel oil and hydrazine dosing lines	A 53 Grade A or equivalent (End connection: Butt Welded or Socket Welded)	A 105 or A216 Grade WCB or equivalent. Sealing elements (disc and seat) materials with a minimum Cr. content of 13%. Hardness³250 HB in case of auxiliary cooling water the sealing of rubber or equivalent suitable for the service	Valves - kind of connection butt welding ends for valves with rubber elements. - stem: rising - hand wheel; non rising - bonnet connection: flanged.
Lines for dosing additives such as Trisodium Phosphate solution, Ferrous sulphate solution	A 312 Grade TP 304 or equivalent	A 182 Grade 304, A 351, CF 8 or equivalent	Valves with butt welding ends.

General Requirements for Valves, Gates and Strainers

In case owner desires, the experience list/feed back from the users shall be made available to owner for any or all the equipment's during the detailed engineering phase.

Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the contractor.

Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.

The various equipments shall be installed so that they are easily approachable for the operating and maintenance personnel. Generally Valves shall be located about 1.2 metre to 1.5 metre from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.

However valves which are provided (in the burried pipe line) with a valves chamber shall have manual operator/Handwheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.

Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.

The Line list for pipe/valve/any specialties shall be submitted or made available by the bidder during the detail engineering as a consolidated document. Which should include all the relevant information like Service Description, KKS number if any,

Design/Operating Pressure, Design/Operating Temperature, flow End Connection, Material, Valve Class, Pipe Size x Thk. (Avg & Min.), Governing Std., Hydrotest pressure, Insulation material, Insulation Density, Insulation thk., Cladding material, Cladding Density, Cladding thk. for applicable systems along with reference P&ID & reference layout dwg no.

1.4.4 Thermal Insulation

The insulation shall be installed in accordance with the recommendation of the British Standard Code of Practice CP3005, 1969 or equivalent.

Special attention shall be paid to the ease of maintenance of each part of the plant and straightforward access to insulated components requiring maintenance should be possible.

Insulation shall be provided for heat conservation, for personnel protection and for the prevention of condensation.

The basis for economic calculation of thermal insulation thickness shall be a surface temperature of 60°C at an ambient temperature of 40°C and at a wind velocity of 1 m/s.

Insulation for personnel protection shall be such that surface temperatures do not exceed 60°C.

Insulation for condensation prevention shall be applied to equipment operating at temperatures below the maximum dew point, where condensation could form to the detriment of plant structures or equipment or cause discomfort to operating personnel.

Only mineral fibre mats shall be used. Asbestos is not allowed to be used for insulation.

The mats must be stable in shape, chemically inert, free of sulphur and alkali, resistant to water and steam; non-flammable and capable of withstanding continuous exposure to the pipe design temperature. The insulating mats used for insulation of stainless steel equipment shall have a chloride content of less than 0.15%.

The density of mineral wool mats shall be not less than 100 kg/m3 under a loading of 100 kg/m2.

The nominal thickness of the mats must be stated on the mats by the manufacturer.

The thermal conductivity of the material at 100°C shall not exceed 0.055 W/m2.

All insulated equipment shall be provided with a jacket of aluminium sheeting outdoor, galvanized sheeting indoor, which must have the following minimum thicknesses:

Outer insulation diameter up to 350 mm	Sheet thickness 0.8 mm
Outer insulation diameter above 350 mm	Sheet thickness 1.0 mm
Tanks and other large equipment	Sheet thickness 1.2 mm

Annexure 11

Vendor's Name & Address:	**MANUFACTURING QUALITY PLAN**	Document No.
	Customer : Project : Product : COAL DE-BLOKING DEVICES FOR COAL BUNKER	Rev.: Date : Page 1 of 3

SL NO	COMPONENTS	CHARACTERISTICS	CLASSIFICATION	TYPE OF CHECK	QUANTUM OF CHECK 6		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*D	AGENCY			REMARKS
					M	C/N					M	C	N	
1	2	3	4	5			7	8	9	10				11
1.0	**RAW MATERIALS & BOUGHT OUT ITEMS**													
1.1	Plates for Shell & Dished End	Composition Chemical & Physical	Major	Review of TC	100%	100%	Approved Drawing		MTC	✓	V	V	V	MILL TC Document Review
1.2	BOI Items including SOV (As per GA Drawing)	Make, Type, Size Rating	Major	Visual Inspection, Verification	100%	100%	Approved Drawing		TC	✓	V	V	V	Document Review
2.0	**INPROCESS INSPECTION**													
2.1	QUALIFACTION	WPS/PQR/WPQ		Procedure/Qualification		-	ASME SEC XI	ASME SEC XI	Document		V	V	V	
2.2	Cutting, Edge, Preparation, Rolling, Fitting	Fit-up	Major	Visual	100%		Approved Drawing	Approved Drawing		-	P	V	V	Review of Reports
2.3	Welding of Joints (Cir seam& Long seam)	Weld soundness	Major	DP Test	100%	-	Approved Drawing	Approved Drawing	Report	✓	P	V	-	
3.0	**FINAL INSPECTION & TESTING**													
3.1	Dimension & Visual Air blaster & Pneumatic Panel	Dimensional Conformity	Major	Visual & Dimension	100%	25%	Approved Drawing	Approved Drawing	Report	✓	P	W	W	Review of Reports

LEGEND:
P: Perform, W: Witness, V: Verification. Under the Columns M/C/N, vendor to indicate,
M: Manufacturer C: BHEL / BHEL nominated Inspection Agency, N:
Customer(, MTC-Mill TC , IR- Internal Inspection ,DP- Dye Penetrant test
* For items marked ✓ (Tick) under column 'D', Test Certificates shall be submitted to BHEL for records.

PREPARED BY
VENDOR'S SIGNATURE & STAMP

CHECKED BY
BHEL'S SIGNATURE & STAMP

APPROVED BY
CUSTOMER'S SIGNATURE & STAMP

Vendor's Name & Address:	**MANUFACTURING QUALITY PLAN**	Document No.
	Customer : Project : Product : COAL DE-BLOKING DEVICES FOR COAL BUNKER	Rev.: Date : Page 2 of 3

SL NO	COMPONENTS	CHARACTERISTICS	CLASSIFICATION	TYPE OF CHECK	QUANTUM OF CHECK 6		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*D	AGENCY			REMARKS
					M	C/N					M	C	N	
1	2	3	4	5			7	8	9	10				11
3.2	Leakage Test of Air Blaster	Hydro Test	Major	Visual	100%	25%	Approved Drawing	Approved Drawing	Test Report	✓	P	W	W	Review of Reports
3.3	Pneumatic Test /function Test	Pneumatic Test/function Test with Pneumatic Panel	Major	Visual	100%	25%	Approved Drawing	Approved Drawing	Test Report	✓	P	W	W	Review of Reports
4.0	**SURFACE PREPARATION & PAINTING**													
4.1	Painting	Visual & Measurement DFT	Major	Visual	100%	-	Approved Drawing	Approved Drawing	COC	-	P	W	V	
5.0	**PRESERVATION & PACKING**													
5.1	Packing	Visual	Major	Visual	100%	-	As per PO/Specification	As per PO/Specification	List/COC		P	V	-	Photographs

Notes:

1. Drawing / Data Sheet / Specification shall prevail over Quality Plan in case of any contradiction.
2. Latest revision of Drawing / Specification shall be applicable.
3. Pre-dispatch inspection photograph of item shall be included in the quality documentation.
4. BHEL reserves the right for conducting repeat test, if required.
5. BHEL approved inspection engineers to be deployed for inspection.
6. Only Level II & above qualified person in respective NDE (as applicable as per PO) to verify or witness the NDT test report/results.
7. Inspection to be offered only after ensuring that all documents (Quality Plan, Drawings, Data Sheet, MTC, Purchase Specifications, etc) are available as per Purchase Order.
8. Vendor to offer Original Test Certificates. In absence of MTC , test shall be carried out from NABL approved laboratory.
9. Vendor to ensure with TPIA that a note ' Compared with Original Test Certificate. Reviewed, Verified and found in order ' shall contain with every Inspection Report.

LEGEND:
P: Perform, W: Witness, V: Verification. Under the Columns M/C/N, vendor to indicate,
M: Manufacturer C: BHEL / BHEL nominated Inspection Agency N: Customer , MTC- Mill TC , IR- Internal Inspection ,DP- Dye Penetrant test
* For items marked ✓ (Tick) under column 'D', Test Certificates shall be submitted to BHEL for records.

PREPARED BY	CHECKED BY	APPROVED BY
VENDOR'S SIGNATURE & STAMP	BHEL'S SIGNATURE & STAMP	CUSTOMER'S SIGNATURE & STAMP

Vendor's Name & Address:	MANUFACTURING QUALITY PLAN	Document No.
	Customer : Project : Product : COAL DE-BLOKING DEVICES FOR COAL BUNKER	Rev.: Date : Page 3 of 3

SL NO	COMPONENTS	CHARACTERISTICS	CLASSIFICATION	TYPE OF CHECK	QUANTUM OF CHECK 6		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*D	AGENCY			REMARKS
											M	C	N	
1	2	3	4	5	M	C/N	7	8	9	10				11

10. Only valid and calibrated measuring instruments and equipment shall be used.
11. Vendor to ensure that Material Test Certificate & Traceability Records are available for use of correct material.
12. Qualification of equipment, process & personnel for special Processes like welding, brazing, painting & metal coating etc.(as applicable as per PO) shall be ensured.
13. Vendor to ensure that all certificates are endorsed by TPIA with comments (Witnessed or Verified), as applicable per quality plan.
14. Vendor shall ensure to offer log sheets containing actual measured values instead of saying OK/Not OK to TPIA.
15. Vendor shall submit complete Inspection and test documentation whichever is identified with (√) under column-D of approved quality plan shall be enclosed with the Inspection Report.
16. Vendor shall submit Original copies of all inspection and test documents authenticated by TPIA.

LEGEND:
P: Perform, W: Witness, V: Verification. Under the Columns M/C/N, vendor to indicate,
M: Manufacturer C: BHEL / BHEL nominated Inspection Agency N: Customer MTC-Mill TC , IR- Internal Inspection ,DP- Dye Penetrant test
∗ For items marked ✓ (Tick) under column 'D', Test Certificates shall be submitted to BHEL for records.

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Annexure 12

TECHNICAL SPECIFICATION
FOR
PAINTING & COATING
OF
EQUIPMENT & STRUCTURES

CONTENTS

1.0 INTRODUCTION

1.1 Scope

This specification covers the minimum requirements governing surface preparation, selection, application & inspection of the protective coating system to be used on the interior and exterior exposed surfaces of all types of structural steel placed in thermal power plant to get high durability (above 15 years) in C5-M, C-4 & C-3 environment classified according to ISO 12944- 2.

Individual equipment specifications and /or drawings, when furnished, are to be used withthese specifications. If conflict exists, the individual specifications and/or drawings shall govern.

Since maintenance –painting requirements are usually different from that necessary for newconstruction, salient points for each will likewise be addressed separately.

1.2 Definitions

The following definitions shall apply:

COMPANY	shall mean Adani or the designated representative.
CONTRACTOR	shall mean the party contracted to perform the work in accordance withthe drawings, specifications & work scope.

2.0 CODES AND STANDARDS

2.1 Mandatory Statutory Requirements

This document has been prepared to the International Standards detailed within. The CONTRACTOR shall ensure that the Work is executed in accordance with internationalstandards, Statutory & Regulatory requirements as per system application.

2.2 Codes and Standards & Regulations

The requirements of the latest published versions of the following listed Codes, Recommended Practices. Specifications and standards shall be meet

2.2.1 Steel Structure Painting Council (SSPC)

SSPC-PA1	:	Shop, Field and Maintenance Painting of Steel.
SSPC-PA2	:	Measurement of Dry Coating Thickness with Magnetic Gauges
SSPC-SP1	:	Solvent Cleaning
SSSC-SP2	:	Hand Tool Cleaning
SSPC-SP3	:	Power Tool Cleaning
SSPC-SP5	:	White Metal Blast Cleaning

SSPC-SP6	:	Commercial Blast Cleaning
SSPC-SP7	:	Brush –Off Blast Cleaning
SSPC-SP10	:	Near White Blast Cleaning
SSPC-SP11	:	Power Tool Cleaning to bare metal
SSPC-SP12	:	Surface Preparation & cleaning of Steel and Other Hard Material by High and Ultra High Pressure Water Jetting Prior to recoating
SSPC-AB1	:	Mineral and Slag Abrasive
SSPC-SP20	:	Zinc rich coating Type-I (Inorganic) & Type-II (Organic)
SSPC-SP COM:		Surface Preparation and Abrasives Commentary, SSPC Painting Manual, Volume 2, "Systems and Specifications"
SSPC VIS-1	:	Visual Standard for Abrasive Blast Cleaned Steel
SSPC Vol.2	:	SSPC Painting Manual. Other equivalent Swedish, BS standard also applicable.

2.2.2 American Society for Testing and Materials (ASTM)

ASTM D4228:		Standard practice for qualification of coating Applicators for application of coating on steel surfaces.
ASTM B117	:	Salt Spray Test
ASTM G50	:	Standard practice for conducting atmospheric corrosion test
ASTM G53 (Part-B):		Weathering Test
ASTM D520	:	Zinc Dust (Metallic Zinc Powder)
ASTM D523	:	Specification for Gloss
ASTM D1200:		Viscosity
ASTM D1640:		Drying time
ASTM D1653:		Standard test method for evaluation of painted or quoted specimens subject to corrosive environment.
ASTM D2247:		Relative Humidity Test
ASTM D2697:		Volume of Solids
ASTM D4060:		Abrasion Resistance of Coating
ASTM D3359:		Standard test method for measuring adhesion by tape test
ASTM D5894:		Standard test method for evaluating drying or Curing during film. Corrosion resistance under Cyclic condensation/UV

2.2.3 Indian Standards

IS 5	:	Colours for Ready Mixed Paints and Enamels

2.2.4 International Standards Organization

ISO –8501	:	International Standard for Preparation of Surface
ISO-8502	:	Preparation of steel substrates before application of Paints & related products
ISO-8502 (1 to 10)	:	Tests for the assessment for surface cleanliness
ISO –8504	:	Preparation of steel substrates before application of Paints and related products-Surface preparation method Part – 1, 2 & 3
ISO 14713	:	Protection against corrosion of iron and steel structure-Zinc and aluminum coating.
ISO 4624	:	Adhesion test of paint
ISO 12944	:	Corrosion protection of steel structure by protective paint system part 1 to 8
ISO 4628	:	Evaluation of degradation of paint coating
ISO 4628-6	:	Paints & varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity & size of common types of defect - Part 6: Rating of degree of chalking by type method.

2.2.5 Occupational Safety and Health Act

OSHA : Occupational Safety and Health Act

2.2.6 NACE Standards

NACE RP0188:	Discontinuity (Holiday) Testing of Protective coating
NACE RP0287:	Surface profile Measurement of abrasive blast Cleaned steel surfaces using a replica tape.

2.2.7 RAL COLOUR CHART

3.0 SURFACE PREPARATION

3.1 General

The surface preparation procedures and requirements except for galvanizing and Cadmium plating shall be in accordance with Steel Structural Painting Council SSPC and ISO–8501.

The method of surface preparation used shall be compatible with the priming coat of Paint and be one or a combination of the following:-

1. Solvent Cleaning- SSPC-SP1
2. Hand Tool Cleaning - SSPC-SP2

3. Power Tool Cleaning - SSPC-SP3
4. Blast Cleaning refer 3.2 as below

All fabrication and assembly shall be completed before surface preparation begins.
Blast and prime of structural items prior to assembly will be permitted. All bolt holes shall be drilled and their edges smoothed prior to blasting.

3.2 Requirements of Blasting

Only dry blasting procedures are allowed. Definitions and requirements for, the various methods of surface cleaning are given below:

A) White Metal Blast: As per SSPC SP5, & visual reference Sa3 as per ISO 8501-1.
B) Near-White Blast: As per SSPC SP10, & visual reference Sa2.5as per ISO 8501-1.
C) Commercial Blast: As per SSPC SP6, & visual reference Sa2 asper ISO 8501-1.
D) Brush-off Blast: As per SSPC SP7, & visual reference Sa1 as per ISO 8501-1

3.3 Pre Blasting preparation

3.3.1 Rough Edges

Sharp edges, fillets, corners and welds shall be rounded or smoothened by grinding (minimum radius 2 mm).Hard surface layers (e.g. resulting from flame cutting) shall be removed by grinding prior to blast cleaning.
All surfaces should be washed with clean fresh water prior to blast cleaning.
Any major surface defects, particularly surface laminations or scabs detrimental to the protective coating system shall be removed by suitable dressing. Where such defects have been revealed during blast cleaning, and dressing has beenperformed, the dressed area shall be re-blasted to the specified standard. Surfacepores, cavities etc. shall be removed by suitable dressing or weld repair.

3.3.2 Weld Flux and Spatter

Weld flux, slag spatter, slivers etc. shall be ground smooth before blasting.
Welding surface imperfections shall be removed and surface profile shallbe prepared as per ISO 12944-3.

Any surface on which grinding is done shall be spot blast cleaned orpower tool cleaned to obtain required anchor pattern.
All welds shall be inspected and if necessary repaired prior to final blastcleaning of the area.

3.3.3 Surface Cleaning

Prior to blasting, all deposits or grease or oil shall be removed from thesurface in accordance with SSPC-SP1 Solvent Cleaning usingbiodegradable water soluble cleaner.

3.3.4 Chemical Contamination

All chemical contamination shall be neutralized and/or flushed off prior to any other surface preparation.

3.4 Blasting Operations

3.4.1 Weather conditions

Blast cleaning shall not be done on any surface that is moist, or that may become moist, before the application of a primer.

Blasting is not permitted when:-

a) The temperature of steel is less than 3°C above the dew point, as measured by a sling hydrometer,
b) The relative humidity of the air is more than 60 %.

Relative humidity shall be maintained by an adequately designed Dehumidification systemand the record shall be maintained.

3.4.2 Preliminary Blasting

If blasting is performed at night, the surfaces shall be re-blasted the following day to provide the specified surface preparation standard and the anchor profile required for the specified coating system.

3.4.3 Blasting and Painting

Blasting shall not be done adjacent to painting operations or coated surfaces that are not fully dry. Blasting shall overlap previously coatedsurfaces by at least 150 mm.
Blasting and Painting shall be done in closed chamber only.
The record of atmospheric conditions (Temp, RH, Due Point) before the blasting & painting shall be maintained.
The use of silica sand is strictly prohibited

3.4.4 Post – Blasting Procedure

The surface to be coated shall be clean, dry, free from oil/grease, and have the specified roughness and cleanliness until the first coat is applied.

Blast cleaned steel surfaces shall not be touched by bare hands.

The blast cleaned surface shall be rendered dust free and coated with the specified primer a soon as possible to avoid formation of oxidation on the surface, but in any case, four one from the time of blasting, and at least one hour prior to sundown of the day it is blasted and before any rusting occurs.

Any steel surface not primed within these limits or that is wet shall be reblasted.

No acid washes or other cleaning solutions or solvents shall be used on metalsurfaces after they are blasted. This includes washes Intended to prevent rusting.

All areas around the intended paint surface shall be cleaned of blast material prior tocoating. Drains shall be purged of blast material and flushed.

Biodegradable water – soluble cleaning solution used to clean previously painted surfaces shall not lift softens or otherwise damages the existingcoating.

For determination of chloride surface; relavent ISO 8502 part 2 & 5 shall be applicable. Chloride contamination shall be checked using-SCM 400 / brestle patches / quanta strips. Maximum permissible limit is 10 micro gram / sq.cm. for external surface & 5micro gram / sq.cm. for internal of vessels.

3.5 Blasting Equipment

3.5.1 Compressed Air

The air compressor shall be capable of maintaining a minimum of 700kpa (7 kg/cm 2 or 100 psi) air pressure at each blasting nozzle. The compressed air supply shall be free of water and oil. Adequate separators and traps shall be provided on the equipment, which shallbe regularly purged of water and oil to maintain efficiency.

3.5.2 Nozzle

The nozzle shall be a 10 mm (maximum) internal diameter venture style nozzle.

3.5.3 Power Tools

Power tools may be used to obtain a metal surface finish as per SSPC SP11 where blasting is not possible, or on items which might be damaged by blasting.

3.5.4 Shot Blasting Equipment

Shot blasting equipment may be used for specific applications. Shot shall be changed as required to maintain the angular profile requirement.

3.6 Blasting Abrasive

3.6.1 Abrasive

The abrasive shall be as per SSPC-AB-1. The abrasives shall be copper slag, steel balls shall be free of contamination of dust and chlorides to produce the required anchor profile and graded as to be free from clay, silt or other matter likely tobecome embedded in the steel surface. Abrasives which have atendency to shatter and adhere or embed in the steel surface shall notbe acceptable. Recycled abrasive shall not be used. The use of sand is prohibited

3.6.2 Shot Blasting Material

Shot blasting material shall pass through a G-16 to G-40 mesh screen. At least 25% to 30% steel grit shall be mixed with the graded shot to remove any rust, scale or other impurities pined into the surface. Shot blasting material is limited to iron, steel or synthetic shot which is applied by compressed air nozzles or centrifugal wheels. Shot blasting material shall be checked at least two times a week for replacement of abraded material.

4.0 COATING APPLICATION

4.1 General Application

All application, inspection and safety procedures shall be carried out inaccordance with SSPC Painting Manuals, Vol. 1 Chapter 14.2 and Vol. 2 Chapter 5) and as set out below.

4.1.1 Supply and Storage

All coatings shall be furnished, mixed and applied in accordance with manufacturer's recommendations and as specified here in. Mixing of different

Manufacturer's coatings or applications on the same surface are not permitted.

All coating materials and thinners shall be in original, unopened containers being the manufacturers label batch numbers and instructions. For materials having a limited shelf life, the date of manufacture and the length of life shall be shown. Materials older than their stated shelf life shall not be used.

Materials shall be stored in accordance with the manufacturers Recommendations.

Coating materials that have gelled, other than thixotropic materials or materials that have deteriorated during storage shall not be used.

4.1.2 Pot Life

If the coating requires the addition of a catalyst, the manufacturer's Recommended pot life for the application conditions shall not be exceeded.

When the pot life is reached, the spray pot shall be emptied, cleaned and a new material catalyzed. Manufacturer's recommendations to be followed

4.1.3 Mixing

Mixing and thinning directions as furnished by the manufacturer shall be followed. Only thinners specified by the manufacturer shall be used.

All coating materials shall be stirred with a power mixer use, until the pigments, vehicles and catalysts are thoroughly mixed and then strained while being poured into the spray pot. During application the materials shall be agitated according to the manufacturer's recommendations.Different brands or types of paints shall not be intermixed.

4.2. Cleanliness

All Surfaces shall be clean free from dust and dry. Any blast cleaning dust orgrit remaining on the surfaces shall be removed by means of compressed air before priming or application of any coating. Any surface with a rust bloomshall be re-blasted as per ISO: 8504.

4.2.1 Temperature

Coating shall only be applied when the temperature of the steel is atleast 3°C above the dew point;ambient air temperature must be withinthe limits specified by the manufacturer.

4.2.2 Weather Conditions

No coatings shall be applied during fog, mist or rain or when humidity is not greater than 60% or on to wet surfaces. In case the minimumtemperature at the fabrication yard is below 5 deg C, the contractor shallpropose alternate coating procedure for Company's approval at thebinding stage itself.

The company has the right to suspend application of coating whendamage to the coating may result from actual or impeding weathercondition.

4.2.3 Coats

Each coat shall be applied uniformly and completely over the entiresurface. Each coat shall be allowed to dry for the time specified by themanufacturer before the application or a succeeding coat. To reducethe possibility of intercoat contamination and to assure proper adhesionbetween successive coats, all coats shall be applied as soon aspossible after the minimum specified drying time of the preceding coat.

4.2.4 Brush Application (Stripe Coating)

A stripe coat shall be applied by brush or roller after the prime coat has been applied. The stripe coat shall be applied to edges, corners,welding seams, bolt holes, back side of piping, stiffeners, vent anddrain holes, notches and any other area that is difficult to reach byspray gun.

4.2.5 Finish Coat

An additional layer of finish coat shall be hand brushed at edges,corners, welds and hard-to spray areas to eliminate holidays in the finalcoats.

4.2.6 Field Welds

No coating shall be applied within 150 mm of edges prepared eitherfor field welds or to surfaces waiting non-destructive testing.

4.2.7 Inorganic Zinc Primer

It is preferred that intermediate/top coat for inorganic zincprimer coats be applied within minimum of seven (7) days after theprimer coat.

4.3 Spray Application

4.3.1 Equipment

(a) All equipment to be used for spray applications shall beinspected and tested before application begins.

(b) All equipment shall be maintained in good working order andshall be equal to that described in the manufacturer'sinstructions.

(c) All equipment shall be thoroughly cleaned before and aftereach use and before adding new material.

(d) An adequate moisture trap shall be installed between the airsupply and each pressure pot. The trap shall be of the typethat will continuously bleed off any water or oil from the airsupply.

(e) Suitable pressure regulators and gauges shall be provided forboth the air supply to the pressure pot and the air supply to thespray gun. Spray equipment and operating pressures shallcomply with therecommendations of the manufacturer.

(f) The length of hose between the pressure pot and spray gunshall not exceed 15 m.

4.3.2 Procedures

(a) Pressure pot, material hose and spray gun shall be kept at thesame elevation where possible. When spraying inorganic zinc,the elevation difference shall not exceed 3m.

(b) The spray gun shall be held at right angles to the surface.

(c) Each pass with the spray gun shall overlap the previous passby 50%.

(d) The spray width shall not exceed 300 mm.

(e) All runs and sags shall be immediately brushed out or thesurface
re-coated.

(f) Large surfaces shall receive two passes (except when applyinginorganic zinc) at right angles to each other (crosshatched).

4.3.3 Airless Spray Equipment

(a) Airless spray equipment may be used for applying inorganic zinc, epoxy oraliphatic polyurethane coatings.

(b) The manufacturer's recommendations in selection and use ofairless spray equipment shall be followed.

4.4 Brush Application

4.4.1 General Requirements

(a) Coating shall be applied by brush on all areas, which cannot beproperly spray coated such as corners, edges, and welds etc.,

(b) Inorganic zinc primer coatings shall not be applied by brushing,not even for touch – up repairs.

4.4.2 Equipment for Brush Application

Brushes shall be of a style and quality that will permit properapplication of coating. Round or oval brushes are most suitable forrivets, bolts, irregular surfaces and rough or pitted steel. Wide flatbrushes are suitable for large flat areas. Brush width shall not begreater than 100 mm. No extension handles shall be used on brushes.

4.4.3 Procedure for Brush Application

(a) Brushing shall be done so that a smooth coat, uniform inthickness, is obtained. There shall be no deep or detrimentalbrush marks.

(b) Paint shall be worked into all crevices and corners.

(c) All runs and sags shall be brushed out to prevent air pockets,solvent bubbles or voids.

(d) When applying solvent type, coatings, care shall be taken toprevent lifting of previous coats.

4.5 Safety Equipment

Appropriate safety equipment shall be provided for blasters, painters andother workers involved in the preparation and application of coating systemsas per recommendation of paint manufacturer. Work areas shall beadequately ventilated.

5.0 REPAIR OF DAMAGED AREAS

All areas of paintwork that are locally damaged during transportation,handling or erection shall be fully repaired to the satisfaction of the company.
Prior to the application of any coat, damage to previous coat(s) shall be touched-up by removing the damaged coatings, preparing the surface andreapplying the protective coat(s).

5.1 Repair Procedure for Damaged coating
Surfaces where coating is damaged after application of the finish coat shall berepaired as follows;

5.1.1 Top Coat
The top coat damaged, but base coat undamaged and the metal substrate is not exposed:

(a) Damaged coating shall be removed with a hand file and abraded back tothe sound coating using emery paper or a fine grinder.

(b) The damaged area shall be wiped with a suitable solvent to removedebris. The periphery of repair area shall be feathered back for a minimumdistance of 25 mm into the adjacent undamaged coating by light abrasion orgrinding to produce a smooth chamfered surface profile.

(c) Apply a new topcoat as specified.

5.1.2 Base Coat
Coating damaged to base metal

a) The damaged area greater than 0.2m^2 in area, the surface of exposed
metal shall be prepared to the original specified standard prior to repairing bypower tool cleaning as per SSPC-SP3 or spot blasting to SSPC-SP5 andapplying primer, intermediate coat and final coat as specified. Alternatively,high solid surface tolerant epoxy coating such may be used in place of primer &intermediate coats, followed by specified topcoat.

b) The damaged areas less than 0.2 m^2 in area may be repaired as per
manufacturer's recommendation or by preparing the surface of exposed metalby power tool cleaning as per SSPC-SP11 to the original specified standard.

A primer, intermediate and final coat shall be applied as specified. Alternatively,high solid surface tolerant epoxy coating such may be used in place of primer &intermediate coats, followed by specified topcoat. Brush application isacceptable. Even appearance and smooth feathering into surrounding coatingin addition to correct dry film thickness and holidays must be achieved. Coatingand surrounding repaired areas shall not be damaged and complete tie-in ofthe coating with surrounding areas shall be obtained. Zinc based productsshall not be applied without Blast Cleaning to Sa 2 ½, instead Surface tolerantepoxy such at 100 microns shall be used as a primer in case blast cleaning is notpossible or practical.

6.0 INSPECTION AND TESTING

6.1 Quality Control

Procedures for testing and documenting quality control shall be prepared prior to theinitial start up of any work covered by this specification & submitted to company forapproval. The procedures shall include methods to assure the specification requirements are met and forms to document environmental conditions, surface temperature, coating applicator, surface(s) being coated, coating applied and status of required examinations and tests.

Testing and inspection shall be carried out in accordance with Table-6.2. Surfaces shall be accessible until final inspection is carried out.

6.2 Inspection and testing requirement

Test type	Test Method	Test Frequency	Acceptance criteria	Consequence
Environmental conditions	Ambient and steel Temperature. Relative Humidity. Dew point.	Before start of each shift +minimum twice per Shift.	In accordance with Specified requirements	No blasting or coating
Visual examination	Visual for sharp edges	100 % of all surfaces	No defects, see Specified	Defects to be repaired

	weld spatter slivers, rust grade, etc.		requirements	
Cleanliness	a) ISO 8501-1 b) ISO 8502-3	a) 100 % visual of all surfaces b) Spot checks	a) In accordance with specified Requirements b) Maximum quantity and size rating 2	a) Reblasting b) Recleaning and retesting until acceptable
Salt test	ISO 8502-6 and ISO 8502-9	Spot checks	Maximum conductivity corresponding to 20 mg/m_2 NaCl	Repeated washing with potable water &retesting until acceptable
Chloride test	ISO 8502-2 ISO 8502-5	-	10microgram/sq.cm for external & 5 microgram/sq.cm fir internal vessel	-
Roughness	Comparator or stylus instrument (see ISO 8503)	Each component or once per 200 m_2	As specified	Reblasting
Curing test (for Zn silicate)	ASTM D4752	Each component or once per 100 m_2	Rating 4-5	Allow to cure
Visual examination of coating	Visual to determine curing,contamination, solvent retention, pinholes/popping, sagging & surface defects	100 % of surface after each coat	According to specified requirements	Repair of defects
Holiday detection	NACE RP0188 and as per *note -1 below	As per coating system specification	No holidays	Repair &retesting.
Film thickness	ISO 19840. Calibration on a smooth surface	ISO 19840	ISO 19840, and coating system data sheet	Repair,additional coats orrecoating as appropriate
Adhesion	ISO 4624 using equipment with an automatic centeredpulling force	Each component or once per 200 m2	*See note-2 below	Coating to be rejected

	& carried out when coating system are fully cured			

*Note:

1. Holiday Testing
   Holiday testing shall be conducted in accordance with NACE SP0188. Minimum 10% of the coated areas, which include weld seams, corners, and edges, shall beholiday detected. Any holiday is unacceptable and shall be marked and repaired according tospot repair procedures.
2. Adhesion test
   Adhesion test shall be carried out on separate test plates, minimum adhesion values inaccordance with ISO 4624 shall be 5,0 MPa when using automatically centered test equipment.

6.3 Qualification of supervisors, foremen and QC personnel at The FabricationYard

The contractor's quality control inspector shall be qualified as a coating inspectorin accordance with NS 476 Inspector level I or NACE level-I.

The contractor's quality control inspector shall qualify the tradesman level asblast-cleaner, painter, and applicator etc. for painting application.

The personnel shall have relevant knowledge of health and safety hazard, use ofprotection equipment, coating materials, mixing and thinning of coatings, coatingpot-life, surface requirements etc.

Contractor shall carry out tests in accordance with the company approvedCoating Procedure Specification for all coating systems thatare planned to be used for this project before commencement of painting work.
The test shall be supervised by the coating manufacturer's Authorized technicalrepresentative and the contractor's quality control inspector andshall be witnessed & inspected and accepted by the FQA of Adani. Contractor shallissue an inspection report covering the qualification tests for the companyapproval.

The test shall be carried out on a test panel (minimum 1 m x 1 m) and at least onone end of, angle, channel, beam and flat bar and analternative location providing similar complexity on the component to be used.

The acceptance criteria are the requirement to the visual and non – destructive
inspection of the coating system described in this specification.Operators failing to meet the requirement shall not be allowed to carry out thework on this project.

6.4 Equipment and Material

Materials, tools or equipment used in the surface preparation and coatingapplications, shall be inspected regularly and rejected if they do not comply with
the Specification.

6.5 Inspection Instruments

The following items shall be inspected using the inspection instruments listed below:

Instrument Item	Inspection Instrument
Surface Profile	Keane-tator Surface Profile Comparator or Testex Press-o-Film Elcometer 124 with 122 testex tape
Holidays	Tinker – Rasor Model M – 1
Surface Cleanliness	SSPC – Vis – 1
Viscosity	Zahn Viscometer or Ford Cup
Wet Film Thickness(WFT)	Nordson Wet Film Thickness Gauge Sheen WFT Gauge
Temperature & Humidity	Gardner Certified Hydrometer And Temperature Indicator
Surface Temperature	Pandux Surface Temperature Thermometer Elcometer Surface temperature gauge
Compressed Air Quality	Dry white cloth

6.5.1 Calibration

Each test instrument shall be maintained and calibrated as prescribed by themanufacturer.

6.5.2 Dry Film Thickness

The dry film thickness of the coating system shall be determined in accordancewith SSPC-PA2 or by a Micro test thickness gauge or comparable instrument in
accordance with the following procedure.

(a) Ten readings shall be taken for every 10m^{2}of painted areas.
(b) 90% of all readings shall be within the specified dry filmthickness.
(c) Where thickness accordance with the above procedure fallbelow the specified minimum an additional coat of theintermediate or finish coat shall be applied.

7.0 PAINT MATERIALS:

The coating manufacturer shall provide a Coating System Data Sheet (CSDS) foreach coating system to be used, containing at least the following information foreach product:

- Surface pre-treatment requirements;
- Dry Film thickness (maximum, minimum and specified);
- Maximum and minimum re-coating intervals at relevant temperatures;
- Information on thinners to be used (quantities and type);
- coating repair system.
- Practical consumption
- Expected life of product with guarantee.
- MSDS

Paint manufacturer shall furnish all the characteristics of paint materials onprinted literature, along with the test Certificate with actual test values ofsupplied batch for all the specified characteristics given in the specifications.

All the paint materials shall be of first quality, should pass all pre qualification testing for corrosive category – C5-M as per ISO 12944 and conform to the followinggeneral characteristics as per the tables below:

TABLE 7.1: REQUIRED CHARACTERISTIC OF PAINT MATERIALS

Technical Name	Type & Composition	Volume of solids (apprx.)	DFT (Dry Film thickness) per coat (apprx.)	Weight Per liter in kgs/ liters (approx)	Touch Dry at 25°C (approx	Hard dry at 25°C (approx.)	Over coating Interval (approx.)	Pot life (approx.) 25°C
Inorganic zinc silicate CoatingContaining	A two pack air drying self –	65 %±2	65-75 µ	2.2+/-0.02	30 mts.	Over night	Min.; 16-24Hrs Max. Indefinite.	4 Hrs

minimum 85% ±2 zinc in dry film by weight & 96% Purity of Zinc.	curingsolvent basedInorganic Zinc silicatecoating.							
Epoxy MIO High build containing minimum 50% MIO in dry film.	Two pack, super high build, polyamide cured epoxy, pigmented with natural lamellar micaceousironoxide	Min. 80%± 2	125-150 µ	1.82+/- 0.02	3 Hrs.	Overnight	Min. : 18 Hrs. Max. : Indefinite	2 hrs.
Glossy Aliphatic acrylic Polyurethane Topcoat	Two Components High Build Aliphatic Acrylic Polyurethane.	min 62% ±2	50-75 µ	1.46 +/- 0.02	1.5 hrs	12 hrs	Min. ;12 hrs Max. ;As per suppliers data	3 Hr
Inorganic zinc silicate Coating Containing minimum 75% ±2 zinc in dry film by weight & 96% Purity of Zinc.	A two pack air drying self – curing solvent based Inorganic Zinc silicate coating.	Min 60%± 2	65-75 µ	2.0+/- 0.02	30 mts	Overnight	Min.; 16-24 Hrs Max. Indefinite.	4 Hrs
Epoxy MIO High build containing minimum 50% MIO in dry film.	Two pack, high build, polyamide cured epoxy, pigmented with lamellar MIO.	Min 60%± 2	100-125 µ	1.58+/- 0.02	4 Hrs	18 hrs	Min. : 18 Hrs. Max. : Indefinite	5 hrs
Epoxy Direct to Metal Primer cum Finish Coating	Two pack, rapid cure, high build epoxy DTM primer cum finish	Min 70%±2	75-150 µ	1.63 +/- 0.02	30 mts	60 mts	60 mts	2 hrs
Rapid cure epoxy high build zinc phosphate primer(16% ZP content)	Two pack, rapid cure, high build polyamide cure, epoxy zinc phosphate primer.	Min 63%±2	50-100 µ	1.51+/- 0.02	45 mts	3 hrs	3 hrs	6 hrs
Self -priming Surfacetolerant High build Epoxycoating	Two pack amid amine cured self priming epoxy mastic.	Min. 80%± 2	100-125u	1.46 +/- 0.02	5 Hrs.	24 Hrs	Min, :24 Hrs Max –As recommended by manufacturer	2 hrs

8.0 COATING SYSTEMS

8.1 Scope

The following section outlines the requirement of supply & application of anti corrosive coatings for corrosion protection of steel structural's

exposed to environments classified by ISO 12944-2 as C5-I,C5-M, C- 4 & C-3and to get long term life (High Durability – above 15 years)

8.2 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP 1. The absence ofoil and grease after degreasing shall be tested by method given elsewhere in thespecification.

Grind all sharp edges and corners to a minimum radius of 2 mm. Remove all welding slag, spatter & blend grind all sharp welds & high spots. Remove all salt deposits by jetting with clean (potable) water. Thereafter the surface to be abrasive blasted to near white metal finish as perSSPC-SP 10. Using SSPC VIS 1, it is to bevisually assessed that the blast cleaned surface meets requirement of SSPC-SP 10.

Thereafter clear cellophane tape test as per ISO 8502-3shall be used to confirmabsence of dust on the blasted surface. Finally blasted surface shall be tested forpresence of soluble salts as per method ISO8502-9. Maximum allowable salt content shall be considered 50mg/M2. (5 micrograms/cm^2) In case salt content exceedsspecified limit .The contaminated surface shall be cleaned by method as per Annex –Cof ISO - 12944-4 (Water Cleaning.) or as per ISO 8501 – 4 (Wa-Wa 2 ½). After cleaning the surface shall be retested for saltcontent after drying.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3of mesh size G-16 to G-40. Copper or Nickel slag or Garret as abrasive will also besuitable having mesh size in the range of G16 to G24, conforming to SSPC-AB-1.

Mesh size shall be required as appropriate to the anchor tooth depth profile requirementand blasting equipment used. The blasted surface should be having angular profiledepth of 50 to 75 microns with sharp angular shape. The profile depth shall bemeasured according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417method B (Profile depth gauge).

Suitable enclosure shall be provided to carry out the blast cleaning operation. The contractor shall put up minimum three temporary sheds each of size 15m x 30m with handling facilities at site to carry out abrasive blasting. If required prior approval from the factory inspector/pollution

control board etc. shall be obtained regarding the method of blast cleaning and abrasives used therein.

For manual blasting one profile depth measurement shall be taken every 10-20 M^2 ofblasted surface.Surface preparation shall be completed in one abrasive blast cleaning operationwherever possible.If rust bloom(visual appearance of rust) appears on the blast cleaned surface beforepriming, the affected area shall be re-blasted to achieve specified degree ofcleanliness after which only application of inorganic zinc silicate.

Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressureand media size should be reduced and adjusted to preclude damage/distortion to thingauge materials. Blasting time on work piece should be adjusted to only clean thesurface and cut required anchor tooth with minimum loss of metal. Blast angle shouldbe as close to perpendicular as possible but in no case greater than $\pm 30^0$ fromperpendicular to work surface. Blasting media must be free of debris, excessive fines, contaminants such as Nacl and sulfur salts (Ref. SEC 13.2.1.6 of this Spec).

F-Tests for blasting media, blasting air& surface contamination.

F-1- Blasting Media

(For every fresh batch of media and one random test during blasting)

a) Blasting Media shall be visually inspected for absence of contamination anddebris using 10 X magnification.

b) Inspection for the absence of oil contamination shall be conducted usingfollowing procedure:

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

c) Soluble salt contamination if suspected shall be verified by method ASTM D4940. If present, media to be replaced.

d) Clean blasting equipment, especially pot and hoses, thenreplace blasting media and retest.

F-2 Test for Blasting Air

(Once Daily before start of blasting & once at random duringblasting)

The air for blasting shall be free from moisture and oil. The compressor air shall bechecked for oil and water contamination per ASTM D 4285.

F-3-Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per followingprocedure to validate absence of oil and grease contamination.

a) Visual inspection - Continue degreasing until all visible signs of contaminationare removed.

b) Conduct a solvent evaporation test by applying several drops or a small splash
Of residue- free trichloromethane on the suspect area especially pitting, crevice corrosionareas or depressed areas. An evaporation ring formation is indicative of oil and greasecontamination.Continue degreasing and inspection till test is passed.

8.3 Paint Systems

8.3.1 For C5-M Environment Classification

Primer Coat: 1 coat of inorganicethyl self curing zinc silicate primer (coating) at 75 microns DFT/Coat to be applied by airless/pressure pot for high durability >15 yrs. The primer should meet the requirements of SSPC-SP 20 performance standard. Minimum Metallic Zinc in the dry film by weight must be 85%. Volume solids of the primer must be 65% .

Intermediate coat – 1 coat of Super High build epoxy MIO coatingcured with polyamide hardener at 150 microns DFT/ Coat to be applied by airless spray. Minimum Natural Lamellar Micaceous Iron Oxide content in the dry film must be 50% by weight. Volume solids of the product must be 80% .

Finish Coat- Two coats of High Build Gloss Aliphatic Acrylic Polyurethane at 50micron/coat dry film thickness to be applied by brush/airless spray. Total thickness of the finish coat will be 100 microns. Volume Solids of the product must be 62% .

Total DFT minimum: 325 Microns and maximum: 350 Microns.

Notes:

1. This paint system is equivalent to the protective paint system no's (S7.14 & S 6.08) recommended for corrosion category C5-M & C5-I in ISO 12944-5.
2. This system is satisfactory for surface temperatures to 90° Ccontinuous dry temperature.
3. Colour for final coat shall be as per colour code.
4. All material shall be supplied in the manufacturers original cans, durably & legibly marked with the description of the contents. This shall include the batch number, date of manufacturing & the manufacturer's name.
5. All coating materials used shall confirm to the composition clauses given against each product in the specification. In meeting the composition clauses, the manufacturer shall provide evidence of compliance from approved third party lab before start of the job & internal test report along with every supplied batch.
6. Material containing cadmium, lead or any other toxic material to environment/personnel shall not be used.

8.3.2 For C-4 Environment Classification

Primer Coat: 1 coat of inorganic ethyl self curing zinc silicate primer (coating) at 75 microns DFT/Coat to be applied by airless/pressure pot. The primer should meet the requirements of IS - 14946 performance standard. Minimum Metallic Zinc in the dry film by weight must be 75%. Volume solids of the primer must be 60% .

Intermediate coat – 1 coat of High build epoxy MIO coating cured with polyamide hardener at 100 microns DFT/ Coat to be applied by airless spray. Minimum Natural Lamellar Micaceous Iron Oxide content in the dry film must be 50% by weight. Volume solids of the product must be 60% .

Finish Coat- One coat of High Build Gloss Aliphatic Acrylic Polyurethane at 50 micron/coat dry film thickness to be applied by brush/airless spray. Volume Solids of the product must be 62%.

Total DFT minimum: 225 Microns.

Notes:

1. This paint system is equivalent to the protective paint system no S4.30 recommended for corrosion category C-4- in ISO 12944-5.
2. This system is satisfactory for surface temperatures to 90° C continuous dry temperature.
3. Colour for final coat shall be as per colour code.
4. All material shall be supplied in the manufacturers original cans, durably & legibly marked with the description of the contents. This shall include the batch number, date of manufacturing & the manufacturer's name.
5. All coating materials used shall confirm to the composition clauses given against each product in the specification. In meeting the composition clauses, the manufacturer shall provide evidence of compliance from approved third party lab before start of the job & internal test report along with every supplied batch.
6. Material containing cadmium, lead or any other toxic material to environment/personnel shall not be used.

8.3.3 For C-3 Environment Classification

Covered Areas like TG Shed etc:

Primer cum Top Coat: Two coat of DTM – Direct to Metal epoxy primer cum finish with optimum loading of Zinc Silicate anti corrosive pigments at 75 microns DFT/Coat to be applied by airless/pressure pot. The total thickness of the system will be 225 microns. Volume solids of the DTM coating must be 70%.

Total DFT minimum: 225 Microns.

Uncovered Areas – Exposed to UV Rays:

Primer Coat: 2coat of Rapid Cure, High Build, Epoxy Polyamide Cure Zinc Silicate Primer with optimum loading of Zinc Silicateanticorrosive pigment at 175 microns DFT/Coat to be applied by airless/pressure pot.Minimum Zinc phosphate pigment in the dry film by weight must be 16%. Volume solids of the primer must be 63%.

Finish Coat- One coat of High Build Gloss Aliphatic Acrylic Polyurethane at 50 micron/coat dry film thickness to be applied by brush/airless spray. Volume Solids of the product must be 62% .

Total DFT minimum: 225 Microns.

Notes:

1. This paint system is equivalent to the protective paint system no S3.18 recommended for corrosion category C-3- in ISO 12944-5.
2. This system is satisfactory for surface temperatures to 90° C continuous dry temperature.
3. Colour for final coat shall be as per colour code.
4. All material shall be supplied in the manufacturers original cans, durably & legibly marked with the description of the contents. This shall include the batch number, date of manufacturing & the manufacturer's name.
5. All coating materials used shall confirm to the composition clauses given against each product in the specification. In meeting the composition clauses, the manufacturer shall provide evidence of compliance from approved third party lab before start of the job & internal test report along with every supplied batch.
6. Material containing cadmium, lead or any other toxic material to environment/personnel shall not be used.

9 COLOUR SCHEDULE

9.1 EQUIPMENT AND PIPING STANDARD COLOUR CODE FOR MECHANICAL

EQUIPMENT

S. No.	Description	Ground Colour
A	**CLOSED COOLING WATER SYSTEM**	
1	Closed cooling water pumps	Sea Green
2	Plate heat exchanger	Sea Green
3	Closed cycle cooling water pump	Sea Green
4	CCCW Expansion tank	Sea Green
5	CCCW chemical dosing tank	Sea Green

B	**WATER TREATMENT PLANT**	
1	River water & Raw water	
a	Raw water pump	Sea Green
b	Clarifier	Sea Green
c	- Raw / Fire water storage tank	Sea Green
d	DM plant supply pump	Sea Green
e	Filter air blower	Sea Green
f	Filter back wash pump	Sea Green
g	Lime slaking tank & agitator	Sea Green
h	Lime slurry transfer pump	Sea Green
I	Lime solution tank	Sea Green
j	Lime solution dosing pump	Sea Green
k	Alum solution tank	Sea Green
l	Alum solution metering pump	Sea Green
m	Polyelectrolyte solution tank	Sea Green
n	Polyelectrolyte solution metering pump	Sea Green
o	Sludge feed pump	Sea Green
p	Filter press	Sea Green
q	Service water tank for DM building	Sea Green
r	Service water tank for control annex	Sea Green
2	Demineralisation system	
a	Activated carbon filter	Sea Green
b	Cation exchanger	Sea Green
c	Anion exchanger	Sea Green
d	Degasser tower	Sea Green
e	Air blower for degasser tower	Sea Green
f	Strong base anion exchanger	Sea Green
g	Degassed water transfer pump	Sea Green
h	Strong base anion exchanger	Sea Green
I	Mixed bed polisher	Sea Green
j	Air blower for mixed bed polisher	Sea Green
k	DM Water Storage tank	Sea Green
l	DM water transfer pump	Sea Green
m	Acid unloading cum transfer pump	Dark Admiralty Grey
n	Bulk acid storage tank	Dark Admiralty Grey
o	Acid measuring tank for SAC	Dark Admiralty Grey
p	Acid measuring tank for MB	Dark Admiralty Grey
q	Regeneration water pump	Dark Admiralty Grey
r	Caustic Lye unloading cum transfer pump	Dark Violet
s	Bulk caustic storage tank	Dark Violet
t	Caustic regeneration tank & agitator	Dark Violet
u	Caustic solution filter	Dark Violet

S.No.	Description	Ground Colour
v	Caustic dilution tank for SBA/WBA	Dark Violet
w	Caustic dilution tank for MB	Dark Violet
x	Caustic pump for regeneration for WBA/SBA	Dark Violet
y	Waste water recirculation cum disposal pump	Sea Green
C	**CRANE & HOIST**	
1	Power house EOT crane	Canary Yellow
2	CW pump house EOT crane	Canary Yellow
D	**COMPRESSED AIR PLANT**	
1	Air compressor	Sky Blue

2	Compressed air dryer	Sky Blue
3	Air receiver	Sky Blue
E	**Chemical Dosing**	
1	Hydrazine preparation tank	Dark Admiralty Grey
2	Ammonia preparation tank	Dark Admiralty Grey
3	Hydrazine & ammonia dosing tank	Dark Admiralty Grey
4	Hydrazine & ammonia dosing pump	Dark Admiralty Grey
5	Phosphate preparation tank	Dark Admiralty Grey
6	Phosphate dosing tank	Dark Admiralty Grey
7	Phosphate dosing pump	Dark Admiralty Grey
8	- Sampling system	Dark Admiralty Grey
F	**FIRE PROTECTION SYSTEM**	
1	Diesel engine driven pump	Fire red
2	Fuel tank for diesel engine driven pump	Fire Red
3	Main hydrant pump (Electrical)	Fire Red
4	Jockey pump	Fire Red
5	Fire Water Storage tank	Fire Red
6	CO2 cylinder	Fire Red
G	**FUEL OIL SYSTEM**	
1	Fuel oil pumps skid	Light Brown
2	Fuel oil Storage tank	Light Brown
3	Fuel oil strainer	Light Brown
H	**ASH DISPOSAL SYSTEM**	
1	Ash transmitting vessel	Aluminium
I	**AIR CONDITIONING AND VENTILATION SYSTEM**	
1	Refrigerant compressor	Sky Blue
2	Chilled / condenser pumps	Sea Green
3	Condenser water pipe	Sea Green
4	Fans	Grey

9.2 STANDARD COLOUR CODE FOR ELECTRICAL EQUIPMENT

Sl. No.	Description	Colour	Colour No.
1	Transformers	Light grey	Shade 631 of IS : 5
2	Bus ducts	Light grey	Shade 631 of IS:5
3	Junction boxes.	Light grey	Shade 631 of IS:5
4	HT/LT Switchboards, Distribution boards, Control & Relay panels		
	a) Indoor	Siemens	RAL 7032
	b) Outdoor	Light grey	Shade 631 of IS:5
5	UPS Panel, charger panels	Siemens	RAL 7032
6	DG Alternator	Onan Green	-
7	NGR	Light grey	Shade 631 of IS : 5
8	Motor	Light grey	Shade 631 of IS : 5
9	Lighting fittings	As per manufacturer's	As per manufacturer's
10	Cable trays	Galvanized	

Note: 1. All panels that are to be erected at CCR floor shall be painted using RAL 7032 (exterior colour). All Electrical, C&I, Fire alarm or any other panel shall have this colour.

9.3 COLOUR CODING FOR IDENTIFICATION OF PIPELINES USED IN THERMAL POWER PLANTS

Sl.No	Medium	Ground Shade		Band Shade		Remarks
		Color	Color No. as per IS:5	Color	Color No. as per IS:5	
1	Water system					
a)	Untreated or raw / service	Sea green	217	White	-	White is not included in IS - 5-2007
b)	Treated/dematerialized	Sea green	217	Light orange	557	
c)	Condensate	Sea green	217	Light brown	410	
d)	Potable water	Sea green	217	French blue	166	
e)	RO water	Sea green	217	Light orange	557	
f)	Service & clarified water	Sea green	217	French blue	166	
2	Steam system					
a)	Auxiliary steam	Aluminium	-	Signal red	537	with aluminium
3	Air system					
a)	Instrument	Sky Blue	101	White	-	
b)	Service/Plant	Sky Blue	101	White	-	White not included in IS-5 - 2007
c)	Vacuum pipes	Sky Blue	101	Black	-	Black not included in
5	Gas system					
a)	Hydrogen	Canary yellow	309	Signal red	537	
b)	Chlorine	Canary yellow	309	Dark violet	796	
c)	Carbon dioxide	Canary yellow	309	Light grey	631	
e)	Oxygen	Canary yellow	309	White	218	White is not included in

Sl.No	Medium	Ground Shade		Band Shade		Remarks
		Color	Color No. as per IS:5	Color	Color No. as per IS:5	
6	Oils					
a)	LDO/HFO	Light brown	410	Brilliant green	221	
b)	Transformer oil	Light brown	410	Light orange	557	
7	Chemical feed					
a)	Acid piping (in water treatment plant)	Dark admiralty grey	632	Signal red	537	Hazard mark is given
b)	Alkali Piping (in water treatment plant)	Dark violet	796	Golden yellow	356	Hazard mark is given
8	Fire services	Fire red	536	-	-	
9	Effluent pipes	Black	-	-	-	

9.4 COLOUR CODE FOR STRUCTURAL STEEL

SL. NO	ITEAM/SERVICE	COLOR	COLOR No. as per IS:5
1	Gantry girder & monorail	Brilliant green	221
2	Gantry girder & monorail stopper	Signal red	537
3	Building structural steel columns brackets, beams bracings, roof truss, purloin, side grit, louvers, stringers	Dark admiralty grey	632
4	Pipe rack structure & trestle	Dark admiralty grey	632
5	Chequered plate (Plain Face)	Black	-
6	Grating	Black	-
7	Ladder	Dark admiralty grey	632
	Hand railing		
8	Hand rail	Signal red	537
9	Middle rail	Signal red	537
10	Toe Plate	Signal red	537
11	Vertical post	Black	-
12	Structural steel for Silo	Smoke grey	692

10 RECOMMENDED LIST OF PAINT MANUFACTURER

1.Asian Paints India Ltd
2. Shalimar Paints
3.Jotun
4. Akzonobel
5. Berger Paints
6. Good lass Nerolac Paints
7. Bombay Paints
8. Jenson & Nicholson

11 PROCEDURE OF APPROVAL OF NEW COATING MATERIAL

Following procedure recommended is to be followed for approvalmaterials Manufactured by new manufactures (indigenous andforeign):

1. Sample shall be selected by adani and the manufacturer should arrange testing of the coating materials as per the List of tests given in Para 5 below from one of the reputed Government Laboratories. Testing charge shall be borne by manufacturer.

2. Samples of coating materials should be submitted to the Govt.Laboratory in sealed containers with batch number and testcertificate on regular format of manufacturer's testinglaboratory.

3. All test panels should be prepared by the Govt. testing agencycoloredphotographs of test panels should be taken before and afterthe test and should be enclosed along with test report.

   Sample batch number and manufacturers test certificate should beenclosed along with the report. Test report must contain detail ofobservations and rating if any as per the testing code. SuggestedGovt. laboratories are:

   RRL, Hyderabad
   HBTI, Kanpur
   DMSRDE, Kanur
   IIT, Bombay
   BIS, Laboratories
   UDCT, Mumbai

4. Manufacturers should intimate the company, details of samplesubmitted for testing, name of Govt. testing agency, date. Contactpersonnel of the Govt. testing agency. At the end of the test themanufacturer should submit the test reports to the Company forapproval. The manufacturer(s) shall be qualified based on the resultsof these tests and the Company's decision in this regard - shall be Finaland binding on the manufacturer.

5. All tests required for evaluation of acceptance coating materials forstructural steel in thermal power plant shall be as per C5-M classification in ISO 12944 – 2 relevant ISO/ASTM standards.

Types of Environment

ISO 12944 classification	Typical Environments
C1 & C2	Rural areas, low pollution. Heated building/neutral atmosphere.
C3	Urban and industrial atmospheres. Moderate sulphur dioxide levels. Production areas with high humidity.
C4	Industrial and coastal. Chemical processing plants.
C5I	Industrial areas with high humidity and aggressive atmospheres.
C5M	Marine, offshore, estuaries, coastal areas with high salinity.

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TECHNICAL SPECIFICATION

SECTION 6

SITE CONDITIONS

6.0 SITE CONDITIONS

6.1.0 Location and Infrastructure

2 x 800 MW coal based Ultra Super Critical Thermal Power Station (USCTPP) is being set up by **Adani Power Ltd.** at Bandhaura village, Singrauli District, Madhya Pradesh, India.

The site is well connected by the National / State Highways; State Highway (SH-14) is passing about 16 km from the site.

Bandhaura is well connected with Road as well as Rail network from all the major towns Waidhan and Singrauli in Madhya Pradesh

The Nearest Airport is at Varanasi at a distance of 280 km from the project site. The nearest railway station Singrauli station is located at 52 km from project site. The nearest seaport is at Dhamra at a distance of 770 km from project site.

6.2.0 Basic Plant Data

GEOLOGICAL CONDITIONS

Soil Data

Layer 1 - At project site sandy Clay soil strata is available having N values 8 to 16; average soil layer thickness 5m.

Layer 2 – Browning stiff Clay having N value 19 to 24; having soil layer thickness 5 to 10m.

Layer 3 – Poorly graded sand having N value 10 to 43; strata thickness from 10 to 15m.

Layer 4 – compacted sand having N value > 100; layer thickness 15 to 18m,

Subsequently sandy stone encounters.

Seismic intensity

Seismic Intensity:	As per IS: 1893
Zone:	IV
Importance Factor:	1.75
Zone Factor:	(Moderate)

METEOROLOGICAL CONDITIONS

Ambient Air Temperature

Highest monthly mean of daily maximum temperature: 42 °C

Highest monthly mean of daily minimum temperature Min. 3.3 °C

Highest ambient temperature: 48.8 °C

Lowest ambient temperature: 1 °C

Relative Humidity

Maximum Humidity: 85%

Minimum Humidity: 20%

Average relative humidity: 66% during morning hours and 49% during evening hour

Rainfall

The annual average rain fall: 1132.7 mm.

Wind

Basic wind Speed experienced: 47 m/s as per IS 875 part 3:1987

Wind loads to be considered for design of structures shall be based on the design wind speeds arrived at. Based on IS: 875 (Part -3) or the actual observed wind speeds furnished above, whichever is more critical. The parameters for calculation of design wind speed as per IS: 875 (Part -3) -1987 are as follows:

Basic wind speed	47 /sec
Risk coefficient (K1 factor):	1.07 for plant structures
	1.00 For non-plant structures
Terrain category (K2 factor):	Category 1
Topography factor (K3 factor):	1.0

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TECHNICAL SPECIFICATION

SECTION 12

SPECIAL TOOLS & TACKLES

11 SPECIAL TOOLS & TACKLES

Special tools and tackle/ equipment for the maintenance, inspection and repair of the individual main equipment and auxiliary equipment (For eg. SG, ESP, FGD, etc.) shall be supplied by the Contractor in sufficient quantity to equip the operation and maintenance personnel.

The special tools and tackle/ equipment for maintenance and repair shall be delivered by the Contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The special tools and tackle/ equipment to be handed over to the Owner shall be new and unused.

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TECHNICAL SPECIFICATION

SECTION 7

GENERAL PLANT AND TECHNICAL REQUIREMENTS

7.0 GENERAL PLANT REQUIREMENTS

7.1 General

The design of the 2 x 800 MW coal fired power station will be based on unitized principle i.e. there will be one boiler and one turbine and a set of auxiliaries for the same.

The auxiliary systems and plant facilities are designed for serving the whole power station with adequate redundancy.

Critical Secondary system components shall be designed generally for 100% redundancy in order to achieve high reliability and availability of the power unit.

The life span to be considered in the design, equipment and component selection shall be at least 30 years.

For the design of the power plant, it is necessary not only to consider the requirements of operation, but also, by suitably planning the layout, the convenience of inspection, cleaning, maintenance and repair.

In order to achieve reliability, high efficiency and safe operation of the power plant, it is also necessary to consider various precautions to safeguard the operating and maintenance personnel.

The design of the power plant shall ensure that the plant can, in the state of normal operation, adapt itself to load, pressure and temperature variations within the allowable range of design.

The various parts and systems of the power plant shall be designed to achieve the object of providing an integrated and coordinated power plant.

In the design of the power plant and selection of equipment, the special features of this project and likely occurrences have to be taken into consideration to ensure that the power plant can, under these circumstances, operate continuously, safely and with high efficiency. The selection of building materials shall be suited to local conditions. It is required that equipment shall be of a rustproof, moisture proof and waterproof type.

Equipment installed outdoors shall be able to operate in all-weather conditions and to withstand the work site environment. For equipment in operation or in standby that may be influenced by direct sunshine, shelter or cover shall be provided.

All equipment materials, spare parts, special tools and tackles supplied under this contract will be new and unused.

The plant may be asked to operate at any value from rated load up to max. rated load on continuous basis.

If instructions are given for downward trend or upward trend then bunch of such instructions will be considered as one instruction.

7.1.1 Design Requirements & Operating Capabilities of the Plant

The Plant / Systems and its Equipment (s) 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 specifications.

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

1. VWO with rated steam parameters, rated Condenser pressure and 1% make up

2. Operate continuously with Final HP Heater out of service with max. specified cooling water temp, 1% make up and normal aux. steam requirement being tapped from CRH line. The power output of the unit under this operating condition shall commensurate with SG capacity in the above condition.

3. In case of sudden reduction in demand (load throw off), the unit should get safely unloaded and stabilized for continuous operation at house load.

4. HP-LP bypass operation under rated steam conditions with Bypass valve open to full capacity of the HP-LP Bypass system and turbine on house load.

5. The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5HZ to 51.5HZ.

All the equipments and auxiliaries should be designed to cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.

The plant should be designed to operate as a base load station. The design would cover adequate provision for quick startup and loading of the units to full load at a fast rate. The design of the plant equipments and control system would permit participation of the plant in automatic load frequency control.

7.2 Plant Layout

The layout of the main plant along with all the auxiliary systems for the 2 x 800 MW units is shown in Drg. No. MAH1-E-EPC-SPE-TM-T-I-101 Plot plan.

The layout shall also facilitate communication of men and materials between the various facilities both during initial construction and also during subsequent operation and maintenance.

- Availability of adequate space for fabrication / construction equipment beyond the power plant boundary which can be hired temporarily for the purpose.
- Wind direction to minimize carry over of ash, coal and dust, to minimize fire risk etc,
- Hazop studies shall be conducted.
- Width of road to be provided in the plant is 10.5m/7.5m/3.75m (width) as per Owner's requirements.
- A berm of 1.5/1.0m is to be provided on either side of the roads.
- Adequate space as required by the owner for operator's rest room, tool room and pantries shall be included in all buildings/operating area.

The bidder shall prepare his proposal on the basis of the above and justify and evaluate alternative layouts he might suggest. And shall propose a suitable layout optimizing use of the available space considering the above aspects.

After selection of the Contractor, the layout will be jointly assessed and finalized. However, the final layout shall be subject to approval by the Owner.

7.2.1 Layout requirements

The layout for the area shall be developed by the contractor based on the plot plan and the conceptual design furnished in this specification. Apart from the above layout considerations, the additional features to be considered by the Contractor for the development of the layout and arrangement of equipment and facilities are described below.

In compliance with the needs of normal operation of the power plant, the Contractor shall consider the vehicles passing the buildings and entering and leaving the plant by proper planning of the layout of paths and building in the plant area.

In arranging the paths, the conditions of communication during the period of operation and overhaul have to be considered. For the design of paths, the possible types of vehicles that might run on the paths have to be taken into account, so that the radius of curvature, section and noise levels of these paths can thereby be determined.

In the power plant layout design, consideration shall be given to maintenance and overhaul, i.e. also to free access of equipment. In the equipment hoisting floor and platform, sufficient means shall be provided to meet the requirement of shifting, maintaining and overhaul of equipment.

According to the request of overhaul outline, it is necessary to consider the requirement of lifting up the upper cover and dismounting main components of steam turbine generator units during general overhaul. For this reason the operating floor around the steam turbine shall have a very clean and open space provided. The amount of space shall be specified by the turbine island supplier. The arrangement of main area in the turbine room shall also require that some components have to be transported to stores or repair shop during the period of overhaul.

The Contractor shall provide all platforms, foot paths and stairs conforming to the requirements of safety and of providing exclusive entrance and exit to equipment operation and maintenance.

For design of all platforms and footpaths, the minimum clearance height is 2.2 m and all the lifting platforms and walkways shall be provided with stop bar.

For oil and any chemical substance which is likely to leak, dykes and containment areas shall be provided.

Dangerous areas for equipment shall be designed in conformity to the appropriate safety regulations by striving to reduce the hazard to the minimum.

The complete arrangement of equipment buildings, and other service and safety facilities shall also meet the statutory requirements of various Government Agencies.

The power plant will be connected to the grid. The connection to the grid is at 400 kV level.

7.3 Mode of Operation

The plant shall be designed for an availability of more than 90%.

Plant Operation

Load Ramps
The Facility shall be capable of the following normal and emergency ramp rates for sliding pressure operation.

	Normal	Emergency
Sliding Pressure	3% / min	5% / min

Low Load Operation

The facility shall provide safe and stable long-term operation with the controls in full automatic mode without any supplemental oil firing in the range of 30% to 100% of SG MCR.

Load Regime:

The facility is a base load power plant operating at or near MCR. The facility may, at some times be operated in cycling mode.

7.4 General Technical Requirements

7.4.1 General design requirements

The equipment of the entire supply, the main parts as well as auxiliary parts and accessories, must be designed in such a way as to ensure its proper operation, easy control, regulation, erection and maintenance under every working condition.

In the design, particular importance shall be assigned to simplicity, accessibility and solidity of the machinery and its parts. It is of particular interest to achieve simple assembly, easy access for maintenance and repair and simple and safe operation.

The equipment must operate without vibrations that may affect its operation, that of other machinery or of civil works under every condition.

The works shall be designed to facilitate inspection, cleaning, maintenance and repair. Continuity of supply is of prime concern. The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the works. The plant shall be designed to operate satisfactorily under all variations of load, pressure, and temperature, as may be met in normal usage under the variation in climatic conditions.

Corresponding parts throughout shall be made to gauge and be interchangeable wherever possible. In case required, the supplier shall provide the necessary references for all kinds of equipment.

All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts required and maintain uniformity of plant and equipment to be installed.

In selecting materials and in manufacturing, it is necessary to take into consideration the anticipated operating conditions of components and the environmental state of

the plant site. The selection of materials shall also ensure the effective service life of each of the components used in the power plant.

The selection of materials shall conform to the requirement of International Standards Organization. Where there is no sufficient information issued by ISO, it is permissible that the material supplying standards of the manufacturing factory of Contractor are adopted. For all the materials and equipment required by the power plant, only new ones or those which have not been used before shall be supplied. This requirement means that the raw material of the equipment and that part of new materials may not be derived from recycled material.

7.4.2 Standards and Codes of Practice

The work must be performed according to the most recent relevant codes, and standards, accident prevention regulations and legal regulations.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the International Organization for Standardization (ISO). IEC recommendations apply to the electrical equipment.

Equipment and special guarantees not covered in the scope of ISO and IEC, shall conform to approved international standards.

The Contractor is not only responsible for each piece of equipment being correct but also the completed plant must meet design operating condition and performance requirements.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice with Owner's approval.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard. Upon mutual agreement, the amended standard can then be followed.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

7.4.3 Vibration

Vibration shall be reduced to the minimum as far as possible where there is vibration. Amplitude and frequency limitation in the design and supporting structure shall be considered.

Special care shall be taken to avoid operating equipment making resonance with foundations, packing, duct, platform, piping or other components.

Unless otherwise stated or agreed by the Owner each rotating machine has to comply with the requirements for designation as 'good' stipulated by VDI (Verein Deutscher

Ingenieure) Specification 2060 for the respective group of machinery. If the vibration is higher than stipulated as 'satisfactory' the Owner has the right to reject the corresponding equipment, subject to the conditions specified elsewhere.

7.4.4 Noise levels

The plant shall be designed and constructed to reduce the operating noise level as much as possible and when the plant is operating at all loads, the noise pressure levels. At a distance of 1.5 m from the floor or the platform of equipment, if in operation, the level of noise shall be less than 85 dB(A) at a distance of 1.00 m from the shell of equipment.

7.4.5 Units of Measurement

For all the technical tables and diagrams, calculation results, drawings, test data and scales adopted in the design and provided for the power plant, the standard international unit system (SI) as per International Standardization Organization (ISO) shall be uniformly employed.

SI system shall be employed for all the first-class plant layout and arrangement drawings of equipment made especially for the project.

In all correspondence, technical schedules, drawings and instrument scales, MKS system of units and standards shall generally be followed.

7.4.6 Safety

Special importance shall be assigned to all aspects related with the safety of personnel operating, assembling and maintaining the equipment, including other persons who may come in contact with same.

The possibilities of human failure must be foreseen. Provisions shall be taken to avoid damage caused by human error, or to ensure that such damage both to persons as well as to the equipment is the least possible.

Rotating or any other moving part of the machinery, hot parts or any part that may cause accident to the staff, must be adequately protected, in accordance with the safest method known.

All components with surface temperatures exceeding 60 $^{\circ}$C shall be fitted with insulation to protect personnel. The surface temperature shall not exceed 60°C in the condition of the ambient temperature is 40°C.

When it is required to limit the medium temperature drop to meet the requirements of anti-block, anti-dew and other process, it must be insulated from the point of view to control the medium temperature.

Bright paints will be used to be agreed upon with the Owner to protect personnel, so that anything representing a potential danger will stand out: such as elements in movement, suspended hot, with electric tension, etc.

Likewise, appropriate colors shall be selected for the equipment for the purpose of diminishing weariness of workers.

It should be possible to carry out frequent maintenance operations required by the equipment without interrupting its operation and without danger to the personnel.

The equipment shall be provided with the necessary elements to keep possible failure of the main, auxiliary or control elements from causing serious consequences. For this purpose, protections shall be installed such as: stops in case of failure of shafts auxiliary suspensions that will keep parts from falling or coming loose because of centrifugal forces or others; stops to limit movement in case of failure of normal limiting devices, etc. Protections that will decrease or deviate liquid or gas escapes shall also be provided for the same purpose.

Brakes, gears, clutches and similar devices will be located preferable in the last stage of the transmission, so that they will remain operational even in case of failure in other stages.

Access stairs to the equipment must be safe, with anti-skid rungs and handrail. Normal operating areas of the equipment shall be protected to keep personnel from falling or shall be surrounded by strong guardrails. Platforms should have kicking plates to keep loose objects placed on the floor from dropping off. Entrances and large openings in the equipment shall be provided with lids or doors affixed in such a way as to open them also from the inside.

The equipment should be adequately protected against environmental elements, such as humidity, dust etc., and the influences that other equipment may have, such as heat radiation, induced vibrations, etc. The supply shall include protective cabinets for parts exposed to the open air or sensitive parts requiring such protection.

Lubricated parts and parts containing lubricants should be protected against oil leakages, as well as against contamination with extraneous material, with oil seals, packings and similar devices.

Every equipment or parts of equipment that must operate under certain conditions of maximum pressure, temperature, speed, position etc., should have devices to keep such limits from being exceeded and, if necessary, to stop the operation of the machine (Safety valves, limit switches, thermal switches, etc.).

The operational certainty of these devices should be in relation with the importance and operational need to maintain the established limits. Resetting of these devices, either automatic or manual shall be agreed upon with the buyer in each case. These elements shall be installed in such a way as to make it easy to detect the device that caused the machinery to stop.

For protection against the possible failure of the above devices, additional safety elements shall be provided such as stroke limiting stops, diaphragms, bolts, etc. and/or links or other dimensioned rupture elements so that in case of failure, when exceeding extreme operating conditions, additional safety is provided to the equipment.

Inside air and gas ducts, ladders have to be installed for inspection of dampers, venturies, etc.

In designing an area where combustible gases are likely to accumulate, due consideration shall be given to providing safety measures to allow the gas to continuously diffuse or leak off to prevent explosion. The electric equipment in those areas shall be of the fireproof and explosion proof type. Suitable grounding shall be provided on the casing of electrical apparatus which might be energized.

The design of power plant shall include a complete set of composite fire monitoring, protection, and fighting system to identify, isolate, and distinguish fires as well as minimizing potential fire hazards.

A warning alarm for the power plant and alarm for evacuation shall be provided. The alarm is to be audible in the normal working areas of personnel. The selection of the alarming device shall be such that it is audible about the normal background noise of the plant. Visual alarm shall be provided in addition to audio alarms in high noise areas.

Draining of water, oil and venting of gas shall be performed with respect to the safe mode of discharge, and is not allowed to be carried out at or near the places where people exit and at the exit of the plant.

7.4.7 Fire Protection and Precautions

The Contractor shall adopt necessary methods to minimize fire hazards.

The fire protection system shall in general follow the recommendation of Local Fire Authority/ Regulations and the system and equipment shall met with their approval. In addition they shall meet NFPA Code.

The basic guiding ideology is to adopt two methods: fire prevention and fire control. The following design philosophy will apply:

1. Ensure the safety of personnel;
2. Ensure the safety of the important and main equipment of the power plant;
3. Prevent fire from spreading;
4. Limit the damage to equipment.

Fire precaution shall comply with the following principle:

To improve conditions in designing and layout and to reduce potential fire danger, and the spreading of fire by adopting the method of observation.

The following methods shall be adopted to prevent fire from occurring:

1. Using as far as possible fire proof or fire resistant materials
2. Ensuring that, isolating combustible material is not used or stored in possible fire source area of the power plant.
3. Reducing the area where cleaning and examination are difficult in power plant arrangement.

The following methods shall be taken into account to control the spread of fire:

1. Use of fire proof material
2. use of fire detection sensors and/or fire proof construction materials;
3. providing a set of effective fire extinguishing system;
4. providing a set of effective fire detecting equipment;
5. providing the fire detection device in civil construction;

The fire detection system should detect a fire quickly and reliably at the beginning of the fire and activate a special alarm device operation.

The designing of detection system shall prevent against erroneous operation.

The supplied fire protection system will be a combination system involving an automated and manual hydrant, water hose, take up reel and special fire extinguisher.

The end connection type of hydrant shall fit in with local fire brigade requirements to ensure the manual device in power plant to be compatible with the fire control device of local fire brigade.

During the construction phase of power plant, the Contractor adopts advanced and safe working practices and a set of guidelines to keep the site in a clean condition to reduce the possibility of fire.

7.4.8 Markings, Labels

All elements should be properly marked at the workshop, in order to make assembly and maintenance work as easy as possible. Whenever necessary, markings should be indicated in the corresponding drawings and/or special drawings for markings. Marks should be unmistakable and as far as possible follow a logical system that will make it easy to find the marked element. Marks should be indelible and clearly visible. Marks made only with paint will not be accepted. Parts that are the same but are not interchangeable shall be marked so as to differentiate them. Wherever necessary the position of a part within the whole shall be marked.

7.4.9 Signs

7.4.9.1 General

Safety colors, safety symbols and safety signs must comply in construction, geometrical form, color and meaning with the ISO Recommendation 507 of the ISO committee TC 80 'Safety Colors'. All signs should give the identification number. All signs shall be in the English language.

The signs should be of a material which is weather-resistant and of sufficient durability of 30 years for the conditions prevailing on site.

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs. The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.

7.4.9.2 Information signs

Information signs should supply the necessary information to acquaint personnel with the physical arrangement and structure of site, buildings and equipment, e.g. floor numbers, load-carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification etc.

In the choice of information signs in situations not covered by ISO Recommendation 507 the possibility of using pictograms should be considered. Pictograms are particularly suitable for the identification of rooms, areas and buildings in the non-technical areas of the plant, sanitary and amenities buildings, etc.

7.4.9.3 Emergency Signs

In the event of accidents, all necessary information should be available immediately to those affected. Thus, a sufficient number of signs of appropriate size should be installed, e.g. escape routes (including marking of floor areas), emergency exits, fire alarms, fire extinguishers, instructions for special fire-extinguishing agents, warnings against fire-extinguishing agents (CO_2), first aid equipment, first aid points, accident reporting points, telephones etc.

7.4.9.4 Mandatory signs

Signs indicating obligatory actions must be provided and installed wherever certain action is necessary e.g. do not obstruct the entrance; keep right etc.

Signs should also indicate when the wearing of protective clothing and equipment is necessary and obligatory, e.g., protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs etc.

7.4.9.5 Warning signs

Warning signs should refer to the existence or possible existence of danger, e.g. flammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, steps, risk of trapping, slipping, falling, etc. In addition to warning signs, appropriate black-yellow strip markings should also be used where necessary.

7.4.9.6 Local indicators

Easily visible indicators have to be arranged for: All dampers, valves, coal level indicators and coal flow indicators for coal feeders, air swirl dampers of burners, mill classifier(if applicable), etc.

7.4.9.7 Package, Storage and Store House

The Contractor should provide all the specifications and instructions for the self-purchased and fabricated equipment during the planning period of the Contract. These specifications should include the cleanliness and maintenance requirements of materials during fabrication and the protection measures for the equipment from damage during transportation. Loss of materials during storage should be avoided before installation. The instruction should be worked out especially to suit the particular work site program.

7.4.9.8 Packing

All equipment and instruments should be fully packed and protected from damage during transportation and field storage. The equipment instruments should be provided with thorough protecting measures before packing. All machine surfaces should be protected with planks or similar materials and reinforced with metal strips or plates from the outside.

Under actual conditions, all equipment such as motor, switch. control device, instrument and component should be sealed at the joint with polyethylene insulation board and a corresponding drying agent should be provided.

For all piping ends as well as pipes and tanks, the openings should be protected from damage and sealed to avoid the invasion of ash, moisture and air. These protection measures should be kept intact before the start of installation or during periodic inspection. The cost spent for the moving, modification and replacement of the packing and protection device should be paid by the Contractor.

A waterproof enclosed packing list should be provided in each planks or packing case.

The name of articles in the packing case should be marked clearly on the packing list so as to be identified easily.

The articles in the case should be supported by wooden bars in order to be fixed safely and it should not be wedged individually with wooden pad. The marks outside the case should be printed with climate proof materials or paints so as to be protected from being removed during transportation.

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The marks should be painted or printed clearly and durably with characters of 40 mm height at minimum on both ends of the packing case. The labels should be well protected to prevent loss.

A mark indicating the correct lifting position should be shown with arrow on the packing case.

7.4.9.9 Field Storage and Cleaning.

The arrangement requirements of storehouse should be developed during the program contracting period to suit the field conditions and possible storage facilities. Equipment components should be packed and maintained to suit the needs of transportation and field storage. The detailed rules should be worked out in the contract to suit the general requirements and any special requirement of storehouse as well as the inspection requirements for special components.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them.

Classes for Storehouse

Three classes for storehouse are described as follows:

Storehouse class A : Special measures are taken to protect the stored goods and the temperature, humidity, dust/ash are controlled within a specified range.

Storehouse class B : Goods are stored with temperature uncontrolled.

Storehouse class C : It is an outdoor storage with a drainage system on the ground.

No matter what class of storehouse is used, the following basic requirements shall be satisfied.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground.

Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oilcloth or wax or other similar materials between the machine surface and ground surface.

After the storehouse/field are accepted, all components should be inspected as to whether the paint, seal and packing are mechanically damaged. All these damages should be repaired if these components will not be installed immediately.

The components stored in storehouse class C should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible. A drainage device should be provided for this temporary cover or tent .

Inspection during Storage

All components shall be inspected for their painting, storing, sealing etc. and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Unpacking or inspection for outdoor package (class C) shall not be carried out during rainfall or big wind (salt corrosion is possible).

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage after 4 weeks and 8 weeks from acceptance, and then in an interval of every 12 weeks. If it is necessary to replace the drying agent during any inspection, a full inspection every 4 weeks shall be carried out until a successful inspection result is obtained and in the meantime, the conventional inspection shall be carried out continuously.

7.4.10 Painting, Insulation, Anti-dewing

Anti-corrosive coatings and painting should be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have different colors so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Color strip indication system should be used for pipes.

These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some color in whole length.

Annexure 16

VOLOUME II

TECHNICAL SPECIFICATION

SECTION -4

CONTROL AND INSTRUMENTATION

TABLE OF CONTENTS

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1.0 GENERAL TECHNICAL REQUIREMENTS

1.1 INTENT OF SPECIFICATION

This specification is intended to provide the technical guidelines for the fully coordinated Control & Instrumentation system with auxiliaries and accessories for 2 X 800 MW Coal based Super Critical Thermal Power Project. The duty of services as specified below and in other drawings and documents forming part of this specification are as required for safe, reliable, trouble free and efficient operation with adequate maintenance facilities as per modern power station practices and as per terms and conditions enumerated in this specification.

The technical specifications that follow serve as the guide specification for the C & I systems supplied as part of equipment packages within the contract, as also various system controls included as part of sub-packages, as in case of plant auxiliaries and off site units. Interfaces with external systems are also addressed.

In conformity with the guidelines provided in the specification, the scope of works shall completely cover all the control & instrumentation equipment, functions, activities and documentation specified under the accompanying Technical Specifications and shall not be limited to the following:

a) Detailed design and engineering of the manufactured equipment; system integration and system engineering.

b) Complete manufacture including shop testing.

c) Specifying, procurement, quality inspection of bought-out items from sub-suppliers. Design co-ordination for and integration with bought-out items with sub-suppliers.

d) Coordination, integration and interface between the station C&I system and various proprietary (from major equipment suppliers) and plant auxiliaries & off site control systems.

e) Providing engineering drawings, documents, licensed copy of software and developmental tools, data, instruction, operation and maintenance manual etc. for Owner's review/ approval / record.

f) Arranging for Owner's inspection and testing of manufactured as well as bought-out items at the respective works.

g) Packing and transportation of instruments, equipment, accessories and erection hardware from the manufacturer's works to the site, including transit insurance.

h) Opening of site office at location provided by Owner.

i) Receipt, storage, preservation and conservation of instruments, equipment and erection hardware at the site.

j) Fabrication of site-constructed items.

k) Pre-assembly (if any), erection, testing and commissioning of all the equipment and instruments in totality (including erection hardware, accessories/devices etc.).

l) Performing availability tests and Performance and Guarantee tests on completion of commissioning.

m) Prepare and submit all approved and as-built drawings both in hard and soft copies.

n) Furnishing of spares, tools and tackle, test and laboratory instruments.

o) Fulfilling post-commissioning liabilities.

p) Arranging training of owner's personnel of different categories at equipment manufacturer works.

q) Other activities detailed in the previous and subsequent sections of the Specification.

r) Any other activity, not mentioned explicitly, but felt by Bidder as essential for successful completion of work.

The requirements enumerated in this specification are based on typical configuration of the plant for bidding purpose. It shall be the responsibility of Bidder to offer the Control & Instrumentation system to meet the actual functional requirements of the plant.

The unit control and instrumentation system and other major proprietary control systems based on integrated Microprocessor Based Distributed Digital Control and Management Information System (DCS) shall be supplied for each unit. Complete operation and control of Steam Generator, TG Auxiliaries, Station C&I and auxiliary systems shall be carried out from DCS. In general no Back up Analogue Indicators or Recorders are foreseen for the operation of the main plant, other than cases where need for such back-up is strongly recommended by equipment suppliers or in cases where such requirements are clearly spelt out in the specification. However, Bidder shall demonstrate as to how the plant can be brought to safe shutdown condition without any damage to any plant personnel or equipment in case of total black out condition of Distributed Control System (DCS). To this extent any back up controls, indications, switches etc. as required by Bidder shall be supplied. However, there shall be back up panels which shall house the emergency trip buttons of boiler & turbine, start & stop PB and ammeters of critical drives, open & close PB for critical valves & dampers, electrically assisted safety valve, Remote Electronic water level Indicators (EWLI) for Deaerator & HP heaters and Manual synchronization station. Bidder shall furnish a list for the backup instrument /devices for engineer's approval. DCS shall be adequate for start-up, shutdown, load adjustment, load throw off, emergency handling etc. including operation of electrical breakers from the operator stations of DCS. In addition Four (4) x 72" LED based Large video screens (LVS) per Unit and Two (2) x 72" LED based Large video screens (LVS) for common system shall also be provided for control, monitoring and alarm.

It is not the intent to completely specify all details of design and construction features herein. Nevertheless, the instruments / equipment and their installation shall conform to high standards of engineering design and workmanship in all respects.

In case of any conflict or contradiction between any two or more sections of this specification the more stringent condition shall generally be applicable. Owner, however, reserves the right to relax this condition at his discretion.

1.2 GENERAL PERFORMANCE REQUIREMENT

All instruments and control equipment shall be guaranteed to meet the performance, functional and accuracy requirements enumerated in different sections of the specification. All instruments and control equipment shall be guaranteed against manufacturing defect for at least one (01) year from the date of handing over of the C&I system in totality to Owner.

The guaranteed performance criteria shall be met in full during the guarantee period.

Any predictable or planned deterioration and / or obsolescence of equipment shall be clearly brought out in the bid.

All instruments and control equipment shall be capable of maintaining the performance and accuracy standard over the complete regime of operation of main equipment taking into account the excursion of parameters during emergency or during malfunction of main equipment.

Control & Instrumentation system shall not impose any limitation or constraint on the operation of the main equipment. It shall be possible to utilize any in-built over capacity in design of any equipment with complete controllability and observability.

The control system shall be designed to prevent abnormal swings due to loss of control power, instrument air pressure, failure of any control system component, open/short circuits or any other such failure or degradation in the system and shall be driven to the fail safe condition. All modulating control valves shall be in stay put condition during any of the above failures.

The Mean Time between Failure (MTBF) of the instruments shall be considerably higher than the equipment they shall cater to in order to avoid shutdown on account of instrumentation failure. Apart from the cases clearly brought out in the specification, Bidder shall introduce control equipment or redundant instruments wherever it is felt that the introduction of the same may lead to reduction of downtime of plant and equipment.

In cases where continuous monitoring of performance of equipment is envisaged in the specification, Bidder shall supply instruments of suitable accuracy class to meet the accuracy requirements of the performance calculation as per standard.

All instruments and control equipment shall ensure high reliability, low downtime and ease of maintenance.

The protection systems and their safety features shall be guaranteed to ensure the main equipment safety in the event of tripping, mal-operation and malfunction.

The performance guarantee shall be on complete system basis as well as on the basis of isolated, individual instrument or component.

Bidder shall replace all instruments failing to meet the performance stipulations of the specification at any stage of the project.

All instruments / equipment shall be capable of performing satisfactorily in continuous commercial operation conforming to all relevant codes and regulatory requirement under the specified environmental conditions. In general, equipment located in air condition environment shall be capable of operating without any degradation of performance or damage to the equipment or components for at least twelve (12) hours to keep the plant in

running condition in case failure of air conditioning units. For any equipment or component that cannot conform to this requirement, Bidder shall consider redundant back-up package split type air conditioning unit/s.

1.2.1 Trial operation

The trial operation shall be conducted by Contractor as per the stipulation of this specification.

1.2.2 Performance and guarantee test

Contractor shall perform the tests for performance and guarantee as per the stipulations of this specification.

Performance and Guarantee Test Procedure

A. Normal Loading & Unloading

Bring the unit to maximum load capability and change the load in the range from 65% to 100% MCR at the rate of (±) 3% and (±) 5% per minute for maximum duration of 5 (five) minutes from unit master. Observe the deviation from the set point for the parameters stated in the attached table.

B. Sudden Loading Changes & Runback

01) Drop 50% of maximum load capability from approximately full load at a rate of 10% per minute or more if permitted by the main equipment.
02) Drop load from full rated output to the lowest load run-back limit, at a rate corresponding to the fastest runback rate.
03) Pick-up 50% of the maximum load capability from approximately 50% load at a rate of 10% per minute or more, if permitted by the main equipment.

The Contractor shall 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 limit specified in the attached table, so that the equipment being controlled will operate as specified below, over the range required. The Contractor shall operate the unit automatically, with no assistance from the operator. The Contractor shall successfully demonstrate the performance of the Control Systems as per attached table before acceptance and taking over the system by the Owner.

NOTE: Control Systems limit the transient disturbances within the specified limits and shall return the controlled variables to the set points within the shortest possible time without undue oscillation.

MAXIMUM DEVIATION OF PARAMETERS FROM SET POINT							
SL. NO.	LOAD RANGE (% OF MCR)	RATE OF LOAD CHANGE (% OF MCR PER MINUTE)	THROTTLE PRESSURE DEVIATION (KG/SQ.CM)	FLUE GAS O_2 DEVIATION (% OF O_2)	SH TEMPERATURE DEVIATION (DEG. C)	RH TEMPERATURE DEVIATION (DEG. C)	FURNACE PRESSURE (MMWC)
Steady State Condition							
1.	65% to MCR	(+) 0	(±) 2.0	(±) 0.5	(±) 5	(±) 5	(±) 10
Ramp Load Changes (For 5 Minutes) Constant Pressure Operation							
1.	65% to MCR	(±) 3	2	(+) 0.7 (-) 0.5	(±) 10	(±) 15	(±) 20
2.	65% to MCR	(±)5	3	(+) 1.0 (-) 0.5	(±) 15	(±)15	(±) 30
Sliding Pressure Operation							
1.	65% to MCR	(±) 3	3	(+) 1.0 (-) 0.5	(±) 15	(±)15	(±)30
Step Load Changes							
1.	From 65%	(+) 20	(±) 4	(+) 2.5 (-) 0.5	(±) 10	(±)15	(±) 40
2.	From 65%	(–) 20	(±) 4	(+) 2.5 (-) 0.5	(±) 10	(±)15	(±) 40
3.	From 80%	(+) 20	(±) 4	(+) 2.5 (-) 0.5	(±) 10	(±)15	(±) 40
4.	From 100% to 15%	Fast Run Back Rate	Up to Safety Valve Pressure	(+) 3.0	(±) 10	(±) 15	(±) 60

1.2.3 Total system availability

Bidder shall guarantee the total system availability of 99.7%.

1.3 GENERAL TECHNICAL REQUIREMENTS

Equipment and system shall be designed and constructed to meet all specification requirements and perform accurately and safely under the environmental and operating conditions described or implied in this specification without undue heating, vibration, wear, corrosion or other such operating troubles.

Equipment, systems and accessories shall be supplied from latest proven product range of reputed experienced manufacturer whose successful performance has been established by a considerable record of satisfactory operation in large capacity coal fired thermal power stations and shall be based on the latest engineering practice. Bidder shall obtain owner's approval for the selected manufacturers.

The equipment, systems and accessories furnished shall be designed and constructed to meet all specification requirements and performance specifications during the continuous service life of the plant. Equipment or components that cannot meet this life expectancy or specified design and operational requirements during the entire service life shall be

identified in the offer and their expected failure rate shall be indicated, otherwise it shall be deemed that the equipment or components are suitable for the service life of the entire plant.

Bidder shall indicate the year in which the offered models of the instruments and control system have been introduced and how long the commercial production of the same is expected to continue. In any case bidder shall ensure supply of spare parts for life time of the plant. In case if it is felt by the bidder that certain equipment/component is likely to become obsolete the bidder shall clearly bring it to the notice of owner and indicate step proposed to deal with such obsolescence.

Any part/module of the C&I system which are not listed under recommended spares shall be deemed with life expectancy not less than the expected life of the plant i.e. 30 years.

Bidder shall supply proven latest version of hardware and software available at the time of system designing. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system at par with the new version within the warranty period. Beyond the warranty period and during the remaining life of the plant, any Upgradation in hardware and software shall be brought to the notice of owner and shall indicate whether it shall be possible to upgrade the system by replacing certain pieces/components of hardware /software.

Instrumentation & Control System envisaged shall be adequate for control & monitoring of significant variables, in accordance with the requirements of the process, to meet all operational requirements and provide safety controls needed for the plant and auxiliaries. Any improvement in system design beyond what has been specified may be accepted provided the project schedule and the functional and operational requirements of the plant remain unaffected.

For the sake of completeness of the system for each application and in order to ensure desired performance & safety measures, any hardware or software item felt required, shall be in the scope of Bidder irrespective of their explicit or implicit inclusion in the accompanying document. Bidder shall be responsible for proper functioning of the system as a whole or any part thereof and shall render guarantee for all addition/deletion.

Technical details furnished in the accompanying documents which are subject to change in future within reasonable limits which Bidder shall abide by.

1.4 DESIGN PHILOSOPHY

Integrated microprocessor based closed loop control, open loop control and sequential control and bulk data acquisition system for SG & auxiliaries, TG & auxiliaries, station C&I and auxiliaries in hierarchical levels and integrated unit monitoring and station monitoring systems in the upper level, has been envisaged for the plant.

Instruments, in general, shall be miniaturized type using latest solid-state technology capable of functioning reliably in a trouble free manner in an extremely dust laden environment. Plug-in type connection with mechanical latch shall be preferred. The I&C equipment shall be designed suitably that are subjected to saline atmosphere.

Field process transmitters and pneumatic control valve & damper positioners shall be smart type HART compatible. Each transmitter and positioner shall communicate with the control system in the form of analog signal 4 – 20 mA DC along with superimposed digital signal through any proven protocol like HART to facilitate configuration, zero adjust, calibration and diagnostic from remote station in addition to configuration by handheld

smart configurator. However, for the OEM supplied equipment and for off-site & plant auxiliary packages, communication in conventional mode of 4-20 mA DC may be used. Transmitter response time shall be less than 100 msec. Turn down ratio shall be 100:1. Proven transmitters with the fastest response time shall be provided for critical application like Furnace pressure and Condenser Vacuum measurement etc.

Loops shall be hardwired connected to the instruments/switches.

Power supply for Transmitters and contact interrogation / solenoid shall be 24V D.C. and (+/-) 24/48 Volts D.C respectively. Interrogation /solenoid power shall be made separate from control system rack power supply. In all cases redundancy in power supplies shall be considered.

Within the battery limit of contract, the supplied Instruments such as transmitters, switches, temperature elements, motorized actuators, pneumatic actuators, solenoid valves, DCS systems, vibration monitoring system, CCTV equipment, work stations, PCs, printers, UPS, network components etc. irrespective of any sub-vendor for any package shall be of proven design. Uniformity of make and type of instruments in similar applications shall be followed throughout the contract, except for the proprietary items where this requirement may not be possible to meet and for all such cases bidder shall establish his attempt towards fulfilment of the requirement.

The Control System Architecture for the DCS is schematically shown in **Annexure – CI-01.**

When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.

Instrumentation sensing, transmission, measuring and computing system shall be solid-state electronic type. Final control device for regulating / closed loop control shall have pneumatic actuator & HART based smart pneumatic positioners. Actuators for isolating and inching duty dampers and valves shall be, in general, electrical motor operated.

All electronics located outside control room areas shall be tropicalized and enclosed in dust & weatherproof enclosures.

Local instruments shall be provided in cases where these are required for commissioning and re-commissioning of major equipment, for calibration and setting of other instruments, equipment safety etc.

In general transmitters & switches installed at outdoor location and in areas where it may be subjected to splashing oil, water, steam etc. shall be mounted in closed type illuminated transmitter enclosure. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. Drain from instrument rack/enclosure shall be connected to nearby plant drainage system.

Temperature measurement shall have upscale / down scale protection features not to cause major process upset in case of sensor failure. Both the elements of duplex temperature sensors shall be brought to junction boxes. In general, for temperature measurements up to 300°C, Platinum resistance temperature detectors shall be used unless the area is prone to vibration. For temperature above 300°C, chromel-alumel (K)

type thermocouples shall be used up to 750°C. For lower temperature, vibration prone areas, iron-constantan (J) type thermocouples shall be used. All temperature elements shall be in sheath tube and bar stock thermowells of suitable material not less than stainless steel grade. For high temperature applications, noble-metal thermocouple such as Pt Rh-Pt (R) type in Inconel sheath and thermowell shall be used.

In general temperature transmitter shall not be used for DCS based control & monitoring system. For such functions, temperature elements shall be connected to the respective system input module through pair cable in case of RTD type element and compensating cable for R type TC and extension cable for K & J type TC.

For non-critical applications (such as Boiler metal temperature measurements) where the measurements are not used for control / protection may be suitably grouped and connected to local RIO units of DCS.

In general temperature switch function shall be derived by use of temperature element and limit value monitor function instead of using conventional field mounted temperature switch. This function shall be software configured in DCS. For package supplied equipment where this philosophy cannot be implemented and /recommended by OEM, conventional temperature switch can be used as an alternative.

The instruments and control equipment shall be logically grouped in electronic cabinets in a functional sequence for convenient fault location, troubleshooting and maintenance.

Instruments shall have optimum response time. Equipment and devices which require maintenance shall be suitably located to ensure easy accessibility.

The related technical requirements, drawings and schedules are indicative only to provide a general guideline for the basic engineering standards acceptable to owner and are subject to change in future as necessary.

On-line testing, self-checking & diagnostic facility of control system shall be provided with indication for easy identification of the faulty module, while the unit is in operation. The system shall continuously check health of its modules including its redundant part and shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition and without endangering the safety of equipment without having any influence on the process being controlled.

Failure of equipment used for alarm & trip purposes will cause switching to the alarm state.

Automatic switchover to standby equipment (such as fan /blower /pump) is foreseen in case of either running equipment is not adequate to maintain the process or due to tripping of running equipment.

Bidder shall be fully responsible for safe and efficient operation of the control loops and interlock / protection logic even under all plant disturbances, disabilities, emergencies and component failures.

All the Control & Instrumentation devices supplied by Bidder shall be of reputed make and of proven record in similar plant applications.

Effort shall be made towards detection and thereby prevention of losses in the plant. All critical drain lines of high pressure & high temperature steam & water line shall be monitored for passing condition of the closed valves by providing temperature sensors.

Valve end position shall be monitored for the manual operated suction valves of critical pumps and all other manual operated critical valves wherever provided.

Motor winding temperature of HT motors and bearing temperature of HT motors & driven equipment shall be measured in all cases. Bearing temperature shall be measured with J type thermocouple / RTD. Temperature shall be measured, configured and monitored in DCS. Use of temperature scanner has not been envisaged. For monitoring of such temperature in a local panel where no operator station has been provided, suitable electronic display device driven by the output of DCS system shall be provided.

Unless otherwise specified duplex type Resistance temperature detector (RTD) and Thermocouple (TC) shall be provided.

Motor current and KWh signal for motors with rating on and above 30 KW shall be interfaced with the DCS for monitoring at respective control room.

Drive shall have its local emergency stop and local maintenance/trial start pushbutton station with local & remote selection switch in SGR/MCC. During the trial run safety permit and protection shall be ensured.

Position transmitter for modulating duty control valve shall be non-contact type.

Ergonomically designed chairs & desks shall be provided for use at the control room and various programming stations. Equipment like programming stations, PCs, various peripherals & similar devices shall be complete with desks, stands and other mounting accessories.

Required furniture consisting of table, desk, chairs, almirah, rack etc. shall be provided to set up maintenance & calibration laboratory. Same shall be completely erected and commissioned by bidder.

Alarm Annunciation System:

a) Conventional hardwired alarm annunciation system has not been envisaged in control room. All alarm will be displayed in DCS operator station. In addition to the DCS alarm, first three (3) rows of LVS will be used for critical alarm display. First row will be kept reserved for fixed alarm and the following two rows will be used for other alarm display for which location of window may vary.

b) Number of DCS alarm and LVS alarm will be decided during detail engineering stage.

c) Conventional CMOS / Microprocessor based window type alarms in local panels wherever required shall be provided.

Steam and Water Analysis System (SWAS):

a) The steam and water analysis system shall be designed in accordance with the recommendation as per ASME PTC 19.11/BS 1756 Part II, Water and Steam in Power Cycle.

b) The SWAS Transmitters shall be equipped to provide all signal requirements for connectivity of local indicators / recorders and DCS and such signal exchange shall be hardwired. SWAS shall be installed in air conditioned room.

c) The sample conditioning system shall be designed and constructed to receive and condition all samples required by the respective analyzer connected to the sample stream. This conditioning system shall perform the following functions:
   i) Primary high temperature sample cooling at field
   ii) Sample filtering
   iii) Sample secondary cooling and temperature control
   iv) Pressure reduction and control
   v) Flow rate control
   vi) Protection of analyzer against high sample Temperature and Pressure

Control Valves:

Control valves for regulating service shall be pneumatically operated and shall be provided with Smart Electro-pneumatic positioner. Control valves in high-pressure services shall have welded end connections. Control valves and actuators shall be equipped with standard accessories like air filter regulator with pressure gauge, valve positioners with pressure gauges, position transmitters, hand wheel, limit switches, air failure lock etc. Control valves for HP & LP Bypass system shall be hydraulic operated.

Steam Generator (SG) Integral Control and Monitoring:

This shall include major Boiler controls like Burner Management System (BMS) including Master fuel Trip (MFT), Secondary Air Damper (SADC), Soot Blower Control and other controls like Start, Stop, Automatic and Protective functions of coal mills, seal Air fans, scanner air fans, HP Bypass system etc. and other integral auxiliaries control as a minimum. SG integral Control and Monitoring system shall be implemented in the DCS and shall be complete with its Man Machine Interface (MMI) functions. All trip and interlocking inputs shall be hardwired.

BMS and Soot Blower Control system shall be complete with Local gun maintenance switch box and local control box respectively. In addition adequate number of Local control panels with push buttons, clustered LEDs, switches etc. as required and recommended by the bidder for the balance SG system shall be provided.

Turbo Generator (TG) Integral Control and Monitoring:

Turbine Control System (TCS) will be supplied by TG supplier. However, interface of TCS with main plant DDCMIS shall be ensured for operation, control & monitoring of complete BTG & auxiliaries from main plant DDCMIS.

Station C & I System:

Includes the control & monitoring of all other balance controls in SG area, TG area and other Balance of Plant equipment and auxiliaries such as ID fans, FD fans, PA fans, Air preheater, Fuel oil forwarding pumps, Boiler feed pumps, Condensate pumps, DM water cooling pumps, Condensate transfer pumps, Service water pumps, HP & LP chemical dosing, Pressure reducing & de-super heating system etc. along with all equipment integral instruments and balance field instruments and shall be complete with MMIs.

CW & ACW pumping system, Fuel oil system & Mill Reject System shall be DCS controlled & operated from their unit operator workstation as well as from local operator workstation.

Electrical Distribution and Management System:
Electrical Distribution Network of the units i.e. Unit Bus, Station Bus, Incoming & Outgoing feeders, transformer feeders etc. shall be operated and monitored from DCS with its Man Machine Interface (MMI) stations. Supervisory functions including data acquisition shall be realized in DCS. Trip and interlocking functions shall be hardwired in all cases.

Interface with Other Systems:
MODBUS / OPC link between the Offsite plant Control System and the main plant DCS shall be considered for display of data & status of the areas like Coal Handling System, Ash Handling System, Desalination & Water treatment System, Waste water / effluent treatment plant, Fire-Fighting pumps system, Air Conditioning & Ventilation System, Hydrogen Generation Plant, Chlorination System etc.

MODBUS / OPC link with DCS shall be considered for display of data & status from the switchyard SCADA, numerical relays and energy meter.

Bidder shall furnish necessary gateways, optic fibre cable & accessories for acquisition of data from the Offsite Control system and Switch yard SCADA system, numerical relays and energy meter.

Erection Hardware:
All erection materials and accessories required for erection of all items supplied as per the specification shall be included. The following shall be included, in general:

a) Process connection & stub and piping materials including impulse pipes, isolation valves, tubes of different grades with fittings, instrument racks (open & close type), clamps etc..
b) Stainless steel tubes along with required SS fittings and isolating valves for all pneumatic drives and field mounted regulators etc.
c) Junction boxes required for the complete instrumentation and control systems.
d) All cabling accessories required for laying and erection of cables e.g. flexible conduits / HDPE conduits / trays for compensating / instrument signal & control cabling along with pull/cable boxes, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts etc.
e) Root valves of two numbers for process pressure of 40 Kg/cm^2 and above and single for process pressure less than 40 Kg/cm^2 as per piping specification.
f) Root valves and thermowells with protecting cap for all test points.

Local Instruments:
a) Required local instruments, panels, gauge boards etc. shall be provided for safe and efficient operation of the plant.
b) Local and remote performance mentoring of heat exchangers and coolers shall be provided with upstream and downstream temperature measurement.
c) Heat exchangers and strainer chocking condition shall be monitored at local and remote.

1.5 PROVEN PRODUCT

All C&I equipment / systems / sub-systems / instruments and accessories shall be of make and model whose guaranteed and trouble-free performance has been proven at least for two (2) years in not less than two (2) different reheat type pulverized coal fired utility stations of similar capacity.

Bidder shall furnish all required information to fully satisfy Owner regarding successful operation and high reliability of products / systems furnished.

1.6 CODES AND STANDARDS

Refer Vol – II / Section – 18.

1.7 DESIGN CRITERIA

This section lays down the general design criteria to be adapted in designing the instrumentation and control system of the entire plant.

1.7.1 General Requirements

Each pneumatic device requiring air supply and intended for field mounting shall be provided with stainless steel tubing, filter regulator set with gauge and stainless steel isolating cock.

Process fluids shall not be piped directly to instruments located in Central Control Room (CCR) and Control Equipment Room (CER) area.

All parts subject to high pressure, temperature or other severe duty shall be of materials and construction suitable for the service conditions and long operating life.

Components of instruments, control devices, accessories, piping etc. which contact steam, condensate or boiler feed water shall be manufactured from copper-free materials.

1.7.2 Instrument Accuracy, Standard Scales and Ranges

a) Instrument Accuracy

The accuracy requirements for various types of instruments have been provided in the specification of the respective instruments and are applicable for the following

- Transmitters for pressure shall transmit signal, which is linear with respect to the measured pressure.

- Flow meter transmitter shall meet the specified accuracy criteria when operating between 25 and 100 percent of full-scale flow value. The accuracy guarantee shall include the effect of errors in the differential head measuring device, square root converter and signal generator, but not the primary device.

- Transmitters for level shall transmit signal, which is linear with respect to the measured level based on a specific gravity of 1.00.

- Wherever the measurement is influenced by process pressure & temperature, for example measurement of steam flow, feed water flow, air flow etc. required correction against pressure and temperature shall be introduced for such measurement.

- Temperature compensation shall produce corrections, over a flow range from 10 percent to 100 percent of maximum flow, subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

- Accuracy requirements of other instrument types are given in the respective specifications.

b) Instrument Scale Displays

- All displays shall be in engineering units. Instrument scales displayed on screen will have graduations with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.

- Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure, respectively.

- Scales and charts of all instruments shall have linear graduations

c) Instrument Ranges

Instrument range shall be selected to have the normal reading, preferably between 50% and 70% of full scale for linear parameters and 70% to 90% for flow measurements. Deviation indicators shall have the null position at midscale. The normal operating parameter shall be identified with a clear green mark.

1.7.3 Operability & Maintainability

The system shall be designed such that any 'single-failure' should not lead to loss of availability of the plant, modification in operating routine or degradation of performance. This shall be achieved by judicious introduction of redundancy at all critical levels like providing hot-standby multi loop controllers, redundant data hi-ways, duplicating console functions and servers. The plant operator remains totally transparent to 'single-failures'.

Control system shall be designed in a fail-safe mode so that loss of signal, loss of excitation, loss of motive power or failure of any component shall not cause a hazardous condition for the plant & personnel and at the same time prevent occurrence of false trips.

The types of failure which shall be taken into account for ensuring operability of the plant shall not be limited to the following:

- Failures of sensors or transmitters.
- Failure of controller during automatic operation.
- Loss of motive power to final control elements.
- Loss of control power.
- Loss of instrument air.

The unit control consoles shall be designed for operation of the unit with minimum operational manpower deployment. Bidder shall ensure proper operability and also take into account protections to minimize accidental mal-operations in the operator's interfaces.

The choice of hardware shall take into account sound maintainability principles and techniques and shall not be limited to the following:

- Standardization of parts.
- Minimum use for special tools.
- Modular and hot replacement.
- Logical grouping of functions.
- Separate and non-interactive adjustability.
- Malfunction identification facility through self-diagnostics.
- Easy removal, replacement and repair.
- Easy assembly and disassembly.
- Fool-proof design providing proper identification and other features to preclude improper mounting and installation.
- Redundancy of critical parts.

- Unique system-hardware identification by assigning sub-racks / sub-rack sections to specific control loops with no mutual sharing of input / output cards between different loops.

Intercommunications in between sub racks and system termination cabinets and in between sub racks and other panels shall be made by prefabricated connectors and cables with mechanical latch.
Adequate test facility shall be incorporated in the design.

1.7.4 Established Reliability & Availability

All components and systems offered shall be of established reliability. The minimum target reliability of each component shall be established, considering taking into consideration its failure rate/ mean time between failures (MTBF), mean time to repair (MTTR), such that the availability of the complete system is assured for 99.7%.
In order to ensure the target reliability Bidder shall perform necessary availability tests and burn-in tests for major systems. Surge protection for solid state systems, selection of proper materials, manufacturing process, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.
Continuous self-checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

1.7.5 Redundancy Criteria

Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations in critical applications are fully met.

a) Input and output

- Redundant field transmitters shall be offered for critical parameters in the plant. 2 out of 3 voting logic and 1 out of 2 comparison circuit shall be used for critical applications as elaborated later.

- All critical unit interlock and protection systems shall incorporate two out of three redundancy concepts to ensure adequate safety of plant equipment.

- Redundancy in output module shall be provided for all HT and important LT drives and all modulating control drives so that any single failure shall not lead to the failure/disturbance of process.

b) Control System

Reliability of the DCS and other control systems offered shall be established by judicious incorporation of redundancy. The issue is described in detail in technical specification section. However, in general all critical parts/components shall have hot standby feature to render the system immune to any single failure. Typically duplicated parts shall include multi-loop controllers, servers, data hi-ways etc. Operator's consoles shall have fall back feature so that, in case of failure of any console, its functions can be taken up in an adjacent console.

1.7.6 Design of Enclosures

Design of outdoor enclosures shall be weather proof, dust-tight, drip-proof and shall take into account the environmental conditions.

Enclosures shall be adequately sized so that the maximum permissible temperature rise inside the enclosures is 10 ^{O}C (maximum).

Enclosures design shall also take into account greatest possible personnel safety.

1.7.7 Electrical Noise Control

Equipment furnished by Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise interferences and power line borne surges especially encountered in power plant environment. Equipment, which are vulnerable to electrical noise interference or surge, shall be suitably immunized to eliminate possible problems.

Bidder shall be fully responsible for detailed implementation of the type, size, shielding, input balancing, ripple amplitude and grounding for field inputs and for the equipment furnished by Bidder to achieve an installation with minimum noise coupling from all sources.
Any additional equipment, services required for effectively eliminating the noise problems shall be identified and included.
Radio frequency interference shall be in accordance to IEC 801-3.

1.7.8 Surge-Protection for Solid State Equipment

All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand the surge without damage to components and/or wiring on application of surge wave whose shape and characteristics are defined in ANSI publication C37.90-a (IEEE-472-1974) entitled "Guide for Surge Withstand Capability (SWC) Tests".

Details shall be provided of production tests being carried out to fully satisfy owner that the proposed equipment meets the above requirement and to assure that the products furnished shall be of the desired grade. To immunize the system against surge or coupling it is preferred that freewheeling diodes, surge suppressors, opto / galvanic isolators be used as required.

1.7.9 Burn-in and Elevated Temperature Test

All solid-state equipment shall be tested for a minimum of 168 hours continuously under power prior to shipment.

During the first 48 hours of testing the ambient temperature shall be maintained at 50^{O}C and the equipment shall be made to repeatedly perform all operations it will be expected to perform in service with loads on various components being equal to those which will be experienced in actual service.

The 48 hours test period shall be continuous but shall be divided into four 12-hour segments. The input voltage during each 12 hours segment shall be nominal voltage for 11 hours; followed by 110 percent of nominal voltage for 30 minutes; followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test at normal operating temperature. This test shall also be conducted as per above procedure.

Solid-state logic systems shall be subject to the elevated temperature test and burn-in test as complete assemblies. Testing of individual components or modules shall not be acceptable.

1.7.10 Panels, Cubicles and Enclosures

a) General

- All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, and necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.

- Unless otherwise specified cable entry for panels /desk/cabinets shall be from bottom through bottom plate with glands. Fireproof seal shall be used to seal the bottom to prevent entry of dust.

- Cabinet/panel shall be designed for maximum ambient temperature of 50^0C and maximum temperature rise of 10^0C above ambient temperature under all operating condition.

- Electrical switchboards; panels and cabinets, except mosaic grid type and those of cast metal, shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the steel plate shall conform to the requirements of UL 50 or equivalent standard. Switchboards, panels and cabinets shall be of adequate strength to support mounted components during shipment and to support a concentrated load of 100 Kilograms on their top after erection.

- Panel /cabinet shall have eyebolt on top for lifting.

- Junction boxes / pull boxes shall be made of either with Sheet Steel or better.

- All panel/desk/cabinet shall be grounded.

- The nameplates and terminal blocks shall be provided on as required basis for panels, cubicles and enclosures.

b) Surface Preparation and Painting

All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

- Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

- Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish color for exterior and interior surfaces shall conform to the following shades:
  - Exterior – Light grey RAL 7035.
  - Interior - Brilliant White.

- Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

c) Wiring

Interconnecting wiring shall be provided between all electrical devices mounted in the panels and between the devices and terminal blocks if the devices are to be connected to equipment outside the panels by cabling and not through pre-fabricated plug in cables. All control and instrument wiring used within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Sufficient clearance shall be provided for all Control & Instrumentation leads.

- All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All interconnections between sections of panels/desks shall be furnished.
- Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.
- All wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Open ended terminal lugs shall not be used. Wires shall not be looped around the terminal screws or studs.
- Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.
- All low-level signal cables shall be separately bundled from control cable.
- Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- Where pre-fabricated cables are used for direct connection to electronic cubicles plug in type connectors shall be used as per manufacturer's recommendation.
- Shield wires shall be terminated on separate terminals.
- Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.
- Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue failure of the conductor.
- Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

- Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

- Panels /cabinets /desks shall be provided with removable gasket cable gland plates and cable glands. Split type grommets shall be used for prefab cables.

- Wire shall be multi stranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.

- Wire sizes used for internal wiring shall not be lower than the followings :

  a) Control wiring (Such as switches, ammeters etc.) : 1.5 Sq. mm
  ii) Power supply/receptacle /illumination wiring : 2.5 sq. mm or higher as per load.
  iii) 4-20mA DC current and low voltage signal up to 48V DC : 0.5 Sq. mm

- Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.

d) Grounding

- Separate Protective and Electronic grounding system shall be provided for DCS and offsite package.

- All panels and cabinets shall be provided with a continuous tinned copper ground bus of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. The ground bus shall be bolted to the panel structure and effectively ground the entire structure.

- The panel /desk /enclosure /JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI/ copper flat ground riser by means of insulated copper ground cable of required cross section with lug.

- Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by lugs.

- For electronic system cabinets the electronic system ground bus shall be similar but insulated from the cabinet enclosure and shall be separately connected to the system ground. The same ground may be used to earth the shield of shielded signal cables if recommended by equipment manufacturer, otherwise a separate ground bus shall be provided for connecting the shields of signal cable. Cable shields shall be grounded at the panel end only and shall never be left open. The ground in between panels of a shipping section shall be firmly looped.

- Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

e) Miniature Circuit Breakers (MCB)

MCB shall in generally be used for circuit protection and isolation of power distribution circuit covered under the specification.

f) Fuse Blocks

Where fuse blocks are required by the specifications or the manufacturer's design, they shall be modular type with Bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

g) Fuses

Where slow blow fuses are required for protection of instruments /devices they shall have ampere ratings of 1/4, 1/2, 1 or 2. Where fast acting fuses are required for protection of equipment they shall have ampere ratings of 1, 3, 6, 10, 15, 20 or 30.

h) Panel / Cabinet/ Desk/Enclosures Environmental Protections

- Panels, cabinets, desks, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures located in outdoor, indoor and air conditioned environment shall suit the environmental condition of the area shall not be lower than the requirement indicated in the following table.

SL. NO.	LOCATION	ENCLOSURE TYPE
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-42
4.	Outdoor type in non-hazardous areas	IP-65
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

- The construction of electrical enclosures located in areas subject to conditions classified in the National Electrical Code (NEC) as hazardous shall be of a type designated suitable for the environment in which they are located.

- Junction boxes and pull boxes shall be in accordance with the requirements of NEC, Article 370, Paragraphs 18, 19, 20 and 21 and shall be without knockouts.

i) Terminal Blocks

- Terminals shall be chromated galvanized DIN rail mounted screw less cage clamp type or maxi termi type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm2. Terminal blocks shall conform to IEC 947-7-1.

- The characteristics of the terminal blocks shall be as follows.

  - High contact force, independent of conductor cross-section and large contact surface area.
  - Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
  - Inspection and maintenance free (resistant to thermal aging and vibration)
  - Low and constant voltage drop

- Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screw less terminals, the tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.

- Terminals shall be of non flammable suitable thermoplastic material.
- Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block.
- Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- At least 20 percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc. This shall be in addition to 20% spare wired terminals of spare IO channels.
- Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.
- Other requirements of the terminal blocks are as follows:
  - The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
  - For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
  - Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
  - It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
  - Where more than one connection to a terminal block is required, two tier terminals shall be used.
  - Terminal blocks shall preferably be assigned different color depending upon voltage and current levels.

j) Nameplates and Labels

- Each main and auxiliary items of plant shall have permanently attached to it in a prominent position, a rating plate of non-corrosive material upon which is to be engraved the manufacturer's name, equipment, type / model number, range, serial number, together with details of the loading conditions under which the item of plant in question has been designed to operate.
- Such nameplates or labels are to be of white non hygroscopic material with engraved black lettering, or alternatively, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably colored lettering engraved on the back.
- The nameplates shall be held by self-tapping screws. The size of nameplate shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels.
- Items of plant such as valves, which are subject to handling, are to be provided with an engraved chromium plated nameplate or label with engraving filled with enamel, suitably mounted or affixed with strong rustproof chain.
- All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

k) Tests On Solid State Logic Cabinets

- All solid-state logic cabinets shall be tested in manufacturing works as per approved Quality Assurance Program. Acceptance Tests shall include visual and functional checks not limited to the followings:
  - All solid-state logic cabinets shall successfully undergo the burn-in test and elevated temperature test as per this section prior to shipment from manufacturing works.
  - All solid state logic systems shall be tested for surge withstand capability test in accordance with the requirements of ANSI c37.90a prior to shipment from manufacturing works.
  - All solid-state logic cabinets shall be tested for noise.

- All facilities for such test shall be created by Contractor at his manufacturing facility or at the works of the sub-suppliers.

1.8 METERING BASES AND CHART UNITS

The following system of units shall be followed for various displays and scales unless otherwise mentioned:

i)	Pressure	:	bar
ii)	Differential Pressure	:	mbar
iii)	Draught	:	mbar
iv)	Vacuum	:	bar (abs)/mm of Hg column
v)	Temperature	:	Degree Celsius (^{O} C)
vi)	Flow (Steam, Water)	:	Tonnes / hr.
vii)	Flow (Oil)	:	Tonnes / hr.
viii)	Flow Air	:	Tonnes / hr / M^3 / Hr.
ix)	Density	:	gms / c.c.
x)	Level	:	mm
xi)	Conductivity	:	Micro-mho / cm
xii)	Gas Analyzer	:	Percentage by weight or as specified in respective case.
xiii)	Dissolved Oxygen / Silica / Sodium & Hydrogen	:	ppm /ppb or %

1.9 PROCESS CONNECTION & INSTRUMENT HOOK UP

Instrument connection to the process system (piping, vessel etc.) shall be according to the process & piping specification up to and including the root valves. Root valves shall be installed as close as possible to the piping or vessel.

Each instrument shall have its own connection except for instruments located on standpipe. In this case only the connections to the vessel are common. Each instrument shall be connected independently to the standpipe through isolation valve. Standpipe shall have isolation / block valves for connection with the process.

Gate type (full opening) isolation valve and blow down drain valve adequate for duty requirement and for withstanding continuous design pressure and temperature of main process medium shall be provided in the hook up. Instrument blow down valve near to the instrument shall be of gradual opening type. For process pressure equal or above 40 kg/ sq.cm double blow down valves shall be used before connecting to blow down header. Instrument manifold / gauge valve shall be installed close to the instrument.

The nominal size of the take-off connections on line shall not be less than NPS ½" for source conditions not in excess of either 900 psi or 425^{0}C and NPS ¾" (for adequate physical strength) for design conditions exceed either of these limits. Where the size of the main is smaller than the limits given above, the take-off connections shall not be less than the size of the main line.

Process connection for instruments on line and vessel shall be in accordance to standards such as ASME and other recognized international standards. Table below indicates the type of connection generally to be used for the various types of instruments. Bidder shall furnish detail of tapping points with drawing during detailed engineering.

INSTRUMENTS	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
Level Instruments		
Internal Displacer	4" - Flanged	4" - Flanged
External Displacer	2" - Flanged	2" - Flanged
Level gauge	¾" -Flanged	¾" - Flanged
DP Type	½" (min.)-welded 1" – welded for vessel like HP heaters, LP heaters, De-aerator, Boiler Separator etc. application	½"- NPT
External cage Level switch	1"- welded	1"- welded
Flow Instruments		
DP Type	½" - welded in general 1" – welded for high pressure / temperature main steam, feed water, PRDS etc. application	½" - NPT
Pressure Instruments		
Conventional	½" (min.)-welded 1"- welded for high pressure/ temperature main steam, feed water, PRDS etc. application	½" - NPT
Temperature Instruments		

INSTRUMENTS	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
Thermowell	Generally - M 33 X2 (M) 1½" Flanged- For air/FG path application	½" NPT
Analyzer		
Liquid analyzer	½"- 1" - welded	½"

Size of impulse pipe for pressure measurement in air and flue gas duct path of boiler shall not be less than ¾" NB.

Rotameter shall generally be flanged type except if less than ½", in such case connection shall be screwed type.

For level measurement by DP cell low level taps on the vessel shall be made horizontal to avoid plugging.

Separate stubs and take-off points with thermowell / root valves shall be provided for performance guarantee test.

Impulse pipe shall be seamless type and conform to ANSI B 36.10.
Impulse pipes shall be clamped at suitable interval not exceeding 1.5 meter. Process pipe shall not be used for supporting the impulse pipe.

Fittings shall conform to ANSI B 16.11. Threads of piping component shall be of tapered construction.

Instrument blow down header shall in no case be lower than the material grade ASTM A 105 Gr. B.
Impulse pipe shall be laid at least with slope of gradient 1:10.

Expansion loop shall be provided at least at every 2.5 meter interval without affecting the gradient of slope in long run impulse pipe to avoid stress on the piping.

Material of impulse pipe for the instruments mounted on rack and enclosure shall be same as that of main process pipe except stainless steel tube of Gr. 316H or better shall be provided for connection in between impulse pipe (from tee connection on impulse pipe) and instrument manifold valve & instruments. Impulse pipe, tubes, fittings and accessories shall have the same design pressure and temperature applicable for the related main pipe.

1.10 POWER SUPPLY SYSTEMS

Bidder shall be fully responsible for engineering and furnishing a complete operational C&I system fully meeting the intent and requirement of the specification. Bidder shall furnish all equipment and accessories required for the complete system whether these are specifically mentioned in the specification or not. Type of power supply system shall be provided for the various C&I system including DCS shall be as follows:

a) 240V AC UPS (Main Plant UPS) -

For complete Distributed Digital Control including Boiler protection, OLCS /CLCS hardware, Turbine control, Turbine protection, Man Machine Interface, Peripherals and Interface Stations of DCS and other systems such as panel instruments, field instruments, SWAS, Microprocessor based control (Viz. gravimetric feeder) etc. requiring stabilized power source.

b) 240V AC UPS (Offsite Package UPS)

For DCS based off site & unit auxiliaries.

c) 24 V DC supply required for Control system shall be derived from 240 V AC UPS supply by using 240 V AC / 24 V DC converter. No separate 24 V DC system is required.

1.11 DRIVE CONTROL PHILOSOPHY

DCS INTERFACE WITH SWGR / MCC / INTEGRAL ACTUATOR			
SL. NO.	**SIGNAL DESCRIPTION**	**I/O TYPE**	**REMARKS**
A	**DCS INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE**		
a	Start Command	DO	
b	Stop Command	DO	
c	ON Feedback	DI	
d	OFF Feedback	DI	
e	Switchgear Disturbance (Overload relay operated/ control supply fail)	DI	
f	Electrical Trip	DI	
g	Emergency LPBS stop operated	DI	
h	Switchgear Available (Breaker in service position, switchgear in remote & breaker spring charged)	DI	
i	Motor Current (4 - 20 mA DC)	AI	
j	Speed Control	AO	For VFD Drives
k	Speed Control	AI	For VFD Drives
B	**DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE**		
a	Start Command	DO	
b	Stop Command	DO	
c	ON Feedback	DI	
d	OFF Feedback	DI	
e	MCC Disturbance (Overload relay operated/ control supply fail)	DI	

f	Emergency LPBS stop operated	DI	
g	MCC Available (MCC in remote)	DI	
h	Motor Current (4 - 20 mA DC)	AI	For Drive Motor >= 30 KW
C	**DCS INTERFACE FOR BIDIRECTIONAL LT DRIVE (With Integral Starter)**		
a	Open Command	DO	
b	Close Command	DO	
c	Integral Starter Disturbance (Overload relay operated / control supply fail / Emergency LPBS stop)	DI	
d	Local / Remote selection in Remote	DI	
e	Open limit switch feedback	DI	
f	Close limit switch feedback	DI	
g	Open Torque switch feedback	DI	
h	Close Torque switch feedback	DI	
i	Position Feedback (Position Transmitter 4 - 20 mA)	AI	For Inching type Drive
j	Speed input (For VFD Drives)	AI	
k	Speed output (For VFD Drives)	AO	
D	**DCS INTERFACE FOR SOLENOID DRIVE (Single coil)**		
a	Energise or De-Energise	DO	
b	Open limit switch feedback	DI	
c	Close limit switch feedback	DI	
E	**DCS INTERFACE FOR SOLENOID DRIVE (Double coil)**		
a	Energise	DO	
b	De-Energise	DO	
c	Open limit switch feedback	DI	
d	Close limit switch feedback	DI	
F	**DCS INTERFACE FOR PNEUMATIC CONTROL**		
a	Command to I/P converter	AO	
b	Position Transmitter	AI	
c	Open limit switch feedback	DI	
d	Close limit switch feedback	DI	
e	Command to Solenoid valve	DO	Wherever applicable
Note:			
1. Local / Remote Selection shall be located at SWGR / MCC side.			
2. Interposing Relay (IPR) shall be located at SWGR / MCC side.			
3. For Bi-directional Drives with Integral Starter, all the terminals (for Command / Feedback) shall be			

provided as potential free type.

2.0 SCOPE OF WORK

2.1 SCOPE

This section describes Control & Instrumentation equipment, material and services to be provided for 2 x 800 MW coal fired boilers & auxiliaries, steam turbine - generating units & auxiliaries, plant auxiliaries of the generating units.

Bidder shall be responsible for providing all material, equipment & services specified or otherwise required to fulfil the intent of specification ensuring operability, maintainability and reliability of Instrumentation and Control system described in this specification.

2.1.1 Scope of Supply

The scope of supply shall include but not be limited to the following:

(A) Hardware:

1) All Field instruments viz. smart transmitters (HART protocol), thermocouple, RTD, process switches, sensors, converters, analyzer etc. along with all accessories.
2) All primary flow elements along with branch pipes, root valves, flanges, nuts, bolts, gaskets and accessories.
3) All pneumatic control valves and dampers along with actuators, smart pneumatic positioners, limit switches, hand wheels, solenoid valves, position transmitters and accessories.
4) Thermocouple extension cables, Instrumentation pair & control cable, power cable, optical fibre cable, special cable as required.
5) All special & optical fibre cable for data acquisition from third party control systems including gateway and links.
6) Control panel, desk, operator's terminals, panel instruments, accessories and furniture.
7) Mounting, wiring, powering of all items to be mounted/installed on desks irrespective of the source of procurement shall fall in the scope of erection of contractor; this shall also include free issue items furnished by Owner.
8) Boiler integral instrumentation related to BMS/FSSS, SADC, Soot blower system, Coal Feeder, Electromatic safety valve, furnace Temperature Measurement system, Furnace temperature probe, and Automatic steam leak Detection System etc.
9) Integrated Distributed Digital Control & Management Information System for closed loop control, open loop control, sequence control and bulk data acquisition system for steam generator & its auxiliaries, TG & its auxiliaries, SCR, FGD, station C&I, electrical distribution system and other auxiliary systems with operator work stations, historical storage units, alarms, sequence of event recording, engineering & diagnostic terminal, required highway & interconnecting cables and devices, interface relays for signal exchange with electrical system, printers etc. and gateways and links for interface with third party systems.
10) GPS Master Clock System including Slave Clocks (25 nos. GPS Synchronising Signals (IRIG-B, SNTP, NTP, Pulse O/P) and 25 nos. Slave Clock of six digit display of digit size 100mm) including interconnecting cables, connectors, signal booster units, etc.
11) The preferred system architecture is illustrated in drawing no.: Annexure – CI-01 (Control System Architecture). Bidder shall be responsible for developing the system architecture, system integration, software design & documentation and proper commissioning of the system.

12) Isolation, conversion and distribution of Power supply to all instruments, panels, consoles, etc.
13) Required MCB/MCCB, fuse, isolation transformer, voltage conversion and power Distribution as required for instrument shall be considered.
14) All local Panels, Gauge Boards and Transmitter Racks (both open and closed type shop manufactured), stanchions, brackets etc.
15) All Local field instruments e.g. - pressure gauges, temperature gauges, pressure switches, temperature switches, level switches, flow gauges, flow switches, level gauges etc. with all accessories.
16) RTD / J type thermocouples for bearing temperatures measurement of pumps, motors or other equipment driven by H.T. motors.
17) All HT motors windings shall be provided with Duplex RTDs (PT-100) / suitable thermocouples - for monitoring & interlocking at DCS.
18) 3D Scanner type Level Monitoring System shall be provided for Bunker Level Monitoring.
19) Temperature elements at upstream & downstream of Heat Exchanger and Coolers. DP gauge & switch to check fouling condition of Heat exchangers and strainers.
20) Remote I/O multiplexers for bulk data acquisition of boiler & turbine metal temperatures shall be provided.
21) Digital display type MW, Generation Voltage and Frequency indicator at central control room.
22) All process connection and piping materials including impulse pipes of different grades & stainless steel tubes, stub, bosses, root valves, isolation & drain valves, valve manifolds, gauge valves, condensate pot, fittings, stands, brackets etc. as applicable for satisfactory installation of all field instruments like transmitters, local instruments etc.
23) Stainless steel grade pneumatic tubes along with required fittings and isolating valves for pneumatic drives, control valves including positioner and field mounted regulators.

- All erection hardware including junction boxes, pull boxes, canopies, structural steel items viz steel angles, channels, flats.
- Complete cable accessories inclusive of all flexible conduits, sub-trays/perforated tray, inspection covers, bends, elbows, mounting brackets, clamps, nuts and bolts, glands, lugs, ferrules, connectors, markers, sub-tray supports, rigid conduits, tie wraps etc.
- Complete optical fibre cable with accessories like terminators, taps, optical fibre distribution box, patch cord / pigtail, light interface unit, heavy duty conduit etc. to make the system complete in all respect.
- Rating plates, Nameplates and Labels for all I & C items.

24) Optical Time Domain Reflectometer for optical fibre cable testing.
25) Special maintenance, calibration, commissioning, site testing and troubleshooting equipment required for the Distributed Control System & Programmable Logic controller. For each unit, minimum 02 (Two) nos. of handheld Programming and Calibration instrument for Smart Transmitter shall be provided.
26) Supply of all start-up, commissioning and recommended spares in addition to the mandatory spares. Bidder must indicate minimum inventory requirement for start-up and commissioning spares.
27) Other items e.g. Four (4) LED based Large Video Screen of 72" per unit, 3 nos. LED based Large Video Screen of 72" for common system, GPS Master Clock, CCTV Monitoring Systems as described in various sections of the specification.
28) Plant view & Management Information System server for MIS function, plant-wide network with user terminals, networking hardware, optic Fibre cable etc.

29) Remote I/O (RIO) from same DCS family of hardware shall be provided for Off-site & Plant auxiliaries control.
30) Data collection from control system of all offsite package such as CHP and Plant water system, Ash handling Plant, Fire Fighting System, HVAC, etc. through OPC including required optic fibre cable and accessories.
31) Vibration Monitoring with Machine condition monitoring system for all HT drives & driven equipment including all monitors, and required cabinets, cable including optic fibre / special cable & accessories for each unit. SG island & auxiliaries HT drives/motors Vibration monitoring system is in SG island Bidder's scope. Bidder shall provide buffer output for vibration analysis system (By other) at VMS panel.
32) Complete Steam and Water Analysis System (SWAS) for SG & TG island including Wet Panel, Dry Panel, Piping/tubing (SS or better), sample conditioning system, valves, fittings, coolers, Chiller Unit, analyzer, indicators, recorders, grab sampling system, annunciator, PC station for monitoring & maintenance etc. is in SG Island Scope. For TG area system, Tubing / Piping from TG Area Sampling Points (root valves onwards) up to SWAS Wet Panel is in SG Island Scope.
33) Complete flue gas analyzer including emission monitoring instruments. On-line Continuous Emission Monitoring System (CEMS) at Chimney including analyzer remote monitoring and calibration facilities and compliant to Central Pollution Control Board (CPCB) / State Pollution Control Board (SPCB) latest guideline/norms.
34) Plant performance calculation and plant performance analysis & data optimization system.
35) Supply of all performance test instruments.
36) Training Simulator with four (4) nos. OWS, one (1) no. Instructor Station & Data Base Server shall be provided. The Simulator shall be replica of Main Plant DDCMIS.
37) APH Infra-red hot spot detection system
38) APH Rotor Stoppage Alarm Device
39) APH Gap Adjust & Fire Detection System
40) Flame Scanner & Monitoring System
41) Flame CCTV monitoring system
42) Coal Feeder Control System
43) Bunker Level Monitoring system
44) Mill CO Monitoring System
45) Boiler Tube Leak Detection System
46) Zirconia based Oxygen Analyzers (2 nos. in each side of economizer outlet & one no. in each side of APH outlet)
47) CO analyzer at each side of economizer outlet
48) SADC actuator with smart positioners
49) Complete I&C for FGD system
50) On line fuel measurement facility for accurate measurement of coal mass flow rate and air fuel ratio in each PF pipe from each coal pulveriser. The equipment shall comprise of sensors/ working on microwave technology including necessary software. The error in measuring system shall not be more than 5%, which shall be demonstrated by comparisons with isokinetic measurements.

2.1.2 Software

Bidder shall be responsible for software licensing, design, development, debugging, system engineering, customizing, installation, site modification, tuning, adjustments, commissioning and furnishing manuals, documentation etc.

2.1.3 Drawings and Documents

Bidder shall furnish system description, operational write-up, bill of materials, drawings, data, information, technical catalogues, test certificates and other details required to fully

establish the capability and performance of the equipment and systems offered. Any bid not containing sufficient details to fully describe the equipment and systems offered may be treated as non-responsive and hence rejected.

Document to be submitted in the bid shall not be limited to the following:

- DCS architecture with write up explaining SG control, Station C&I, Electrical distribution & management system.
- GPS system write up with configuration / scheme.
- LVS system write up with configuration / scheme.
- Bill of Materials of items indicating make, model, range, power requirements with technical features/catalogue/write up etc. required to establish product quality and completeness for scope of supply.
- Proposed General Arrangement of Control panels and Desks, System Cabinets, Power Supply Panels, Local panels, Gauge boards, Transmitter cabinets & racks etc.
- Schedule of type and routine tests proposed to be carried out by Bidder at shop and at site and write-up on the in- house quality assurance practice.
- Write-up on major hardware and software package with schematic drawings.
- Control system architecture with write up for all DCS controlled area.
- List of reference of similar system already in service with complete performance record details.
- Details of training of owner's personnel specifying duration of each course, course material, number and category of personnel proposed to be trained in each course, location etc.
- Field quality plans and testing program.
- Details of post commissioning services.
- Organizational structure of the company and proposed site organizational structure.
- Details of system engineering.
- Write up and scheme for power UPS & distribution system.
- Write-up on furnace temperature measurement and acoustic steam leak detection system.
- Write up on Plant performance analysis and optimization system.
- Write-up and specification of vibration monitoring system.
- Write-up on Management Information System including plant-wide Network.
- Write up on Steam water analysis system establishing completeness of supply.
- Deviation list, if any.
- All other schemes, data, drawing, document required to establish product quality and completeness of supply.

Submission of Drawings and Documents by the Successful Bidder (Contractor)

On award of the contract, the successful Bidder shall submit progressively, drawings and documents for approval of owner at different stages of the contract. Contractor shall obtain owner's approval in writing and manufacture the equipment as per these approved drawings and documents. Contractor shall revise the drawings in line with owner's comments and resubmit till approval is accorded. The drawings & documents shall not be limited to the following. After award of the contract owner in association with contractor will draw up a list of drawings, document/ deliverables with corresponding submission schedule and will assign review status of either "A" (for approval) or "I" (for information) to each deliverable.

1. Write up on various schemes viz. acoustic steam leak detection, furnace temperature measurement, soot blower system, SG BMS & FSS, ERV etc.

2. Write up on Plant performance calculation.
3. General arrangement drawings of desk, panels, various equipment, components/ sub-assemblies.
4. DCS system architecture drawings with write up.
5. Controller partitioning diagram /document.
6. Scheme drawing of SWAS
7. Equipment layout drawings viz. control room, equipment room, SWAS room, off site plants etc.
8. Schedule of instruments
9. Specification and Data sheet of various Instruments & devices
10. Drive control philosophy & interface diagram with write up
11. Analog & Binary Drive list
12. Cable block schematic diagram.
13. Specification and Data sheet of cables
14. Specification and Data sheet of junction box
15. Specification, Sizing calculation of control valve & data sheet
16. Sizing calculation of flow element & data sheet
17. Specification and Data sheet of Temperature element & gauges with sizing calculation of thermowell.
18. Closed loop control scheme & write up
19. Logic control scheme
20. Sensor grouping in racks
21. Instrument hook up drawings
22. Analog & Binary IO list
23. Schedule of alarms
24. Sequence of events (SOE) schedule
25. Schedule of logs and display
26. Plant schematic display
27. Cable schedules
28. Wiring & Interconnection diagram.
29. Product catalogues
30. General arrangement drawing of Instrument racks with data sheet

31. Data sheet for HART Management Scheme

32. Data sheet for Global Positioning System (GPS)

33. Data sheet LVS

34. Scheme & data sheet for TSI & VMS

35. MIS scheme including plant wide network.

36. Architectural 3D drawing of unit control room showing arrangement of LVS, Panels, Control desk etc.

Final Drawings:

- Before starting manufacture of the fabrication, Contractor shall secure approval on the design drawings from owner for the drawings identified as category "A", in writing. Any manufacture done prior to approval of the drawings shall be rectified in accordance with the approved drawings by contractor at his own cost and the equipment shall be supplied within the stipulated period.

- Contractor shall furnish final drawings and documents both in hard and soft copies as mentioned elsewhere in the specification. Contractor shall furnish instruction manuals containing various components, sub-assemblies, method of installation, check-ups and tests to be carried out during erection and commissioning of the equipment. The manual shall also include instruction for step checking, trouble shooting and fault rectification for different components and sub-assemblies.

- Contractor shall incorporate all modifications in the drawings carried out at site during trial run, start-up performance and guarantee tests till hand over of the units to purchaser and submit these final as-built drawings both in hard and soft copy.

- Care shall be taken to present all final documents in proper form. All catalogues and literature (including sub-suppliers' catalogues), datasheets, Instrument list, input output list, function control diagram, loop diagrams, configuration diagram etc. shall be bounded together in indexed volumes. All O&M manuals shall be in handy size and neatly bound for carrying to the work place.

2.2 SCOPE OF SERVICES

2.2.1 Engineering and other Services

The Bidder shall refer Lead Specification and Conditions of Contract for scope of services, in general. The Bidder shall render all services necessary for meeting the intent and requirement of this specification.

Supply of spare parts for at least 30 years after commissioning of the plant shall be provided by the Bidder.

Participation of bidder's personnel and experts as well as experts from their collaborator in discussion with owner/consultant and other equipment vendors during various stages of contract implementation as required by the owner to achieve desired system configuration and performance.

2.2.2 Erection

Scope of Erection

Scope of erection work shall include but not be limited to the following:

- Installation of all equipment, system, control room panels, desks, cabinets, junction boxes, instruments, gadgets and other accessories as per this specification.
- Cable interconnection amongst different panels/cubicle/field instruments etc.
- Installation of all field mounted instruments and devices including all primary elements supplied by contractor along with impulse pipe laying and wiring etc. Installation of all thermowells on the stubs provided at the tapping points.
- Installation of all transmitters' racks & enclosure, cubicles, brackets, laying of impulse pipes and cable termination etc.
- Hook up of pneumatic tubes and interconnection between air supply point and all accessories of final control element as required.
- Laying of all cables including erection of sub trays, G.I. conduits along with accessories, termination and ferruling at both ends of all cables laid.
- Termination & testing / checking of cable.
- Supply of all the erection hardware, consumables, tools and tackle, test instruments and deployment of experienced personnel needed for completing the erection of the total instrumentation and control system under this package.
- Painting of all site mounted structures and impulse lines after completion of erection. All panels, cabinets will be retouched / repainted if required by the Owner after erection and commissioning.
- Providing a tentative programme of manufacture, erection, testing and commissioning.
- All the erection activities shall comply with stipulated project schedule.

2.2.3 Scope of Testing Calibration / Commissioning

Scope of work shall include but not be limited to the following:

Testing/calibration/configuring/software development, loading, commissioning liabilities are envisaged for every instrument and system to be supplied by the bidder.

All types of testing equipment viz. Dead weight tester, manometer, standard calibration set etc. and instruments needed to carry out the testing, calibration and commissioning activities shall be arranged by the Contractor.

The Contractor shall supervise and test for correctness of the termination of all cables installed so as to eliminate the possibility of mal- operation or damage of related equipment / system/cabinet.

The Contractor shall perform continuity and insulation checking of cables & wires laid.

The Contractor shall perform leak test on process impulse pipe / tubes and pneumatic tube.

The Contractor shall perform loop checks for all inputs & outputs to eliminate the possibility of mal-operation or damage of equipment.

Commercial Operation, Performance Liabilities, Guarantees, Penalty Clauses

Major services to be rendered by the Contractor shall include the following:

Supply of all drawings, data and information as stated herein, in multiple copies to Owner.
Erection, commissioning, trial operation and performance guarantee of the complete system interfacing and co- ordination with other agencies, as indicated in relevant clauses of specification.

Satisfactory operation of the entire instrumentation and control system at varying loads within the capacity of the boiler after commissioning for one month without disturbing any setting or adjustments whatsoever during this period to enable the owner to declare the unit for trial operation. During this period, maintenance and supervision shall be in the scope of the Bidder. Any defect or deficiency noted during this period shall be rectified by the Bidder at no extra cost.

In various stages of engineering, the successful Bidder shall arrange to depute his representative for participation in technical discussions with the Owner to evolve proper system engineering as described in the specifications.

Bidder shall refer to chapters of specification for 'Performance and Guarantee Test' and 'Total System Availability'.

3.0 C&I FOR STEAM GENERATING UNIT & AUXILIARIES

3.1 INTENT OF SPECIFICATION

This section is intended to broadly describe the requirements of Control & Instrumentations related to Steam Generator and its auxiliaries such as Burner Management System (BMS) / Furnace Safeguard and Supervisory System (FSSS) including Master Fuel Trip, Secondary Air Damper control, Scanner air fans, Pulverizer, Seal air fans, Intelligent Soot Blowing System, Draft control, Air preheater, Primary Air Fan, SCR, FGD etc. and other integral auxiliaries. Complete control & monitoring shall be DCS based and shall be guided by the Instrument & System specification in Section-6.0 of this volume.

3.2 GENERAL REQUIREMENTS:

The Control & Instrumentations related to the steam generator being specific to the design of the steam generator, the subsequent clauses in this section shall be deemed as typical and qualitative requirement only.

Conventional indicators, recorders, control plaques etc. shall be offered only if Bidder has specific insistence on such items.

Redundant (1 out of 2 or 2 out of 3) field transmitters shall be provided to increase reliability of the C&I system and shall not be limited to the following:

PARAMETER	*INPUT REDUNDANCY*
Boiler Separator Level	2 out of 3
Boiler Separator Pressure	2 out of 3
Boiler Separator outlet temperature	1 out of 2
SH/DSH outlet temperature	2 out of 3
SH/DSH inlet temperature	2 out of 3
Feed Water Flow	2 out of 3
Feed Water Temperature	1 out of 2
SH Spray Water Flow (Left and Right)	1 out of 2
RH Spray water Flow (Left and Right)	1 out of 2
Main Steam Pressure	2 out of 3 (Left Side)
Main Steam Pressure	2 out of 3 (Right Side)
Main Steam Temperature	2 out of 3 (Left Side)
Main Steam Temperature	2 out of 3 (Right Side)
BFP Suction Flow	1 out of 2
Secondary Air Flow	1 out of 2 (Left & Right)
Oxygen in Flue Gas	2 out of 3 (after economizer)
Furnace Pressure	2 out of 3

P.A. Header Pressure	2 out of 3
PA Flow to each Mill	1 out of 2
Wind box to furnace DP	2 out of 3
Mill O/L Temperature	2 out of 3
Final Superheater Steam Temperature	2 out of 3 (Left & Right)
Final Reheater Steam Temperature	2 out of 3 (Left & Right)
Auxiliary Steam Pressure	1 out of 2
Auxiliary Steam Temperature	1 out of 2
DP across feed control station	1 out of 2
DP across feed control station	1 out of 2
LDO header pressure	1 out of 2
Additional measurements:-	
Furnace draft	Wide range

- Bidder shall offer 1 out of 2 measurement for control and 2 out of 3 measurements for all critical areas.
- For measurement of metal temperature of super-heater, re-heater and boiler separator, Bidder shall provide permanent / removable duplex type mineral insulated thermocouples terminated in junction boxes at boiler platforms. Suitably located remote I/O unit has been envisaged for these inputs.
- Bearing temperatures of ID, FD, PA Fans, Pulverizers and any other equipment driven by H.T. motors shall be provided with direct mounted dial thermometers for both driven equipment and motor.
- Duplex J type thermocouples / Duplex RTD shall be provided for measurement of bearing temperature of all HT motor & driven equipment - for alarm, monitoring and interlocking in DCS.
- All HT motors windings shall be provided with six (6) duplex RTDs (PT-100)- for alarm, monitoring & interlocking.
- Necessary primary elements for measurement of secondary airflow to the furnace and primary airflow to pulverizer shall be provided.
- Total airflow shall be measured by aerofoil or venturi or by any special on line measurements technique with high accuracy as per proven standard and practice of the Bidder. Generally Flow nozzle shall be used for measurement of Feed water flow, SH & RH attemperation flow, Auxiliary steam flow and for lines equal to or above 4" diameter.
- Adequate sensors for monitoring, alarm, interlocking, automatic changeover to standby equipment shall be provided for the parameters like lube oil pressure, flow, temperature etc. of lube oil systems of equipment like Mills, ID Fans, PA and FD Fans etc.
- Coal feeder shall be gravimetric type based on variable voltage & frequency drive with proven microprocessor based controller. The coal flow measuring system shall have an output of 4-20 mA DC for indication and control purposes. Weighing system of the equipment shall be based on load cell and shall have the high resolution by proper selection of load cell range.
- Feeder shall be controlled by 4-20 mA DC signal from station DCS. Required signal like feeder run, feeder stop, coal flow rate, totalizer, clean out conveyer run & stop, coal plugged etc. shall be available at station DCS for control and monitoring. Bidder shall provide acoustic type no coal flow detector.
- Features of coal feeder controller shall not be limited to the following:
- Alphanumeric display of feed rate; density; motor speed; total weight, automatic and manual calibration of the weighing system and adjustment of system drift, non-volatile memory to store information and program data, alarm generation automatic

transfer from gravimetric to volumetric in case of failure of load cell, status LED, keyboard for configuration.

- Required interface terminals for control and monitoring of coal feeder from DCS including feeder diagnostics shall be provided.
- Measurement and totalization of both heavy and light oil flow shall be provided with Coriolis mass flow measuring type instruments with 4-20 mA DC output for indication, control and totalization giving actual oil consumption in boiler. The Mass flow meter electronics shall have the facility for configuration to indicate Mass and Volumetric Flow rate. Heat tracing wherever required shall be considered.
- Temperature and pressure measuring devices shall be installed at different zones in the flue gas path for monitoring. All temperature measuring elements shall be of duplex type and both the elements shall be terminated to junction box. Extension cable shall be provided for TC signal transmission to DCS.
- Bidder shall provide electrically operated retractable type furnace temperature probes at both sides of furnace complete with actuating mechanism, duplex temperature element, position transmitter, limit switches, cooling system etc.
- Flue gas temperature measurement system shall be provided to determine the average and complete temperature profile at different sections of boiler and furnace such as economizer, furnace exit zone etc. during all regime of boiler operation. System shall be complete with required sensors located in different zones, air purging system, PC with all required hardware, software & colour 24" TFT monitor and colour laser printer etc. The system shall be able to eliminate the effect of varying high noise to obtain a high accuracy of measurement. Range shall be adequate to cover boiler operation during all regimes. Accuracy of measurement shall be better than 2%.
- For measurement of pulverizer outlet temperature and flue gas / air temperature, suitable abrasion resistant thermowells of material such as Tungsten carbide and Inconel respectively shall be provided.
- Remote indication for open & close status shall be provided for critical manually operated HP & LP line drain & vent valves. Isolation valves at suction of critical pumps shall have dynamic open & close indication at DCS.
- Adequate local instruments such as pressure gauges, temperature gauges etc. shall be provided wherever it is required for local monitoring, start up, commissioning and maintenance.
- Automatic steam tube leak detection system shall be provided for detecting leaks at different zones of boiler. Separately isolated 4-20mA DC analogue signals shall be provided for monitoring the acoustic level in DCS. Bidder shall provide necessary acoustic signal generator, signal receiver, air purging system, signal processor & controller, PC with KB & 24" LED TFT colour monitor, cabinet, junction boxes, connecting cables and interface to DCS. The system shall be able to eliminate the effect of varying surrounding noise to obtain a high accuracy of leak detection.
- Isolated 4-20mA DC from guided wave radar type coal level measuring system with two output signal at coalbunkers shall be provided for display of bunker level at the central control room.
- Television system shall be provided for furnace flame monitoring. System shall be complete with retractable camera, cooling system, air purging system, operator control station.
- (Three) switches operating at exactly same settings shall be used for all critical trip interlocks such as furnace pressure high, furnace pressure low, air flow, fuel oil pressure low, atomizing steam pressure low etc.
- All initiating devices for auxiliaries viz. ID fan lube oil system, FD fan lube oil system, Pulverizer lube oil system etc. shall be provided for starting, stopping, interlock, protection, automatic change over and annunciation. Protection of main equipment

against abnormality of parameter such as lube oil pressure, temperature, flow etc. as required shall be configured in 2 out of 3 configuration.

- Necessary pressure controller for Electromatic safety valve/s complete with all accessories like special cables, pressure sensing devices, solenoid valves, impulse piping etc. shall be provided. A miniature control station suitable for mounting on back up control desk/panel shall be furnished with indicating lights and switches to facilitate auto/remote/manual operation of the valve. System shall also be operable from DCS.
- All local instruments viz. pressure and temperature gauges, pressure and temperature switches, transmitters shall be mounted on gauge boards /racks located at convenient places. Open type racks with canopy shall be used for indoor environment and closed type racks shall be used for outdoor installation.
- Air preheater shall be monitored for fire by means of strategically located temperature sensors both at cold and hot ends. Protection of air preheater shall incorporate the fire protection logic as well. Air preheater shall also be monitored for differential pressure across air and flue paths.
- Skin Temperature measurement for APH & Economiser Hopper
- Alarm condition of various strainers in the fuel oil line and lube oil line shall be monitored in DCS.
- Flow measurement shall be corrected for pressure/temperature as required by providing PT (Pressure transmitter) and TE (Temperature element). The computation will be done in DCS.
- All pilot solenoid/solenoid operated valves, motorized valves, initiating devices & switches, sensors, transmitters, all flanges, gaskets, nuts & bolts shall be provided.
- All instruments for guarantee test measurements including tapping points with root valves for pressure measurement and temperature stubs with thermowells are to be provided. Two root valves shall be provided for pipe pressure 40 Kg/sq. cm and above and single root valve for below 40 Kg / sq. cm.
- Necessary purge connections shall be provided for pressure and flow instruments on air, flue gas and coal/air lines for periodic cleaning.
- Local start and stop switches for drives shall be provided for maintenance and emergency operation.
- All HT fans & motors and pulverizer motors shall be provided with bearing vibration probes (both in X and Y direction) at all bearings, including key phasor. The vibration monitoring system (VMS) shall be complete with pickups, special cables, vibration monitors, cables, trip and alarm relays, power supplies, necessary panels and hardware & software links to DCS. The data from vibration monitoring system shall be analyzed in vibration analysis system for frequency spectrum and other necessary balancing information.
- Motorized actuator for on & off duty and pneumatic actuator for regulating duty shall be provided.
- Passing condition of all critical drain valves in high pressure / temperature steam & water line shall be monitored in DCS by providing suitable metal temperature element on the pipe at downstream of valve.
- Thermocouple of K type and R type and RTD (PT 100) depending upon process condition shall be used.
- All pressure & temperature stubs, thermo-wells, root valves, impulse lines, for on line and performance guarantee test measurements. Stubs and take-off points for performance guarantee test measurement shall be separate and shall not be shared with online measuring instruments.
- Motor current & energy metering for drive rating on and above 30 KW shall be monitored in MMI in DCS and suitable transducers for the same are to be located in respective electrical switchgear.

3.3 BURNER MANAGEMENT SYSTEM (BMS)

This includes major integral boiler controls like Burner Management System (BMS) including Master fuel trip (MFT) relay; Milling plant; Seal air fans; and scanner cooling fans. Soot Blower control (SBC) and SADC control etc. shall be considered as separate sub systems of SG controls.

Burner Management system shall be implemented in the DCS with adequate safety, diagnostic and redundancy. Related hardware shall be segregated in identifiable cabinet/s with no sharing of I/Os with any other system. Features of the BMS shall conform to NFPA 85 requirements in all respects for (i) the prevention of furnace explosions/ implosions in multiple burner boilers and (ii) for pulverized fuel system.

Boiler protection shall be based on 2 of 3 configuration in hardware & software to meeting NFPA requirement. Configuration shall be realized in DCS with three sets of processors /input & output modules /relays.

The boiler protection system (FSS) shall adopt triple redundant configuration (TMR) system and FSSS provided by the bidder must be in accordance with international standards such as IEC 61508 SIL-3, ANSI / ISA.84.01.1996, DIN.V.VDE 0801, DIN.V.19250 etc.), and through international certification authority TUV. FSSS shall be part of DCS. Triple Modular Redundancy (TMR – Fail Safe 2 out of 3 logic) configuration right from field sensor through I/O module with safety requirements including those stipulated in latest editions of NFPA 85. Bus system, Controllers / Processors, interposing relays, Interposing Relay contacts) shall be provided which is TUV approved and part of the DCS family.

For critical closed loop control system 2 out of 3 redundant sensors / transmitter shall be used.

For balance protection, control loops, sequential logic and related measurement dual redundant hardware including field instruments shall be used.

Dual redundant fail safe hardware and software has been envisaged for all other controls.

The BMS shall include the following systems:

- Master Fuel Relay.
- Individual controls for oil and coal burners including sequential start-up and shut-down of individual mill system.

BMS will be adequate for pre-light up checking, purging of the boiler, sequential start / stop operation of burners, milling system, scanner air fans, seal air fans, emergency and administrative shutdown of the boiler and/or any of the auxiliaries and all relevant safety protection of furnace and boiler as a whole.

To facilitate modification of logic at site, at least 40% extra memory space shall be made available. Bidder shall provide spare Input & Output channels & modules as per Section-6.0 of this volume.

BMS shall have password protected forcing facility by over-riding auto logic circuit so that start-up and normal running of boiler is not affected unduly as a result of mal-function of any part of the auto circuits.

Complete BMS logic configuration, loading and documentation shall be permissible from common DCS engineering station.

The final modulating control drives shall be pneumatic power cylinders and hand wheel operation facility with linkages for dampers and for burner secondary air register control. Mechanical position indicator and contactless position transmitter shall be provided with all actuators for monitoring of the position from local and control room respectively.

Local burner control cubicles shall be provided for maintenance of burners.

All initiating devices for safety and interlocks like pressure switches, temperature switches, level switches, flow switches, transmitters, temperature elements etc. shall be provided.

The BMS shall be designed to:

a) Prevent any fuel firing unless a satisfactory purge sequence has first been completed.

b) Prevent start-up of individual fuel firing equipment unless permissive interlocks have first been satisfied.

c) Monitor and control proper equipment sequencing during its start-up and shutdown.

d) Provide flame monitoring when fuel-firing equipment is in service and effect a burner trip or master fuel trip upon warranted firing conditions.

e) Continually monitor boiler conditions and actuate a master fuel trip (MFT) during adverse operating conditions which could be hazardous to equipment and personnel.

f) Reliably operate and minimize the number of false trips.

g) Provide a master fuel trip relay independent of processors and I/O modules to provide a completely independent trip path.

h) Include **a first out feature** in all controllers to identify the cause of any burner trip or boiler trip.

Allow the automatic start and stop of burners based on boiler load. The sequence of which burner will be started or stopped will be selected by the operator from a TFT display.

3.3.1 Flame Monitoring System

The Flame Monitoring system shall be provided for the following purposes:
- To detect the individual flame and to enhance the boiler/ furnace safety
- To avoid spurious and unwanted trips
- To increase operational reliability, availability and efficiency of the steam generator

The Flame Monitoring System (FMS) shall include flame detectors of proven type conforming to NFPA recommendation with solid-state logic circuits. FMS shall be capable of discriminating between oil and coal flames and to monitor fireball. The flame monitoring amplifiers shall generate 4-20 mA DC signals corresponding to flame intensity which shall be monitored in DCS and in the backup panel.

FMS shall have the features not limited to following: -

- 100% self-checking for electronics and flagging of failures.

- Flame condition display by means of bar graph indicator on amplifier.
- Early warning of flame instability, flame-out condition and diagnosing of Burner Malfunction.
- Pre selectable "Flame Off" response time.
- Potential free contact for interface with BMS/DCS.
- Automatic shutter closure / retraction on high temperature.
- Detection not influenced by deposits on sighting head
- Immunity from picking up of signal from adjacent burners or other sources.

Cooling air system for the flame scanners shall be provided from the scanner cooling air fans, one AC and other DC operated to constantly purge and cool the flame sighting head. Availability of cooling air from DC emergency scanner air fan shall be ensured during black out condition to protect the scanner from undue heating. The dampers associated with scanner air fans shall be pneumatically operated with DC solenoid valves.

Flame monitoring system shall be fail safe and easily maintainable which shall include flame detectors of proven design for the type of fuel, environmental condition and other conditions, of established reliability at all loads of the steam generator. It shall be designed to work under all adverse conditions such as wide variation in fuel/air input ratio, wide variation in fuel characteristics, variation in operating temperature, and maximum temperature under interruption of cooling air supply.

The system shall conform to NFPA recommendation and location of detectors as per NEC requirements.

The Bidder shall also provide a portable flame detector testing kit with built in stabilizer, capable of simulating both oil and coal flame, and testing of flame detector head unit at field. The testing kit shall also have facility for testing all type of electronic cards as being used in the flame monitoring system.

The Bidder shall demonstrate the complete performance of flame detectors in cold start up test and load condition test. In cold start up test, capability of detectors to detect oil flame under varying oil pressure shall be checked. In load test, the detector shall be able to detect when only oil is present, only coal is present and both coal and oil are present. It shall be ensured that the detectors are able to detect the proven flame at very low load with oil guns withdrawn. The above tests shall be performed for every coal and oil elevation.

3.3.2 ON-LINE CARBONE IN ASH ANALYZER SYSTEM

The system shall utilize non-sampling or non-extraction type microwave technology for online monitoring/measurement of the unburnt carbon in fly ash with minimum 4 nos. probes measurement to have complete profile per location. The system shall measure a fly ash at a representative location (Locations shall be decided during detailed engineering). In order to maximize the reliability, the number of moving parts on the sensor shall be minimized. Fly ash samples shall be measured in the bulk fly ash (first hopper row of the precipitator or in an intermediate bunker. The measurement system shall not use any heating elements for the ash or piping. Each ash sample shall be larger than 100g. System shall be a proven one with the installations and operation record for substantiate the credibility.

Accuracy shall be < 0.6 % minimum. The system shall also provide 4-20mA DC output to DCS and shall also be connected through soft link. Panel protection class shall be IP65. Panel shall be provided with industrial grade LED display. System shall work on UPS power supply. The offered system shall have a record of trouble free performance of minimum one (1) year

in min 1 (one) nos. coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.

3.3.3 COAL MASS FLOW BALANCING SYSTEM

On line fuel measurement facility for accurate measurement of coal mass flow rate/air fuel ratio in each pulverized fuel (PF) pipe for each pulverizer. The equipment shall comprise of sensors working on microwave technology. The scope of each steam generator shall include two (2) nos. of erosion free measurement sensors for each PF pipe from each pulveriser, a control unit, visual display unit, connecting cables etc. for making the system complete. For the purpose of above fuel measurement, each PF pipe shall be provided with two nos. of tapping points of suitable size with necessary plus/dust proof dummies etc. as required. Automatic Motorised Adjustable valve/orifice of erosion resistant/ceramic coated material suitable for highly abrasive pulverized coal applications shall be provided on each PF pipe at pulveriser outlets and the system shall enable on-load adjustment of coal flow in PF pipelines to achieve balanced coal flow. The system shall also provide 4-20mA DC output to DCS and shall be connected by soft link also. Panel protection class shall be IP65. Panel shall be provided with inbuilt laptop for data analysis. System shall work on UPS power supply. The offered system shall have a record of trouble free performance of minimum two (1) year in min 1 (one) nos. coal-fired boiler of size 500 MW or above where the firing arrangement is similar to the offered boiler.

3.4 INTELLIGENT SOOT BLOWING CONTROL SYSTEM (SBC)

Intelligent/Smart Soot Blower System with heat flux sensors will be provided. Propriety control system of smart soot blowing system will have bi-direction interface with DCS for operation and monitoring

Soot blowing control shall be operated from DCS MMI station. When set on automatic mode the sequencing system shall perform soot blowing at predetermined intervals at all specified locations including the main furnace as well as the air preheater areas. The control system shall maintain the required steam pressure and temperature conditions at all times. SBC system shall be implemented in the DCS with adequate safety, diagnostic and redundancy. Related hardware shall be segregated in identifiable cabinet/s with no sharing of I/Os with any other system. Smart soot blowing system shall be provided.

Functional requirements of Soot Blowing System shall not be limited to the following:

- Automatic sequential starting of each soot blower.
- Selection facility for individual soot blower for automatic sequential operation.
- Manual over-riding of automatic operation.
- Cancellation of operation of any soot blower, if required.
- Indication of the soot blowers in operation.
- Monitoring all essential parameters of the soot blowing system.
- Indication of malfunctioning of soot blower.
- Steam pressure and drain temperature control
- Local operation of blowers and 'Local/Remote' selection facility.

Local control box with PB and lamps shall be provided for local operation.

3.5 SECONDARY AIR DAMPER CONTROL (SADC)

Control of Secondary Air Damper consisting of both open loop and closed loop controls which will apportion the total secondary air between various elevations depending upon the type of fuel is being burnt; number of elevation is in service and the firing rate in each elevation. SADC system shall be implemented in the DCS with adequate safety, diagnostic

and redundancy. System shall be complete with wind box to furnace differential pressure transmitters, switches, actuators with non-contact position transmitters etc.

3.6 BOILER EQUIPMENTS

Controls for the following equipment including their auxiliaries shall be implemented in station C&I system with redundancy, safety and diagnostic and shall be operated from DCS MMI. Features of the system/equipment shall not be limited to the following.

3.6.1 ID FAN

- Adequate remote monitoring, alarm and safety devices as required shall be provided for the ID fan and its integral auxiliary lube oil / control oil system and shall not be limited to the followings:
  - Fan speed & current
  - Tank oil level
  - Lube oil pumps discharge pressure
  - Lube oil flow
  - DP across lube oil strainer
  - Fan & motor winding and bearing temperature

- Required local instruments such as level, pressure & temperature gauges, flow sight glass, temperature gauges etc. shall be provided.

3.6.2 FD FAN

- Inlet pitch control vanes complete with actuator, converter and position transmitter for control of air flow.

- Adequate remote monitoring, alarm and safety devices as required shall be provided for the fan and its integral auxiliary lube oil / control oil system and shall not be limited to the followings :
  - Fan speed & current
  - Oil pumps discharge pressure
  - DP across lube oil strainer
  - Fan & motor winding and bearing temperature-Alarm, indication and interlocks
  - Lube oil tank level
  - Oil flow

- Required local instruments like level, pressure & temperature gauges, flow sight glass, temperature gauges etc. shall be provided.

3.6.3 PA FAN

- Inlet pitch control vanes complete with actuator, converter and position transmitter for control of air flow.

- Adequate remote monitoring, alarm and safety devices as required shall be provided for the fan and its integral auxiliary lube oil / control oil system and shall not be limited to the followings:
  - Fan speed & current
  - Oil pumps discharge pressure
  - DP across lube oil strainer
  - Fan & motor winding and bearing temperature-Alarm, indication and interlocks
  - Lube oil tank level
  - Oil flow

- Required local instruments like level, pressure & temperature gauges, flow sight glass, temperature gauges etc. shall be provided.

3.6.4 AIR PRE HEATER

- O_2 measurements in FG path at each air pre heater outlet in addition to O_2 measurements (03 nos. for each pass) after economiser.
- Differential pressure transmitter across air preheater.
- Pressure transmitters and Temperature elements/transmitters at I/L & O/L on Flue gas path and Air path.
- Thermocouples for Air pre heater fire sensing and bearing oil temperature element, pressure & temperature gauges, lube oil flow switch etc. for guide & support bearing.
- Adequate number of thermocouples type fire detection system for air heater shall be provided as composite and complete units with all required signals and accessories with adequate redundancy.
- The controls & protection required for air heater fire detection system shall be implemented as Part of DCS using rate-of-rise algorithm taking care of manufacturer's recommendation.

3.6.5 COAL MILL

- DP across lube oil strainer alarm
- Temperature element for lube oil temperature, pressure transmitter for lube oil pressure and flow switches for low lube oil flow.
- Coal mill DP

3.7 CONTROLS

All required transmitters, sensors, control valves; dampers etc. for safe and efficient control of the steam generator shall be included. Following closed loop controls are indicated as minimum.

- Coordinated Master Control.
- Combustion control
- Furnace Draft Control.
- Separator level control.
- SH & RH Steam Temperature control
- Fuel oil pressure control.
- Steam coil air-preheater temperature control.
- Auxiliary Steam Header Pressure & Temperature Control.
- Mill outlet Temperature control
- Primary air header pressure control
- Total air flow control
- Atomizing steam pressure control
- Drain and Flash tank level control
- Feed water control
- Coal flow control
- Secondary air damper control

Open Loop & Sequence Controls:

All required sensors; dampers etc. for safe and efficient control of the steam generator shall be included. Following open loop and sequence controls are indicated as minimum:

- Draft plant (ID & FD Fans) including its auxiliaries/dampers- sequence control
- PA Fans including its auxiliaries/dampers- sequence control
- Air preheater including its auxiliaries/dampers- sequence control

- Control of MOVs / damper non integral to SG control-non sequence control.

Above controls (both CLCS, OLCS & Sequence) shall be implemented in the station C&I DCS. Bidder shall provide the control schemes for owner's approval.

Typical minimum requirement of Interlock and Protection has been stated below:

- Boiler Starting Interlock
  After ID and FD fans have been started, following conditions should be fulfilled for light up of boiler:
  - Purging of Boiler at a predetermined airflow for a pre- determined time.
  - Resetting of MFR.
  - Permissive for starting Igniter.

- For purging the following conditions to be satisfied:
  - Either or both I.D. Fans running.
  - Either or both F.D. Fans running.
  - MFR in tripped position.
  - Air registers in purge position.
  - Air flow between 25% to 30% MCR.
  - No flame condition is true.
  - All fuel closed.
  - Boiler Tripping

- Boiler shall trip automatically through Master Fuel Trip Relay (MFT) if any one of the following emergencies occurs (the list is indicative only). All initiating contact shall be configured in 2 out of 3 configurations.
  - Separator Level Very High
  - Separator Pressure Very Low
  - Air Flow Low < 25 %
  - Furnace Pressure Very High
  - Furnace Pressure Very Low
  - Total Flame Failure.
  - Both ID Fans trip
  - Both FD Fans trip
  - All Feed Water Pumps Tripped
  - Loss of Reheater Protection
  - Loss of DCS Control System
  - Loss of Unit Critical Power
  - Both Air Heater OFF
  - Evaporator Tube Metal Temperature High
  - Emergency Trip Operated
  - Economizer Inlet Flow Low
  - All feeder off and loss of power at oil elevation in service

- Simultaneous occurrence of the following: -
  - Turbine trip.
  - HP bypass valve closed.
  - Coal mill in service

- MFT operated will initiate the followings as minimum: -
  - Tripping of all oil burners.
  - Tripping of all pulverizer and coal feeders.
  - HT supply to ESP.

- Turbine trip.

3.8 HP- LP CHEMICAL FEED SYSTEM

Control & Instrumentation shall not be limited to the instruments as detailed below.

- Each dosing pump shall be provided with diaphragm seal, snubber, glycerine filled type pressure gauge of proper range on discharge piping with isolation valves, fittings etc. Each solution tank shall be provided with level gauge preferably magnetic type with colour changing flapper and graduated scale. Level switch shall be provided for low-level alarm and interlock. Level transmitter shall be provided for remote indication. The chemical feed system shall be operated and adjusted from the local panel and also from the station DCS in unit Control Room.

- Start/Stop operation of the Agitator motors and Dozing Pumps from the DCS.

- Dosing rate control shall be adjusted from both local and remote automatic & manual from central control room DCS. Required local controller, drive unit as required shall be provided for this purpose. Use of resistance type feedback mechanism for position indication shall be avoided.

3.9 FLUE GAS ANALYZERS

Following instruments shall be provided:

- One (1) combined in situ type analyzer per unit on the stack for monitoring SOx, NOx, CO, CO2 & Moisture.
- One (1) no. O2 analyser per unit on the stack
- One (1) no. Smoke density analyzer per unit to be installed on stack
- Opacity monitor at each pass of ESP outlet.
- CO analyzer at each ID fan discharge.
- One (1) no. Mercury analyzer per unit on the stack.
- One no. Flow transmitter, one no. pressure transmitter & one no. temperature transmitter per unit to be installed on stack
- Three numbers in-situ zirconium type oxygen analyzers & 1 no CO analyser after economizer in each pass and one number in-situ zirconium type oxygen analyzer at each air preheater outlet shall be provided for measurement of oxygen in flue gas.

Bidder to provide necessary arrangement with equipment for continuous real-time emission data transmission (wireless) to CPCB / SPCB / Owner's Server from Bidder's System with Remote Calibration facility.

4.0 C&I FOR STG & AUXILIARIES & FEED CYCLE EQUIPMENT

Turbine Control System shall be provided by Other (TG Supplier). Turbine Control System shall be interfaced with Main Plant DDCMIS by SG Supplier. Necessary Input shall be provided by Others to SG vendor for implementation in DDCMIS.

TG Auxiliaries shall be controlled & monitored from Main Plant DDCMIS. Necessary Input such as I/O List, Logics, Write Ups, Alarm/SOE/Historian Tags, P&IDs to be provided by Others to SG vendor for implementation in DDCMIS.

Following major controls are foreseen in the regenerative area viz. steam system, feed water, condensate, drain & vents, heater drains etc. Bidder shall furnish list of controls provided in the offered system.

Closed Loop Controls:

- Coordinated Master Control.
- Combustion control
- Feed water flow control
- BFP speed control
- Drain and Flash tank level control
- HP heater level control
- Condenser hotwell level control
- LP heater level control
- CEP Minimum recirculation control
- Deaerator level & pressure control

Open Loop & Sequence Controls:

- Boiler feed pump sequence control
- Condensate extraction pump sequence control
- Non sequential drives control

HP-LP Bypass System shall consist of integral type pressure reducing and de-superheating stations (PRDS).

- HP Bypass station (HPBP) shall comprise of electro hydraulic control valves along with integral type de-superheater, the integral type de-superheater getting spray water from Boiler Feed Pump. Pressure and temperature measurements for control of HPBP shall be in 2/3 voting circuit.
- LP Bypass station (LPBP) shall also comprise of electro hydraulic control valves along with de-superheater, de-superheater getting spray water from Condensate Extraction Pump discharge. Pressure and temperature measurements for control of LPBP shall be in 2/3 voting circuit.

Closed loop controls, interlock and protection for the system shall be configured in DCS and shall be operated from the operators' station at central control room with adequate monitoring.

System shall be supplied with control oil unit, pressure gauges, temperature elements, transmitters on as required basis for completeness of the system.

In addition to supplier recommendation, following parameters related to oil unit shall be provided for remote monitoring at DCS.

- Tank levels indication & alarm.
- Oil pump discharge pressure indication.
- Oil temperature indication & alarm.
- Group fault alarm.

5.0 C&I FOR PLANT AUXILLIARIES

5.1 GENERAL

Specification herein describes the controls for various plant auxiliaries.
Type of control vis-a-vis the plant area are delineated below.

Plant Auxiliaries System

(i) DM Cooling Water System
(ii) Cooling Water System (CW system).

(iii) Auxiliary Cooling Water System (ACW system)
(iv) Condensate Transfer (CT) pump & DM Service Water (DMSW) pumps
(v) Compressed Air System
(vi) Mill Reject Handling System
(vii) Fuel oil pressurizing / forwarding System
(viii) Centralized Turbine Oil Purification system
(ix) HP/LP Dosing System
(x) Electrostatic Precipitator (ESP)
(xi) Induced Draft Cooling Tower (IDCT)
(xii) Flue Gas desulphurization System (FGD)
(xiii) Condensate Polishing Unit (CPU)
(xiv) Condensate Onload Tube Cleaning System (COLTS)

The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.

Plant auxiliaries shall be operated from their local control panels or monitors located in the respective plant local control rooms. Some of the auxiliaries shall have operational facility both from central control room as well as from local panels/desk.

Control system configuration, whether unit wise or common, shall be guided by the respective equipment configurations indicated elsewhere in the specification and as per approved system design philosophy.

DCS based common system shall be operable from the operator stations of both units.

Sl. No.	Aux. System/ plant	Control System	Control Location	DCS Interface
A.	**Plant Auxiliaries System**			
1	DM Cooling Water System (Turbine)	DCS	DCS Monitors in central control room	Hardwired
2	DM Cooling Water System (Boiler)	DCS	DCS Monitors in central control room	Hardwired
3	CW & ACW system	Remote DCS input & output (RIO).	1. DCS Monitors in central control room 2. Two operator stations at local CW pump house control room	Extended node of plant DCS network.
4	Instrument Air & Service Air Compressors including air drying plant	Microprocessor based control for each compressor	Local compressor panel	Hardwired & soft link connectivity with DCS for remote operation, alarm and monitoring.
5	Mill Reject Handling System	Remote DCS input & output (RIO).	DCS Monitors in central control room	Extended node of plant DCS network.
6	Fuel oil Forwarding System	Remote DCS input & output (RIO).	1. DCS Monitors in central control room 2. One operator stations at Fuel oil pump house	Extended node of plant DCS network.

Sl. No.	Aux. System/ plant	Control System	Control Location	DCS Interface
			control room	
7	DM Service water & Condensate Transfer pumping system	DCS	DCS Monitors in central control room	Hardwired
8	Centralized Turbine Oil Purification system	Local PLC	Local Control Panel	Hard wired interface to DCS for monitoring motor current & On/Off status indication.
9	HP/LP Dosing System	Microprocessor based control panel	DCS Monitors in central control room and Local Control Panel	Hardwired connectivity with DCS for remote operation, alarm and monitoring.
10	Induced Draft Cooling Tower (IDCT)	Remote DCS input & output (RIO) at individual MCC room and shall be linked with Remote I/O (RIO) of CW pump house	1. DCS Monitors in central control room 2. DCS Monitors at local CW pump house control room	Extended node of plant DCS network.
11	Electro Static Precipitator (ESP)	DCS based	1. Two operator work stations in local control room 2. One Engineering cum Operator station in local control room	OPC/MODBUS Soft link with unit DCS for monitoring
12	Condensate Polishing Unit (CPU)	DCS based	1. One operator work stations in local control room 2. One Engineering cum Operator station in local control room	OPC/MODBUS Soft link with unit DCS for monitoring
13	Condensate Onload Tube Cleaning System (COLTS)	DCS based	Local Control Panel near Condenser area	Hardwired and OPC/MODBUS Soft link with unit DCS for Operation and monitoring
14	Fuel Oil unloading System	Remote DCS input & output (RIO)	Fuel Oil pump House Control room 1. One operator work stations in local control room	--
15	Flue Gas De-sulphurization System (FGD)	DCS based	1. Two operator's stations per unit and one engineering cum operator station in local control room 2. Two (02) nos. Industrial 70" Large Video Screen displays with dedicated controller in local control room	OPC/MODBUS Soft link with unit DCS for monitoring

Sl. No.	Aux. System/ plant	Control System	Control Location	DCS Interface
16	Ammonia Unloading System	DCS based	1. One operator station in local control room 2. One engineering cum operator station in local control room	OPC/MODBUS Soft link with unit DCS for monitoring

Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that communication links between plant auxiliaries and plant DCS shall be based on dual Optical Fiber Communication (OFC) medium. Similarly Remote IO (RIO) data highway of DCS system shall be dual OFC medium and separately laid. Necessary ports / converters shall be provided.

All DCS & RIO based controls shall be located in air conditioning environment.

5.1.1 General Design Philosophy

Electronic analog signal transmission from field to area control rooms shall be 4-20 mA DC, while signal transmission within the control room may be 1-5V DC or 4-20 mA.

All regulating duty control valves shall be equipped with 2-wire position transmitter having 4-20 mA DC output linear with respect to valve position.
All signal processing hardware like signal isolators, limit value monitors, computing modules, transmitter power supply units shall be modular and 19" rack mounted type.

All control board mounted items as required shall be electronic, miniature type.

Control systems configured in fail-safe mode have been envisaged.

In general, instrumentation sensors, transmission, measuring & computing hardware shall be electronic, while control actuators for regulating duty shall be pneumatic.

All package PLCs shall be of proven design & reputed international make and from same manufacturer.

System shall be of high reliability by providing adequate redundancy in the system.

DCS & package PLC system shall be time synchronized with the Master Clock.

5.2 SPECIFIC TECHNICAL REQUIREMENTS

5.2.1 Fuel Oil Unloading system

- Fuel Oil Unloading shall be implemented in DCS Remote IO Panel located in Fuel Oil pump house area. 1 no OWS 24" TFT along with 1 no A4 Color Laserjet printer shall be provided.
- Flow Measurement of both heavy and light oil Unloading shall be provided with Coriolis mass flow meter with Totalizer with isloated 4-20 mA DC output for monitoring and totalization.

5.2.2 Fuel Oil Pressurising / Forwarding system

Control Philosophy

- The control system shall be responsible for forwarding of fuel oil from the storage tank up to the furnace in the Boiler area. Required OLCS & CLCS controls shall be realized in DCS.
- Pressurizing pumps shall be operated from both local operator station as well as from remote operator station in central control room. Start of standby pump in case of running pump trip or pump developing low pressure shall be provided. Required pressure switches shall be furnished.
- Fuel oil header pressure control in local shall be automatic. Adjustment shall be possible from both local operator station as well as from remote operator station in central control room (CCR). Required control valve with accessories and pressure transmitters shall be provided.
- Drain oil pumps in boiler area shall be operated from CCR. Whereas drain oil pumps in the Fuel oil pump house area shall be operated from local operator station. Drain tank shall be provided with high and low level switch for alarm & protection.
- Alarms and Sequence of event shall be displayed and printed in operator station in CCR and local control room.
- Non-contact type radar level transmitters, mechanical type level gauges, level switches, temperature elements & gauges etc. shall be provided on fuel oil tanks for control & monitoring.
- Adequate no. of transmitters, pressure & level switches, gauges, temperature elements etc. as required for the complete system shall be provided.
- Strainer shall be monitored for alarm condition and local indication.

5.2.3 Compressed Air Plant

Control Philosophy

Microprocessor based control with LCD colour graphic user interface has been envisaged for each compressor. The control system together with the power supplies and other accessories will be located within the local panel. The system shall include required control for safe operation of the compressor. Required hardware interface with DCS is foreseen for remote operation, monitoring & alarm.

a) Control Modes

Each compressor shall be controlled either by "Dual Control" or by "Automatic Start-Stop Control" Method.

b) Dual Control

Dual Control shall permit operation of a compressor in either of the two following modes :

1) Continuous Run Load-Unload Control (Base duty)
   In this mode of control, compressor shall be made to run continuously.
   If, due to fall in air consumption, the air pressure in the receiver reaches a high preset limit, a pressure switch will operate to de-energize a three-way solenoid valve, thereby diverting the compressed air from receiver to unloader and the compressor will be unloaded. On fall of air pressure in the receiver to a low preset limit, the pressure switch will energize the solenoid valve to cut-off compressed air supply to unloader and trapped air between the unloader and solenoid valve will be released to atmosphere from third port of the solenoid valve, thus the compressor will be loaded. The capacity control shall be achievable at 50% and 100% loads.
   The compressor shall be started manually either from control room DCS or from the local panel if all its permissive conditions are satisfactory. Provision shall be made in the control system to delay the energisation of the solenoid valve at the time of starting of the compressor to allow it to start at unloaded condition.

2) Automatic Start/Stop Control (Standby duty)
In this mode, whenever the air pressure in the receiver reaches a preset low limit, the compressor will start automatically under unloaded condition with the unloader solenoid valve de-energized through a timer till motor picks up full speed. After a set time delay, the solenoid valve will be energized to cut-off compressed air supply to unloader and the compressor will be loaded. When the pressure in the receiver reaches the higher preset limit, the pressure switch will first de-energize the solenoid valve and subsequently trip the compressor motor.

a) Operational Requirement

Operation of the compressors and dryers shall be performed from their respective local control panels. Panel shall have facilities not limited to display graphic, equipment & system status indication, operational keys, alarm display, running hour display & maintenance requirement prompt, motor current indication etc.

All pressure and temperature conditions used for tripping the compressor shall be displayed in the panel. Pre-trip & trip annunciation shall be repeated to remote DCS.

b) Integral Instruments

With acknowledgement to the fact that the entire area is vibration prone, instruments like temperature switches shall be avoided as far as practicable. Instead, duplex thermocouples shall be provided with software generated trip and alarm points.

Bidder shall furnish instruments with adequate measurement & protective device not limited to the following:

a) Pressure transmitters at suction and discharge of each stage.
b) Temperature elements at suction and discharge of each stage
c) Lube oil temperature
d) Lube oil level gauge
e) Cooling water flow switch
f) Drain valves
g) Switches / safety devices

c) Field Instrument

In addition to the compressor integral instruments, following instrument shall be provided:

a) Pressure transmitter and vortex flow meter at discharge of each compressor shall be provided for monitoring in local panel and DCS.
b) Water flow switch on each compressor cooling water outlet.
c) Dew point cum moisture measurement system with 4-20mA DC output to ADP panel & DCS.
d) Local pressure gauges on individual air receiver & common air headers.
e) Pressure switches at air outlet for high & low alarm.
f) Pressure transmitters for monitoring pressure at different points on instrument air header to ensure availability in each header.

5.2.4 Circulating Water (CW) & Aux. Cooling Water (ACW) System

Control shall be realized in local DCS RIO. CW pumps & ACW pumps shall be normally be operated from DCS MMI at central control room. For local operation two operator stations are foreseen.

Pump and motor bearings of CW & ACW pumps shall be provided with vibration pickups (X-Y) alongwith key phasor. System shall be a part of rotating machine condition monitoring system described in section-6.0 of this volume. Vibration data shall be displayed in DCS.

HT motor winding temperature and bearing temperature of equipment and motor shall be monitored in DCS.

Magnetic Flow meter shall be provided in each CW header to Condenser of each unit & in each ACW header for each unit.

Motor current & energy consumption indication for motor rating above 30 KW shall be monitored in DCS.

Operation of Electrical Power Distribution system at the pump house building shall be executed from DCS. Open/Close command with adequate monitoring shall be provided for operation of PCC, Bus coupler, Incomer etc.

Two nos. of Guided wave radar type (1 V 2 logic) CW/ACW sump level measurement shall be provided in each partition of sump and CW forbay for control and monitoring.

Inlet & outlet temperature of heat exchangers shall be monitored. DP transmitters & gauges for monitoring fouling condition of heat exchangers.

5.2.5 Mill Reject System

Mill reject system shall be controlled and monitored from the Mill reject system local control room, through DCS based control system consisting of Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors/instruments/erection hardware envisaged to control and monitor it.

Mill reject system local control room shall be provided with Two (2) no. 24" TFT Operator cum engineering station for control and monitoring the Mill reject system locally in addition to remote monitoring from the central control room in the main plant DCS. 1 no. A4 BLW printer shall be provided in the local control room for the operator station.

5.2.6 HP/LP Dosing System

Microprocessor based local control panel shall be provided for HP/LP dosing system. Hardwired interface of local control panel with unit DCS shall be considered for remote operation and monitoring as well as stroke adjustment.

The levels transmitters of proven type for various chemical tanks of HP/LP dosing systems and Pressure transmitters & pressure gauges for all the dosing pumps shall be provided.

5.2.7 Flue Gas De-Sulphurisation System (FGD)

The Flue gas De-sulphurisation System, referred here shall be implemented in redundant DCS based system, located at FGD Control room. Two operator's stations (with 24" TFT monitors) per unit and one engineering cum operator station (with 24" TFT monitors) shall be provided. In addition there shall be two (02) nos. 70" Large Video Screen displays with dedicated controller for display of process, monitoring and alarm and operation. Two (2) nos. A3 cum A4 color LaserJet printer shall be provided in the local control room.

Field Instrumentation including field instruments, analysers, absorber flue gas inlet analysers (SO2, O2, dust analyser, flow transmitter, pressure transmitter, temperature transmitter), absorber flue gas outlet analysers (SO2, O2, flow transmitter, pressure

transmitter, temperature transmitter) [other than chimney CEMS analysers] shall be provided.

Motor current & energy consumption indication for motor rating above 30 KW shall be monitored in DCS.

Following measurements shall be provided:

Density meters shall be provided for continuous monitoring and recording of density in the primary hydro-clone feed lines, secondary hydro-clone feed lines, mill classifier feed lines, limestone slurry feed lines and, any other location required by the Bidder's FGD control system design.

Continuous monitoring and recording of absorber reaction tank pH.

In-line instrumentation for continuous monitoring and trend recording of chloride concentration (ppm weight chlorides) in the FGD system makeup water supplies, FGD system absorber modules, and FGD dewatering equipment.

Moisture analyzing instrumentation for each dewatered gypsum line upstream of each gypsum transfer conveyor.

5.2.8 Ammonia Unloading System

The Ammonia Unloading System, referred here shall be implemented in redundant DCS based system, located at Ammonia unloading Control room. One operator's station (with 24" TFT monitors) and one engineering cum operator station (with 24" TFT monitors) shall be provided. One (1) nos. A3 cum A4 color lazerjet printer shall be provided in the local control room.

Field Instrumentation including Ammonia Leak Detector, pressure measurement, temperature measurement, level measurement etc. shall be provided.

Coriolis Mass Flow meter with Totalizer for measurement of Ammonia unloaded from tanker shall be provided with isloated 4-20 mA DC output.

Guided wave radar type level measurement for Ammonia Storage Tank shall be provided.

5.2.9 Electrostatic Precipitator

Electrostatic Precipitator shall be controlled and monitored from the local control room, through DCS based control system consisting of Redundant Processor, power supply, communication module, redundant communication link, all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it.

Electrostatic Precipitator local control shall be provided with Two (2) nos. 24" TFT type operator station and one no. 24" TFT operator cum engineering station & A4 laser jet printer B/W in local control room.

Local annunciation panel with minimum amount of conventional hardwired pushbutton stations and indicators shall be provided for the safe shutdown of the plant.

5.3 TECHNICAL SPECIFICATION – PLC BASED CONTROL SYSTEM

Programmable Logic Controller (PLC) based control system shall be complete with a configuration of 1:1 hot redundancy having Central Processing Units (CPUs) of word length of 32 bits minimum, redundant communication processors, redundant memory modules, redundant power supply units, redundant data highway & link connecting Input / Output modules and redundant data network connecting operator station.

Two CPUs shall operate on fault tolerant mode with continuous self and cross-monitoring facility. Failure of the active CPU shall not affect the operation of the plant. In the event of failure of active CPU, tasks shall be transferred to the standby CPU within fastest possible transfer time without causing any output to drop during the transfer period. In the event of both the CPU failure, the system shall revert to the fail-safe mode. The complete system of CPUs shall not be loaded over 60% of the individual capacity even under worst data loading conditions. It shall be possible to make a manual transfer from the active to the back-up CPU from engineering station and as well as from the front panel of CPU module. Module shall have adequate status and diagnostic indication on the front panel.

The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 15% or minimum one number, whichever is a higher, spare channel as hot-on-rail spares in each configured cards/modules. In addition to this 10% or minimum one number, whichever is higher, extra assigned complete spare modules mounted on rails in racks for each type of I/O modules shall also to be provided. The spare channel and cards shall be fully wired and terminated.

The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient for complete system operation and shall have the capability for future expansion at least to the tune of 25%. The application program/sequence logic etc. shall be stored in non-volatile memory (EEPROM). However, all the dynamic memories shall be provided with battery backup with at least for 360 hours.

The number of input / output points per card shall not exceed 32 for digital and 16 for analog/thermocouple/RTD. Individual input channels shall have galvanic isolation. Output points shall also have optical/galvanic isolation. Merely fusing of individual or a group of channels is not acceptable.

6.0 TECHNICAL SPECIFICATION - INSTRUMENTS AND SYSTEMS

6.1 FIELD INSTRUMENTS

This section provides general hardware guidelines for field instruments and equipment to be supplied under this specification.

6.1.1 Pressure Transmitter/ Differential Pressure Transmitter

01.	Working Principle	:	Smart
02.	Type	:	2 - Wire
03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal. HART protocol.
04.	Signal Processing	:	Silicon solid state electronic circuitry
05.	Measuring Element	:	Capsule / Diaphragm
06.	Element material	:	AISI-316 (Stainless Steel) or better
07.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration.
08.	Turn-down ratio	:	100 : 1

09.	Span and Zero		:	Locally adjustable non interacting. Facility for elevation and suppression by 100% of span
10.	Enclosure Class		:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
11.	Output Indicator		:	LCD type
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate
13.	Body		:	Forged Carbon Steel (SS for DM Water).
14.	Operating Voltage		:	16 - 48 Volts D.C.
15.	Load		:	600 Ohms (min.) at 24 Volts D.C.
16.	Ambient Temperature		:	0 - 50^{O}C
17.	Performance:			
	i)	Accuracy	:	For PT: ± 0.04% or better of FSR for BTG package, ± 0.065% or better of FSR for BOP packages and ± 0.2% for remote seal type transmitter. For DPT: ± 0.025 % of calibrated span or better
	ii)	Repeatability	:	± 0.05% of Span or better
	iii)	Response time	:	100 msec or better
	iv)	Warranty & Stability	:	min. of 5 yrs or better

(Pressure transmitters with fastest response time shall be provided for critical application like furnace pressure, condenser vacuum etc.)

18.	Sealing/Isolation	:	Extended diaphragm with 5 meters SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm as per application.
19.	Accessories	:	a) Universal mounting bracket suitable for pipe mounting. b) High tensile carbon steel U- bolts. c) Installation accessories as per relevant installation drawing. d) Syphons for steam and hot water services. e) For PT: - ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock. f) Companion flange with nuts, bolts and gaskets. g) Hand held configuration kit for calibration of Smart Transmitter. h) ½" NPT cable gland i) For DPT: - ½" NPT generally 5-valve stainless steel manifold, constructed from SS316 bar stock.

6.1.2 Mass Flow meter

A. Sensor

01.	Measuring Principle	:	Coriolis Mass flow.

02.	Primary Element	:	Flow Tube of 316SS or better
03.	Heating Arrangement	:	Integral with Flow Element.
04.	Temperature Control For Heating	:	To be provided for heavy fuel oil application.
05.	Process Connection	:	Flanged and rating as per process requirement.
06.	Drain	:	Self-draining facility
07.	Enclosure	:	Stainless steel
08.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

B. Transmitter

01.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
02.	Input Signal Processing	:	Digital Processing.
03.	Display	:	Digital Display (LCD).
04.	Output	:	2 Nos. isolated output of 4-20mA DC & HART selectable from four measured quantities.
05.	Load	:	< 750 ohms.
06.	Power supply	:	240V AC, 50 Hz.
07.	Turn Down	:	100:1
08.	Accuracy	:	± 0.2% of measured value or better
09.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area).
10.	Hazardous duty Version	:	FM Standards.
11.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
12.	Accessories	:	a) As required for field mounting b) Handheld configurator c) Mounting U-bolts, nuts, bolts, prefab cable etc. d) ½"NPT cable gland

6.1.3 Pressure Gauge and Differential Pressure Gauge

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arc.
07.	Window	:	Shatterproof glass
08.	Range Selection	:	Normal process pressure – 50 ~ 70 % of range (approximately).
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT(M) Bottom connection for local mounting, back connection for panel mounting.

13.	Performance	:	Accuracy of ± 1.0 % of span or better.
14.	Operating ambient temperature	:	0 - 50^{O}C
15.	Safety Feature	:	Blow out disc./diaphragm at the back
16.	Accessories	:	a) Snubber and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel Diaphragm seals for corrosive, viscous and solid bearing or slurry type process fluids. c) 3-Way stainless steel Gauge cock for pressure gauges. Process connection ½" NPT. d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection ½" NPT. e) Union, nut & tail piece and other Installation accessories as required. f) Syphons for steam and hot water services.
17.	Applicable standard	:	International standard
18.	Electrical Contact rating	:	240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts: 1 SPDT
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

6.1.4 Temperature Gauge

01.	Type	:	Mercury or gas filled remote mounting system.
02.	Sensing Element Material	:	Bourdon - AISI-316 SS
03.	Capillary Armouring	:	Stainless steel flexible
04.	Movement Material	:	AISI 304 SS
05.	Bulb / Stem Diameter	:	12 mm
06.	Bulb / Stem Material	:	AISI 316
07.	Capillary	:	Stainless Steel
08.	Thermometer Connection to well	:	½" NPT
09.	Case Material	:	Stainless steel
10.	Dial Size	:	150 mm in general (100 mm for SWAS gauges)
11.	Scale	:	Black lettering on white background in 270 Deg. arc.
12.	Mounting	:	Surface/Panel
13.	Over range Protection	:	125 % of range or more
14.	Instrument connection	:	Bottom connection for local mounting and back connection for panel mounting.
15.	Range	:	Normal temperature –50 ~ 70% of range approximately.
16.	Zero adjuster	:	Micrometer screw adjustable from front.
17.	Window	:	Shatterproof glass.
18.	Accuracy	:	±1 % or better
19.	Enclosure Class	:	IP-65

20.	Capillary	:	5 meters (local)/15.0 meters (local panel) - armoured stainless steel
21.	Compensation	:	Capillary and Case Compensation
22.	Accessories	:	a) Forged/barstock SS316 thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). b) Installation accessories as required.
23.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

6.1.5 Thermocouples

01.	Type	:	a) Type - J (Iron Constantan) or Type - K (Chromel Alumel) or Type - R (Pt.-Rhodium Pt.). [As per application] b) Duplex c) Ungrounded
02.	Wire gauge	:	16 AWG for Type-K, 24 AWG for Type-R
03.	Standard	:	ANSI-MC 96.1.
04.	Protecting Tube:-		
	i) O.D.	:	8 mm
	ii) Material	:	316-SS Seamless
	iii) Filling	:	Magnesium Oxide (Purity above 99.4%)
05.	Response time	:	a) Less than 20 seconds for measurement. b) Less than 10 seconds for control.
06.	Accuracy	:	± 1.1^{0}C up to 300^{0}C & 0.4% of measured temperature range above 300^{0}C.
07.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass - screw type / silver plated
	iv) Instrument connection: to well		½" NPT
	iv) Cable connection	:	½" NPT gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
08.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection b) Compression fittings / unions c) Flanges etc. (for flanged connections only) d) SS 316 forged/barstock thermowell as per ASME PTC code. Process connection M 33X2 (M) in general or 1½" Flanged for Flue gas/Furnace/Air etc. application.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

6.1.6 Resistance Temperature Detector

01.	Type	:	Platinum (Duplex), Ungrounded
02.	Resistance	:	100 ohm at $0^{O}C$
03.	Base	:	Wound on ceramic (anti inductive)
04.	Wiring	:	3 /4 Wire
05.	Protecting Tube :-		
	i) O.D.	:	8 mm
	ii) Material	:	SS-316, Seamless
	iii) Filling	:	Magnesium oxide (Purity above 99.4%).
06.	Response time	:	a) < 20 seconds for measurement. b) < 10 seconds for control.
07.	Calibration	:	DIN 43760
08.	Accuracy	:	± 0.5%
09.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	iv) Cable connection	:	½" NPT gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
10.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) SS 316 forged/barstock thermowell as per ASME PTC code. Process connection M33X2 (M).
11.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

6.1.7 Pressure Switch/ Differential Pressure Switch

01.	Type	:	i) Piston for high pressure application ii) Bellow /Diaphragm for low pressure application
02.	Sensing element material	:	AISI SS-316. All other wetted part SS316.
03.	Case Material	:	Die cast aluminum alloy with neoprene gasket.
04.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
05.	Over range	:	150% of maximum pressure
06.	Adjustments	:	a) Internal Set Point b) Differential adjustment
07.	End Connection	:	1/2" NPT (M) bottom connected
08.	Switch configuration	:	Two SPDT
09.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
10.	Switch Type	:	Snap acting, shock & vibration proof
11.	Terminal Block	:	Suitable for full ring lugs for cable connection.

12.	Cable connection	:	½" NPT conduit connection or compression gland.
13.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
14.	Performance	:	a) Repeat accuracy ±1.0% b) Accuracy of Setting Indication of ±1.5%
15.	Ambient temperature	:	0 – 50 Deg. C
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement. b) Snubber for pulsating fluid application. c) Syphons for steam and hot water services. d) Retention ring and screws for surface mounting. e) For PS: 1/2" NPT 2 Valve SS-316 manifold constructed from barstock f) ½" NPT cable gland g) For DPS: 1/2" NPT 5 Valve SS-316 manifold constructed from barstock

6.1.8 Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel or better
03.	Other wetted parts	:	AISI-316 stainless steel or better
04.	External Cage	:	Carbon steel / Stainless steel or better as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
05.	External cage mounting	:	Side-Side.
06.	External cage connection	:	25 NB socket welded.
07.	Switch housing	:	Epoxy coated die cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
08.	Type of switch Configuration	:	2 SPDT (two nos.)
09.	Contact rating	:	5A, 240V/AC, 0.25A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve. c) ½"NPT cable gland

d) Stainless steel alpha-numeric engraved for service and tag.
e) Globe drain valve

11.	Preferred feature	:	Switch operating point marked on cage
12.	Mounting	:	On standpipe

6.1.9 Ultrasonic Level Transmitter

01.	Principle of Operation	:	Detection of reflected ultrasonic pulse
02.	Signal processing	:	Microprocessor Controlled Signal Processing
03.	Type	:	Smart
04.	Display	:	Large alpha-numeric back lit LCD/LED
05.	Calibration & configuration	:	Accessible from front of panel
06.	Diagnostic	:	On-line
07.	Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
08.	Construction	:	Plug-on board
09.	Power supply	:	240 V AC 50 Hz / 24V DC
10.	Signal Output	:	4-20 mA DC (isolated) - 600 Ohm load with HART protocol.
11.	Hysteresis	:	Fully adjustable preferred
12.	Output contacts	:	2SPDT Potential free changeover contacts @ 5A 230V AC.
13.	Accuracy & Repeatability	:	0.25% of span or better
14.	Resolution	:	0.1% of span
15.	Operating temp.	:	Transmitter-50° C and Sensor – 80° C
16.	MOC Sensor	:	SS 316 in general / PTFE, PP for corrosive application.
17.	Humidity	:	1% to 95% non-condensing.
18.	Enclosure	:	IP-65 powder coated die cast aluminium
19.	Cable connection	:	½" NPT with cable gland
20.	Mounting	:	2" flanged for sensor and Transmitter on panel / surface.
21.	Accessories	:	Cable gland, prefab cable, mounting accessories.

Note: Sensors and transmitter shall be separately mounted.

6.1.10 Air Filter Regulator

01.	Filter Element	:	Sintered Bronze
02.	Filter Size	:	5 microns
03.	Input Air	:	10.0 Kg/Sq. cm (maximum)
04.	Output	:	Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
05.	Effect of Supply	:	Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
06.	Bowl Material	:	Metallic.
07.	Accessories	:	2" dial size output pressure gauge
08.	Feature	:	No perceptible drop of pressure on opening the drain port.

6.1.11 Solenoid Valve

01.	Operating Principle	:	Electromagnetic (noiseless)
02.	Coil voltage rating	:	24V DC /48V DC (in general) other 220V DC /240V AC /110V AC as required
03.	Ways	:	3 ways in general other depending on requirement
04.	Port size	:	1/4" NPT all ports
05.	Body	:	SS Bar Stock
06.	Trim	:	AISI SS-316
07.	Manual Operator	:	In built
08.	Duty	:	Suitable for continuous energisation
09.	Sealing	:	Airtight and leak proof
10.	Ambient Temperature	:	0 - 50^{O}C
11.	Fluid Temperature	:	0-150^{O}C (approx.)
12.	Coil Enclosure	:	Stainless Steel
13.	Insulation	:	Class - H
14.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
15.	Mounting	:	On pipe or on panel
16.	Cable Connection	:	½" NPT cable gland
17.	Accessories	:	Mounting brackets, nuts and bolts
18.	Special feature	:	(i) LED indication (ii) Double coil type for open & close operation of valve / damper.

6.1.12 Orifice Plate

01.	Application	:	Low fluid velocity flow measurement
02.	Design Standard	:	BS-1042, Part - I
03.	Number of Tapings	:	As required plus one additional pair of taps
04.	Diameter Ratio	:	Between 0.4 to 0.7
05.	Thickness	:	3 mm for main pipe diameter up to 250 mm, 6 mm for main pipe diameter above 250 mm and 10 mm for main pipe diameter of 500 mm and above.
06.	Document	:	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
07.	Meter run pipe	:	Same as pipe material
08.	Accessories	:	Flanges, gaskets, nuts & bolts, root valves jack screw, meter run pipe, Drain & vent hole as per application etc..

6.1.13 Flow Nozzle

01.	Application	:	High fluid velocity flow measurement
02.	Design Standard	:	ASME PTC 19.5
03.	Number of Tapings	:	As required plus one additional pair of taps
04.	Diameter Ratio	:	Between 0.4 and 0.7
05.	Thickness	:	Suitable for the application
06.	Document	:	Beta ratio calculation, assembly drawing and Flow vs. DP curve.
07.	Meter run pipe	:	Same as pipe material
08.	Accessories	:	Meter run pipe, nipples and root valves. (Inspection port assembly for nozzles used in plant performance purpose)

6.1.14 Power Cylinders (Pneumatic)

01.	Mounting Type	:	a) Fixed position mounting (End mounting).
		:	b) Trunnion mounting
02.	Control Signal	:	4-20 mA DC to smart positioner with HART protocol for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line for open & closing purpose of on & off drive.
03.	Supply Air	:	0-7 Kg / Cm^2.
04.	Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air to open and air to close operation.
05.	Casing	:	IP-65.
06.	Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Smart Positioner with Input and Output pressure gauges, local keypad & display. g) Solenoid Valve h) Integral non-contact type position Transmitter (4-20 mA DC linear output). i) Junction box with cable gland
07.	Fail-safe operation	:	Stay put for regulating duty.
08.	Repeatability	:	Better than 0.5% of full travel.
09.	Hysteresis	:	Less than ±1% of full travel
10.	Operating Temp. limit	:	80 Deg. C (min.)

6.1.15 Radar type Level Measurement

01.	Type	:	Radar based on Time Domain Reflectometry
02.	Antenna	:	Co axial / single rod type guided wave or Horn type as required for the application
03.	Communication	:	Two wire 4-20mA DC, HART protocol
04.	Environmental temperature	:	0 – 50°C
05.	Enclosure	:	Explosion proof /IP 65 as per application
06.	Cable Entry	:	½" NPT
07.	Calibration	:	a) Self calibration with internal reference b) Zero & Span calibration
08.	Programming	:	Handheld programmer & Local key pad
09.	Process Connection	:	Flanged /screwed
10.	Electronic Housing	:	Epoxy painted Die-Cast aluminium alloy
11.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
12.	Output Indicator	:	Digital Integral Display
13.	Accuracy	:	± 0.03% of Measured distance or ± 3 mm
14.	Accessories	:	a) Programming tool kit

b) Gasket

6.1.16 Ultra sonic type Flow Meter

- Ultrasonic Flow meter shall be dual path transit time clamp-on type.
- The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.
- All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.
- Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

Type	Transit time Clamp On Ultrasonic meter
Mounting Style	Dual path with two sets of transducers on the same pipe
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply	230 V AC
Analog Output	Isolated 4-20mA linear outputs for each path
Binary Output	Contact relay outputs, 2 NO + 2 NC for alarm
Communication ports	RS 232 C digital Hand held terminal port
Display/Indication	Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
Recording / Totalizing /Logging Facilities	Yes. Should be able to compute cumulative flow over intervals selectable by owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future.
Software features	Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
Diagnostics	False signal tolerance , power supply failure etc.
Protection class	IP-65 or better, Weather protection against direct sunlight, rain etc. for Flow meter and suitable for Cooling water for Transducer
Accuracy	+/- 1%
Electrical connection	Plug and socket
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting Cables etc. All weather canopy for protection from direct Sunlight and direct rain. Material of all fittings shall be SS316.

6.1.17 Electro Magnetic Flow-Meter

The electromagnetic flow meter shall include flow sensor and flow indicator cum integrator / totalizer and shall include all required accessories for satisfactory operation. The flow meter shall be based on full bore electromagnetic principle and shall be electronic type of proven design, make and model acceptable to the owner.

The flow meter shall meet or exceed the following requirement:

(a) Output: 4-20 mA DC Isolated output
(b) Accuracy: ± 0.5% of calibrated span or better
(c) Repeatability: ± 0.2% of calibrated span or better
(d) Power Supply: 240V AC ± 10%, 50 HZ ± 5%/ 24 V DC.
(f) Protection class: IP-67
(e) Flow tube SS304
(f) Liner Hard Rubber

The flow meter shall provide local indication for instantaneous flow. It should also be possible to get local display for daily and monthly discharge. The flow meter shall indicate totalizer/ integrator to get the daily and monthly discharge as stated above.

6.2 CONTROL VALVES, ACTUATORS & ACCESSORIES

General Technical Guidelines for the Control Valves shall be as follows:

a) Bidder shall exercise extreme caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperator valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose downstream are connected to condenser and in vacuum such as HP/LP heater emergency level control, GSC minimum flow, gland sealing control, condensate spill to condensate storage tank, Deaerator drain to condenser Hotwell, condenser make up water control valve and CEP minimum flow control valve. For such critical applications, Bidder shall offer valves which are proven for similar application for not less than 2 years of continuous service in power plant environment. All the above valves shall have leakage class equal or better than class-V with metal-to-metal seating. These valves shall be of multi-stage, multi-path trim design to eliminate vibration, erosion, and noise effects. All other control valves shall not be inferior to leakage class IV.

b) Wherever, steam conditioning calls for Pressure reducing & desuperheating as well, combined PRDS type valves shall be offered.

c) Bidder shall provide redundant control valves for Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

d) All control valves shall be located near floor or platform for ease of access with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream isolating valve, inching duty motorized bypass valve and manual drain valves as per P&ID. Each redundant control valve shall have its upstream and downstream motorized isolating valves.

e) For detail technical specification of control valve, kindly refer Mechanical section.

6.2.1 Valve Actuators

Spring diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Bidder shall provide piston type actuators for the following services as a minimum requirement.

a) Auxiliary Pressure reducing & De-super heating stations (excluding spray valves if spray is considered from condensate discharge).
b) Superheat and Reheat Spray Control Valves.
c) Main condensate flow control valve.

The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an airline supply pressure of 5.5 Kg/Sq. cm.

All the actuators shall be supplied mounted on the valve with all the accessories integrally mounted. Diaphragms shall be designed for 200% maximum operating pressure.

Nylon reinforced neoprene shall be used as diaphragm material.

Valve actuators shall be capable of operating at 80 Deg. C ambient, continuously.

Entire actuator assembly shall be painted with corrosion inhibiting paint.

Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be of stainless steel construction.

Bidder shall indicate the stroking time of the valve assemblies with positioner.

All actuators shall be of failsafe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.

6.2.2 Valve Positioners

All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response. Positioners shall have integral non-contact type position transmitter, input and output gauges, local keypad & display and 4-20 mA DC output for position indication in CCR. Positioners shall be capable of functioning under hot, humid and vibrating conditions. Positioner casings shall be dust tight, corrosion resistant and weatherproof.

In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required. Remote calibration from control room shall be possible through HART management station.

6.2.3 Valve Accessories

The accessories of the valves shall include side mounted hand wheels, limit switches, junction boxes, airlock relays etc.. Solenoid valve wherever required shall be furnished.

6.3 CONTROL DESK / PANEL / RACK

Detail of control desk / panel including dimensions, material, construction details arrangement etc. shall be as per the actual requirement and shall be finalized during detailed engineering. Convenient and logical approach to operational interfaces and to enhance aesthetics in the overall view of the panel /desk shall be considered.

For items susceptible to vibration, suitable rubber gaskets or padding shall be provided to prevent damage or malfunction.
All items like MCB, Terminals, instruments, lamps etc. inside the panels/cabinets shall be neatly arranged with easy access/ maintenance approach to avoid undue disturbing the wiring.

Power supply feeders shall be double so that a single failure shall not affect the operation of the unit. Required isolation & protection through MCB shall be provided in all cases. Alarm shall be provided against failure of a single power supply.

Desk / panel shall be provided with interior illumination lamp with door switch, space heater with thermostat and 5A, 3 Pin receptacle with plug.

Lamp, heater and receptacle circuits shall be suitable for available AC supply and furnished with individual ON-OFF switch.
Panel / Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.

Panels / enclosure shall be provided with 20% spare terminals. In addition, the spare hot on rail mounted input output channels /modules shall be in fully wired & terminated condition for system cabinets.

Wire shall be routed / laid in the covered PVC cable trough / tray.

Nameplate

a) Nameplate shall be furnished for each instrument or device mounted on the panel/desk.
b) The material shall be laminated phenolic, 3 mm thick with white letters on black background.
c) The nameplates for panels / consoles shall be provided both on the front and the rear.
d) Nameplates for all devices shall be located adjacent to the respective devices.

6.3.1 Control Desks

All devices mounted on the panel /desks shall be flush type. Instruments / devices shall be so mounted that the removal and replacement can be accomplished individually without interruption of services to others.

Aesthetic, agronomy and lighting shall be considered while positioning of the desk, large video screen and panels in control room.

Control desk shall be free standing floor mounting type table top design with compartment & door for locating the computer and other hardware. Desk shall be of latest technology aesthetic design and constructed from aluminium or steel with scratch proof teak wood or high density fiber. All operators' MMI and keyboard shall be placed on the desk. Desk shall be arranged in arc like shape. Exact profile & shape shall be finalized during detailed engineering.

Crating of the desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing and all panel mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

Telephone and intercom shall be provided on the desk.

The desks shall be complete with floor channels sills, vibration damping pad and stainless steel kick plate.

6.3.2 Cabinets / Enclosure / Panels

01. Material of construction : Cold rolled steel sheet

02.	Thickness of Sheet		:	a) 3.0 mm for faces supporting instruments / terminals. b) 2 mm for other sides and top.
03.	Construction		:	Welded throughout as per (metallic parts) approved National Standards.
04.	Panel height		:	2300 mm (approx.)
05.	i)	Corners	:	7 mm inner radius
	ii)	Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm. c) Total for a group - 6 mm
06.	Doors		:	Double, recessed, turned back edges
	i)	Thickness of Sheet	:	2 mm
	ii)	Hinges	:	Stainless steel
	iii)	Door latches	:	Three point type
	iv)	Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure.
v)	Opening of the doors		:	Outward
	vi)	Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07.	Color of interior		:	Brilliant white
08.	Colour external		:	RAL 7035 (Approval shall be accorded from owner during engineering)
09.	Painting		:	Epoxy powder coated or better
10.	Gland plates		:	Removable 4 mm thick (bottom)
11.	Cable entry		:	Bottom
12.	Hardware		:	a) Anti vibration pad- 15 mm b) Predrilled base channel ISMC - 100 or equivalent for all sides. c) Stainless steel buff- finished 2 mm thick kick plate for all sides.

d) Stainless steel scratch strips along desk edges fixed with pan head recessed screws.
e) Rubber strips to ensure air tightness between kick plate and finished floor.
f) Lifting hook / Eye bolt
g) Drawing pocket
h) Door switch, lamps, thermostat, heaters and fans
i) External Earth Stud

13. Enclosure Protection : As per environment condition of the area of installation. Refer section-1.0 of this volume.

6.3.3 Local Instrument Racks & Enclosure

Transmitters and switches located in the field shall be grouped together and shall be installed in the enclosure (Closed Transmitter Racks) in case of outdoor area such as Boiler area etc. and in Open Type Rack in case of covered area. Racks shall be factory prefabricated & painted and complete with internal tubing, manifold valve, isolation valves, integral junction box with outside access door, illumination etc. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging.

6.4 DISTRIBUTED CONTROL SYSTEM (DCS)

6.4.1 System Functional Description

Integrated functionally & geographically distributed hierarchical Control System (both binary and modulating) including data acquisition, historization and Management Information System (MIS) system synthesized from one general family of identical interchangeable multifunction hardware with adequate redundancy shall be envisaged for the plant.

The system shall be unit wise and connectivity with other plant control system & Management Information System (MIS) network has been envisaged.

Bidder shall provide Remote Input Output as a data concentrator for acquisition of non-critical monitoring parameters like Boiler metal temperature and RIO shall be suitable for locating in non-air conditioned environment.

Controls of some plant auxiliaries and off site plants such as CW & ACW Pumps, Fuel oil forwarding & pressurizing system controls, IDCT controls and mill reject system shall be realized in the Remote I/O unit (RIO). RIO consisting of input / output modules with their local operator stations shall be located in the respective air conditioned local area control room. RIO shall be considered as an extension of the DCS node/network and complete with optical fiber cable and accessories.

Bidder shall provide OPC interface for the purpose of data acquisition from Switchyard SCADA system with all necessary hardware, software and interconnecting cables.

Selected data from offsite DCS based plants such as Coal Handling System, Ash Handling System, Desalination (as applicable) & Water treatment System, Waste water / effluent treatment plant, Fire fighting pumps system, Air Conditioning & Ventilation System,

Hydrogen Generation Plant, Chlorination System shall be displayed / historized in CCR. Bidder shall provide the suitable DCS gateway (OPC interface), optical fiber cable & interface hardware as required.

The system shall be based on open system architecture, shall be modular, expandable and upgradable technological advancement.

The control and monitoring hardware and peripherals for the unit shall be located in the Central Control Room (CCR) & Control Equipment Room (CER) area (air-conditioned) of the two units.

The DCS shall be configured to broadly perform the following basic functions: -

a) Automatic sequencing of the start-up, shutdown and load rejection of equipment and auxiliaries including group / plant level start-up to minimize operator's intervention under normal operating conditions ensuring safety of man and machine as well as to ensure high plant availability (OLCS & Sequence functions).

b) Automatic regulation of various valves and dampers to achieve guaranteed performance of various controlled variables and to achieve most fuel-efficient operating regime (CLCS functions).

c) Acquisition, display, real time & history trend, logs, report generation and archiving of plant data and maintain historical data for a defined period (DAS functions).

d) PLC Gateway for collection of selected data from package PLCs.

e) Major functional sub systems of DCS are conceived like SG control, TG Aux control, Station C&I (Regenerative area & balance of plant) and Electrical Distribution & Management System (EDMS). SCR, FGD, DCS interface with other systems like Vibration Monitoring & analysis System, Plant performance calculation; Plant Optimization etc. are also envisaged.

f) Presenting salient plant parameters to plant executives to display the health and condition of the plant and to aid the decision making (MIS functions).

g) Energy management and audit of the plant and equipment by measuring consumption of power of all salient equipment and measurement of fuel, steam, water and all other relevant cost-bearing parameters.

h) The DCS system should have a facility for simulation of control loops / logic.

i) System shall have the tool for automatic generation of documents like loop & logic diagram to be auto derived from the DCS configured loop / logic / data. Logic & loop diagram such prepared can be functional in auto CAD environment so that further preparation of wiring drawing shall be possible.

j) Interfacing of both unit DCS for common data exchange, if any.

The DCS shall consist of the following broad sub-systems functionally independent of each other except for mutual signal exchanges: -

a) Input / Output Subsystem
b) Open & Closed Loop and Sequential Control Subsystem (OLCS & CLCS)
c) Data Acquisition Subsystem (DAS)

d) Historical Storage Subsystem (HSS)
e) Performance analysis, diagnostic and optimization system (PADO)
f) Man Machine Interface (MMI) / Operator's Terminals
g) Engineering and Diagnostic Station (ES)
h) Sequence of Event Monitoring Subsystem (SOE)
i) Management Information System (MIS)
j) HART Management System
k) Large Video Screens (LVS)

All these subsystems for each unit shall be connected together through redundant data highways at both control and information level. Additionally there shall be integration between both the units at the Management Information System (MIS) level for the purpose data sharing and information. The functional independence between various subsystems shall be to the extent that failure of any subsystem shall not affect the availability of other subsystems. The mutual interdependence between the subsystems shall be limited to sharing the global database of the plant, which shall be resident at various locations within the system, to facilitate rapid response of the control system. The same database will be accessed, shared and updated by various consumers of the data, seamlessly and transparently.

The system architecture of the DCS shall, by and large, be unit wise with both unit systems performing in a manner independent of each other with limited data exchange. This is to accommodate the fact that the commissioning of the two units will be executed in phases and commissioning activities on one unit shall not interfere with the functioning of the other running unit.

Independent nodes and section shall be provided in DCS for interfacing with inputs and outputs from equipment / system common to both units like DM water supply to Condensate storage tanks, Fuel oil pressurizing system, common electrical distribution system etc. to ensure control and availability of information at each unit without any limitation.

Power supply to common cabinet (common for both unit) shall be such that non-availability of power supply from one unit (under complete shutdown) shall not impose any limitation on functioning.

All unitized networks and the above station auxiliary network shall be 'bridged' into a common high-speed network with authorized data access between sections.

The system shall have interface so that pre-selected plant parameters can be viewed at selected nodes on the company local area network (LAN) or wide area network (WAN) or from remote location via ISDN or equivalent connections. The exact nature of the interface shall be finalized during detailed engineering. To protect against any unauthorized access of the network, adequate cyber-security in the form of Firewall with suitable hardware and software key & antivirus software etc. shall be deployed.

Bidder shall provide one PC and laser printer along with required software at owner's head quarter for remote monitoring /access.

Web based MIS subsystem with HTML compatible display format for accessing plant graphics / data shall be provided. The system shall support unlimited access for casual users for viewing the static display of plant information / graphics and at least Ten premium users license for viewing the information / plant graphics with automatic refresh features. The server shall be of proven make and shall have latest processor.

For coordinated machine control (CMC), the DCS shall interface with 'Load Demand' & other signals from owner's Central Load Dispatch centre. Detailed scheme drawing for the CMC shall be furnished for owner's approval.

No back-up discrete hardwire based control or hard-manual operation is envisaged for normal operation of the unit. Bidder shall, however, perform a failure analysis to establish that the plant can be shut down safely or can be brought to a safe holding condition without any damage to equipment and/or personnel under the unlikely event of catastrophic failure of DCS. Any back-up instrument or controls necessary to achieve the above condition shall be provided at back up panel, which shall otherwise house the EWLI(as applicable), Electromatic safety valve controls, emergency PB like MFT, Turbine trip & Unit trip and emergency start & stop PB of critical drives, valves & dampers etc.

It has been envisaged that in addition to automatic synchronization through turbine run up system, manual synchronization of generator shall also be provided and for this purpose required synchroscope, synchro check relay, switches, speed control switch, voltmeter, ammeter, indication lamps etc. shall be provided in the Generator control panel.

Bidder shall furnish all required equipment and materials including system hardware and firmware components, peripherals and operator work station, all necessary licensed software platforms - compilers, interpreters, builder packages etc; programming, diagnostic and test routines, instruments and equipment; development of application software, data base, screens, graphics and other functional programs; establishing the network structure, debugging and loading; develop and follow a quality assurance plan, system integration, simulation and checkouts; offering the system for owner's shop inspection and testing including hardware, software and heat run tests, packaging for transportation, delivery at plant site, unloading, warehousing, installation, site integration, program loading and documentation, system check-out, interconnection with field inputs, pre-commissioning checking, commissioning including tuning of control loops and put the complete system in operation with necessary site modifications, conduct performance guarantee tests, system availability test and develop as-built documentation.

Bidder shall supply all related documentation including original software manuals, application software manuals, operation and maintenance manuals, instruction handbooks for graphic and data-base building and other related documents and manuals in hard copies as well as in soft medium. Bidder shall furnish the entire plant database and configuration in as-built condition in CDs for reloading/ record.
Bidder shall also supply maintenance and troubleshooting tools viz. test instruments, extender cards, DVDs containing programs including virus detection and elimination programs, DVD writers, diagnostic programs etc.

Bidder's scope of supply shall include the supply of commissioning, recommended and mandatory spares as per guidelines given in the specification.

Bidder shall supply a fully engineered and operative system meeting the general purpose and intent of the specification. Bidder shall include all equipment, component and sub-systems necessary for the completeness of the system, irrespective of whether such items have been specifically identified in the text.

Bidder's scope of work shall also include the training of Owner's personnel at original equipment designer / manufacturer's office and providing the warranty for the equipment supplied.

Suggested configuration of the DCS is illustrated in the Drawing no. Annexure CI-01 enclosed which also gives an indication of the different peripherals & their provisional assignment.

All inputs/outputs to/from the DCS, from field or other cabinets in and beyond Control Equipment Room shall be routed through Termination Cabinets.

There shall be functional duplication for MMI fall back so that in case of outage of any operator station, other operator's station can take up its entire assigned function transparently, without any sacrifice in performance and without the need for rebooting. However, for normal duty operation, assignment for man machine interface severs and other peripherals are envisaged as follows. Printers shall have graphic capability and any printer shall be accessible from any workstation.

a) Steam Generator Control Stations (2 per unit) – For closed loop, open loop and sequence controls of SG integral control & monitoring, alarm and SOE within boiler area.
b) Turbine Generator Control Stations (2 per unit) - For closed loop, open loop and sequence controls of TG integral control & monitoring, alarm and SOE within turbine area.
c) BOP stations/ Electrical Distribution system (2 per unit)- For closed loop, open loop and sequence controls of Station C&I / Balance of Plant/ Electrical System control & monitoring, alarm and SOE.
d) LED based Large Video Screen Display unit 72" with controller to display salient plant parameters, graphic & alarm (04 nos. per unit).
e) Engineering cum diagnostic Terminal (2 per unit) - located in Engineering Room - with one (1) Color laser jet printer (A3/A4 size).
f) Plant Performance Calculation & Plant optimization system Terminal (One per unit)- located in Engineering Room
g) Management Information System (MIS) / Plant View Server - located in Engineering Room – common system
h) Shift charge Engineer's Station (1 per unit)- with printer
i) Printer shall be freely assignable to any operator station. Printer configurations for each unit shall not be limited to the following:
   i) A3/A4 color laser jet-07 nos.- Reports, Graphics, Logs

   In addition to the above there shall be MMI not limited to the following:
   - VMAS - with colour laser printer - for each unit.
   - HART management system-with printer- for each unit.

The DCS System shall have the following capabilities, as minimum: -
a) Scan, acquire, validate, time-tag, process, store, update, archive, retrieve and display all analog and digital data and parameter.
b) Monitor real and calculated variables for multi-level alarm conditions.
c) Accept and execute operator's commands and pre-programmed routines and run-times.
d) Perform all open and closed loop control functions.
e) Display plant mimics, bar graphs, control faceplates, point description, trend graphs (real time & history) in interactive mode with the operator.
f) Prepare and print logs and reports.
g) Performance calculation & Plant optimization based on real time and manually entered data.
h) Dynamically reconfigure itself on command from engineering station.

i) Run its own diagnostics, watch dogs, system checks and consequent fallback routines.
j) All system information and diagnostic alarm like failure of I/O module, Multifunction controller, communication modules, node failure, CPU loading, Network loading, workstation diagnostic etc. shall be annunciated and displayed at any workstation.
k) Dynamic data exchange through OPC /MODBUS with other computers.

6.4.2 GPS Master Clock

The Redundant Master Clock system shall receive the synchronizing pulses from the Global Positioning Satellite (GPS) system and form a common time reference for recording of any alarm, sequence of event, logs and reports, which may take place in any portion of the network distributed throughout the plant.

Master Clock system shall synchronize the entire system for uniform time stamping of all parameters of both units as well as other sub-systems of the plant. System shall comprise of receiver antenna, redundant master clocks and slave clocks, interconnecting cables, cubicles, redundant power supplies & other accessories. Failure of the antenna will lead to systems falling back on their internal master clock. A minimum of 25 external slave display devices (receiver clocks) of 6-digit display of digit size 100 mm approx. shall be located at various strategic locations of the plant and shall be connected with the centralized master clock system. All the microprocessor based control systems like DCS, PLC based systems, CCTV, TSI & VMAS, Switch yard control and Disturbance recorder shall be time synchronized with the master clock system to have common time reference. In addition, the system shall also have 10 (ten) nos. of additional spare ports of each type for time synchronization of future utilization.

6.4.3 Control System Description

Broadly, DCS shall comprise closed loop control, open loop control, sequence control, data acquisition (both hard and soft data) and data archiving sub-systems.

The closed loop, open loop and sequential controllers are envisaged to be a single subsystem synthesized from Multi-loop Multifunction Controller cards / blocks from the same family of hardware capable of handling both Closed Loop and Open Loop Controls.

The DCS shall be configured such that degradation of performance in the event of a single failure of control equipment shall be eliminated. However, such failures shall be suitably annunciated to draw the attention of the plant personnel. Multifunction controllers, Communication Processors and Power supply modules (both for control and field supplies) for all open- and closed- loop controls shall be hot redundant to minimize risk arising out of failure. Similarly, output modules of all HT drive; critical LT drive and all modulating control drives shall be redundant. All redundant cards and modules shall be hot-withdrawable and hot-insertable.

A single multi-loop controller pair based on 64-bit processor or above shall not handle more than twenty (20) PID functions.

The hardware and software for the DCS shall be from the latest proven design for real-time environment meeting the pre-qualification requirement of this specification. The system shall operate on a global database with authorized access of any data at any point of the network.

Comprehensive automatic diagnostic system shall periodically verify the integrity of the system and shall cause auto-transfer to the stand-by equipment without any loss of data

or shall lead to fail-safe situations in case of catastrophic failures with reporting at higher level.

Following guidelines regarding the data loading of various components of DCS and the response time of the system will determine the extent of functional distribution.

The maximum permissible loadings are as follows:

a) Multi-loop Multifunction Controller –60%.
b) Input / Output - 80%
c) Console – 80%
d) Historical Storage - 75 %
e) Data Highway / communication link – 60%
f) Other computing modules – 60%

Control functions shall be judiciously assigned to various controllers such that,

a) Controllers are uniformly loaded.
b) Loops are assigned logically to the controllers so that peer-to-peer active data transactions are kept at minimum.
c) There remains a simple correlation between plant equipment / system and corresponding controller (hardware-wise).

The maximum permissible response time for various functions is as follows:

a) CLCS scan time - 100 m. sec for Critical closed loop controls such as Hotwell level, Furnace draft control etc. and 250 m. sec for others
b) DAS data update time - 1 sec
c) SOE data update time - 1 m. sec
d) OLCS scan time - 50 to 100 m. sec
e) Refresh real time data on screen - 1 sec
f) Operator's command execution time - 1 sec

For hardware configuration, following guidelines shall be followed:

a) Boiler protection system shall be configured in three processors in 2 00 3 configuration and Turbine protection system shall be configured in three processors in 2 00 3 configuration. Each Processor along with their respective I/O cards shall be installed in different cabinets. Electro Hydraulic Turbine control shall have redundant controller as per manufacturer standard.
b) All other controllers shall be dual redundant in fault tolerant mode.
c) Rack power supplies shall be redundant in all cases. Sensors / transmitters shall be redundant for all critical control loops and for non-critical control & measurement the transmitters / sensors can be non-redundant.
d) Analog & Digital output modules shall be dual redundant for all HT drives, critical LT drives, all modulating duty control valves etc. so that failure of a single channel shall not lead to any abnormality of the process.
e) Cabinet Power supply feeders, control & MMI data hi-ways and network interface units shall be redundant.
f) Each system cabinet shall have both protective and electronic ground.
g) Offsite & plant auxiliaries DCS and VMAS shall be interfaced with main plant DCS through redundant gateway / converter / serial link with STP / OFC connectivity for information & monitoring.

Input / Output modules shall have the following features:

a) Signal conditioning, A/D conversion, Signal validation, Diagnostic, Engineering conversion, Time stamping, Limit value monitor etc.
b) Capability of interfacing smart transmitter though smart interface module with optical and galvanic isolation.
c) All analog & digital inputs and outputs shall necessarily be either galvanically or optically isolated. Function of input / output module shall not be disturbed in case of failure or damage of a channel.
d) The channels in the modules can be individually addressed during routine diagnostic check.
e) Any failure in the module, breakage in analog signal wires and any signal input crossing the range domain on either side (below 4 mA and above 20 mA in case of analog input) are immediately detected at I/O level and reported to monitoring console. Similarly, thermocouples shall be checked for open circuit condition. Resistance temperature detectors shall be validated against open and short circuit conditions. Non coincidence monitoring shall be provided for important trip & interlocking contact.
f) Number of channels in IO module shall not be more than the following:
   i) Analog input (Non HART) - 16 channels
   ii) Analog input (HART) - 16 channels
   iii) Analog output (Non HART) – 16 channels
   iv) Analog output (HART) – 16 channels
   v) Digital input - 32 channels
   vi) Digital input (SOE) – 32 channels
   vii) Digital output - 32 channels
   viii) RTD input – 16 channels
   ix) TC input – 16 channels
g) Replacement of module shall be possible to carry out in system power on condition.
h) Signals for panel mounted recorders, indicators, annunciators etc, where provided, shall be fed from I/O level.
i) Lower level bus viz. I / O bus and I / O communication processor shall be redundant. Alternatively, IO bus can be a backplane encapsulated not exposed to external environment.
j) Separate redundant power supplies for powering field sensors shall be provided. This interrogation power supplies shall not be derived from the rack power supply used for control modules.

Controllers shall have the following minimum features:

a) Controller shall have 64bit or higher CPU and typically 64 MB RAM minimum with battery backup.
b) Communication speed shall be 10Mbits/s / 100Mbits/s / 1 Gbps.
c) Communication shall be deterministic and peer-to-peer with other controllers on the network.
d) Controllers, power supply, communication modules /processor & associated links cables shall be redundant. Failure of any single component shall not lead to failure of the system.
e) CPU and memory capacity shall be utilized up to maximum 60% in worst data loading condition.
f) Replacement of electronic modules like controller, communication module /processor, IO modules can be done in system power on condition.
g) The application/configuration program shall be resident in non-volatile flush memory/EEPROM so that no down loading of program is required in case of system restart.
h) Processing time of any parameter shall be freely configurable.

Closed Loop Control System (CLCS) shall act on modulating control valves, dampers, or other regulating devices to achieve stable control action under steady state condition, for load swings in the step / range over the entire load range with permissible variation in parameters and under failure/trip or limiting condition of process equipment.

CLCS controllers shall have system resident library functions including linearizers, characterizers, square root extractors, signal limiter, one-out-of-two selector, two-out-of-three voting system, averaging, PID block, logical functions, Auto / manual selector and other software configured mathematical blocks to be strung together to form the desired strategy for control. Synthesizing, configuring, tuning or adjusting control loops should not involve writing elaborate programs.

Open Loop Control System (OLCS) shall perform interlocking, protection, sequential interlocking functions; individual drive control interlocks with their associated safety protection. The OLCS shall provide adequate and reliable protection & safeguard for various equipment and shall assist the operator in easy, safe & efficient starting, stopping and tripping of various drives in the plant.

OLCS shall perform all permissive, start, stop, auto-start, auto-stop, wait- and step-timing, emergency start/stop, drive interface and other related binary functions. It shall also perform to indicate drive status feedback like On, Off, Fault, Local & Remote selection, Normal & Trial selection, Switchgear disturbance, Electrical protection operated, Safety interlock operated, standby mode etc. on the screen.

OLCS controllers shall have system resident library functions including logic functions, timers, registers, counters, Boolean operators, encoders, one-out-of-two selector, two-out-of-three voting system, logical functions and other software configured mathematical blocks to be strung together to form the desired strategy for control. Synthesizing, configuring, tuning or adjusting control loops should not involve writing elaborate programs.

Each of the multi-loop controllers shall cater to a group of related loops and shall have its own in-built communication function for interfacing with the redundant control system bus.

The main and the hot stand-by controllers shall be identical in all respects. Any one of the two controllers can be selected as 'main' controller; the other shall automatically flip to standby mode. The output of the stand by controller shall be disabled. However, the controller shall receive and update its database from field inputs and main controller. In case of failure of the main controller, the stand-by controller shall come on line automatically and transparently without any upset in the process. The changeover shall be Bumpless.

When a controller is put back after removal for maintenance or if a new controller is put in service, there shall be provision for high speed down loading of data from the hot controller without affecting the main highway traffic and without involving any operator intervention.

It is preferred that in case of an internal diagnostic failure of a multi-loop controller pair, all concerned loops shall trip to manual and drive will go to fail safe mode.

The functional capabilities of the multi-loop multifunction controller shall include but not limited to the following: -

a) Accepting operator commands from and providing operator feedback to Operator's Terminal via redundant highway.
b) Interact with other subsystems via Control System Bus.
c) Carry out computation actions (Square root, Addition/Subtraction, Limiter, Multiplication/division, High/Low Selectors, Totalizer, Non-linear function, Ramp generator/Time delay, Integrator/Differentiator)
d) Carry out and control actions (viz. P, PI, PID, Cascade, Feed-forward, Ratio, Lead/lag compensation, Override, PI Adaptive gain etc.)
e) Perform binary and sequential operations (AND, OR, NOT, gates, timers, etc.)
f) Self-monitoring and auto-diagnostic leading to transparent changeover to stand-by and reporting of failure.
g) Program modification and configuration via Engineering Terminal, on line.
h) On line system tuning and setting via Operator's terminal / Engineering Terminal.
i) Testing and simulation from Operator's terminal / Engineering Terminal.

Transfer of control mode from automatic to manual and vice versa shall be of procedure less and bumpless, incorporating necessary output tracking facilities.
The controller's gain shall automatically and accurately adapt to the number of drive units in a given subsystem that are on auto control to maintain constant loop gain with any combination of drives on automatic and manual mode.

Excursion of a control related current / voltage beyond acceptable values shall cause the corresponding control loop to trip automatically to manual mode with the control output latching in at the last value, until manipulated in manual mode.

Controllers shall not be assigned without validation check function of the field inputs. All failures shall be duly alarmed and reported.
In addition to CLCS control, artificial intelligent adaptive control for critical loop such as SH/RH temperature control loop shall be provided. Bidder shall furnish write up on the same.

Controller assignment /partitioning shall be judiciously decided considering minimum outage of the equipment/system in case of failure of a functional group and shall not lead to complete unit outage. Bidder shall furnish his partitioning scheme based on the equipment /system offered for owner's approval during detailed engineering. The same shall be done without any cost implication.

Data Acquisition Sub-System meant for acquiring plant data for monitoring purpose shall be implemented in multi-loop processor in fault tolerant mode and shall acquire, process and store the following types of plant data for display, performance calculation and monitoring purpose. Data acquisition subsystem shall also include various gateways capable of acquiring, processing and storing data from third party system data highways.

Data Acquisition sub-system shall acquire process and store data of following types:

a) Data from field transmitters and sensors, both analog and digital.
b) Hardwired analog & digital inputs from other systems.
c) Data acquired through OPC/Modbus links and gateway of stand-alone unit systems such as Ash Handling Plant, DM Plant, Rotating machine condition monitoring system etc.
d) Acquisition of data from OLCS & CLCS
e) Binary inputs for sequence of event monitoring.

The data collected by the DAS may also be used for SOE, overview, logging, historical storage and performance calculation.

The data acquisition sub-system shall be built around the hardware of similar make as that of OLCS & CLCS and the acquired data shall seamlessly blend with the rest of data acquired.

The System Data Highways & links shall be dual redundant at all levels.

Network elements like gateways, bridges, controllers etc, interfacing with the data highways shall have two independent couplers linking the dual highways. All messages received through dual highways shall be validated individually for error and between themselves for fidelity of both the highways. Faulty data highway shall be automatically isolated, without any loss of data but with appropriate alarm. Erroneous messages shall be flagged and rejected. The previous value shall be retained until the fault is cleared.

Plant data highway and all other major internal highways shall be high speed digital links of speed preferably 100 MBPS / 1 GBPS. Bus protocols such as TCP/IP at control levels shall conform to OPC compliant ISO 7-layer protocol in master less, token ring or token bus (as per IEEE-802) or any standard proven & accepted protocol in deterministic mode. Extensive error checking (CRC-16/12) or error correcting codes shall be used in these levels to improve the reliability of communication.

All the Controllers and gateways shall be connected to the redundant common high speed data highways for global distribution and access of data. Any data shall be available at any point on the network as and when required.

DCS network for the remote nodes and OPC/MODBUS communication link with external PLC / microprocessor based sub systems shall be dual hot redundant.

6.4.4 Historical Storage Unit (HSU)

HSU shall be Industry Standard Time series Historian, Non SQL based It shall augment the global memory in the system and will archive data and parameters for logs and historical records including trends, alarms and events. These will be used for analysis, data presentation and performance calculation. The historical storage unit shall be a stand-alone unit on the data highway performing as file server.

Redundancy for Historical Storage Unit shall be provided either by dual disc imaging or by some other technique so that any single failure shall not lead to complete loss of historical data.
Assignment between globally distributed memory and the historical storage shall be judiciously determined during system engineering stage. While the historical data storage function shall be exclusively performed in HSU, some invariant application programs / data like mimic diagram (the fixed part) may be resident in selected fixed sectors of the HSU provided the display latency requirements can be fulfilled. The latency between addressing a display to its appearance on screen shall be less than 3 seconds. The latency for historical trend display shall be less than 10 seconds. If these latency criteria cannot be met, the relatively invariant application programs shall also be globally distributed for faster response.
Data to be stored in HSU shall include alarm, event list, periodic plant data, selected logs/reports such as start-up, trip analysis logs, shift logs, daily logs etc..
Bidder shall furnish data/information to be stored and frequency of storage and retrieval for approval.

Data shall be stored in the Historian on exception basis whenever any deviation from last stored data takes place or by any other suitable scanning techniques. Module shall also have the capability of storing both snapshots and average value.
System shall be provided with External hard disk (Adequate capacity) for long term data archiving.
Dead band compression shall be configurable on the collection of the data as a percentage (%) of engineering limits.
The system shall provide a method for backing up all active archives on-line without the need to stop the archive system.
Auto discovery Facility shall be available on historian station for auto-identification of all the changes made at controller level.
Sizing of the HSU shall be carried out in such a way that at least 25% over the already configured tags can be added in future.
Historical storage should permit trending of all analogue inputs with time scale (X-axis) selectable as 1Sec, 10Sec, 30Sec, 1 min, 4 min., 20 min., 2 hours, 8 hours & 24 hours on MONITOR Screen. Vertical scale (parameter range) shall be freely programmable. It shall be possible to map the real time and history trend on the same trend group display. History data storage shall be for minimum 30 days and after expiry, data shall be automatically/manually transferred to the external storage device such as External hard disk (Adequate capacity). Data related to plant life shall be stored in the HSU for the complete plant life.

6.4.5 Alarm Display

Alarm shall be displayed on the operator station on occurrence of any alarm. At least 1000 alarm points with paging feature shall be provided. Keyboard & monitor shall have the function keys such as alarm acknowledge, reset, paging, summary display etc. Format of the alarm page display shall be finalized during detailed engineering.

6.4.6 Sequence of Event (SOE)

It shall be an integral function DCS with 1msec time resolution. Number of SOE points shall be on as required basis but not less than 512 points per unit. SOE inputs shall be sourced directly from the primary switches and primary relay / contactors for real time "time-stamping" following any tripping of major equipment, sub-systems and the plant as a whole. SOE shall be available at all the operator stations resident on the network with printing on occurrence of any status change of contact. Operator can access the SOE on activation of SOE page. SOE report shall include a list of major equipment trip in chronological order and also include the points which initiated the SOE collection. Storage capacity for SOE in HSU shall not be less than 3 months. Format of the SOE display page shall be finalized during detailed engineering.

6.4.7 Online Performance calculations, Diagnostics & Plant optimization (PADO)

Performance calculation shall be performed automatically by using online global plant data from DCS or retrieving data from the global data base/HSU and will perform plant efficiency, heat rate and other calculations as per ASME PTC and other relevant standards.

The Plant optimization system shall combine the thermodynamic models of the plant components with economic related parameters like revenues from electricity sales, variable and fixed costs. The thermo-economic optimization shall take account of all important constraints of operation and shall be able to update on current equipment performance by adjusting model parameters from its database without user interaction. System shall be able to predict and optimize the optimal setting of controllable parameters based on current equipment performance. It shall also include an off-line manual ("What-if") analysis tool that will enable the user to conduct model-based analysis of plant

operation. The above systems calculations shall be performed by an independent "Plant Performance Calculation & Data Optimization Package".

System shall include the following:

d) Performance analysis and monitoring of systems and components
e) Boiler Performance Optimization package including optimized operation of soot blower system
f) Boiler stress analyzer
g) Water and gas chemistry management
h) Emission analysis & monitoring
i) Regenerative /power cycle performance optimization
j) System and performance optimization
k) System and performance diagnostic

The system shall satisfy criteria for proven equipment as laid down in the specification. Bidder shall furnish the supporting document in the bid.

Bidder shall also furnish detail of the system offered including the process inputs required.

The plant performance calculation package shall also embody programs and routines to generate parameters to provide expert guidance to the plant operator. Suitable prompts and guidance messages shall be generated in the operator's terminal to guide the plant operator towards optimal plant performance.

Provision shall be made, including all required custom programmed software, for performance calculations and turbine steam supply accounting. All calculations shall use a high level language. Calculations shall be made using floating point arithmetic. These equations shall be changeable on-line at the job site. The calculation results shall automatically be quality coded according to the worst quality of any of the inputs to each calculation. The results of these calculations shall be available through the database for appropriate logs and operator displays.

All required curve fitting shall be performed at the highest value of the polynomial exponent for greater accuracy. Averages used in calculations and/or logging shall be true "load weighted" averages (load weighted with the proper variable to give true averages over the given time period). The ASME Steam Tables shall be employed. Water, steam and fuel flow equations shall be based on ASME Power Test Code.

The plant performance computations are broadly subdivided into two classes of calculations:

Class (I) - Equipment protection calculations (software generated alarms); and

Class (II) - Plant/equipment efficiency, Heat rate calculations.

i) Class-I Calculations

Class-I calculations include those calculations that are made every scan cycle of the slowest scanned input entering the calculation generally for the purpose of detecting and alarming unit malfunctions. The following lists typical Class-I calculations that shall be required.

- Cold reheat steam approach to saturation temperature.
- Superheater spray outlet approach to saturation temperature.

- Turbine steam metal temperature differences
- Turbine metal temperature rates of change
- Excess air deviation from standard
- Feed water heater temperature deviation from standard

ii) Class-II Calculations

Class-II Calculations shall be performed in the real time for displaying and subsequent logging using data, which is accumulated over a period of time. This time period shall be selectively adjustable from 10 to 60 minutes. The system shall have the capability to store the data when instructed to do so. The operator shall be able to input coal analysis data and other data in the computer for Class-II Calculation.

Class-II calculations shall include but shall not be limited to the following:

- Boiler efficiency (Input / Output & Heat loss)
- Turbine Generator heat rate
- Gross unit heat rate
- H.P. turbine enthalpy drop efficiency
- I.P. turbine enthalpy drop efficiency
- L.P. turbine enthalpy drop efficiency (using dry exhaust)
- Feed water heater performance terminal difference
- Heat rate from Accumulated Heat input & MWH
- Plant load factor from accumulated MW hour.
- Feed water heater performance drain cooler approach
- Condenser performance
- Economizer performance
- Air heater performance
- Deaerator performance.
- Deviation from expected value for each calculation

Apart from Class I & Class II calculations, this sub-system shall also perform the following functions.

a) Running hour computation of different rotating machineries.
b) Cumulative time the TG runs below or above alarm level of steam temperature.
c) SH / RH tube creep life calculation.
d) Cumulative time of any bearing running above alarm level of vibration.
e) Number of Start & Stop of various drives
f) Number of hot, warm and cold starts of the turbine
g) Plant life calculation
h) Variable Alarm Limit Calculation.
i) Revenue calculation
j) Frequency excursion time beyond limit.
k) Plant availability and load factor calculation
l) Operating cost and cost of generation calculation
m) Merit order rating calculation

Bidder shall provide adequate energy metering for auxiliary power consumption of the unit and which shall be used to achieve optimum plant performance.

Provision shall be made for manual resetting of cumulative time computations after overhaul or shut-down.

6.4.8 Man Machine Interface (MMI) and Peripherals

Operator interface to the process & equipment shall be through MMI/operator interface. It shall perform supervisory, monitoring and information functions. Operator interface shall comprise of PC /workstation, colour LED monitor, KB, mouse, colour laser jet printers, large video screen, multimedia beeper/buzzer etc. Quantity /assignment for MMI and Peripherals are described elsewhere this section. Data pertaining to common system shall be available in the MMI of both units.

Operator's terminals shall permit the operation and monitoring of the unit under normal condition and in all emergencies. Each terminal shall be independent with its hardware including adequate local memory for resident database. The resident data will be continuously updated at all terminals and in no case real time plant data will have to be retrieved from other resident memories. Operator station shall have auto reboot feature and in all cases network link shall be redundant. MMI shall be built on high performance, non-proprietary open system configuration. It shall suit to the equipment and process requirement.

Operation shall be menu driven in latest windows environment. MMI shall be user friendly and no special knowledge is required to operate the system

Each MMI shall be adequate with all operator function such as access to the display, alarm, trend, control faceplate etc. and quick access to plant & process. Complete operation of the plant shall be possible from any operator station. Multiple windows, not less than 4 (four) nos., at a time shall be available on the MMI screen for operation.

Each station shall be complete with latest configuration window based PC, application software, anti-virus software, display builders with object oriented programming like Visual basic, Active-X etc..

Display selection shall be possible with least number of keystrokes or steps. Functional requirement of an operator station shall not be limited to the followings:

a) Issuance of control command like start/stop, set point adjustment, auto/manual, increase / decrease etc.
b) Display of plant graphic, overview display, area display, loop/drive display, control related displays, other standard displays for monitoring, trending of parameters.
c) Display & print of SOE/Trend/Graphic / System Diagnostic.
d) Alarm display & acknowledgement.
e) Print of screen, logs, operator message, etc.
f) Last command call.
g) Copy & paste.
h) Display of sequential / logic and tag with facility of forcing through suitable password
i) Multiple pop up faceplate for drive control & point detail.
In case of exigencies, operator station shall be capable to be used as an engineering / diagnostic station with Password protection & hard key switch operation.

6.4.9 Large Video Screen

a) Bidder shall supply Four (4) numbers of 70 inch LED based Large Video Screen (LVS) display unit with controller for monitoring of salient plant parameters, plant status, alarms, graphics etc. to be placed in upright encasement in front of the operator. The LVS controller shall be interfaced with DCS network for monitoring and display of information.

b) The system shall have facility of complete and partial overview of the plant, display of alarms in the form of normal window appearance, display of important parameters of the plant, complete status of electrical system etc.

c) Controller shall be on latest Windows environment or higher. Screens shall have seamless integration and can be viewed as a single display unit. The software shall have capability to display multiple windows on any part and any size on the screen. The system shall have facility to zoom any part of the display on the screen and move anywhere on the screen. Controller shall be integrated with the DCS through dual hot redundant link.

d) First three (3) rows of the LVS will be used for alarm/ annunciation. First row will be kept for fixed alarm.

6.4.10 ENGINEERING /CONFIGURATION CUM DIAGNOSTIC STATION

It shall perform programming /configuration of complete control system and MMI along with system diagnostic. System shall be adequately guarded, by software & hardware locks etc., against any inadvertent and un-authorized access. Two nos. of such stations shall be provided on per unit basis at engineering room.

It shall be capable of storing, loading, editing, testing, tuning, monitoring etc. for all the controllers. In case if different hardware is employed for some system and the same is not possible to configure from this station, additional engineering station for those controllers shall be provided. System shall be complete with monitor, keyboard, mouse and colour LaserJet printer.

Programming technique shall not require any special knowledge on high level programming and easy to learn.

Station shall archive all the addresses, setting parameters, screen statistics etc. for future downloading in case any controller/operator's terminal is replaced by a new one or any data is lost or during rebooting of the system. The unit shall remain on-line and serve as the administrator for the entire network, if require.

Bidder shall also provide minimum two numbers of laptop computers with latest hardware configuration and loaded with suitable operating and application program as a backup portable programming and configuration station.

Configuration / modification in graphics executed in the Engineering station shall be available at all the operators' station through network sharing function. No duplication of engineering efforts shall be required to build control displays at each station.

Each station shall be capable to execute the functions not limited to the followings:

a) System configuration
b) Data Base configuration
c) Graphics display generation and modification
d) OLCS/CLCS Control algorithm generation and modification
e) Report/Log configuration and modification
f) System access configuration
g) Downloading of program
h) High level programming language as required for the system.

Each station shall be equipped with a DVD writer for archiving of the configuration.

The station shall be capable of generating all real time graphics, trends, plots etc., necessary for optimum tuning of the controllers and shall not require any assistance from the trend recorders and controller face plate displays for performing the tuning function. This feature shall also be duplicated in the operator's station.

The open loop controllers shall be programmable from the Engineering Terminal in simple ladder network representation or in symbolic form.

Engineering/configuration stations of the unit shall also serve as Diagnostic Stations to perform system maintenance functions. This shall serve as an aid to the maintenance engineer and supplement various functions available in the engineering terminal for system diagnostics and fault location up to module level identifying location on the panel and sub rack where the fault has occurred. The standard diagnostic displays provided in the engineering cum diagnostic terminal and operator's terminal shall be identical.

The system maintenance function shall not be limited to the followings:

a) Station status overview.
b) System alarm message display.
c) Individual station status display.
d) Data base equalization.
e) Date and time setting.

Diagnostic System shall provide all relevant information about the system fault on the display screen. The fault may be grouped section-wise or station-wise on the initial screen and subsequent paging should specifically lead to the rack number, card number, type of card etc, so that any fault on the system shall become transparent to the operator and maintenance personnel without approaching individual cubicles for fault finding. The system shall also provide guidance for fault clearance and shall reduce downtime of the system.

6.4.11 Security

Multiple security levels with hard and soft key lock shall be provided with two (2) or more at operator levels and one (1) at Engineer level to make it possible to restrict access to critical parameters and minimize the possibility of operator errors.

6.4.12 Plant Operation

The general modes of operation from the operator's terminal shall be as follows.

The closed loop and binary controls shall be implemented in hierarchical structure.
Manipulation of set point shall be permissible from the Operator's terminal in incremental mode.

It shall be permissible to transfer a loop from "auto" mode to "manual' mode or vice versa from operator's terminal. All such transfers shall be bumpless and procedure less. During transition from "auto" mode to "manual", the output to the final element shall be maintained until manipulated from the operator's terminal. Similarly, during transfer from "manual" mode to "auto"; when effected from the operator's terminal, the auto output shall take-off from the last value and shall regulate the final element in a predetermined and adjustable ramp to final computed value as per the control loop algorithm. This will necessitate continuous auto tracking between "auto" mode and "manual" mode outputs. Control valve position shall be indicated on the monitor.

Binary control shall be implemented in hierarchical structure. It is proposed that the following points of control shall be available.

a) Local Control Station (LCS) for trial start & emergency stop operation
b) Operator's terminal for normal operation
c) Control Panel (wherever applicable)

Switchgear and MCC shall be equipped with TEST, TRIAL and NORMAL operation.
In "TEST" mode, operation shall be performed from the MCC / Switchgear only to verify the integrity of electrical system. No actual operation of the main equipment will take place.

In "TRIAL" mode (for local maintenance), control can be affected from local control station. To start a drive from LCS, apart from the electrical protections critical process/drive related safety protections, if any, shall have to be ensured for safety during trial operation.

In "NORMAL" mode drives are operable from remote (CCR). During operation from remote all process, sequence and basic safety related permissive and interlocks shall be in place.

The STOP functions at all points shall be active at all time, irrespective of the selection.
The drives, which are part of a sequence, shall be operable in sequence mode from Operator's terminal. In sequence mode, a single command shall lead to predetermined sequence of operation. Following information, as a minimum, shall be available on the monitors.

a) All permissive
b) Start & Stop sequence
c) Start sequence complete
d) Stop sequence complete
e) Sequence fail
f) Stepwise sequential progress of operation indication with permissive for each step to enable the operator that for particular step all permissive are met and the step is executed.
g) Disturbance indication
h) Sequential operation indication on monitor in the form of ladder logic diagram
i) Override of hold-up sequence as per operator's discretion.

6.4.13 Functional Description of Auto Control loops

The functional description of major regulating loops described in this section is to be treated as typical only. Bidder shall furnish the scheme of control loops & write up on his system meeting intent of specification for approval of owner's engineer.

Coordinated Control System

a) The coordinated control system shall be implemented to enhance the response of the boiler and turbine control system under all operating conditions while maintaining the outputs of the turbine, boiler and all major plant auxiliaries within their safe operating limits.

b) The coordinated control system shall receive a unit load demand signal from owner's automatic load dispatch center or from unit load setter of respective unit's operators' console and shall translate this signal into demand signal for boiler and turbine control systems.

c) Mode Selection
The system shall have facility for different mode selection such as coordinated mode, boiler follow mode, Turbine follow mode and manual mode. The system shall be provided with the facility of bump less transfer between one mode to another mode without disturbing the process.

d) Load limiting, directional blocking, run-up, run down
The system shall have facility for setting maximum unit load, maximum unit load limit, minimum unit load limit, and unit load rate of change limiter. Directional blocking of the unit demand (increase/decrease of load) will be provided based on the equipment status and applicable process conditions.

e) Run-up and run-down
The run up and run down actions shall be provided for reducing the deviations when the respective final control elements are in the extreme positions and are unable to correct the error. Run up and run down actions shall manipulate the unit demand signal till the adverse conditions are cleared.

f) Emergency run back
The system shall provide automatic run-back facility based on the load demand signal on loss of critical auxiliary equipment. The limits and rate of run back shall be pre-determined according to the individual capacity of each auxiliary equipment and shall be supervised by Turbine Stress Evaluator. The control system shall have capability for implementation of the functional requirement with true characteristics of equipment.

g) Frequency correction
The unit load demand shall also be corrected by deviation in system frequency. This correction provides a change in unit load demand equivalent to the expected change in megawatt output due to any deviation in system frequency.

h) Transient operation
Under transient operating conditions, the demand signal shall be modified to change the turbine output by utilizing stored capacity of the boiler and to raise or lower the energy levels in the boiler by over or under firing.

i) Throttle pressure error correction
Throttle pressure shall be controlled at a preset value to ensure that there is no mismatch between the output of the boiler and turbine. Throttle pressure controller shall be provided. Provision shall be made to feed the set value signal for throttle pressure controller to HP bypass controller.

j) Megawatt error correction
Feed forward signals will be calibrated initially to produce a specific relationship between turbine steam flow and boiler firing rate on one hand and unit output on the other hand. However the relationship may change due to changes in system parameters such as cycle efficiency, heating value of coal, feed water temperature etc. When such a change occurs, it will be reflected in a steady state error in megawatt output. A controller shall be provided to automatically recalibrate the feed forward signals by reducing the steady state error to zero.

Operation in coordinated mode
In coordinated control mode the load demand shall be sent simultaneously to the turbine controls and boiler controls. The required load shall be set by the operator or automatically entered into the system from load dispatch center.

a) Operation in Boiler following mode
In the boiler following mode the megawatt load control shall be the responsibility of the turbine control system with boiler controls responsible for throttle pressure control. Boiler following mode shall be automatically selected during start up when turbine

control system is on manual. In the boiler following mode all boiler inputs and turbine pressure limits are initiated through turbine limiting action. If runback occurs in this mode, the system shall automatically transfer to turbine following mode when turbine governor is on automatic.

b) Operation in turbine following mode
In the turbine following mode the megawatt control shall be the responsibility of the boiler and throttle pressure shall be controlled by the turbine control system. In this mode the unit demand shall be subject to maximum and minimum limits, rate of change, interlocks and run backs etc. When turbine following mode is in automatic, all runbacks, run-ups limits and rate of change shall be automatic.

c) Operation in manual mode
In this mode the turbine governor shall be capable of being operated manually

d) Master Pressure Control
In this mode, the responsibility of the boiler shall be to maintain throttle pressure at turbine inlet and turbine control shall be responsible for maintaining megawatt load. To enhance the speed of response, the megawatt generated signal shall be imposed on the master controller output causing the demand signal to follow load changes instantaneously as the steam flow changes.

e) Fuel Flow Control
Fuel flow control shall change feeder speeds in a defined manner based on the demand signal for fuel from combustion control. The fuel demand signal shall be distributed among available coal feeders. Total fuel flow will be computed by adding coal flow of all mills and weighted value of oil flow.

f) Air Flow Control
Air flow will be controlled by adjusting the blade pitch control /regulating vanes of FD Fans with the air flow demand signal received from combustion control. Air flow measurement used in the loop shall be oxygen corrected.

g) Furnace Draft Control
Furnace pressure shall be controlled by adjusting the regulating inlet dampers of ID fans and by adjusting fan speed. Speed adjustment will come into picture when the pressure excursion will be beyond certain limit.

h) Wet Mode and Dry Mode Operation
Wet Mode Operation:

- Initial Operation Of Boiler Light Up. When Economizer Flow is maintained by BCP.
- Boiler Will Operate till 30 % TMCR on Wet Mode.

Dry Mode Operation:

- At 30 % TMCR Separator water level will become disappear and Boiler Operation mode will change to Dry
- BCP Will shut at this load
- Warm Up system for Boiler Start Up System will get armed
- Boiler will turn to once through Boiler
- ECO Water flow will be controlled by Feed Water Pump in service

i) Mill Outlet Temperature Control
Mill outlet temperature shall be maintained at set value by varying positions of hot air damper and cold air damper.

j) Deaerator and Hot Well Level Control
Deaerator level shall be maintained by regulating condensate flow control valve in the main condensate line to deaerator. This will be 3 element controls consisting of Deaerator level, Feed water flow and condensate flow. Hotwell level will be maintained by regulating the DM water make up to hotwell.

k) Superheater Steam Temperature Control
The overall temperature control scheme shall coordinate the two methods as follows:
The feed water/firing rate ratio stations shall control the long term final temperature which in turn shall control inputs to the ratio function between the boiler and firing rate masters.
The spray valves shall control the short term final temperature.
The feed water flow to the firing rate ratio shall also be controlled by a cascaded control scheme.

l) Reheat Steam temperature control
Reheat Steam temperature control shall primarily be done by burner tilt mechanism. Reheat attemperator water shall only function as an emergency measure to bring down hot reheat temperature. During normal operation there shall not be any reheat spray flow.

m) Balance of plant controls
The following are some typical BOP controls to be provided:
HP Heater level control- normal & emergency drain
LP heaters level controls- normal & emergency drain
GSC level control
Deaerator pegging steam pressure control and other control systems

6.4.14 Electrical Distribution Management System (EDMS)

The purpose of the EDMS is to provide Control and Monitoring of the in plant Electrical Distribution System for Unit 1 & Unit 2. No conventional hardwired panels are foreseen in the central control room unless it is critical. It shall be possible to control and monitor the complete electrical Distribution system from the redundant operator station at central control room. Supervisory control & monitoring function shall be realized in DCS.

Control system architecture shall not be limited to the following:
a) Dual redundant multifunction controllers (MFC).
b) Two operator station for each unit. Common system shall be possible to execute from both unit operator station.
c) DCS Historian will be used for collection of events, analog values.
d) DCS printer shall be used for printing.

The EDMS shall have both serial and discrete digital / analogue input/output capability.

Contractor shall configure the EDMS including interface with switchgear units for complete remote and local operation of the system.

EDMS shall display the followings as a minimum:
a) Animated single line diagram of the electrical network
b) Alarm summary
c) Display of analog & digital parameters.
d) Display of switchgear status (local/Remote, Service/Test, Spring charge etc.)
e) Display of breaker status.

f) Display of faceplate.
g) Real time and history trend of all analog and critical digital parameters.

Event shall be time and date tagged with a resolution of 1.0 ms.

The Control System shall be time synchronized with Master clock.

The maximum time taken from issuing a circuit breaker close / open command at the MMI keyboard to observing a change of status on the screen shall not more than 1.0 Second.

Electrical parameters displayed at monitor or in local shall have accuracy less than 2%.

All switch contact and analog inputs shall be hardwired to the system. Similarly, output from the system connecting to different switchgear units shall also be hardwired. Interlocks & protection for the switchgear units shall be resident to its respective cubicle. Any interlocking between different switchgear units shall be hardwired between them. However, if situation demands, few non-critical interlocks can be implemented in the system. Control System shall be designed in such a way that failure of the control system shall not lead to the failure of electrical network. In case of failure of the control system operator shall be able to carry out the operator function from the respective switchgear unit cubicle by taking the system into local mode.

Redundancy in output module for remote open & close of breaker/switchgear shall be provided.

Contractor shall furnish list of functional grouping of controller for approval.

6.4.15 PLC Gateway

Functional Description:

Interface between "package PLC" and DCS system for remote information and monitoring, shall be carried out by a dual hot redundant PLC gateway. Proposed Gateway shall operate as a node pair, one in operating and the other shall be in hot standby, serving as its redundant partner, with an exact up-to-date copy of the database and ready to take over full operation should the operating member of the pair fails or be taken out-of-service. The gateway shall provide the data conversion, buffering, and sequencing to provide an efficient interchange of information between the DCS network and the programmable controllers.

Communication link in between the DCS and the Programmable logic controllers shall be dual and optical fibre based.

Data communication shall be in OPC.

OPC system interface shall also comply with the following requirements as a minimum.
(a) OPC Data Access (OPC DA)
(b) OPC Alarm & Event (OPC A&E)
(c) OPC Historical Data Access (OPC HDA)

20 % tag handling capacity over the configured tags shall be kept as spare for future expansion.

Nodes shall be time synchronized with GPS master clock.

6.5 DCS HARDWARE & SOFTWARE SPECIFICATION

This section generally describes the requirements regarding hardware components and the software features of the Distributed Digital Control System.

Bidder shall furnish adequate information of the system offered and shall not be limited to the following:

a) System architecture and BOM to establish completeness of supply.
b) Write up and catalogues
c) Expected duty cycle of each controller with the proposed assignments.
d) Capacity (baud rate) of each level of highway and expected data traffic at each level under normal and worst case situations.
e) Failure analysis of the complete system detailing the MTBF and MTTR. The analysis shall be projected to system availability computation.
f) Spare capacity in respect of controller, IO modules, network, operator station.
g) Number of displays and logs offered.
h) Response time of the control keyboard (from initiation to execution of a command).
i) System auto start up and initialization time.
j) Operating limit of temperature, humidity, voltage, frequency of the system/modules, susceptibility to contaminants in the ambient etc.
k) Hot repairing of modules

6.5.1 Hardware Specification

System Cabinet

a) The electronic modules located within operator's terminal shall be of completely enclosed type for protection from dust and / or mechanical damage.
b) All electronic cards and modules located in electronic cubicles in Control Equipment Rooms shall be neatly arranged in sub-racks. Each rack shall have power supply modules catering to the cards mounted in the sub racks.
c) Separate cabinets shall be provided for each functional group and data acquisition sub-system.
d) The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10 °C above ambient even under worst operating conditions. Cooling fans shall be provided, wherever required.
e) The modules shall be arranged logically and sequentially in the sub racks. Modules associated with a closed loop / open loop controller viz. input cards, output cards etc. shall be housed together with the corresponding controller in the same cabinet.
f) If, after housing a controller with associated cards in a sub rack 25 % or less card slots are left vacant, the same shall not be used to accommodate any card related to any other system. Adjacent slots to dissipative cards shall be left vacant for proper cooling air circulation within the panels.
g) If cards related to a particular controller spill over beyond one sub rack at least 4 cards slots shall be kept vacant before cards related to other systems can be placed in the sub rack. Vacant slots shall be covered with blank plates.
h) Cards, in a sub rack, shall be uniformly grouped, type-wise.
Panel specification is described elsewhere in this volume.

Termination & Relay Cabinet

a) Incoming cables originating from beyond the control room and control equipment room area shall be routed through the termination cabinets (TC) located in control equipment room except for the cases like special cables, network / highway cables, thermocouple cables where standard termination concepts are not applicable.
b) Termination cabinets shall be free standing, closed type, bottom entry, front and rear accessible cabinets with terminal blocks arranged in vertical rows on side walls and

partition walls. Panels shall be provided with internal illumination operated through door switch. Adequate area shall be provided for glanding field cables.

c) In no case the number of terminal blocks accommodated in each section shall exceed 1000. Terminal blocks shall preferably be arranged in four vertical rows in two sidewalls with two sets of cable troughs (one for incoming and one for outgoing) arranged on two sides of the terminal block. At least 20% terminal blocks shall be left as spare. This shall be in addition to the terminal blocks for 15% wired channel.

d) Troughs shall be slotted PVC type. The gland plate shall be removable and shall be in sections. Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

e) Terminal assignment in the termination cabinet will be such that cables originating from a field junction box shall be terminated in one termination cabinet only. This will facilitate use of multi-core cable for field wiring. For each incoming cable an additional terminal block shall be provided adjacent to signal wire termination point for termination and continuation of cable screen.

f) Relay used for interfacing with other system shall be modular, plug in type and provided with snap on transparent cover. Rating shall be of 24/48V DC and shall have at least 2 changeover contacts. All contacts of the relay shall be terminated in terminal blocks. Each relay shall be provided with "Coil on" indication LED and coil protection diode. At least 10% of installed capacity shall be kept as spares.
Panel specification is described elsewhere in this volume.

General - Input / Output Interface For DCS

All cards shall be in standard 19" sub rack format. Preferred features are as follows:

a) Surge withstand capability shall conform to IEC-255.4 Class- II, ANSI C 70.90 a.

b) Adequate protection against radio frequency interference & electromagnetic interference (SAMA 33.1).

c) Hot removal and insertion of card from rail without adversely affecting the system (alarm shall be generated at the time of pulling out of card).

d) Redundant configuration support.

e) A.C Isolation of up to 1500 V.

Process Interface Modules of DCS (Analog / Binary Signal Conditioning)

a) The process interface section of DCS shall comprise of various signal interface cards. I/O processing shall be totally independent of control processing so that IO scan rates are independent of controller loading. It is preferred that the Input Interface Modules (IIMs) shall be intelligent and shall form a common IO bus to the controller/s they are catering to. Generally the following types of modules shall be included:

- High level analog input modules
- Low level analog input modules
- Binary input modules (Fast & Slow scan)
- Pulse input modules
- Smart interface modules.
- Modbus & other serial module interfaces
- Analog output modules
- Binary output modules

b) The IIMs shall, generally, perform the following functions :

- Provide isolated inputs and isolated & short circuit proof outputs.
- Data Acquisition with time stamping.

- Data validation and quality tagging.
- Generation of interrupts
- Data processing like linearization, A/D conversion, multiplexing, noise filtration, Engineering Unit conversion, limit value detection etc.
- Extensive diagnostics and fail-safe operation, with reporting.

c) Following shall be provided:

- Test sockets for on-line monitoring of signals.
- Front panel display in each module for fault alarm/ status etc.
- Bidder shall provide 20% or minimum two numbers, whichever is higher, spare IO channels per module. In addition to this 10% spare of each category of IO module shall be provided on overall basis in each group such as SG, TG, BOP, Electrical etc. The spare channel and cards shall be fully wired up to termination cabinets.
- Isolated/fused 24/48 V D.C power supply.
- Providing transmitter power supply and contact interrogation voltage (isolated).

Furniture

Bidder shall include a complete set of furniture for the Control Room and Engineering Room of ergonomic design from reputed manufacturer especially designed for computer peripherals. The set of furniture shall include but not be limited to control desk, chair, printer table, computer tables etc., all necessary furniture for Engineering Room peripherals, cabinets for storage of manuals / booklets, storage racks for special tools/ DVDs and Shift Charge Engineer's desk/chair/side rack etc.

6.5.2 Software Specification

General

The system shall utilize a readily upgradeable, public domain software platform proven for real-time operation environment at the control and monitoring level overlaid with a relational database program. The desirable features are enumerated below.

a) The operating system shall be suitable for real time operation both at process as well as MMI end.

b) The software system shall be fully modular.

c) The software shall meet the following general requirements.

- Simple, easy to learn editing language for editing and on-line operation.
- Wide range of standard and non-standard peripheral support capability by modular controllers/supervisors.
- Effective task scheduling and support of multiple priority structure including event based interrupt etc.
- Effective debugging.
- Provision for on-line editing and program development without interrupting on-line functions.
- Self-diagnostic routines.
- Efficient memory management and effective utilization of system time.
- Quick start-up and loading.
- Support of multiprogramming and multi-user operation.

Memory Management / Operating System:

a) The main memory capacity shall be adequate to minimize swapping in the processors.

b) Individual task shall reside in partitions, which can be split into sub partition for parallel task handling.
c) The operating system shall automatically perform housekeeping functions including file management.
d) Task swapping shall be dynamic.
e) Programs called frequently or requiring rapid access shall remain as resident in main memory.
f) Individual program partitions shall be suitably linked.

Device Support:

The operating system shall support the following devices.

a) Hard/DVD /CD ROM disc drives.
b) Magnetic tape (if necessary).
c) Monitors.
d) Printer, key board, mouse / trackball.
e) Random Access Memories.
f) Communication interface (10/100 Base-T Ethernet, TCP/IP etc.)
g) Controller and other 16 bit systems
h) DVD Writer etc.

I/O Management:

The I/O Management system shall have the following features.

a) Device independent address processing.
b) Peripheral diagnostic.
c) Retransmission on request.
d) Exclusive, shared and priority mode of device assignment.
e) Flagging of device failure, etc.

Program Development and System Generation:

The operator shall have the flexibility to customize or develop program to suit the system requirement.

a) The system generation shall be on-line without interruption to the program under processing.
b) It shall be possible to introduce new programs dynamically.
c) The program development system may include its own assembler, editor, loader etc.
d) The program development process shall be conversational and shall reject faulty or erroneous entry with proper flagging.
e) New programs shall be automatically integrated into the system by interfacing with existing programs.

Power Failure Restart:

a) I/O transfer stoppage shall not be abrupt.
b) Provision shall be there for manual restart and auto restart on resumption of power supply.
c) In case of power failure interrupt the boxing up sub-routine shall be automatically initiated.
d) In case of power failure, all data including register content, volatile memory content etc. shall be transferred to the bulk memory.
e) The program status shall be latched.
f) On resumption of supply. registers shall be loaded and programs shall start from the status where they were latched earlier.
g) All system devices/logics shall be provided with dual power supply in order to ensure that any supply failure does not hamper the system performance.

Check Routines & System Failure:
On-line diagnostic routine shall be run continuously or periodically, as applicable. Detected failures shall be displayed in monitor & printer. The following checks shall be performed.

a) Peripheral / Operator's Terminal failure.
b) Memory Failure/ Error.
c) Parity Error, Interrupt Error.
d) Program Hang up.
e) Power Supply Failure.
f) Input Card Failure.
g) Interface Failure.
h) Output Card / Drive Control Module Failure.
i) SC/OC Tests,
j) Controller Failure
k) Highway failure and communication failure etc.
l) Failure shall lead to graceful degradation of the system.

Database and Database Management:
Data shall be keyboard addressable. It shall be safe-guarded against unwanted and unauthorized manipulation of data.

The database management system shall have the following salient features.

a) Modular expandability, dynamic partitioning.
b) Sequential and random access to data and files.
c) It shall be possible to update, display, dump (selectively), create, search data by simple keyboard entries.
d) The editing language shall be simple and easy to learn type, requiring no detailed programming.

Utility Programs:
The utility program shall constitute a modular system. The priority status of lengthy routines shall be low as to be interrupted from operator's terminal. Individual functions in the routine shall be amendable. Provision shall be there to initiate utility program from user programs. Broadly, the system shall perform the following functions by utility requests.

a) Selective dumping.
b) Dump memory (file to file or file to peripheral)
c) Execute a program selectively.
d) Tracing and break pointing errors.
e) List debugs commands and error messages.
f) Change debugs input devices.
g) Operation on octal or hexadecimal numbers.
h) Memory search by interactive editor.
i) Reschedule job priorities, etc.

Programming Language:
The programming languages shall support Relational Data Base Management in a global and truly distributed Client-Server environment and shall have the following minimum features.

a) Modern high level block structures type.
b) Powerful, compact syntax.
c) Logical organization that facilitates documentation, modification and maintenance of programs.

d) Early detection of errors at compiles and run time.
e) Fast debugging.
f) Improved program reliability.
g) Clearly defined data structure complemented by flexible user- declared data types.
h) Fast execution.

Editing Functions:

a) The following editing functions shall be performed on the variable via on-line database editor. The editing of an access to the database shall be by simple English like easy to learn language.

b) For analog inputs the variables shall have different scan rate, linearization options, software filtering option etc. as can be assigned externally via the keyboard. Option is to be provided to perform the following operation on each of the variables.

- Provision to assign scan frequencies of 1 sec., 2 sec, 5 sec, 30 sec or 60 sec.
- Provision to continuous scan and store in working/main memory and display or print-out on demand. Changing the scanning rate for trend display.
- Provision to continuous scan, store and printout of values at a specified interval as routine.
- Provision to execute immediate scan for a specified interval with or without display and/or print-out.
- Provision to assign abbreviated engineering unit in display and print-out along with absolute value.
- Provision to assign Hi and Lo alarm limits.
- Provision to assign Hi and Lo transducer range limits.
- Provision for analog points to be deleted from and restored to scan status.
- Provision for observing whether the variable is within a specified limit of at a slow scan rate and immediate restoration of storage status at a higher scan rate in case of anomaly.
- Provision to specify individual coded sub-routines, which shall be executed when any alarm or return to normal message occurs.
- Provision to define time averaging of analog inputs.
- Provision to assign significant change/increment alarm limits.
- Provision to assign alarm dead bands.
- Provision to assign rate of change alarm limits and dead bands.
- Provision to specify software filtering constant individually.
- Provision for linearization routines by polynomial approximation with specified or adaptive coefficients up to 5th order.
- Provision to assign an alphanumeric point value to each analog input and each calculated point.
- Rounding off facility when fed to MONITOR, graphic or digital display units.
- Serial tabulations on demand in time sequence with HH:MM:SS tag.
- Storage of maximum and minimum value amongst specified values or within a specified interval of time.

6.6 VIBRATION MONITORING SYSTEM (VMS)

VMS shall automatically acquire data related to the mechanical health of rotating equipment of the acquired data in a proven software platform and display vibration and other machine data for all HT motor & their driven equipment Circulating Water pumps & motors, Auxiliary cooling water Pumps & motors, ID fans & motors, FD fans & motors, PA fans & motors, Coal Mills motors etc. during all regime of operation. System shall be proven and from latest product range of the manufacturer. System shall be supplied for each unit.

There shall be hardwired data exchange from VMS to DCS for display, trending, alarming and interlocking / protection. Buffer output shall be provided at VMS Panel for data exchange with Vibration Analysis System (by Other).

The system shall have the following sub systems:

a) Field Transducers
b) Data Interface with DCS
c) Data Interface with Vibration Analysis System (VAS)
d) On-line Machinery Protection and Monitoring
e) Machine data acquisition, condition management and display
f) Automated machine diagnostic with decision support system.

The system shall be complete with sensors, proximitors, monitors, relay modules, networking hardware, machinery condition management server, dual redundant power supplies, special cables etc. for measurements, protective alarm & trip, diagnostic etc.

In all cases vibration shall be measured in both X-Y directions along with key phasor for phase reference.

The system shall have feature to bypass a relay contact in the event of sensors/ proximitor failure.

In all cases power supply modules and incoming power feeders shall be dual on line. Failure of single power supply shall not affect system functioning.

All critical measurement shall be in 2 of 3 or 1 of 2 as per the requirement.

Critical alarm & trip relay output shall be configured in 2 of 3 voting or 1 of 2 voting logic as required for the machine criticality.

Contact of alarm & trip relays shall be hardwired to the respective control system.

For 1 of 2 and 2 of 3 voting philosophy each trip channel shall be configured in separate cards.

Analog output to DCS shall be in the form of isolated 4-20 mA DC and contact output shall be potential free.

Following type of transducers shall in generally be used:

For all HT drive & driven equipment: -
- Bearing pedestal Vibration: Seismic vibration transducers
- Key phasor & Speed: Non-contact type proximity transducers for once per revolution phase reference measurement.

a) System shall be capable of operating from 0 to 50 ºC and at 95% non-condensing moisture.
b) Panels in offsite area shall be fitted with local air conditioner if the area is not air conditioned.
c) Sensors shall be dust proof & weather proof rated to IP-65 and suitable for work in harsh environment. Sensors, proximetor and monitors shall be fully compliant to API670.

6.6.1 Monitor Racks / Cabinet

System mounting racks shall be furnished to house monitor modules, indicating/ display units, power supplies, test and calibration equipment. Grouping of modules in racks shall be equipment wise. The mounting racks shall be fully factory wired up to rear terminal blocks.

The mounting racks for all equipment shall be designed for flush mounting through the front face of upright panels.

The front of each mounting rack shall house a monitor test switch, test condition indicating lamp and power on indication lamp.

Panel shall be provided with necessary MCBs, switch etc. Power and signal cable shall be routed in separate tray.

Panel shall have the provision for protective and DC system ground.

Each vibration monitor and mounting rack shall have nameplate engraved to indicate the main equipment to which the module is catering and the bearing details.

6.6.2 Low Noise Cable and Cable Conduit

Each transducer shall be furnished with flexible conduit and low noise cable. Conduit fittings shall be furnished for connection to transducer. The other end of the flexible conduit will be connected to a suitable junction box.

Junction box shall be corrosion, dust & weather proof rated to IP 65.

6.7 CONTROL & INSTRUMENTATION CABLE

THERMOCOUPLE EXTENSION & COMPENSATING CABLE

01.	Conductor	:	Solid conductor
02.	Conductor size	:	16 AWG (1.31 Sq. mm)
03.	Type	:	KX (Extension) (Chromel Alumel) RX (Compensating) (Copper-Copper alloy) JX (Extension) (Iron Constantan)
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	300V /500V RMS (Core to earth / core to core)
06.	Twisting	:	Pair twisted with lay of 60 mm (max)
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.

08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyster tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10.	Armour	:	Galvanized steel round wire / strip
10.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554Part-I 1976
11.	Rip Cord	:	Non metallic under sheath
12.	Filler	:	Non hygroscopic with FRLS property
13.	Temperature Range	:	Up to 85 °C
14.	Insulation at 20^0 C	:	100 MOhms/Km [Min]
15.	Capacitance at 800 Hz	:	120 nf/km
16.	Cross talk	:	60 dB
17.	Attenuation	:	1.2 dB/Km
18.	Codes & Standards	:	a) IEC 332-1 b) ANSI MC 96.1 c) IS-8784-1987
19.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)

b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I

c) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863)

d) Smoke Density Rating :Max.60% (ASTM-D-2843).

e) Flammability Test : as per IEC 332 Part-I /IEEE-383

Swedish Chimney Test-SS-424-1475 F3

f) High voltage test

Core to core- 1.5 KV for 1 min.

Core to screen- 1.0 KV for 1 min.

g) Insulation Resistance 100 M Ohm / Km Min

h) Rodent & Termite repulsion test (Presence of lead shall be confirmed)

20. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
Kx	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
Jx	Black	Positive	White	Iron
		Negative	Red	Constantan
Rx	Green	Positive	Black	Copper
		Negative	Red	Copper Nickel Alloy

21. Durable printed or embossed numbering at regular interval of 50mm shall be provided for identification of pairs.

INSTRUMENTATION MULTI PAIRED SIGNAL CABLE

01.	Conductor type	:	Stranded (7) annealed tinned copper
02.	Conductor size	:	0.5 / 1.0 / 1.5 Sq.mm (as required)
03.	Conductor resistance	:	39 Ω/Km/18 Ω/Km/12 Ω/Km
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	300 / 500V RMS (Core to earth / core to core)
06.	Twisting	:	Twin twisted with lay of 60 mm
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyster tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire. * Analog signals- Individual pair & overall shield to be considered. * Binary signals- overall shield to be considered.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10.	Armour	:	Galvanized steel round wire / strip
10.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti-termite & moisture resistant properties)

			HR PVC Type ST2 of IS-5831, 1984 Thickness as per IS-1554, Part-I 1976
11.	Rip Cord	:	Non-metallic under sheath
12.	Filler	:	Non hygroscopic with FRLS property.
13.	Temperature Range	:	85 ^{O}C
14.	Insulation at 20 Deg. C	:	100 MOhms/Km [Min]
15.	Capacitance at 800 Hz	:	120 nf/km
16.	Cross talk	:	60 dB
17.	Attenuation	:	1.2 dB/Km
18.	Codes & Standards	:	a) IPCEA-S-61-402 b) BS 5308 b) IEC 332-1 c) ASTM-B-33 d) IS-8130-1984 e) IS 1554 Part-1 f) IS 10810
19.	Sheath colour	:	Outer- Gray
20.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index : Min 250 ^{O} C at 21Oxy. Ind. (ASTM-D-2863) d) Smoke Density Rating :Max.60% (ASTM-D-2843). e) Flammability Test: as per IEC 332 Part-I f) Swedish Chimney Test-SS-424-1475 F3

g) Insulation Resistance 100 M Ohm / Km Min

h) High voltage test

Core to core- 1.5 KV for 1 min.

Core to screen- 1.0 KV for 1 min.

i) Rodent & Termite repulsion test (Presence of lead shall be confirmed)

21. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTMD 2116. These cables shall be pair, multipair, triad, multitriad and twisted & shielded.

6.8 ERECTION HARDWARE

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

6.8.1 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow:

a) Rigid Steel Conduit

- Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
- Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.
- All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.
- All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.

b) Flexible Conduit

- Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.
- Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200°C.

c) Special Fittings

- Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.
- Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

Electrical Junction Box

01.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
02.	Material	:	3 mm Sheet Steel or better

Cable Gland

01.	Type	:	Double compression
02.	Entry Thread	:	NPT
03.	Material	:	Brass
04.	Finish	:	Cadmium Plated.

05. Protection : IP 54 or better
06. Accessories : Neoprene gasket, locknuts, reducers etc.

Cable Tray

01. Material : GI
02. Cover : Suitable for tray

6.8.2 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

Specification for Process Hook Up Materials

Sr. No.	System	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
1.	Main Steam, Auxiliary Steam from Main Steam & Aux. steam to de-superheater	ASTM-A335 Gr. P-22	XXS (½ inch)	ASTM-A182 Gr. F-22	ASTM-A182 Gr. F-6a	9000 lb	3000 SPL
2.	Hot reheat	ASTM-A335 Gr. P-22	XXS (½ inch)	ASTM-A182 Gr. F-22	ASTM-A182 Gr. F-6a	9000 lb	3000 SPL
3.	Boiler Drum, Economiser, Feed Water & Boiler Feed Pump Discharge	ASTM-A106 Gr. C	160 (½ inch)	ASTM-A 105	SS or better	6000 lb	2500
4.	RH Attemp. Line	ASTM-A106 Gr. C	160 (½ inch)	ASTM-A 105	SS or better	6000 lb	2500
5.	CRH turbine exhaust	ASTM-A335 Gr. P-11	80 (½ inch)	ASTM-A 182 Gr. F-11	ASTM-A182 Gr. F-6a	3000 lb	800
6.	Down Stream of NRV of CRH	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A 105	SS or better	3000 lb	800
7.	Condensate & Flash Tank Line	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A 105	SS or better	3000 lb	800
8.	Aux. Steam after DESH	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A 105	SS or better	3000 lb	800
9.	Air / Flue Gas Outside Furnace	ASTM-A106 Gr. C	80 (¾ inch)	ASTM-A 105	SS or better	3000 lb	800
10.	Air / Flue Gas Inside Furnace	ASTM-A335	80 (¾ inch)	ASTM-A 182	ASTM-A182	3000 lb	800

Sr. No.	System	Impulse Pipe Material	Schedule	Materials for Valve / Fittings	Stem Material	Rating of Fitting	Pr. Class of valve
		Gr. P-22		Gr. F-22	Gr. F-6a		
11.	Purge Air	ASTM-A106 Gr. C	80 (3/4 inch)	ASTM-A 105 Gr. F-22	SS or better	3000 lb	800
12.	DM Cooling Water	ASTM A312 TP 316	40 (1/2 inch)	ASTM A182 F316	SS or better	3000 lb	800
13.	CW & ACW	ASTM-A106 Gr. C	80 (½ inch)	ASTM-A 105	SS or better	3000 lb	800

6.8.3 Pneumatic Hook Up Accessories

Air Header

Technical Particulars

			For Panel	For Field
01.	Material of Construction	:	Stainless steel	Stainless steel
02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Stainless steel	Stainless steel
04.	Take off connection	:	1 / 2" NPT (M)	1/ 2" NPT (M)
05.	Take-off Valves	:	stainless steel	stainless steel
			For Panel	For Field
06.	Tube Take-off	:	Tube adapter on valve	Tube adapter on valve
07.	Drain	:	SS drain valve at lowest point	SS drain valves at lowest point

6.9 SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT

Bidder shall supply a complete set of new, unused and reliable type of special tools and tackle and test equipment which are necessary or convenient for erection, commissioning, maintenance and overhaul of the plant and equipment provided under this specification. The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended. Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid.

7.0 STEAM AND WATER ANALYSIS SYSTEM

The steam and water analysis system shall be designed in accordance with the recommendation as per ASME PTC 19.11/BS 1756 Part II, Water and Steam in Power Cycle.

The SWAS Transmitters shall be equipped to provide all signal requirements for connectivity of local indicators / recorders and DCS and such signal exchange shall be hardwired. SWAS shall be installed in air conditioned room.
The sample conditioning system shall be designed and constructed to receive and condition all samples required by the respective analyzers connected to the sample stream. This conditioning system shall perform the following functions:

- Primary high temperature sample cooling at field
- Sample filtering
- Sample secondary cooling and temperature control
- Pressure reduction and control
- Flow rate control
- Protection of analyzer against high sample Temperature and Pressure

Steam and Water Analyzers:

Location	Type
Main Steam at SH Outlet	Specific Conductivity Cation Conductivity PH Silica Sodium De-gas cation conductivity
Separator Outlet Steam At LTSH Inlet	Specific Conductivity Cation Conductivity Hydrazine Silica Sodium
Hot Reheat Steam	Specific Conductivity pH Cation Conductivity
Condenser Hotwell	Specific Conductivity Cation conductivity (Hot insertion type probe – left & right) pH
Condensate at CEP O/L	Specific Conductivity Cation Conductivity pH Sodium Silica Dissolved Oxygen ORP De-gas cation conductivity
Condensate Polisher Outlet	pH Specific Conductivity Cation Conductivity Dissolved Oxygen Sodium Silica Chloride
Deaerator inlet	Dissolved Oxygen pH

Location	Type
Deaerator outlet	Dissolved Oxygen Specific Conductivity pH
Feed Water to Economizer	Dissolved Oxygen Residual Hydrazine Specific Conductivity pH Cat. Conductivity Silica ORP
DM make-up to condenser	Specific Conductivity pH Sodium Silica Cat. Conductivity
DMCW pump (TG)	pH
DMCW pump (Boiler)	pH
Condenser Cooling Water	pH Specific Conductivity Free residual Chlorine

8.0 SPECIFIC TRAINING FOR C&I PERSONNEL

This section outlines the training obligations under C&I category under this specification. Bidder shall include in the proposal the training of Owner's personnel of different categories for operation, maintenance and troubleshooting of the supplied equipment. Training courses shall be conducted by experienced personnel of Bidder. Course participants shall receive individual copies of technical manuals at the time the course is conducted. Upon completion of each course, training manuals shall be property of Owner. Bidder shall supply all changes and revisions to the manuals.

Training shall be provided to operating, programming and maintenance personnel. The total duration of training shall be approximately 35 man months at original equipment designer / manufacturer's works. While the exact content and duration of such training shall be guided by Bidder's experience.

CATEGORY	NUMBER	SUBJECT	DURATION	TYPE
Engineer	2	Software	3 Month	Lecture & Hands-on
Engineer	3	Hardware Maintenance	2 Month	Lecture & Hands-on
Supervisor	4	Operation	1 Month	Hands-on
Supervisor	3	Hardware Maintenance	1 Month	Hands-on
Operator	8	Operation	1 Month	Hands-on
Technician	8	Hardware Maintenance	1 Month	Hands-on

Training for the operators shall be based on direct hands-on use of the offered system. Bidder shall train Owner's personnel in the programming and maintenance of the equipment to the extent that Owner's personnel can make corrections and changes to the system and maintain the systems hardware independently. Bidder shall include in his proposal a detailed description of the training course proposed by him (class-room lecture, audio-visual presentation, hands-on). If Bidder conducts Owner's training on regular periodic basis, a printed brochure of such program may be enclosed for reference.

Bidder shall provide all additional training deemed necessary by Owner, if there are modifications to Bidder's system and software after completion of the regular training period.

ANNEXURE – CI-03: C&I SCOPE MATRIX

Scope Matrix SG - Control and Instrumentation including DDCMIS					
Sl. No.		Item Description	Quantity		Remarks
			No.	Unit	
A		**Integrated Distributed Digital Control and Management Information System (DDCMIS) consisting of:-**			**Design ,Engineering , Manufacturing , Supply , Installation and commissioning by SG Vendor/Supplier**
I		**Control System for the following:**	--	--	Input by SG Island Supplier
1		Boiler and its auxiliaries	--	--	
2		Furnace Safeguard Supervisory System (FSSS)/ Boiler Management System(BMS) - TMR & SIL 3 Compliant	--	--	
3		Boiler Metal Thermocouples (Remote I/O)	--	--	
4		Intelligent Soot Blower System with Heat Flux Sensors	--	--	
5		Station C&I	--	--	
6		Fuel Oil Pressurizing and Forwarding System (Remote I/O)	--	--	
7		Secondary Air Damper Control (SADC)	--	--	
8		Selective Catalytic NOx Reduction (SCR) (Remote I/O)	--	--	
9		Boiler Chemical Dosing System	--	--	
10		Mill Reject Handling System (Remote I/O)			
11		Flue Gas De-sulphurization System (FGD)			
12		On-line Continuous Emission Monitoring System (CEMS) at Chimney			

13		TG Auxiliaries Control	--	--	Necessary Input such as I/O List, Logics, Write Ups, Alarm/SOE/Historian Tags, P&IDs to be provided by Others to SG vendor for implementation in DDCMIS. **(Approx. 8000 nos. hardwired I/Os per Unit DCS and 3000 nos. hardwire I/Os for common system to be considered. However the final I/Os with break up shall be provided by Others during detailed engineering)**
14		HP-LP Bypass System	--	--	
15		Condensate Transfer or Hotwell makeup pump systems	--	--	
16		DMCCW for TG auxiliaries	--	--	
17		Condensate Polishing Unit (CPU) (Remote I/O)			
18		Plant Electrical Distribution System-(HT and LT SGWR/MCC)	--	--	
19		CW/ACW Pumping System (Remote I/O)	--	--	
20		Cooling Tower System (Remote I/O)	--	--	
21		DMCCW for SG auxiliaries	--	--	
22		Miscellaneous System	--	--	
II		**Sub System of Main Plant DDCMIS - At CCR**	--	--	
1		Input Output Sub Systems	--	--	
2		Open & Closed Loop and Sequential Control Sub System (OLCS, CLCS)	--	--	
3		Data Acquisition System (DAS)	--	--	
4		Historical Storage Sub System (HSS)- Redundant Server	1	set	
5		Performance Analysis Diagnostic, Optimsation and Calculation System (PADO) including Common Server and dedicated Work Station for each unit	1	set	

6		Man Machine Interface (MMI) Terminals including Shift-In-Charge PC	7	nos.	
7		Engineering and Diagnostic Station (ES)	2	nos.	
8		Laptop with preloaded engineering software	1	no.	
9		Sequence of Event Recording and Monitoring Sub System (SER)-minimum 512 SOE points-Integral to DDCMIS	--	--	
10		Management Information System (MIS)-Redundant Server with Firewall	1	set	
11		72" LED based Large Video Screen with graphic Controller (LVS), Dedicated Work Station including Digital Wall at CCR per unit	4	nos.	Additionally, 3 nos. LVS also to be provided by Bidder, to be located at CCR, for Common Systems
12		A4 Colour Laserjet Printer	5	nos.	
13		A3 Colour Laserjet Printer	2	nos.	
14		HART Management System- Integral to DDCMIS with work station	1	no.	
15		Redundant Communication System	1	Lot	
16		Control Desk and Furniture	1	Lot	Including the console & chair for bidder supplied all the work stations and printers
17		Emergency Push Buttons Station	1	set	Minimum 20 nos. push button per unit
18		GPS Master Clock System including Slave Clocks (25 nos GPS Sysnchronising Signals(IRIG-B, SNTP, NTP, Pulse O/P) and 25 nos. Slave Clock of six digit display of digit size 100mm) including interconnecting cables, connectors, signal booster units, etc.	1	Lot	
19		Third Party Interface (through OPC Gatway) with necessary hardware & software	1	set	
20		Digital display type MW meter / Frequency meter / Volt meter for each Unit and to be installed in Digital Wall	1	Lot	
21		All types of pre-fab cable, Special cable, OFC etc.	1	Lot	

22		DDCMIS Cabinets, Network Cabinets, DDCMIS Power distribution cabinets, Relay Cabinets etc.	1	Lot	
23		Network Hardware, patch cords, LIU, media converters, network switches etc.	1	Lot	
24		Earthing & cable of all field JB / LCP / Cabinet etc.	--	--	
25		All latest licensed version software	1	Lot	
26		Separate Electronic Earth Pit for I&C Systems / Equipment	--	--	
27		Any other item required for system completeness	--	--	
III		**DDCMIS - At FGD Control Room**	--	--	
1		DDCMIS for FGD System including 2 nos. OWS / Unit FGD, 1 no. EWS, 2 nos. 72" LED LVS (Dedicated Work Station), 1 no. Color A4/A3 Laser jet Printer, Control desk/Furniture, All types of pre-fab cable, Special cable, OFC, Network Hardware, patch cords, LIU, media converters, network switches, All latest licensed version software,	1	set	
2		Separate Electronic Earth Pit for I&C Systems / Equipment	--	--	
B		**Other System / Equipment / Packages under Boiler (SG) Area**			**Design ,Engineering , Manufacturing , Supply , Installation and commissioning by SG Vendor/Supplier**
1		Primary and Secondary Instrumentation	--	--	
2		Local Instrument Enclosure(LIE)/Local Instrument Rack(LIR)	--	--	
3		Furnace Temperature Probe	--	--	
4		Air-pre Heater infrared Hot spot detection system	--	--	
5		Air-pre Heater rotor stoppage alarm device	--	--	
6		Air-pre Heater Gap adjust and fire detection system	--	--	
7		Vibration Monitoring System including vibration sensor, key phasor, monitor	--	--	

8		Flame Scanner and Monitoring System	--	--	
9		Flame Monitoring CCTV System	--	--	
10		Coal Feeder Control System	--	--	
11		Bunker Level Monitoring System	--	--	3D Scanner type Level Monitoring System shall be provided.
12		Mill CO monitoring System	--	--	
13		Boiler Leak Tube Detection System	--	--	
14		Zirconia based Oxygen Analysers (2 nos. in each side of Economiser outlet and 1no. in each side of APH Outlet)	--	--	
15		CO analyzer (1 no. at each side of Economiser outlet.)	--	--	
16		SADC Actuators with smart positioners	--	--	
17		On line fuel measurement facility for accurate measurement of coal mass flow rate and air fuel ratio in each PF pipe from each coal pulverizer. The equipment shall comprise of sensors/ working on microwave technology including necessary software. The error in measuring system shall not be more than 5%, which shall be demonstrated by comparisons with isokinetic measurements.	--	--	
18		Steam and Water Aanalysis System (SWAS) including Wet Panel, Dry Panel, pipes / tubings, erection materials, valves, Analyzers etc. for SG area & TG Area	--	--	
19		Opacity Analyser (including monitor) at each pass of ESP outlet	--	--	
20		Soft redundant OFC Communication cable between ESP Control PLC and main plant DCS	--	--	
21		Mill Reject System Instrumentation	--	--	
22		FGD System Instrumentation	--	--	
23		CEMS Analyzers (at Chimney) with Remote Monitoring & Calibration	--	--	As per CPCB / SPCB latest Guideline

24		Instrumentation & Control Cabling as follows: i) From Field instruments to Local JB i) From Field instrument / equipment to Control Panel ii) From Local JB to Control Panel iii) From equipment (drive/motor) JB to Control Panel iv) Between MCC/SWGR and Control Panel v) From VMS Panel to Control Panel vi) From Local Panel/cabinet to Control Panel vii) Earthing cable upto electronic earth pit	--	--	Where both ends are in SG vendor scope, the cables are in SG vendor scope. The TG area signals, to be implemented at DDCMIS, shall be terminated at local field JB / local Panel by TG vendor. From TG area local field JB / Panel to DDCMIS shall be under SG Supplier's scope. TG area field side JB schedule and termination detail shall be provided by TG vendor.
25		I&C Erection Hardware including Valves, fittings, Impulse piping, tubing, stanchion with canopy, manifold, perforated branch tray with cover, HDPE Conduit, Sealing compound etc.	--	--	
26		Earthing & cable of all field JB / LCP / Cabinet etc.	--	--	Under scope of supply of SG supplier
27		Others, as required for system completeness	--	--	
D		**Works / Services under Boiler (SG) Area and DDCMIS**			
1		Training for Owner's Personnel at Site as well as Manufacturer's works	--	--	
2		Factory Acceptance Test	--	--	
3		Site Acceptance Test	--	--	

Note:

1	The data / information mentioned above as unit wise except specifically mentioned.
2	Uniform make of DDCMIS for BTG and BOP Areas shall be envisaged. Make shall be finalized and intimated by Owner during detailed engineering.
3	Nos. of controllers shall be decided during detailed engineering. The same shall be subject to Owner's approval.
4	Uniform make of vibration monitoring system for SG, TG & BOP area HT Drives, TSI shall be provided. Supply & services of Vibration monitoring system including sensor, special cable, I&C cable, monitors etc. shall be under scope of respective Drive Supplier. Make shall be finalized and intimated by Owner during detailed engineering.
5	All the Operator / PC Monitor will be 24" LED TFT Color Monitor
6	All communication network shall be redundant
7	All power supply module shall be redundant

ANNEXURE – CI-01: CONTROL SYSTEM ARCHITECTURE

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MANDATORY SPARES LIST		
SL.NO	**DESCRIPTIONS**	**QUANTITY REQUIRED**
1	**Control Panels**	
1.1	Air Break Switch	1 no of each type and rating or 20% of installed quantity whichever is higher
1.2	Aux Relays, Contactors (Auxiliary)	5 nos of each type and rating or 20% of installed quantity whichever is higher
1.3	Clustered type LEDs of different colours	20 nos of each type, colour and rating or 20% of installed quantity whichever is higher
1.4	Push Buttons	6 nos of each type and rating or 20% of installed quantity whichever is higher
1.5	MCBs for Power and Control Circuits	4 sets of each type and rating or 20% of installed quantity whichever is higher
1.6	Power Contactors	1 no of each type and rating or 10% of installed quantity whichever is higher
1.7	Timers	1 no or 10% of installed quantity of each type, size and rating, whichever is higher
1.8	Thermal Over load relays	1 no or 10% of installed quantity of each type, size and rating.
1.9	Power Fuses of each type and rating	2 nos or 20% of installed quantity of each type, size and rating.
1.10	Control fuse of each type and rating	2 nos or 20% of installed quantity of each type, size and rating.
1.11	Current Transformer	1 no. of each type, size and rating
1.12	Control Transformer	1 no. of each type, size and rating
1.13	Control Switches	1 no or 10% of installed quantity of each type, size and rating.
1.14	Indicating Meters	1 no or 10% of installed quantity of each type, size and rating.
1.15	Terminal Blocks	3 nos or 20% of installed quantity of each type, size and rating.
2	**Field Instrument**	
2.1	Complete Solenoid Valve Assembly	2Nos. for each type and rating used in the system
2.2	Coil (single or double coil type)	10% of total nos. used in the system or minimum 5(five) Nos. whichever is more for each type and rating.
2.3	Gauge (Pressure, Differential Pressure, Temperature, Level)	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.
2.4	Air Filter Regulator complete set with pressure gauges	10Nos.

Notes :

1. Wherever, quantity has been specified as percentage (%), unless otherwise specified, the quantity of mandatory spares to be provided by the Supplier shall be the specified percentage (%) of the total population of two Unit. In case the quantity comes in fraction, then more than 0.5 fractions shall be extended as next whole number.
2. Set = No of items required for one equipment
3. For system having electronic modules, 10% of each type of card or 1 number, whichever is higher shall be considered as mandatory spares.
4. If percentage comes as fraction next higher integer should be considered for the purpose of quantity required.
5. The List is tentative & the bidder shall include in the offer any additional items that shall be required for the system in offer as well any item description that may undergo specific technical changes.
6. “Sets of each type”, “Sets” means 100% requirement for one stack up assembly.
7. Any item which is quoted as “not applicable” and is found to be “applicable” at a later date shall be supplied by the Bidder without any commercial implications. The Bidder shall note that if there in any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.
8. The bidder shall include in their offer, on basis of technical specification, the mandatory spares as applicable for their design.

	2x800 MW MEL SINGRAULI TPP COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	SPECIFICATION NO.: PE-TS-504-161-A001	
		SECTION: II	
		SUB SECTION: IIA	
		REV: 00	DATE: April 2024
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PACKING PROCEDURE

COMMON GUIDELINES FOR PACKING

1. GENERAL:

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit & storage. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage of materials.

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement.

Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

2. TYPES OF PACKING:

The following 5 types of packing have been standardized for packing of General Components/ Assemblies.

1) **'OP'** - Open Type.

2) **'PP'** - Partially Packed.

3) **'CP'** – Crate/Box Packing - Components/Equipment requiring physical protection.

4) **'CQ'** - Case Packing – Machined components-Small & Medium Components/ Assemblies/ Equipment which require corrosion & physical protection.

5) **'CR'** - Case Packing – Electrical/Electronic Components/ Assemblies, which require special packing viz. Water Proof, Shock Proof etc…

3. DESCRIPTION OF TYPES OF PACKING:

The various types of packing, as standardized above, are described below.

3.1 'OP' - Open Type

In case, of components which are not affected by water & dust and do not require special protection, are generally not machined, shall be sent as open packages. However, these components may be sent in crates, wherever necessary.

3.2 'PP' - Partially Packed

Components which need special protection at selected portions only shall be despatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces should be protected with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene
Film. All sharp corners and edges shall be protected by rubber mats to prevent damage to the polyethylene film.

3.3 'CP' - Crate Packing

Assemblies/Components which need only physical protection from the point of view of handling shall be despatched duly packed in crates.

3.4 'CQ' - Case Packing - Machined Components/Assemblies/Equipment

Small and medium sized components/assemblies/equipment due to size/weight and to avoid handling and pilferage problems shall be packed in Case/Containers. Wherever required adequate quantity of silica gel or VCI Powder/Tablets, packed in thin muslin cloth cotton bags shall be suitably placed. Small machines/components of less weight shall be provided with suitable cushioning by Rubberised coir. The components inside the case shall be entirely covered with100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film, wherever required. This may be prescribed for electronic parts/critical machined components/surfaces.

For mechanical product like valves where motors are separately securely wrapped in polyethylene, the requirement of individual component wrapping shall be exempted.

3.5 'CR' - Case Packing - Electrical & Electronic Components/Assemblies

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons. Adequate quantity of Silica gel packed in cotton bags of 100grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with 100GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film before being packed in the cases. VCI Powder/Tablets can be used as an alternative to Silica Gel.

Empty space in the cartons shall be filled with rubberized coir to get proper cushioning effect. The cartons shall be manufactured from corrugated Fiber Board.

4 PREPARATION OF PACKING CASES

4.1 DIMENSIONS:

a) Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25/20mm +2/-3 mm as per applicable drawings of the respective units.

b) Width of all planks including the tongue shall be more than 125mm and after plaining it shall be minimum 100mm.

c) Minimum number of planks shall be used for a shook.

d) Horizontal, vertical, diagonal planks shall be given for binding (number of such planks depend on the dimension of panel.

e) Width of binding planks shall be minimum 100mm.

f) Distance between any 2 binding planks shall be less than 750mm.

g) diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm

h) Distance of the outer edges of these planks from the edge of case shall be less than 250mm.

i) Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.

4.2 JOINTING OF PLANKS

Single length planks shall be used for cubicles whose overall length is less than 2400mm. For cubicles of length more than 2400mm, jointing is permitted. The jointing shall be done with one single or maximum of 2 planks of wood same as other planks of width 250 mm (minimum) with two rows of nails on either side of the joint in zigzag manner. From the joint along height side, it shall be of lap joint with overlap of at least the width of plank.

4.3 TONGUE AND GROOVE JOINTS

Two consecutive planks shall be joined by tongue and groove joint. Depth of tongue shall be 12+1 mm, thickness of tongue shall be 8 +1 mm. The groove dimensions shall be such that the tongue fits tightly into the groove to make a good joint. This type of joint can be done based on the product requirement wherever required.

4.4 PERMISSIBLE DEFECTS

Wood shall be free from knots, bows, visible sign of infection and any kind of decay caused by insects, fungus, etc.

End splits: Longest end splits at each end shall be measured and lengths added together. The added length shall not exceed 60mm per meter run of shook's. Wood pins shall be used to prevent further development of split.

Surface cracks: Surface cracks with a maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

4.5 OTHER MATERIALS

4.5.1 NAILS

The dia. of the nails shall be 3.15mm. The length of the nails shall be 65mm wherever two planks of 25mm thickness are joined and 75mm wherever a 25mm planks is joined to a 50mm plank.

4.5.2 BLUE NAILS

These are used for nailing bituminized Kraft paper/hessian cloth to the planks. The length of the nails shall be 16mm.

4.5.3 HOOP IRON STRIPS

These are used for strapping the boxes. The width of the strips shall be 19+1mm and thickness 0.6+0.01mm. The material shall be free from rust.If sufficient nailing is done for bigger boxes, strapping need not be done.

4.5.4 CLIPS

These shall be used for strapping the hoop iron strips on the boxes.

4.5.5 BRACKETS

These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width 25+1mm. The brackets shall be of "L" shape, the length of each side being 100+2mm. Two holes shall be provided towards the end of each side for screwing /nailing.

4.5.6 FASTENERS

Bolts, double nuts, spring washers will have to be used for packing of some special items like transformers, reactors, breakers, etc., to hold the job to the bottom plank of the box. The bolts, nuts, washers will be provided by the vendor. Drilling of holes will have to be done using contractor's tools.

4.5.7 MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM

100GSM (Colourless) Multi Layered Cross Laminated Polythelene Film are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.

4.5.8 RUBBERISED COIR:

The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

4.5.9 FOAM RUBBER / 'U' FOAM:

This is used for covering the delicate items. This material is provided by the vendor.

4.5.10 MARKING PLATE:

This shall be of anodized aluminium sheet. Size of the marking plate shall be maintained minimum of size as per the details specified in the Figure 4.

4.5.11 PACKING SLIP HOLDER:

This shall be of galvanized iron tinned sheet /Aluminium sheet

4.5.12 SILICA GEL:

Silical gel shall be used for such products only where moisture needs to be avoided.

4.5.13 COTTON BAGS:

These are used for holding silica gel. The bags shall have the following matter indicated on them:

BHEL-UNIT NAME PLACE -PINCODE
SILICA GEL -INDICATING TYPE
BLUE : -ACTIVE
ROSE : -REDUCED ACTIVITY
WHITE : -NO ACTIVITY. TO BE REPLACED WITH FRESH SILICA GEL

4.5.14 COTTON/ PLASTIC TAPE:

This is used for tying small items. And also to prevent vibrations of moving parts within the cubicles.

4.5.15 MARKING INK:

The ink used normally is black in color. In some special cases other color also will have to be used. The ink shall be non-fading/indelible and non-washable by water.

4.5.16 POLYETHYLENE BAGS:

These are to be used for keeping the Packing slips. The bag shall be of size 70mm X 100mm (minimum).

4.5.17 Hessian cloth, twine thread, paint will have to be used in packing certain items.

4.5.18 Mechanical Latching clamps:

For CLW Railway panels and similar Panels self-locking clamps can also be used on need basis in conjunction with or apart from regular bolt and nut fixing arrangement. For reusable boxes, these clamps provide easy locking and unlocking arrangement. These clamps will be made available from BHEL in some cases.

4.5.19 STICKERS

The following stickers to be put by the vendor on cubicles/Boxes after packing.

1) Case No sticker: 2 nos. Size 25.Cm x 0.45Cm
2) BHEL Monogram sticker: 1 no. Size 1.75Cm x 2.3Cm
3) Address sticker: 2 nos. Size 3.8Cm x 3.0Cm
4) Direction sticker “Front” & “Back” - 4 nos. Size 2.0Cm x 0.75Cm
5) Chain Mark Sticker: 4 Nos. Size – 3.0Cm x 0.75Cm
6) "Fragile” sticker: 2 Nos. Size. 2.1Cm x 1.5Cm
7) "DO NOT STACK” sticker - 2 Nos. Size 3.0Cm x 2.2Cm

In place of stickers, writing all the details legibly with paint shall be allowed & respective units may take decision accordingly.

5. PACKING OF CUBICLES:

5.1 The packing is to be done as per clause 4 in all respects.

5.2 The cubicles are already fixed on wooden pallets. Hence the contractor need not arrange the bottom pallets normally.

5.3 The cubicles will be of different sizes both width wise and lengthwise. The cubicles may be made up of single suite, 2 Suite, 3 Suite, 4 Suite, etc., The width of the cubicles generally varies from 400 mm to 1650mm.The length of the cubicle, generally varies from 1500 mm to 4800 mm. The height is normally 2430 mm. In some cases, the height may be less/more.

5.4 MULTI LAYER CROSS LAMINATED POLY FILM

The inner surface of 4 sides of shook's shall be nailed with Multi-layer cross laminated poly film (as per 4.5.7) using blue nails (as per 4.5.2) wherever 2 pieces of Cross laminated poly film are used, the joint shall have an overlap of minimum 20mm.

The inner surface of top cover shall be nailed with Multi-layer cross laminated poly film (as per 4.5.7). This sheet shall project outside on 4 sides by at least 100mm and shall be nailed properly on sides. Joining of sheets should have overlap of minimum 20mm.

The cubicles shall be covered with Multi-layer cross laminated poly film (as per 4.5.7).

5.5 SILICA GEL:

Silica gel (as per 4.5.12) packed in cotton bags shall be kept at different places inside the cubicle as per BHEL-Unit directions. Each suit of cubicle shall be provided with 1 kg of Silica gel (for a 4 suit cubicle 4 kgs of Silica Gel to be used. The bag containing silica gel to be as per 4.5.13).

5.6 LOOSE PARTS:

Any loose parts in the cubicles shall be tied using cotton/ plastic tape. Wooden battens shall be provided wherever necessary.

5.7 WOODEN BATTENS:

In case of cubicle which are not rectangular in shape like control desks, sufficient number of wooden rafters/battens of proper size shall be provided to give strength to the package.

5.8 RUBBERISED COIR:

Gap between the cubicle and the case shall be filled with rubberized coir (as per 5.5.8) with distance between consecutive layers less than 500mm.

5.9 CLAMPING:

Packing shall be bound at edges by nailing M.S. Clamps / Brackets (as per 5.5.5). Each vertical edge shall have minimum 3 clamps. Top horizontal edges will have one clamp for every meter length of package. However, minimum 4 clamps shall be nailed at the top for any cubicle.

5.10 PACKING SLIP:

Packing slip kept in the polyethylene bag (As per 5.5.16) shall be placed in the box at appropriate place. In addition, one more packing slip covered in polyethylene cover and packing slip holder (as per 5.5.11) shall be nailed to front / rear of case.

5.11 MARKING PLATE:

One no. (As per 5.5.10) shall be nailed to the front side of the case.

5.12 CASE MOUNTING:

After complete packing, stencil marking of various details and marking of symbols shall be done as per BHEL instructions using indelible / non washable marking ink.

5.13 Different types (Typical) of Cubicles with sizes for Packing

1. Single suite cubicle - 900 x 950 x2500
2. Two suite cubicle - 1650 x 950 x 2500
3. Three suite cubicle - 2400 x 950 x2500
4. Four suite cubicle - 3150 x 950 x 2500
5. Regulation cub - 1300 x 1350 x 2500
6. Thy cub - 2870 x 1350 x 2500
7. VFD Cub - 3800 x 1550 x 2500

6 PACKING OF LOOSE ITEMS/SPARES

1) Shape of cases shall be square, rectangular with single gabled roof or with double gabled roof depending on the nature of the job to be packed. Construction shall be as per drawings enclosed. Only gable will be additional as required.

2) Wood with Tongue and Groove joint as per clause 4.3.

3) Width of planks shall be at least 100 mm. Width of binding planks (battens) shall be at least 75mm.

4) External surface of planks on front and rear shall be plane 100% (except bottom plank).

5) Inner surfaces of all 6 sides shall be lined with Multi Layered Cross Laminated Polythelene Film (as per clause 4.5.7) using blue nails.

6) Rubberized coir of minimum 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of box.

7) Internal packing: Items that go into the box shall be packed using 100GSM, (Colourless) Multi Layered Cross Laminated Polyethylene Film. Any space left between the job and the sides and the top of the box shall be filled with rubberized coir to get proper cushioning effect.

8) Certain items like transformers, reactors, breakers, etc., shall be bolted to the bottom of the box using bolts, nuts and washers.

9) Silica gel as per clause 4.5.12 held in cotton bags as per clause 4.5.13 shall be kept at proper places in the box.

10) Packing slip kept in polyethylene bag (clause 4.5.16) shall be placed in the box.

11) Marking plate as per clause 4.5.10 shall be nailed to side of the box.

12) Two numbers of hoop iron strips as per clause 4.5.3 shall be strapped tightly on the case using clips.

13) Stencil marking of various details and marking of various symbols shall be done as per BHEL instructions using indelible/non-washable marking ink.

14) Loose items to be kept inside the cubicle

- The components which are removed from cubicle for shipping purpose only, such as meters shall be kept inside the cubicle individually, kept in wooden box and tied firmly in bottom of Cubicle.
- Other items which are given loose in addition to cubicle shall be packed in separate boxes.

7 BOX SIZES

7.1 BOX SIZES

Table 1 – SPARES WOODEN BOX DETAILS

SNO	BOX TYPE	BOX SIZE (in mm)	BOX Wt (in KG)	Carrying Capacity
1	A	800 X 200 X 200	15	
2	B	1500 X 200 X 200	22	
3	C	2000 X 200 X 200	27	
4	D	1100 X 200 X 200	15	
5	E	200 X 200 X 200	5	
6	F	320 X 250 X 260	13	
7	G	320 X 250 X 430	16	
8	H	430 X 370 X 430	23	
9	I	1100 X 400 X 400	45	
10	J	1500 X 500 X 400	65	
11	K	2000 X 500 X 400	93	
12	L	2500 X 500 X 400	88	
13	M	900 X 600 X 600	100	
14	N	3000 X 400 X 400	60	
15	P	600 X 500 X 400	35	
16	Q	710 X 630 X 600	90	
17	R	850 X 630 X 670	102	
18	S	1000 X 770 X 670	140	
19	T	2500 X 850 X 800	180	
20	U	1500 X 700 X 700	120	
21	W	1200X900X600	120	
22	Y	450 X 200 X 200	10	

Table 2 – WOODEN BOX DETAILS

BOX TYPE	BOX SIZE (in MM)	BOX Wt (in KG)	Carrying Capacity
1	320X250X260	10	
2	320X250X430	15	
3	430X370X430	25	
4	670X670X470	65	
5	720X630X600	75	
6	1000X770X660	100	
7	1100X430X670	80	
8	1200X1200X900	80	
9	1300X770X1050	155	

10	2500X850X800	225	
11	2000X1500X1200	305	
12	1850X1050X1250	260	
13	2000X800X800	180	
14	2600X1500X1600	470	
15	250X250X600	20	
16	250X250X880	30	
17	300X300X700	25	
18	380X380X880	45	
19	510X510X1400	60	
20	570X570X1400	80	
21	575X575X1875	105	
22	3600X1100X1100	390	
23	900X500X800	110	
24	2000X950X740	225	
25	1600X1120X700	220	
26	2500X2000X1200	490	
27	2900X1900X1400	525	
28	3000X1000X900	370	
29	3200X2200X950	450	
30	2150X1100X750	325	
31	2000X2000X700	130	
32	700X1200X1325	130	

TABLE 3 STEEL BOXES

S.NO.	TYPE	DIMENSION IN MM			WEIGHT	CARRYING CAPACITY (KGS)
		LENGTH	BREADTH	HEIGHT		
1	I	2480	1680	1500	339	4500
2	II	1200	900	600	61	2000
3	IIB	1800	850	950	115	2500
4	III	900	600	600	29	1000
5	IV	600	450	500	19	750
6	V	400	350	300	11	500

TYPICAL PATTERN OF WOODEN BOX

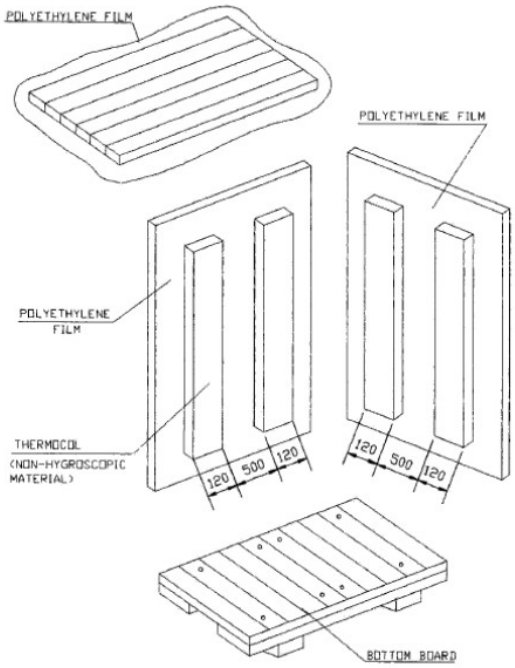

Figure 1

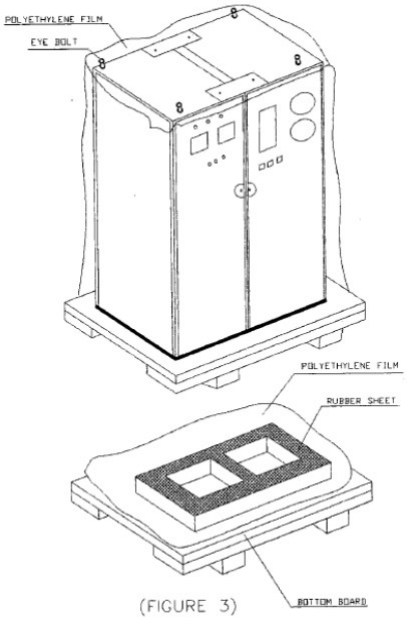

Figure 2

7.3 SEALED PACKING:

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture. The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

8 MARKINGS/STENCILINGS

	2x800 MW MEL SINGRAULI TPP COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	SPECIFICATION NO.: PE-TS-504-161-A001	
		SECTION: II	
		SUB SECTION: IIA	
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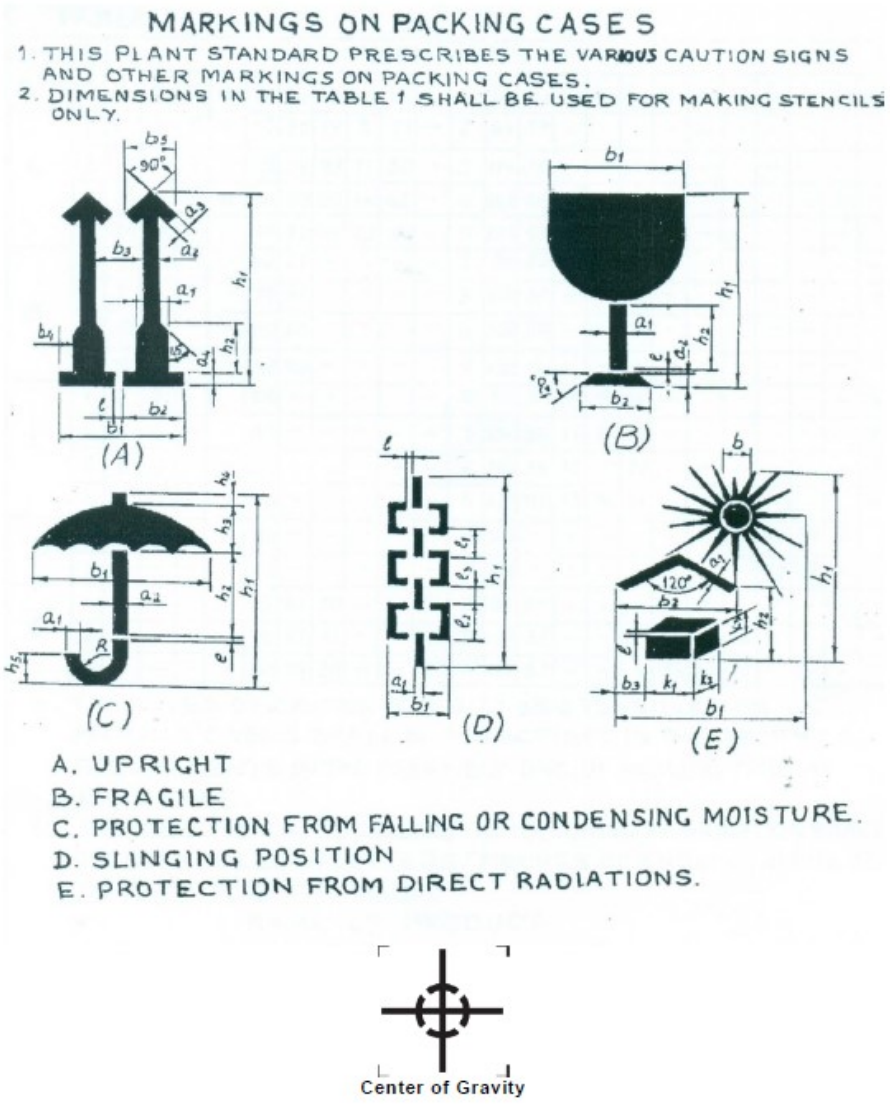

Figure 3

DESIGN-ATION		DIMENSION IN MM																						
		a1	a2	a3	a4	b1	b2	b3	b4	b5	b	l	h1	h2	h3	h4	h5	k1	k2	k3	l1	l2	l3	R
A	1	12	5	5	4	52	25	19	8	21		2	84	23										
	2	17	7	7	6	75	36	29	11	30		3	119	33										
	3	24	10	10	8	104	50	38	16	42		4	168	46										
	4	34	14	14	11	147	71	59	23	60		5	239	65										
B	1	5	5			50	33					2	84	25										
	2	7	7			71	47					3	119	36										
	3	10	10			100	66					4	168	50										
	4	14	14			142	94					5	239	71										
C	1	4	3			66						2	80	39	19	5	11							6
	2	6	4			85						3	114	55	27	7	16							9
	3	8	6			120						4	160	78	38	10	22							12
	4	11	9			170						5	227	110	54	14	31							17
D	1	6				30						4	148								30	30	10	
	2	9				42						5	209								42	42	14	
E	1	3				69	47	10			16	2	91	26				17	8	11				
	2	4				98	67	15			23	3	128	33				24	11	16				
	3	6				138	94	20			32	4	182	62				34	16	22				

Table 4

Black and Red Marking Ink to IS:1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink **"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".**

Besides the caution signs the product information's shall be stencilled of letters with 13mm to 50mm height.

In case of consignment consists of more than one package, each package shall carry its package no as given in shipping list. All caution signs shall be stencilled in high quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel.

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks.

Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: Incase the size of package is small for using the stencils, then hand written letters/figures shall be allowed.

	BHEL – <unit> - <location> - <pin>				
CONSIGNEE					
MATERIAL					
CUSTOMER REF.			MO. NO.		
DESPATCH ADVICE NOTE NO			CASE NO		
DIMENSIONS(MM) L x B x H			NET WT –KGS	GROSS WT –KGS	
SPECIAL INSTRUCTIONS	HANDLE WITH CARE - KEEP DRY DO NOT DROP - DO NOT TILT				

Figure 4 – TYPICAL MARKING PLATE (225 X 170)

Figure 5

Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites:

9 STANDARD METHOD OF PACKING

Table 5 - Standard Method of Packing

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM

PRESSUE VESSELS								
TOWERS					O			
TANKS					O			
VESSELS					O			
GASKETS	O							
FASTENERS	O							
COVERS		O						
EXCHANGERS								
HEAT EXCHANGERS					O			
TUBE BUNDLE	O							
SHELL					O			
AIR FIN COOLERS					O			
COLOUMNS, MOTOR SUSPENSIONS, PLENUM CHAMBERS, SCREEN GUARDS, ETC					O			
BEARING BLOCKS	O							
FANS	O	O						
MOTORS	O							
GASKETS	O							
FASTENERS	O							
TEST FLANGES			O					
TEST RINGS			O					
COVERS			O					
CRYOGENIC VESSELS								
COLD CONVERTERS					O			
HORIZONTAL STORAGE TANKS					O			
TRANSPORTATION TANK					O			
COLD BOX					O			
DRYING UNIT					O			
DRYING BOTTLES					O			
MOISTURE SEPARATORS					O			
SILENCERS					O			
ONGC SKIDS					O			
VAPORISER		O						
SPECIAL PRODUCTS								
SI/VI PIPING		O						
CRO BIO CONTAINERS	O							
DESCRIPTION	**CASE**	**CRATE**	**SKID**	**BUNDLE**	**BARE**	**DRUM**	**METAL DRUM**	**FIBRE DRUM**
AIR BOTTLES	O							
TITANIUM BOTTLE	O							

WAR HEAD CONTAINER	O							
MISSILE CONTAINER	O							
FUEL CONTAINER	O							
AIR LOCK ASSEMBLY	O							
BOILER DRUMS					O			
BOILER ITEMS								
COILS			O					
PANELS					O			
HEADERS			O		O			
FEEDERS								
MACHINED ITEMS								
SHELL SEGMENTS					O			
SHELL SEGMENTS IN STACKS					O			
SPHERE PETALS								
COLOUMNS, BASE PLATES, TIERCOS, PIPES, NOZZLE E1, F1, INTERNAL PIPES, PADS ETC.					O			
ROLLERS	O							
VALVE TRAYS								
VALVE TRAY COMPONENTS	O							
LATTICE GIRDERS		O						
FASTENERS	O							
GASKETS	O							
SUB CONTRACTS								
FAB STRUCTURALS					O			
SUPPORTING STRUCTURALS					O			
STRUCTURE SUB ASSEMBLY					O			
FAB PIPES					O			
GRATINGS					O			
STAIR CASES					O			
HANDRAILS/ PLATFORMS					O			
BOUGHT OUT COMPONENTS								
IRON & STEEL (LIKE PLATES, BEAMS, ANGLES, CHANNELS ETC.)					O			
PIPE FITTINGS								
CS PIPES, TUBES					O			
SS PIPES, TUBES					O			
FIN TUBES	O							
ELBOWS		O			O			
DESCRIPTION	**CASE**	**CRATE**	**SKID**	**BUNDLE**	**BARE**	**DRUM**	**METAL DRUM**	**FIBRE DRUM**
FLANGES	O	O						

VALVES	O							
GAUGES	O							
DEMISTERS		O						
ABSCRBANTS (LIKE MOLECULAR SIEVES, ACTIVATED ALUMINA, MOBILE SORBID)						O		
PAINT TINS		O						
PAINT DRUMS						O		
IGNITORS	O							
SPRAY NOZZLES	O							
ELECTRICAL INSTRUMENTATION								
MOTORS, PUMPS, COMPRESSORS, TURBINES	O							
SWITCH BOARDS, DISTRIBUTION BOARDS, STARTERS, JUNCTION BOXES		O						
INDICATORS, VIBRATOR SWITCHES	O							
CABLE BUNDLES, CABLE DRUMS					O			
CABLE TRAYS, CABLE RACKS, EARTHING MATERIAL		O						
OPERATIONAL SPARES	O							

10 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

10.1 Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.

10.2 Appropriate material handling equipment like fork lifters, cranes etc. shall be used where needed.

10.3 Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. shall be done carefully.

10.4 For critical items, where specified, special handling fixtures shall be used for lifting.

10.5 Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.

10.6 Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.

10.7 Precision machined components like blades, catches, rollers etc. shall be lifted using suitable wooden

pallets.

10.8 HANDLING OF COMPONENTS ON RECEIPT/DESPATCH

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

a) The markings showing the upright position.

b) The markings showing the sling position

c) Markings showing the fragile contents.

d) Other required markings as per clause no.10

10.8.1 Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15º.

10.8.2 Handling and lifting should be done without jerks or impacts.

10.8.3 Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.

10.8.4 On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.

10.8.5 Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

10.8.6 Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

11 GENERAL GUIDELINES FOR ODC TRANSPORTATION/DESPATCH

Based on the Dimensions/Weight indicated in the Transportation Sketch, the type of Trailer is decided and indicated in the Tender Enquiry.

11.1 TRANSPORTATION:

1. LOW BED TRAILERS (LB 8):

Well Bed Length : 10000mm
Over Gooseneck : 13000mm
Width : 3000mm
Carrying Capacity : 40MT

2. LOW BED TRAILERS (LB 16):

Well Bed Length : 12000mm

Over Gooseneck : 16000mm
Width : 3000mm
Carrying Capacity : 75MT

3. TOW TYPE TRAILERS (WITH FRONT DOLLEY 16 TYRES): 12000MM length
(for Exceptional equipment length: 30000mm and above)

Bigger Dia equipment are loaded in the Well with overhanging.

Smaller Dia equipment with excess length are loaded over Gooseneck with rear hanging.
The Vehicle Dimensions are defined above are only guidelines for selection based on actual Dimensions/ Weight of the Consignment

11.2 PACKING:

For all ODCs, Wooden Saddles are cut to the diameter of equipment as per the Transportation Sketch.

Wooden Saddles	For Diameter up to 4000mm	For Diameter above 4000mm
Length:	1836/2743mm (6'0"/9'0")	3353mm (11'0")
Width:	300mm (1'0")	300mm (1'0")
Height:	Saddle + one/two wedges a top	Saddle + three/four wedges a top

Number of Saddles:	
Minimum	3 in case of Loading inside Well +1 when loaded on Gooseneck
Maximum:	4 in case of Loading inside Well +2 when loaded on Gooseneck

For Securing the equipment firmly on the Trailer, 19mm (3/4"), wire rope with 25mm (1") Heavy Duty Turn Buckles / BD Clamps are used as Lashing for the equipment.

12 GUIDELINES FOR HANDLING/LOADING/LASHING

- Jobs to be checked for complete painting before loading.
- Components to be lifted with Nylon belts. This protects painting, edges and attachments.
- All the components to be transported by putting inside the properly fabricated Crating
- Small components may fall down while transporting without closed crating and there are chances of missing of small parts. Hence, it is always better to transport small components in closed containers/crating. Loose to be being shipped in a closed crating.
- No component loaded over the crating.
- **LASHING:** Use Nylon belts only for lashing of all components. It prevents removal off painting and

cut in the materials.

SECTION-III

DOCUMENTS TO BE SUBMITTED BY BIDDER

IIIA	LIST OF DOCUMENTS TO BE SUBMITTED ALONG WITH BID
IIIB	COMPLIANCE CUM CONFIRMATION CERTIFICATE
IIIC	PRE-BID CLARIFICATION SCHEDULE

	2x800 MW MEL SINGRAULI TPP COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	SPECIFICATION NO.: PE-TS-504-161-A001
		SECTION: III
		SUB SECTION: IIIA
		REV: 00 / DATE: April 2024
		Page: 1 of 1

DRAWINGS/ DOCUMENTS TO BE SUBMITTED WITH THE BID FOR TECHNICAL EVALUATION

Bidder shall submit the following drawings / documents along with their techno-commercial bid:-

a) Copy of pre-bid clarifications, if any, duly signed & stamped.

b) Schedule of technical deviations (if any).

Deviation/s with reference to specific clauses of the technical specification along with reason for such deviation and cost-of-withdrawal in the format given with NIT.

OR

No deviation certificate, clearly mentioning that bidder has considered 'No - Deviation' in the cost-of-withdrawal format given with NIT.

c) Signed and stamped copy of Compliance cum Confirmation Certificate.

d) Un priced copy of price format indicating quoted against each row/column.

e) Pre-qualification requirement (PQR) documents.

f) Erection and Commissioning Spares List and Maintenance Tools and Tackles List are to be submitted along with offer. These lists shall be finalized during detailed engineering.

Note: OFFER WILL BE CONSIDERED AS INCOMPLETE IN ABSENCE OF ANY OF ABOVE DOCUMENTS. DOCUMENT OTHER THAN ABOVE, IF ANY, SUBMITTED WITH THE OFFER WILL NOT FORM PART OF CONTRACT AND ACCORDINGLY WILL NOT BE CONSIDERED FOR BID EVALUATION.

	2x800 MW MEL SINGRAULI TPP COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	SPECIFICATION NO.: PE-TS-504-161-A001	
		SECTION: III	
		SUB SECTION: IIIB	
		REV: 00	DATE: April 2024
		Page 1 of 2	

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions other than those mentioned under "exclusion" and those resolved as per 'Schedule of Deviations', if applicable, with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'.

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This shall be within the contracted price with no extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance of.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out. For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.

h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions.

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account.

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's /

Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

	2x800 MW MEL SINGRAULI TPP COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)	SPECIFICATION NO.: PE-TS-504-161-A001	
		SECTION: III	
		SUB SECTION: IIIC	
		REV: 00	DATE: April 2024
		Page: 1 of 1	

PRE-BID CLARIFICATION SCHEDULE

S. No.	Section/Clause /Page No.	Statement of the referred clause	Clarification Required

The bidder hereby certifies that above mentioned are the only clarifications required on the technical specification for the subject package.

SIGNATURE:_____

NAME:_____

DESIGNATION:_____

COMPANY: _____

DATE:_____

COMPANY SEAL

UNPRICED FORMAT

Doc No:	PE-PF-504-161-A001
Rev No:	0
Date of issue:	15-04-2024

NAME OF PROJECT: 2x800 MW MEL SINGRAULI TPP

NAME OF PACKAGE: COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)

TECHNICAL SPECIFICATION: PE-TS-504-161-A001

S. No.	DESCRIPTION	UNIT	QTY	SUPPLY			SERVICES		TAXES				
				Total Ex-Works (excluding GST) (INR)	Freight in %	Total Freight	Unit Price (INR)	Total Price (INR)	GST type	GST rate in %	GST amount in Rs.	Total Price Including Freight & GST (INR)	Total Price Including Freight & GST (INR) in words
1.0	Total lump sum firm Ex. work price for SUPPLY PART, SERVICE PART & MANDATORY SPARES comprising of design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants & consumables along with all accessories and spares for erection, start up and commissioning, forwarding, proper packing, shipment and delivery & warranty as per requirement given in NIT, SUPERVISION SERVICES for erection and commissioning,trial run at site, Performance guarantee/Demonstration tests at site, training of Customer's O&M staff covering all aspects of Operation & Maintenance at site complete with all accessories of Coal bunker Deblocking Device (Air Blasters) for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	Lot	1										
2.0	**MAJOR BREAK-UP OF PRICES GIVEN IN 1.0 ABOVE.**												
2.1	Ex.work Prices **for SUPPLY Part** comprising of manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, Charges of BHEL/ Customer nominated inspection agency (if equipment sourced from outside India), painting, maintenance tools & tackles, fill of lubricants & consumables, alongwith spares for erection, startup and commissioning as required, forwarding, proper packing, shipment and delivery at site and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order. Price breakup to be furnished as per enclosed at **Annexure-I**.	Lot	1										
2.2	Prices for **Services Part** comprising of SUPERVISION SERVICES for erection and commissioning, trial run at site, Performance guarantee/Demonstration tests at site, training of Customer's O&M staff covering all aspects of Operation & Maintenance at site for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order. Price breakup to be furnished as per enclosed at **Annexure-II.**	Lot	1										
2.3	Ex.work Prices for **Mandatory spares** comprising of manufacture, fabrication, assembly, inspection / testing (as applicable) at vendor's & sub-vendor's works, painting, forwarding, proper packing, shipment, delivery at site & guarantee as per tender technical specification above, amendment & agreements till placement of order. Price breakup to be furnished as per enclosed at **Annexure-III.**	Lot	1										
Note for BOP Ordering group/PG: 1) This is suggestive price format. Modification as per commercial aspects of the project requirement may be done by PG.													
Particulars of bidder / authorised representative													
Name	**Designation**	**Signature**	**Date**	**Company Seal**									

UNPRICED FORMAT
ANNEXURE- I

Doc No:	PE-PF-504-161-A001
Rev No:	0
Date of issue	15-04-2024

NAME OF PROJECT:	**2x800 MW MEL SINGRAULI TPP**
NAME OF PACKAGE:	**COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)**
TECHNICAL SPECIFICATION:	**PE-TS-504-161-A001**

S. No.	DESCRIPTION	UNIT	QUANTITY	SUPPLY: Total Ex-Works (excluding GST) (INR)	SUPPLY: Freight in %	TAXES: GST type	TAXES: GST rate in %	TAXES: GST amount in Rs.	Total Price Including Freight & GST (INR)	Total Price Including Freight & GST (INR) in words
	BREAK-UP OF SUPPLY PRICES GIVEN IN 2.1 OF MAIN SHEET.									
2.1	Break up of Prices inclusive of all prevailing taxes, duties and other levies for SUPPLY part for **COAL BUNKER DEBLOCKING DEVICES** comprising of manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants and consumables required for pre-commissioning, commissioning alongwith spares for erection,startup and commissioning as required, forwarding, proper packing, shipment and delivery at site for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.	Lot	1							
2.1.1	**Pneumatic Air Blasters** with all accessories like solenoid valves, mounting bracket, safety chain, nozzles etc.	Lot	2							
2.1.2	**Local Control Panel/Pneumatic Panels/JBs** with required Stainless steel impulse/pneumatic tubing, solenoid valves, filter-regulator-lubricator unit, sequential timer and accessories.	Lot	2							
2.1.3	**Piping, fittings, valves & instruments etc.**	Lot	2							
2.1.4	**Erection & commissioning spares** including fill of lubricants & consumables.	Lot	2							
2.1.5	**Maintenance tools & tackles.**	Lot	1							
2.1.6	Any other item not indicated above, but required to make the system complete in all respects.	Lot	1							

Particulars of bidder / authorised representative

Name	Designation	Signature	Date	Company Seal

Note:

1	In case of any variation in quantity during detailed engineering, same shall be adjusted as per above break-up of prices.
2	Any other item not indicated above, but required to make the system complete in all respects, as per the technical specification, shall be supplied without any cost implication to BHEL.
3	Any cell left blank in the unpriced schedule shall be treated as “Quoted” and is included in total price.

UNPRICED FORMAT
ANNEXURE II: PRICE BREAKUP FOR SERVICES

NAME OF PROJECT:	**2x800 MW MEL SINGRAULI TPP**
NAME OF PACKAGE:	**COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)**
TECHNICAL SPECIFICATION:	**PE-TS-504-161-A001**

Doc No:	PE-PF-504-161-A001
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				SERVICES		TAXES				
S. No.	**DESCRIPTION**	**UNIT**	**QTY**	**Unit Price (INR)**	**Total Price (INR)**	**GST type**	**GST rate in %**	**GST amount in Rs.**	**Total Price Including GST (INR)**	**Total Price Including GST (INR) in words**
2.2	Total lumpsum firm prices inclusive of all prevailing taxes, duties and other levies for **Services part comprising of supervision services** for erection and commissioning, trial run at site, Performance guarantee/Demonstration tests at site, training of Customer's O&M staff covering all aspects of Operation & Maintenance at site for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order.	LOT	1							
	MAJOR BREAK-UP OF PRICES OF 2.2 ARE MENTIONED BELOW									
	COST OF SUPERVISION FOR SERVICES									
2.2.1	Total lump sum prices for **VISITS** [should include travel expenses to/ fro site, visa/ insurance (if applicable), intermediary stay] for Supervision of assembly, erection and commissioning, trial run at site & training of O&M staffs.	Nos.	2							
2.2.2	Total lump sum prices for **SUPERVISION** of assembly, erection and commissioning including local transportation, boarding, lodging & other related expenses.	days	20							
	TOTAL									
	Note:									
1	No. of days at site defined at 2.2.2 above shall be calculated on the basis of presence at site (travel time is excluded).									
2	No. of Visits and days as mentioned above may vary, depending upon site requirement. Any variation in no. of visits & no. of days shall be exercised based on unit rate arrived from above respectively.									
3	Bidder to quote the Prices in 'figures' along with corresponding 'words'.									

Particulars of bidder / authorised representative

Name	**Designation**	**Signature**		**Date**

UNPRICED FORMAT
ANNEXURE III- LIST OF MANDATORY SPARES

Doc No:	PE-PF-504-161-A001
Rev No:	0
Date of issue	15-04-2024

NAME OF PROJECT:	**2x800 MW MEL SINGRAULI TPP**
NAME OF PACKAGE:	**COAL BUNKER DEBLOCKING DEVICES (AIR BLASTERS)**
TECHNICAL SPECIFICATION:	**PE-TS-504-161-A001**

			SUPPLY		TAXES				
S. No.	**Description (The bidder shall include in their offer, on basis of technical specification, the mandatory spares as applicable for their design.)**	**Quantity to be supplied for the package**	**Total Ex-Works (excluding GST) (INR)**	**Freight in %**	**GST type**	**GST rate in %**	**GST amount in Rs.**	**Total Price Including Freight & GST (INR)**	**Total Price Including Freight & GST (INR) in words**
2.3.1	**Control Panels**								
2.3.1.1	Air Break Switch	1 no of each type and rating or 20% of installed quantity whichever is higher							
2.3.1.2	Aux Relays, Contactors (Auxiliary)	5 nos of each type and rating or 20% of installed quantity whichever is higher							
2.3.1.3	Clustered type LEDs of different colours	20 nos of each type, colour and rating or 20% of installed quantity whichever is higher							
2.3.1.4	Push Buttons	6 nos of each type and rating or 20% of installed quantity whichever is higher							
2.3.1.5	MCBs for Power and Control Circuits	4 sets of each type and rating or 20% of installed quantity whichever is higher							
2.3.1.6	Power Contactors	1 no of each type and rating or 10% of installed quantity whichever is higher							
2.3.1.7	Timers	1 no or 10% of installed quantity of each type, size and rating, whichever is higher							
2.3.1.8	Thermal Over load relays	1 no or 10% of installed quantity of each type, size and rating.							
2.3.1.9	Power Fuses of each type and rating	2 nos or 20% of installed quantity of each type, size and rating.							
2.3.1.10	Control fuse of each type and rating	2 nos or 20% of installed quantity of each type, size and rating.							
2.3.1.11	Current Transformer	1 no. of each type, size and rating							
2.3.1.12	Control Transformer	1 no. of each type, size and rating							
2.3.1.13	Control Switches	1 no or 10% of installed quantity of each type, size and rating.							
2.3.1.14	Indicating Meters	1 no or 10% of installed quantity of each type, size and rating.							
2.3.1.15	Terminal Blocks	3 nos or 20% of installed quantity of each type, size and rating.							
2.3.2	**Field Instrument**								
2.3.2.1	Complete Solenoid Valve Assembly	2Nos. for each type and rating used in the system							
2.3.2.2	Coil (single or double coil type)	10% of total nos. used in the system or minimum 5(five) Nos. whichever is more for each type and rating.							
2.3.2.3	Gauge (Pressure, Differential Pressure, Temperature, Level)	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.							
2.3.2.4	Air Filter Regulator complete set with pressure gauges	10Nos.							
NOTES									
1	Any variation/addition/deletion in quantity of items during detail engineering shall be adjusted based on prices quoted above against each item.								
2	For other notes, please refer Annexure - 17 of Technical Specification.								